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MATERNAL-FETAL MEDICINE

Course of mental health and mother–infant bonding in hospitalized women with threatened preterm birth

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Abstract

Purpose Pregnancy complications (PC) with signs of threatened preterm birth are often associated with lengthy hospital stays, which have been shown to be accompanied by anxiety, depressive symptoms, and increased stress level. It remains unclear, whether the perinatal course of mental health of these women differs from women without PC and whether there may be differences in the postpartum mother–infant bonding.

Methods In a naturalistic longitudinal study with two measurements (24–36th weeks of gestation and 6 weeks postpartum), we investigated depression (EPDS), anxiety (STAI-T), stress (PSS), and postpartum mother–infant bonding (PBQ) in women with threatened preterm birth ($N=75$) and women without PC ($N=70$). For data evaluation, we used means of frequency analysis, analysis of variance with repeated measurements, and t-tests for independent samples.

Results The patient group showed significantly higher rates of depression, anxiety, and stress during inpatient treatment in pregnancy, as well as 6 weeks postpartum compared to the control group. While depression and anxiety decreased over time in both groups, stress remained at the same level 6 weeks postpartum as in pregnancy. We found no significant differences in mother–infant bonding between the two groups at all considered PBQ scales.

Conclusion It is recommended to pay attention to the psychological burden of all obstetric patients as a routine to capture a psychosomatic treatment indication. A general bonding problem in women with threatened preterm birth was not found. Nevertheless, increased maternal stress, anxiety, and depressiveness levels during pregnancy may have a negative impact on the development of the fetus.

Keywords Depression · Anxiety · Stress · High-risk pregnancy · Hospitalized women · Mother–infant bonding

Introduction

Even though pregnancy is often associated with a time of pleasant feelings and joyful expectations, it does not always proceed without complications. Study results from various countries show that approximately 7–15% of pregnant women are hospitalized for pregnancy complications (PC) at least once [1, 2]. About ¼ of these treatments results from threatening preterm delivery [1, 2]. Among the signs of threatening preterm birth, premature contractions, incompetence of the cervix, vaginal hemorrhage, and preterm rupture of the membranes are the most common [1, 3]. Causes may include maternal features (e.g. uterine disorders, infections, metabolic diseases, substance abuse, premature birth and miscarriages in the history), but also fetal features (e.g. malformations, multiple pregnancy, infections) and socioeconomical features (e.g. overwork, stress, partner relationship) [4].

PC with signs of threatened preterm birth are often associated with long-lasting hospitalizations. Due to the accompanying medical interventions, unknown prognosis, anxiety of losing the unborn child, or premature birth with the associated risk of permanent impairment of the child, own health risks, and separation of the partner and family

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they represent a sudden unexpected burden [5, 6]. Previous results of research show on one hand, mental strains during pregnancy, which represent predictors of PC [7, 8] and on the other hand, depressive complaints, anxiety, and stress are described as results of the strains through PC [9, 10]. Anxiety hereby correlates with the individual perception of risk [11]. So far, only a few prospective longitudinal studies have investigated the mental burden in the sense of depression, anxiety, and stress perception of women with PC antenatally and 1–2 months postpartum. Their findings are inconsistent [10, 12, 15, 16].

The follow-up study by Maloni et al. [12] found higher levels of dysphoria during pregnancy for women with complete bed rest than for the control group without bed rest, which is consistent with cross-sectional study results of depression [13, 14]. Longitudinal studies indicated both a reduction in depression of inpatient women with PC from pre to postpartum [12, 15, 16] and no significant changes found over time [10]. The prevalence of elevated depressive symptoms in high-risk pregnancies ranges between 17.4 and 58% [5, 9, 15, 17–19] compared to a point prevalence of antenatal major and minor depression in the general population in the third trimester of 8.5 and 12.9%, 3 months postpartum [20].

Regarding the course of anxiety, Weidner et al. [5] showed no changes between baseline measurement in pregnancy and follow-up 1 year postpartum for women with and without PC in the absence of a psychosomatic intervention, but women with PC reporting a higher level of anxiety at both points of assessment. However, a significant reduction of anxiety 1 year postpartum could be confirmed in the group with psychosomatic intervention. Results of other trials found a reduction of anxiety from prepartum to postpartum in a group of hospitalized women with PC [10, 15]. Two older cross-sectional trials demonstrated higher anxiety scores during pregnancy in hospitalized women compared to a control group of healthy pregnant women [13, 14]. Antenatal anxiety is frequent in women with high-risk pregnancy; prevalence ranges between 12.5 and 40.2% [5, 9, 18] and is comparable with those reported in the general population (21.2–28% in the third trimester; 13.7–16.4% postpartum) [21].

