BMC Pregnancy and Childbirth

RESEARCH

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The effects of unintended pregnancy on maternal bonding impairment among Japanese mothers: a longitudinal study from pregnancy to one month postpartum

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Abstract

Background Numerous studies have been conducted regarding maternal bonding; however, there is a lack of studies investigating the association with unintended pregnancy. This study aimed to examine the effects of unintended pregnancy on maternal bonding using a longitudinal design from pregnancy to one month postpartum.

Methods Participants were 78 mothers who attended the Department of Obstetrics for prenatal care at 20.5 weeks of gestational age. They responded to the Postpartum Bonding Questionnaire (PBQ) and the Edinburgh Postnatal Depression Scale (EPDS). Furthermore, we asked whether the pregnancy was unintended. At one month postpartum, they responded to the questionnaires again. We performed two-way repeated-measures analysis of variance to assess the effect of group (unintended pregnancy or intended pregnancy) and time (during pregnancy or one month postpartum) on the PBQ and EPDS scores.

Results Mothers who had unintended pregnancies had significantly impaired maternal bonding compared to expected pregnancy mothers, both during pregnancy and one month postpartum. In addition, both unintended and expected pregnancy mothers had significantly decreased impaired maternal bonding at one month postpartum. Regarding depression, mothers with unintended pregnancy had significantly higher EPDS scores than mothers with expected pregnancy, both during pregnancy and one month postpartum.

Conclusions Our findings emphasize that healthcare providers should promptly identify mothers with unintended pregnancies and conduct thorough assessments of mother-infant interactions postpartum.

Keywords Maternal bonding, Maternal attachment, Unintended pregnancy, Unplanned pregnancy, Postpartum depression

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Background

The development of a bond between mother and their newborn is the central and most important process for mothers and infants that lasts throughout life. Maternal bonding is defined as "an emotional, behavioral, cognitive, and neurobiological tie of the parent to the (unborn) child, as a process from intention to have a child throughout infancy. This is a parental-driven process which can continue to evolve throughout child's and parents' life, characterised as enduring, committed, and engaged. (p. 154)" [1]. One meta-analysis reported that good maternal bonding is associated with higher infant attachment quality, lower colic, easier temperament, and a positive infant mood [2]. Furthermore, maternal bonding predicts a child's social and emotional development [3]. An impaired maternal bond is associated with developmental delays [4]. A recent meta-analysis indicated that maternal bonding impairment is associated with maternal depression and anxiety [5]. Impaired maternal bonding is associated with primiparity [6], poor family support [7], intimate partner violence [8], and suicidal ideation [9]. Although studies investigating impaired maternal bonding have increased, the relevant factors have not yet been fully elucidated.

Societal views of motherhood influence maternal bonding and vary across cultures. Japanese culture holds the view that mothers should devote themselves primarily to childcare. This traditional view of motherhood is dominant and pervasive in Japanese society. The burden of childcare has therefore fallen disproportionately on mothers. A previous qualitative study demonstrated that Japanese mothers tend to adhere to this mothering ideal, often struggling to express negative feelings toward motherhood. Furthermore, they tend to experience guilt for having such feelings or for struggling with childcare [10]. Given that most research on maternal bonding has been conducted in Western contexts, studies investigating maternal bonding within Japanese culture would provide unique and valuable findings.

The budding of maternal–infant bonding starts gradually during pregnancy [11]. Maternal–fetal attachment has been used interchangeably with maternal–fetal bonding and investigated by numerous researchers [12–15]. However, we must distinguish these terms carefully because bonding refers to the affection from the mother to the fetus, whereas attachment refers to the child's behavior directed toward their mother [11, 16, 17]. Maternal bonding is defined as the subjective experience and unidirectional perception of mothers [1]. Several scales have been developed to assess maternal–fetal bonding, such as the Maternal–Fetal Attachment Scale [15], the Maternal Antenatal Attachment Scale [14], Prenatal Attachment Inventory [18], and Antenatal Maternal Attachment Scale [11]. A recent review summarized that maternal–fetal bonding is associated with depression and interpersonal relationships such as social support and intimate spousal relationships [19]. Although numerous studies have been conducted to deal with maternal–fetal bonding, methodological issues arise if researchers attempt to assess maternal bonding consistently throughout the postpartum period, since some of these items would be awkward because of their particular focus on the pregnancy period.