Stainton et al. reported an increase of perceived stress in women with PC from inpatient admission up to 5 weeks [10]. Results of a cross-sectional trial in women with high-risk pregnancy have shown a higher mean score of perceived stress compared to unaffected pregnant women [22, 23]. Only one previous investigation examined the stress level in women with high-risk pregnancy and reported a rate of 14% [24]. In comparison, Woods et al. found a prevalence of high antenatal stress of about 6% in pregnant women of the general population [25].

Further research showed that depression, anxiety, and stress in pregnancy are associated with negative effects on the fetus, an increased risk of preterm delivery and they are also related to adverse birth and developmental outcomes, as well as emotional and behavioral problems of children [26–29].

Some study results indicated a higher risk of postpartum depressive complaints 6–8 weeks postpartum in women with PC compared to women without PC [30, 31]. Moreover, associations between postpartum depression and mother–infant bonding disorders have been confirmed [32–34]. Also, depressive symptoms in second and third trimester seem to interfere negatively with the mother's emotional involvement with the infant 2–3 months after childbirth [36, 37]. Some researchers demonstrated that increases in maternal anxiety, pre [35] and postpartum [35, 37], impair bonding, and attachment behavior of mothers toward their infant. Furthermore, associations between stress in the second trimester and an impaired mother–infant bonding 8 weeks postpartum have been indicated [36], as well as negative correlations between maternal stress and mother–infant bonding at 1 month postpartum [33].

While associations between postpartum mental disorders and impairments in mother–infant bonding have been well-studied, trials investigating in the relation of PC and later disorders of mother–infant bonding are scarce. Disruptions of mother–infant bonding are associated with an impaired development of the child [38]. Results of an earlier study demonstrated that women with high-risk pregnancy perceive their infant as more difficult than women with low risk pregnancy [39]. On the other hand, no differences in postpartum maternal bonding/attachment to the infant between prenatal high and low risk women were reported [40–42].

Interestingly, recent findings [43] showed a lower sensitivity and dyadic reciprocity in the interaction of high-risk pregnancy mothers and fathers and their infants at 3–4 months of age. Besides, no differences could be confirmed between high-risk pregnancy parents concerning perceived efficacy and satisfaction with parenting roles and marginally significant less stress with their role as parents than low risk pregnancy parents.

Overall, there is a lack of longitudinal studies comparing the mental burden and stress perception in hospitalized women with PC to healthy pregnant women in the peripartum course. Further, it remains unknown if postpartum mother–infant bonding in women with signs of threatened preterm birth differs from women without PC. The following questions were therefore examined in this study:

1. Do women with signs of threatened preterm birth and women without PC differ in depression, anxiety, and stress perception during pregnancy and in the postpartum period?

2. Do both groups differ in their course of mental health from 24 to 36th week of gestation to 6 weeks postpartum?
3. Do both groups differ in postpartum mother–infant bonding?

Methods

Participants and procedure

This study was designed as a naturalistic longitudinal trial with two measurement points: pre and postpartum. One hundred and twelve pregnant women who were hospitalized in the University Hospital Carl Gustav Carus, Technische Universitaet Dresden, Department of Gynecology and Obstetrics, due to threatened preterm birth, were recruited between August 2015 and May 2017. Eligible women were contacted verbally on the ward and received information about the process of the trial as well as privacy protection verbally and written. Women gave written consent to participate in the study. The study was approved by the ethics commission of the Technische Universitaet Dresden (EK 277062015).

Inclusion criteria were as follows: hospitalization for at least 3 days, because of signs of threatened preterm birth such as cervical shortening, premature uterine contractions and/or vaginal bleeding, gestational age between 24th and 36th week, at least 18 years of age. Exclusion criteria were loss of pregnancy before the first contact, planned late interruption of the pregnancy, and multiple pregnancy, as well as insufficient German language skills.