Unintended pregnancy is a major public health concern that can have a significant impact on a woman's well-being. Every year, an estimated 121 million women experience unintended pregnancies worldwide, and the global rate of unintended pregnancies per 1000 women is 64 [20]. In Japan, a national survey data showed that 17.9% of married wives had experienced unintended pregnancy [21] and 40.1% of Japanese women who have unintended pregnancy had repeated experiences [22]. A systematic review indicated that the prevalence of maternal depression in unintended pregnancies was 21% [23], and previous studies have indicated that unintended pregnancies have an impact on maternal mental health, such as maternal depression [24–26]. Furthermore, unintended pregnancy was associated with psychosocial factors such as interpersonal violence [27], and relationship with partner [28]. In addition, unintended pregnancy increases the risk of induced labor [29] and adverse neonatal outcomes, such as preterm birth and low birth weight [25]. Women who have unintended pregnancies have had a tough and thoughtful decision-making process regardless of whether they had an abortion or decided to continue with their unintended pregnancy [30].

Although both maternal bonding and unintended pregnancy are extremely critical issue of maternal mental health, empirical studies examining the impact of unintended pregnancy on maternal bonding are noticeably scarce. Considering that maternal bonding starts during pregnancy [11] and continues primarily throughout the first year of life [31], research has yet to fully elucidate whether unintended pregnancy influences maternal bonding from the prenatal period to the postpartum phase. Although existing literature suggests that negative pregnancy emotions are linked to impaired mother-infant bonding at one month [32] and four months [33] postpartum, the specific impact of unintended pregnancy on maternal bonding during these critical periods remains understudied. Moreover, although several studies have been conducted on maternal bonding using a longitudinal design [3, 34–36], maternal–fetal bonding scales are unsuitable for assessing maternal–infant bonding due to lack of content validity, and vice versa. New approaches are required to consistently assess maternal bonding from pregnancy to the postpartum period. This

Table 1 The descriptive statistics values of the participants

Variable	N (%)
Number of children	
1st	31 (39.7)
2nd	35 (44.9)
3rd	9 (11.5)
4th	2 (2.6)
5th	1 (1.3)
Educational level	
Junior high school	1 (1.3)
High school	9 (11.5)
University	59 (75.6)
Graduated university	8 (10.3)
N/A	1 (1.3)
Matemal employment status during pregnancy	
Housewife	33 (42.3)
Self-employed	5 (6.4)
Part-time job	5 (6.4)
Full-time	28 (35.9)
Maternity leave	6 (7.7)
N/A	1 (1.3)
Marriage	
Yes	75 (96.2)
No	3 (3.8)
Experience of divorce	
Yes	6 (7.7)
No	71 (91.0)
N/A	1 (1.3)
Experience of depression	
Yes	13 (16.7)
No	64 (82.1)
N/A	1 (1.3)
Unintended pregnancy	
Yes	6 (7.7)
Moderately yes	11 (14.1)
Neither	2 (2.6)
Moderately no	6 (7.7)
No	53 (67.9)
Infertility treatment	
Yes	31 (39.7)
No	47 (60.3)
Infant sex	
Boy	31 (39.7)
Girl	47 (60.3)
Gestational age	
36–41	77 (98.7)
> 41	1 (1.3)
Birth weight	
< 2500g	4 (5.1)
≥ 2500g	74 (94.9)
Feeding style	
Only breast feeding	40 (51.3)
Only bottle feeding	7 (9.0)
Breast and bottle feeding	31 (39.7)

new approach adds unique knowledge to the process from maternal–fetal to maternal–infant bonding.

To address the limitation of previous research on unintended pregnancy, which has largely neglected the dynamics of maternal bonding across the pregnancy and postpartum continuum, we undertook a prospective study to examine maternal bonding from pregnancy through the postpartum period. The present study addresses the knowledge gap highlighted above by investigating maternal bonding from pregnancy to the postpartum period using a prospective longitudinal design.

The purpose of this study is to examine the effects of unintended pregnancy on maternal bonding. We hypothesized that mothers with unintended pregnancies would have impaired maternal bonding both during pregnancy and postpartum compared with mothers who did not have unintended pregnancies. The second aim was to verify whether the effects of unintended pregnancy on maternal depression were replicated.

Methods

Participants and procedure

This study was performed between March 2020 and February 2024 at the Gifu Prefectural General Medical Center, Gifu Prefecture, Japan. Pregnant women who visited the Center of the Department of Obstetrics were handed a comprehensive package of documents for ongoing antenatal check-ups, and the recruiting flier, which introduced the research with a QR code to access the research site, was included. We provided a detailed explanation of the study on the website, and if the women agreed to participate, they provided signed consent through the website.

During the study period, we distributed 2,534 fliers and ninety-three mothers responded to the questionnaires both during pregnancy and one month after childbirth. Participants received e-mail linked to the questionnaire survey page around one month after estimated delivery date. Inclusion criteria consisted of mothers attending the Center of the Department of Obstetrics, while exclusion criteria included individuals with limited Japanese proficiency. We excluded eight respondents with twin pregnancies due to their specific challenges. Further, exclusions included five participants with insufficient responses, and two with responses in the postpartum period exceeding three months. The mean maternal age was 34.2 ± 4.6 years (range 23–44 years), with a mean gestational age of 20.5 ± 8.1 weeks (range 5–38 weeks). Approximately, 40% of the participants ($n = 31$, 39.7%) were first-time mothers and the babies were boys ($n = 31$, 39.7%). Table 1 presents the descriptive statistics of the participants.

Measurements

Unintended pregnancy

We asked whether the participants pregnancy was expected or not with the question, "Is the current pregnancy unintended or not?" Participants responded with five options: "yes," "moderately yes," "neither," "moderately no," and "no." Participants who answered "yes," "moderately yes," or "neither" were categorized as unintended pregnancy, and those who chose "moderately no" or "no" were categorized as having expected pregnancies.

Postpartum bonding questionnaire (PBQ)

We used the Postpartum Bonding Questionnaire (PBQ), which was originally developed to assess maternal–infant bonding during the postpartum period, to assess maternal bonding. The PBQ is a self-rating scale with 25 items scored from 0 to 5 [37]. Higher PBQ scores indicated greater impairment of maternal bonding. The Japanese version of the PBQ has high internal consistency, with a Cronbach's alpha of 0.84 [6] and 0.86 [38]. During pregnancy, we excluded eight items (Nos. 4, 5, 9, 11, 12, 22, 23, and 25) from the full PBQ because they were related to actual situations with infants. For example, item No 9 "I feel happy when my baby smiles or laughs," is unsuitable because pregnant mothers cannot directly see fetal smiles or laughs. At one month postpartum, we used all 25 items of the PBQ.

Edinburgh postnatal depression scale (EPDS)

We used the Edinburgh Postnatal Depression Scale (EPDS) to assess whether the mothers had depression during pregnancy and at one month postpartum. The EPDS is a self-rating scale that includes ten items scored from 0 to 3. Higher EPDS scores indicated a greater possibility of depression. In Japan, a cut-off score ≥ 13 during pregnancy [39] and ≥ 9 postpartum has been adopted to identify depression [40, 41]. The EPDS has a high internal consistency (Cronbach's alpha 0.87) and good content validity [42]. The Japanese version of the EPDS has been reported to have good validity, sensitivity (0.90), and specificity (0.92) during pregnancy [39], and sensitivity (0.82) and specificity (0.95) postpartum [41].

Demographic data

Sociodemographic data such as age, number of children, experience of miscarriage or abortion, infertility treatment, educational level, and maternal employment status during pregnancy were included in the questionnaire during pregnancy. Infant sex, gestational age, birth weight, and feeding style were included on the one month postpartum questionnaire.