The first assessment ($t1$) took place during hospitalization of the women (mean: 29.11 ± 2.90 weeks of gestation). Duration of hospitalization was on average 19.96 ± 16.07 days. The second assessment ($t2$) was scheduled 6 weeks after birth and finally conducted on average with mean 8.36 ± 4.89 weeks postpartum.

Both surveys used self-administered questionnaires ($t1$ at the hospital, $t2$ sent out and returned by mail). Relevant somatic conditions were confirmed by hospital records.

Among the original 112 women from the patient group of wave one ($t1$), 89 $t2$ surveys could be obtained (postpartum), which equals a return rate of 80%. Subsequently, 14 women had to be excluded due to having given birth to an extremely or a very premature baby ($\leq$ 32nd week of gestation). At the time of $t2$ (6 weeks postpartum), they had not yet had their child at home with them. Therefore, data on mental health and postpartum mother–infant bonding were not well comparable with the majority of women with and without PC. The impact of extremely or very premature birth has its own field of research and it is necessary to be considered independently of our results. Over all of the remaining women with threatened preterm birth, 81% had a diagnosis of cervical shortening ($N = 61$), 52% premature contractions ($N = 39$), and 28% had vaginal bleeding ($N = 21$). 55% of the women carried several of those diagnoses at the same time.

As the unaffected control group, we used a sample of 84 pregnant women without complications who were recruited from routine birth preparation classes from 2011 to 2012 (week of gestation: mean 33.06 ± 2.65). Seventy of them could be obtained for $t2$ (mean: 6.60 ± 2.35), equaling a return quote of 83%. Finally, 75 women with threatened preterm birth and 70 pregnant women without PC were included in the investigation.

Questionnaires

Socio-demographic variables

Socio-demographic variables were captured through structured questionnaires with categorized items. Items included maternal age, week of pregnancy, duration of inpatient treatment, family status, number of children, educational level, employment status, disposable income, week of gestation at birth, as well as the presence of mental disorders (current and in the past).

Edinburgh Postnatal Depression Scale (EPDS)

For assessment of depressive complaints during pregnancy and postpartum, the EPDS [44] was used in the German version [45]. Level of mood during the past 7 days is evaluated through ten items. The EPDS featuring clinical cut-offs (sum score $\geq$ 10: clinically relevant), has a good reliability (split half reliability = 0.82 and Cronbach's $\alpha = 0.81$), as well as excellent convergent and prognostic validities [45].

State-Trait Anxiety Inventory—Trait subscale (STAI-T)

The STAI [46] captures fear and anxiety such as restlessness, strain, worriedness, or a general dissatisfaction/burden. It discriminates between the assessment of fear as condition (state-anxiety) and fear as feature (trait-anxiety). In the present evaluation, the STAI-trait was used in the German version [47], due to availability of comparative values of the control group only for that scale. The scale includes 20 items as well as clinical cut-off values (sum score $\geq$ 47: clinically relevant). The STAI questionnaire has excellent quality criterions and standard values. The internal consistency coefficient is 0.90, retest reliability coefficients of the trait scale are 0.68–0.96. The STAI was validated for various conditions [47].

Perceived Stress Scale (PSS)

Assessment of subjective stress experience was conducted with the Perceived Stress Scale [48] in the German version [49]. Participants were asked to specify the degree to which they appraise situations as stressful during the last month and to rate how unpredictable, uncontrollable, and overstraining they perceive their lives [48]. The PSS comprises 14 items and offers clinical cut-off values (sum ≥ 28: clinically relevant). Further standard values for a female cohort exist [50]. Satisfactory psychometric characteristics (Cronbach's α: 0.84–0.86, test–retest reliability 0.55–0.85) and good convergent validities are described [48].

Postpartum Bonding Questionnaire (PBQ)

This self-rating instrument [51], applied in the German translation [34], is used to assess interferences in mother–infant bonding. The questionnaire incorporates 25 items. Different dimensions of bonding difficulties are evaluated separately (impaired bonding within 12 items, rejection and anger within 7 items, infant-focused anxiety within 4 items and risk of child abuse within 2 items). Further, a sum value as global indicator of the mother–infant bonding can be estimated. Clinical cut-off values exist (cut-offs for clinical relevance: total scale ≥ 26, scale: impaired bonding ≥ 12, scale: rejection and anger ≥ 13 and scale anxiety ≥ 10) [52]. An investigation indicated good internal reliability and acceptable validities for the PBQ scales [53]. Solely the scale risk of abuse could not be confirmed; therefore it was not used for the present investigation. Acceptable internal consistencies could be reached for the overall scale and the scales 1–3 (Chronbach's α: 0.63–0.79) [53].

Data analysis

Statistical analyses were carried out with SPSS for Microsoft Windows 24.0 (SPSS Inc., Chicago, IL, USA). A descriptive, interference statistic evaluation of the data was conducted. To compare the course of mental condition in both groups for each dependent variable (depression, anxiety, stress), an analysis of variance with repeated measures was conducted. Subsequently, their effect sizes were determined through partial Eta η^2 [54]. Group comparisons of postpartum mother–infant bonding were conducted through *t*-test for independent random samples. Alpha error was determined as 0.05. Requirement of homogeneity of variance was re-checked through the Levene's test. Homogeneity of variance was given for the PSS-sum values and sum values of the single scales of the PBQ. For EPDS-sum values and STAI-sum values, requirements of variance homogeneity were not pre-existing. Consequently, for those two *t*1 and *t*2 sum values, a logarithmic transformation of data was performed. Therefore, requirements of variance homogeneity were satisfactory.

Further, it was investigated, whether *duration of inpatient treatment* or *week of gestation at birth* influenced the mental health in our sample. For these purpose, Pearson correlation coefficients were estimated between the control variables *duration of inpatient treatment* and *week of gestation at birth*, respectively, and the dependent variables depression, anxiety, and stress experience. However, no correlations with the dependent variables could be detected. Therefore, these variables were not included in the analysis.

Results

Study population

Table 1 presents an overview of socio-demographic data of both samples. The patient group (PG) and the control group (CG) did not differ in terms of age, marital status, number of children/parity, employment, and the presence of a mental disorder in the past. The number of women with a current mental disorder was higher in the PG than in the CG, but this difference did not reach statistical significance. The PG, however, was recruited about 4 weeks earlier in the course of pregnancy at *t*1 and about 2 weeks later at *t*2. Children were born on average about 2 weeks earlier (37.8 vs. 40.0 weeks of gestation). Furthermore, both groups differed with respect to highest level of graduation and income (less often 12th grade graduation and college or university degrees in the patient group, with respectively, more 9th and 10th grade graduation level), but a higher disposable income of the household.

Dropout analysis did not show any differences between the dropouts and remaining participants in both PG and CG, marital status, number of children, highest graduation level, employment status, disposable income, and pre-existing mental illnesses. However, in the PG, significant differences between dropouts ($N = 23$) and completers ($N = 89$) were found for EPDS (Mann–Whitney *U* test: $U = 1.499{,}5$, $p = 0.001$), STAI (Mann–Whitney *U* test: $U = 1.309$, $p = 0.023$), and PSS (Mann–Whitney *U* test: $U = 1.403$, $p = 0.004$). Dropouts at *t*1 indicated higher means with respect to depression (dropouts: $M = 14.74$, $SD = 5.56$; remaining PG: $M = 10.10$, $SD = 5.08$), anxiety (dropouts: $M = 43.35$, $SD = 9.98$; remaining PG: $M = 38.05$, $SD = 9.29$), and stress perception (dropouts: $M = 29.91$, $SD = 8.33$; remaining PG: $M = 24.26$, $SD = 8.28$). In the CG, dropouts and remaining participants did not differ with respect to EPDS, STAI, and PSS-sum score.