Statistical analysis

Descriptive statistics were used to describe participants' demographic variables. Correlational analysis was used to examine the relationship between maternal bonding and depression. To test the hypothesis, a two-way repeated-measures analysis of variance (ANOVA) was performed to analyze the effect of unintended pregnancy (yes or no) and time (during pregnancy or postpartum) on the sum of the PBQ 17 items. In addition, a two-way repeated-measures analysis of covariance (ANCOVA) was performed to analyze the effect of unintended pregnancy and time on the sum of the PBQ 17 items and EPDS score during pregnancy as a covariate. Since we assessed one-month postpartum bonding using the PBQ full version (25 items), we also performed two samples of t-tests to analyze the differences in the PBQ 25 item full score between unintended and expected pregnancies. Moreover, to analyze the effect of unintended pregnancy and time on the EPDS score, two-way repeated-measures ANOVA was performed. Effect size was calculated in all comparisons of ANOVA and t-tests. In cases where no statistically significant differences were found despite large effect sizes, a bootstrap method with 5000 resamples was used to test the differences. R ver 4.1.1 [43] was used.

Results

Table 2 shows the correlations between depressive symptoms and maternal bonding. Maternal bonding during pregnancy was significantly associated with maternal bonding at one month postpartum, both the sum score of the PBQ 17 items and 25 items ($r = .49$, $p < .001$; $r = .54$, $p < .001$, respectively). Furthermore, maternal bonding during pregnancy was moderately associated with maternal depression during pregnancy ($r = .46$, $p < .001$) and maternal depression at one month postpartum ($r = .27$,

Table 2 Descriptive Statistics and Correlations for Study Variables

	M	SD	1	2	3	4	5
1 PBQ during pregnancy	7.95	7.59	——				
2 PBQ (17 items) at 1 month postpartum	5.87	7.98	.49***	——			
3 PBQ (25 items) at 1 month postpartum	13.72	12.08	.54***	.96***	——		
4 EPDS during pregnancy	5.08	4.39	.46***	.16	.23*	——	
5 EPDS at 1 month postpartum	3.74	4.40	.27*	.62***	.64***	.43***	——

Note. *** $p < .001$, * $p < .05$

$p < .05$). Maternal depression during pregnancy did not have a statistically significant relationship with the maternal bonding of 17 items at one month postpartum ($r = .16$, $p = .15$, n.s.), although a weak correlation coefficient was obtained for the 25 items of the PBQ ($r = .23$, $p < .05$).

Figure 1 shows the results of the two-way repeated-measures ANOVA conducted on the PBQ scores. A significant main effects of group ($F(1, 76) = 11.71$, $p < .01$, $\eta^2 = 0.10$) and time ($F(1, 76) = 7.17$, $p < .01$, $\eta^2 = 0.02$) were observed. Mothers with unintended pregnancies had significantly impaired bonding scores during pregnancy ($M = 13.3 \pm 10.6$) compared with mothers with expected pregnancies ($M = 6.2 \pm 5.4$) (Cohen's $d = 1.00$). Similarly, mothers with unintended pregnancy had significantly higher impaired bonding scores at one month postpartum than expectant mothers ($M = 9.2 \pm 14.0$; $M = 4.81 \pm 4.4$, respectively) (Cohen's $d = 0.56$). Furthermore, the PBQ scores of both unintended and expected pregnant mothers significantly decreased from pregnancy to one month postpartum. There was no significant interaction between unintended pregnancy and time $F(1, 76) = 1.69$, $p = .20$, $\eta^2 = 0.01$

A two-way repeated measures ANCOVA was conducted on the PBQ scores, and the EPDS score during pregnancy was specified as a covariate. The main effect of group was significant ($F(1, 75) = 6.0$, $p < .05$, $\eta^2 = 0.05$), while the main effect of time and the interaction effect were not ($F(1, 75) = 0.0$, $p = .99$, $\eta^2 = 0.00$; $F(1, 75) = 0.21$, $p = .65$, $\eta^2 = 0.00$, respectively).

Additionally, we used a two-sample t-test to compare the 25-item PBQ score at one month postpartum between mothers with unintended pregnancies and those with planned pregnancies. Mothers with unintended pregnancies had a higher PBQ full 25-item score ($M = 19.8 \pm 20.2$) compared to mothers with planned pregnancies ($M = 11.7 \pm 7.2$), showing a large effect size ($d = 0.70$). However, the differences were not statistically significant ($t(19.48) = 1.72$, $p = .10$). Consequently, we tested the difference using the bootstrap method with 5000 resamples. There was a difference of 8.0 in the scores between mothers with unintended pregnancies and those with planned pregnancies at one month postpartum (95% CI [0.9;18.1], $p < .05$).