Table 1 Socio-demographic characteristics of the sample

	Patient group $n=75$ *M* (SD)	Control group $n=70$ *M* (SD)	*p*
Age in years (*t*1)	30.13 (5.76)	28.96 (4.43)	.169[a]
Week of gestation (*t*1)	29.11 (2.90)	33.06 (2.65)	< .001[a]
Days of hospitalization at *t*1*	19.96 (16.07)	0 (0.0)	
Gestation week of birth (*t*2)	37.79 (2.23)	39.96 (1.29)	< .001[a]
Weeks after birth at *t*2	8.36 (4.89)	6.60 (2.35)	.006[a]
	n (%)	*n* (%)	*p*
Marital status (*t*1)			.076[b]
Married	27 (36.0)	25 (36.8)	
Living with a partner/not married	41 (54.7)	42 (61.8)	
Divorced/separated	6 (8.0)	0 (0)	
Single	1 (1.3)	1 (1.5)	
Children (*t*1)*			.598[b]
No	49 (65.3)	45 (65.2)	
1	15 (20.0)	18 (26.1)	
2	5 (6.7)	5 (7.1)	
≥ 3	4 (5.3)	1 (1.4)	
Graduation (*t*1)			< .001[b]
After 9 years of schooling	6 (8.0)	0 (0)	
After 10 years of schooling	37 (49.3)	20 (28.6)	
A-level	16 (21.3)	27 (38.6)	
University degree	16 (21.3)	23 (32.8)	
Employment (*t*1)*			.928[c]
Yes	56 (74.7)	54 (77.1)	
No	16 (21.3)	16 (22.9)	
Disposable income (*t*1)*			.005[b]
< 1000 Euro/month	2 (2.7)	12 (17.2)	
1000–2000 Euro/month	25 (33.3)	27 (38.6)	
2000–3000 Euro/month	16 (21.3)	15 (21.4)	
> 3000 Euro	31 (41.3)	15 (21.4)	
Mental disorder in the past (*t*1)			.269[c]
Yes	16 (21.3)	10 (14.3)	
No	59 (78.7)	60 (85.7)	
Current mental disorder (*t*1)			.064[b]
Yes	7 (9.3)	1 (1.4)	
No	68 (90.7)	69 (98.6)	

*Due to isolated missing values, the subsamples of the marked variables do not result exactly $n=75/70$; M mean; SD standard deviation; *p* *p*-value; *t*1 first measure in pregnancy; *t*2 second measure in postpartum (6 weeks)

[a]*t*-test for independent samples

[b]Fisher's exact test

[c]Chi-squared test based on Pearson

Mental health

Women with signs of threatened preterm birth at both points of measurement had significantly higher scores of depression than women without PC (strong main effect of group). A reduction of depression in both groups at *t*2 (6 weeks postpartum) compared to *t*1 could be confirmed (medium main effect of time). There was no interaction effect (see Fig. 1).

At *t*1 the EPDS mean of our PG exceeded the clinical cut-off (≥ 10), indicating clinical relevance. At *t*2, the PG as well as the CG scored below this cut-off. While 49% of women in the PG ($N=37$) had EPDS-sum scores above the clinical cut-off at *t*1 and 32% ($N=24$) at *t*2, only 11% in

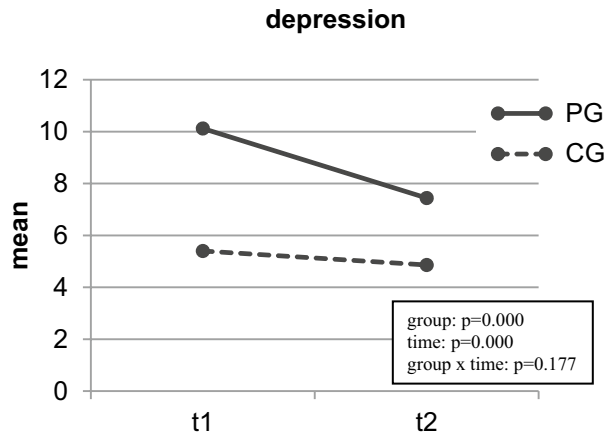

Fig. 1 Course of depressive symptoms (EPDS) from pregnancy to postpartum (analysis of variance with repeated measures). PG patient group ($N = 75$); CG control group ($N = 70$); t1 24.–36. week of gestation; t2 6 weeks postpartum; group main effect of the group; time main effect of the time; group × time interaction effect; *p* *p*-value

the CG ($N=8$) at *t*1 and 13% ($N=9$) at *t*2 were above the clinical cut-off.

Women in our PG showed significantly higher scores concerning anxiety than women in the CG at both points of assessment (medium main effect of group). In both groups, a reduction of anxiety at *t*2 (medium main effect of time) could be determined (see Fig. 2). There was no interaction effect (group x time). The STAI-trait mean score was below the clinical cut-off in both groups at *t*1 and *t*2. 19% of the PG ($N=14$) showed a STAI-T total score above the clinical cut-off at time *t*1 and 13% ($N=10$) at time *t*2. In the CG, the rates were 7% ($N=5$) at *t*1 and 4% ($N=3$) at *t*2.

The PG reported significantly higher scores of perceived stress (medium main effect of group) than the CG at both *t*1 and *t*2 (see Fig. 3). A significant decrease of perceived stress over time could not be determined. There was no significant interaction effect group x time. PSS means were clinically inconspicuous in both groups at both *t*1 and *t*2. Regarding clinical cut-offs, 32% ($N=24$) of women in the PG reported PSS-sum scores above the cut-off at *t*1 and 37% ($N=28$) at time *t*2 compared to 19% ($N=13$) at both *t*1 and *t*2 the CG.

Among women of the PG with a current mental disorder ($N=7$), 57% ($N=4$) reported clinically relevant depressive symptoms at *t*1 and 71% ($N=5$) at *t*2, 29% ($N=2$) had clinically relevant anxiety at *t*1 and 14% ($N=1$) at *t*2, and 57% ($N=4$) reported clinically relevant stress symptoms at *t*1 and 29% ($N=2$) at *t*2. The majority of the women with a current mental disorder (71%; $N=5$) already had mental disorder in the past.

Among the women (PG) without a current mental disorders, but with a mental disorder in the past ($N=11$), 46% ($N=5$) showed clinically relevant depressive symptoms at *t*1 and 27% ($N=3$) at *t*2, 9% ($N=1$) had clinically relevant anxiety symptoms at *t*1 and 36% ($N=4$) at *t*2, and 9% ($N=1$) reported clinically relevant stress symptoms at *t*1 and 73% ($N=8$) at *t*2. In comparison, in those 57 women without a mental disorder (current and/or in the past) 49% ($N=28$) showed clinically relevant depressive symptoms at *t*1, and in 28% ($N=16$) at *t*2, 19% ($N=11$) reported clinically relevant anxiety symptoms at *t*1 and 8% ($N=5$) at *t*2, and 33% ($N=19$) had clinically relevant stress symptoms at *t*1 and 32% ($N=18$) at *t*2.

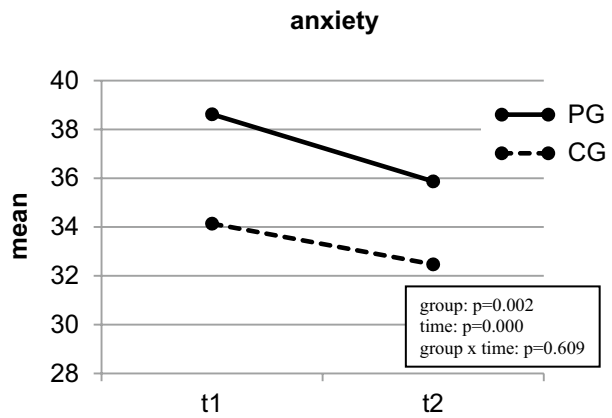

Fig. 2 Course of anxiety symptoms (STAI-T) from pregnancy to postpartum (analysis of variance with repeated measures). PG patient group ($N = 75$); CG control group ($N = 70$); t1 24.–36. week of gestation; t2 6 weeks postpartum; group main effect of the group; time main effect of the time; group × time interaction effect; *p* *p*-value

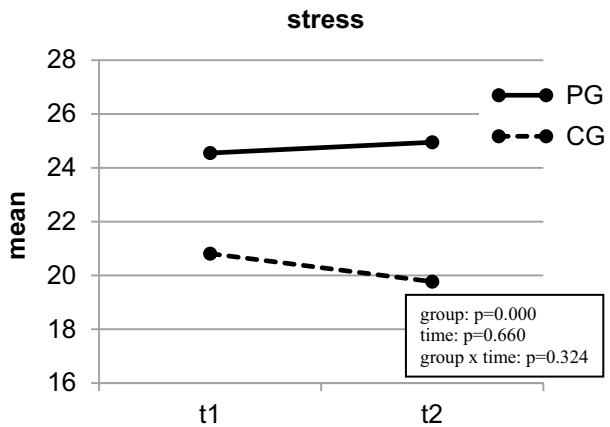

Fig. 3 Course of stress symptoms (PSS) from pregnancy to postpartum (analysis of variance with repeated measures). PG patient group ($N = 75$); CG control group ($N = 70$); t1 24.–36. week of gestation; t2 6 weeks postpartum; group main effect of the group; time main effect of the time; group × time interaction effect; *p* *p*-value

Postpartum mother–infant bonding

We did not find differences between patients and controls for the total PBQ score and all analyzed PBQ subscales: "total value" ($t(142) = -1.006$, $p = 0.316$), "impaired bonding" ($t(142) = -0.783$, $p = 0.435$), "rejection and anger" ($t(142) = -1.301$, $p = 0.195$), and "anxiety" ($t(140) = 0.848$, $p = 0.398$) (see Fig. 4).