Figure 2 shows the results of the two-way repeated measures ANOVA conducted on EPDS scores. A significant main effects of group ($F(1, 76) = 17.34$, $p < .001$, $\eta^2 = 0.13$) and time ($F(1, 76) = 4.39$, $p < .05$, $\eta^2 = 0.02$) were observed. Unintended pregnant mothers had significantly higher EPDS scores during pregnancy than expected pregnancy mothers ($M = 7.8 \pm 4.6$; $M = 4.2 \pm 4.0$, respectively) (Cohen's $d = 0.89$). Similarly, mothers with unintended pregnancy had significantly higher postpartum EPDS scores than mothers with expected pregnancy ($M = 6.6$, $\pm$ 5.8; $M = 2.8 \pm 3.4$, respectively) (Cohen's $d = 0.91$). Furthermore, the EPDS scores of both unintended and expected pregnant mothers significantly decreased from during pregnancy to one month postpartum. There was no significant interaction between unintended pregnancy and time $F(1, 76) = 0.01$, $p = .94$, $\eta^2 = 0.00$

Discussion

This study examined the effects of unintended pregnancy on maternal bonding using a prospective longitudinal design from pregnancy to one month postpartum. We found that unintended pregnancy mothers had a more

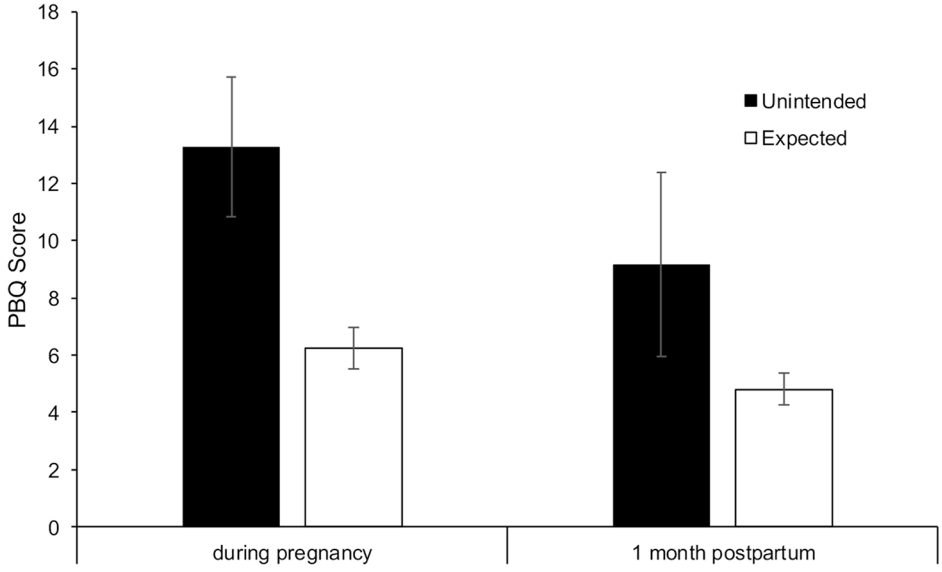

Fig. 1 The results of the two-way repeated-measures ANOVA conducted on the PBQ scores. Error bars show standard errors