Total value in the PG was $M = 10.15$ (SD = 8.23) and $M = 11.59$ (SD = 9.04) in the CG. The scale score "impaired bonding" was $M = 5.40$ (SD = 4.49) in the PG and $M = 6.02$ (SD = 4.93) in the CG, scale score "rejection and anger" was $M = 2.11$ (SD = 2.57) in the PG and $M = 2.71$ (SD = 3.00) in the CG, scale score "anxiety" was $M = 2.61$ (SD = 1.95) in the PG and $M = 2.35$ (SD = 1.60) in the CG. Only 7% of the PG ($N = 5$) and 9% of the CG ($N = 6$) reported a PBQ total score above the clinical cut-off (indication of a mother–child bonding disorder).

Discussion

Mental health

We found higher levels of depression, anxiety, and perceived stress in women with threatened preterm birth compared to women without PC both during pregnancy and 6 weeks postpartum, which is in line with previous findings [12–14, 22, 23]. While depression and anxiety, as in other longitudinal studies [10, 12, 15], decreased postpartum in both groups, the stress level remained unchanged even 6 weeks after birth. The perceived stress scale does not contain information about the factors that caused stress in these women. It can be assumed, however that even though the stress levels in pregnant and postpartum women are comparable the respective stressors differ.

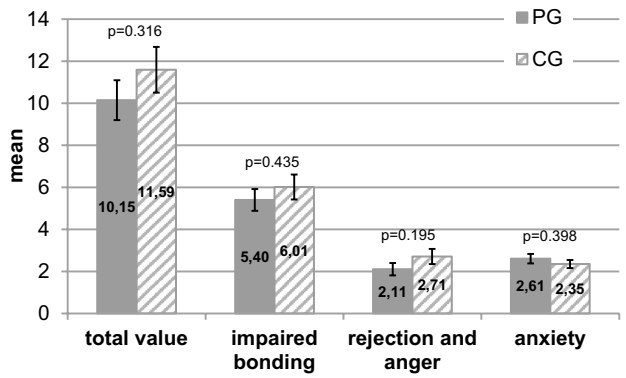

Fig. 4 Mother–infant bonding, sum score-means for PBQ scales. *PG* patient group, *CG* control group, *p* *p*-value of each scale shows no significant differences between the groups; Error bars represent standard error of the mean

In our study, almost half of the women with threatened premature birth reported clinically relevant depressive symptoms during inpatient treatment in pregnancy, far more than in the CG. Regarding anxiety and perceived stress, there were also clear differences between PG and CG, albeit to a lesser extent than in depression. That could be an indication that these differences existed before inpatient treatment. Psychological stress during pregnancy has already been identified as a predictor of pregnancy complications [7, 8]. This hypothesis could also be supported by the fact that women in the PG reported more frequently to suffer from a current mental disorder and/or mental disorder in the past, than women in the CG, although these differences did not reach statistical significance due to the small number of cases. However, women in the PG had a significantly higher rate of depression, anxiety, and perceived stress than women in the CG, regardless of previous/current mental disorders. This finding suggests that a psychological predisposition (in the sense of a current or previous mental disorder) would not be solely decisive for the elevated depressive, anxious, and stress symptoms of the PG during their inpatient treatment. It is more conceivable that other stressful life circumstances, especially stress caused by a long-term inpatient treatment, play a significant role in symptom development [5, 6].

Even if the reduction of psychological symptoms in the course of pregnancy to postpartum period seems pleasing at first glance, the fact that almost 50% of inpatient women with PC had clinically relevant depressive symptoms should be taken seriously. It is well known that depression, anxiety, and stress in pregnant women are associated with a high risk of developmental impairment of the fetus, premature birth, adverse birth, and developmental outcomes, as well as with later emotional and behavioral problems of the children [26–29]. Study results in the field of fetal programming also show effects on the disease disposition of offspring [55, 56]. The underlying mechanisms and moderation by genetic factors are currently being further investigated down to the molecular and epigenetic levels. However, there is a lack of translation between these research findings and their application in clinical care. Interventions to reduce psychological stress in inpatient women with PC are therefore required. This is even more important for women with PC and previous or current mental disorders. These women should be offered psychosocial support both during pregnancy and the postpartum period.