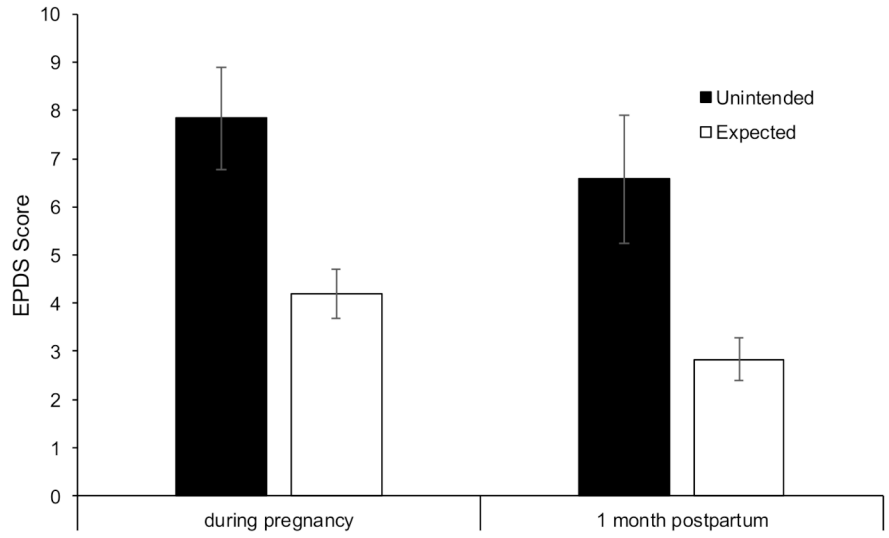

Fig. 2 The results of the two-way repeated-measures ANOVA conducted on the EPDS scores. Error bars show standard errors

impaired maternal bonding score than expected pregnancy mothers, both during pregnancy and one month postpartum. Moreover, both unintended and expected pregnancy mothers had significantly decreased impaired maternal bonding from during pregnancy to one month postpartum. Regarding maternal depression, mothers with unintended pregnancy had higher EPDS scores than mothers with expected pregnancy during pregnancy and postpartum.

Unintended pregnant mothers had significantly higher maternally impaired bonding scores than expected pregnant mothers. Here, we demonstrated for the first time that unintended pregnancy is associated with maternal bonding not only during pregnancy but also one month postpartum. Previous studies have found that impaired maternal bonding is associated with depression [23], interpersonal violence [25], relationship with partner [28], and suicidal ideation [9]. Notwithstanding, research on the impact of unintended pregnancy on maternal bonding remains scarce. A previous review indicated that maternal distress was associated with maternal fetal bonding [19]. Moreover, negative maternal feelings toward pregnancy were associated with impaired maternal bonding at four months postpartum [33]. The present findings extend these previous studies in that unintended pregnancy affects maternal bonding during pregnancy, and the effect continues postpartum.

Unintended pregnancy affected maternal bonding, even when controlling for the EPDS score during pregnancy in the ANCOVA. Moderate correlations were observed between maternal bonding and depression, both during pregnancy and at one month postpartum. Our findings suggest that it may be more beneficial to focus on the effects of unintended pregnancy, rather than the effects of depression, on maternal bonding. A previous study revealed that maternal-fetal bonding moderates the association between a pregnancy intendedness and maternal-infant bonding [44]. Another study showed that maternal bonding mediated the association between unintended pregnancy and psychosocial problems among preschool children [45]. Considering our findings and those of previous studies, health practitioners should pay attention to mothers with unintended pregnancies and provide targeted support to improve maternal bonding. This will strengthen the mother-infant connection and support children's psychosocial development.

Although Japan has been highly industrialized and proceeded to foster diversity in life, Japanese culture still particularly emphasizes the bliss and blessing of conception and becoming a mother. Therefore, Japanese mothers who have unintended pregnancies tend to hesitate to express their suffering and to seek help from their partners, relatives, or friends. A qualitative study conducted in low-income communities of Alabama, U.S., found that young women perceived social norms and stigmas regarding unintended pregnancy. These perceptions persisted despite increasing social acceptance of motherhood following unintended pregnancies [46]. Another study conducted in Finland observed that mothers would disclose their negative feelings regarding motherhood, such as emotional burden and exhaustion, on an anonymous online discussion board. However, mothers refrained from disclosing such negative feelings in face-to-face situations, even in one of the most gender-egalitarian countries [47]. Therefore, it is important to provide timely and appropriate support to pregnant mothers. Based on the Maternal and Child Health Act, Japanese mothers visit public health centers after confirmed their pregnancy to notify their pregnancy, and public health

nurses provide brief clinical interviews. After that, they have 14 times regular prenatal check-ups at obstetric clinics or hospitals until their delivery. Since Japanese mothers have multiple opportunities to contact health service providers from an early stage of pregnancy, we should take mothers' expressions seriously if they reveal their vague or ambiguous feelings about pregnancy to identify unintended pregnancy as soon as possible. Furthermore, we should assess carefully mother-infant interaction after delivery to prevent maternal bonding impairment.

Concerning the lack of statistically significant difference in the 25-item PBQ score at one month postpartum between unintended and expected pregnancies despite a large effect size, one possible explanation is too small sample to detect statistically significant differences. As the results of the bootstrap method are significant, a larger and more robust sample is required to clarify whether the test for difference was hindered by sample size. Another plausible explanation might be that the standard deviation of the unintended pregnancy group was considerably large (S.D. = 20.2) compared to that of the expected pregnancy group (S.D. = 7.2). This represents the PBQ score has scattered distribution and indicates that some unintended pregnancy mothers have high PBQ scores, while others have low PBQ. This arises the key issues of whether the scores deal with the PBQ score of the unintended pregnancy group as a unitary score, the interpretability of group means. Future research is required to increase the study sample and investigate carefully whether PBQ scores of the unintended pregnancy group could be treated as one unitary score or not.

Interestingly, mothers of both unintended and expected pregnancies had significantly decreased impaired bonding in the postpartum period. To the best of our knowledge, this is the first study to show that impaired maternal bonding during pregnancy is reduced after childbirth, even in mothers who have experienced an unintended pregnancy. Although little is known about the change in maternal bonding from pregnancy to the postpartum period, we overcame this issue by using common items that are feasible both during pregnancy and the postpartum period. One possible explanation could be that the actual mother–infant interaction after childbirth could partially alleviate impaired maternal bonding. A previous study demonstrated that maternal behaviors toward the infant after delivery were associated with the quality of the maternal–infant relationship at one year of age [48]. It is plausible that actual mother–infant interactions might lessen maternal embarrassment, and then mothers can develop maternal–infant bonding through a child-rearing process that affords her a certain delight. Moreover, a previous study suggested that mistimed pregnant women could also be resilient in dealing with the daunting challenges faced during the perinatal periods [49]. However, our findings should be interpreted with caution, as the significant decrease in the bonding scores of both unintended and expected pregnancies disappeared when the analysis controlled for depression during pregnancy. This suggests a false reduction influenced by depression. Future research should be conducted whether they can be applied to other groups of mothers who have mental health problems such as depression or anxiety. Further research using a sufficiently large number of samples is needed to clarify this point.

Unintended pregnant mothers had higher EPDS scores than expected pregnant mothers during pregnancy and postpartum. Our findings are consistent with prior studies showing that unintended pregnancy is related to current [50] or three months postpartum depression [49]. The harmful effects of perinatal depression, including impaired infant bonding, suicide, and adverse child outcomes, are well documented. In addition, previous studies have shown that unintended pregnancy increased delayed prenatal care visits [27, 29, 50]. These findings highlight the importance of careful screening and a comprehensive approach for mothers during the perinatal period, including unintended pregnancies and maternal depression.

Meanwhile, maternal bonding during pregnancy was moderately related to one-month postpartum bonding. This finding is consistent with prior studies [16, 34, 35, 51] and suggests that maternal–fetal bonding continues to some extent into maternal–infant bonding. Numerous studies have examined maternal bonding, although most have used cross-sectional designs. Therefore, the present study demonstrated, to some extent, the continuity between maternal–fetal bonding and maternal–infant bonding. However, the correlation coefficients between maternal and fetal and maternal–infant bonding were moderate. This suggests that there might be other factors related to maternal bonding from pregnancy to one month postpartum. Further research is needed to elucidate the factors that explain residual covariance.

The main strength of this study is that we used a longitudinal design from pregnancy to the postpartum period and consistently assessed maternal bonding using a well-established scale. Furthermore, we used feasible and common items during both pregnancy and the postpartum period; thus, we observed a significant change in maternal bonding with both unintended and expected pregnancies from pregnancy to the postpartum period. Nonetheless, this study has several limitations that should be considered. Firstly, the sample size was small, and the response rate was notably low, largely due to the passive recruitment approach, where participants were invited to participate through flyers inserted

in comprehensive document packages. Consequently, the findings of this study are subject to a significant selection bias, which limits their generalisability. Furthermore, the participants were recruited from a Japanese hospital with an obstetrics department. Caution should be exercised regarding the extent to which the findings of the current study can be generalized. Future research should consider a larger sample size and confirm whether similar findings are obtained when participants are actively recruited to participate. Secondly, due to questionnaire item restrictions, we were unable to account for potential confounding variables, including prior maternal mental health, socioeconomic status (SES), and infant-related factors. Additionally, future studies should explore the role of skin-to-skin contact [52], physical closeness, and emotional warmth between mothers and infants as evidence suggests that skin-to-skin contact may mitigate impaired maternal bonding in preterm infants [53]. Thirdly, he complexity of unintended pregnancies and their classification warrants consideration. Relying on a single question to categorize unintended pregnancies may oversimplify the issue, as previous research has differentiated between mistimed and unwanted pregnancies [54]. Moreover, the high variability in 25-item PBQ scores among unintended pregnant mothers raises concerns about the interpretability of the group means. To address these issues, future studies should employ more comprehensive measures, such as the London Measure of Unplanned Pregnancy [55]. Fourthly, our reliance on self-report questionnaires to assess maternal bonding and depression, rather than clinical interviews, may limit the validity of our findings. Future research would benefit from utilizing alternative measures, such as the Stafford Interview [56, 57] to evaluate maternal bonding during pregnancy. Furthermore. self-report questionnaires are subject to social desirability bias or recall bias, especially when they address sensitive topics such as pregnancy intentions and mental health. However, the postpartum bonding questionnaire has the strongest psychometric evaluation with high-quality evidence and is the most frequently adapted instrument in this field [58], and the EPDS cut-offs correlate with prepartum [39] and postpartum depression [41]. In addition, the long-term impact of unintended pregnancy on maternal bonding should be investigated by extending the follow-up from one month to six or 12 months postpartum. Lastly, we had to exclude eight items of the PBQ to assess maternal bonding during pregnancy because of issues of content validity in using the full version of the PBQ as it is during pregnancy. Although we believe that our modification of the PBQ maintains a reasonable degree of validity, it might affect bonding measurements during pregnancy. Therefore, employing alternative and more comprehensive assessment tools to evaluate maternal bonding during pregnancy is of considerable value. It is recommended that the same measurement method be ideally applicable for both, during pregnancy and postpartum; however, such an ideal measurement scale has not yet been developed.

Conclusions

Mothers experiencing unintended pregnancies were at higher risk of impaired maternal bonding during pregnancy and the postpartum period. To mitigate this risk, healthcare providers should promptly identify mothers with unintended pregnancies and conduct thorough assessments of mother-infant interactions postpartum. Future research directions include replicating these findings in diverse populations and investigating the long-term consequences of unintended pregnancy on maternal-child relationships.

Abbreviations

ANOVA	Analysis of variance
ANCOVA	Analysis of covariance
EPDS	Edinburgh postnatal depression scale
PBQ	Postpartum bonding questionnaire
SD	Standard deviation

Acknowledgements

We wish to acknowledge the staff of the Department of Fetal Maternal Medicine and Obstetrics at Gifu Prefectural Medical Center.

Author contributions

HK wrote the first draft of the manuscript and supervised its design and revised revisions. YM and MN conducted the survey and YM performed the statistical analysis. YT, MM and KO critically read and revised the manuscript. MN, YT, MM and KO designed the study. All the authors read and approved the final version of the manuscript.

Funding

This study was supported by JSPS KAKENHI Grant Number 23K02981, the Sumitomo Electric Group CSR Foundation, and the DAIKO FOUNDATION. The funders had no role in the study design, data collection and analysis, decision to publish, or manuscript preparation.

Data availability

The datasets used during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. All procedures performed in this study were approved by the Ethics Committee at the Graduate School of Education and Human Development, Nagoya University, Japan (reference number: 23-1966). Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 12 April 2024 / Accepted: 22 April 2025
Published online: 06 May 2025

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