Previous research has shown that psychosomatic bedside intervention during liaison and consolation might have a positive long-term effect on mental condition of women with PC during hospitalization, in particular anxiety levels could be reduced [5]. For a long-term reduction of depressive symptoms, psychotherapeutic treatment of longer duration

seems to be needed [57, 58]. Screening instruments such as the EPDS [44] can identify women who need further evaluation or treatment. Women with severe symptoms may also need pharmacological treatment. The benefits of psychiatric medication for symptom relief, possible side effects for the women such as post-SSRI sexual dysfunction [59] and risks to the fetus/infant [60] must be well considered and assessed by specific experts in this field with clarification and involvement of the affected women. There are also positive reports of alternative therapies such as light therapy [61], yoga and massage therapy [62], and acupuncture for depression in women during pregnancy [63]. Additionally, Bauer et al. could show that bed rest-related psychosocial distress might also be significantly relieved through music and recreation therapy [64]. However, well-designed trials directly comparing efficacy of these alternative therapy options with the usual standard therapies are scarce, but urgently needed.

Postpartum mother–infant bonding

We did not find differences between women with and without pregnancy complications on all PBQ scales used. Our results are thus in line with previously published data [41, 42]. Similar to Dollberg et al. [43] who did not find differences in the perceived efficacy and satisfaction with parenting roles, we found no differences in the perceived mother–infant relationship, even if these are only similar constructs. Due to the increased mental burden during hospital stays and also postpartum, especially with regard to depression, it could have been assumed that this stress was reflected in a higher impairment of the mother–infant bonding as well. Associations between depression and mother–infant bonding disorders have been well investigated [32–34]. However, in our PG, bonding problems were only more common in women with current mental illnesses to the CG. The predominant proportion of prenatal depression and anxiety during inpatient treatment due to threatened preterm birth could obviously be ascribed etiologically to a situational threat that is no longer present postpartum. In classical postpartum depression with associated bonding problems, further causes may also play a role (e.g. previous history of depression, life events, marital relationship, social support, socioeconomic status) [65]. Risk factors also include depression and/or anxiety in pregnancy [65]. Alternatively, it would also be possible that disturbances in the mother–infant bonding are only consciously perceived by the mothers until later than 6 weeks postpartum, which is why further research in this field is needed.

Limitations

Results of this study should be interpreted considering the strengths and limitations of this study. The longitudinal study design, the homogeneity of the sample with regard to the type of pregnancy complications, and low dropout rates, allow a reliable description of the prospective course of mental health problems in women with PC. However, the study also had some limitations. Women with PC were examined in a single hospital and the PG and CG were recruited in the same German city, which may result in a limited generalizability of the results to other regions. Furthermore, it was not considered how other stress factors besides hospitalization may influence mental condition of the women at both times of assessment. The subsequent exclusion of 14 women from the analyses who had given birth to an extremely or a very small premature baby ($\leq$ 32nd week of gestation), changed our naturalistic sample in the sense of homogenization. This was done to improve the comparability of postpartum mental health and mother–infant bonding in that all the study participants had their baby at home at *t*2. Dropout analysis indicated significantly higher scores of the dropouts in terms of depression, anxiety, and stress compared to the remaining patient group. Therefore, an overall underestimation of poor postpartum mental condition through the results of the present trial cannot be completely ruled out. A high ratio of potential socially desirable responses can, especially in terms of the questionnaires assessing mother–infant bonding, be one cause of absent differences. We did not include mothers hospitalized with threatened preterm birth secondary to maternal illnesses (gestational hypertension, preeclampsia), which could add an important group of women. Their anxiety and other mental health issues might differ in that delivery is often made for maternal health reasons and might lead to different feelings of guilt and stress.

Conclusion

Results of the present work indicate a higher mental burden in terms of depression, anxiety, and stress experience of hospitalized women with signs of threatened preterm birth, pre and postpartum, compared to women with an unthreatened pregnancy. This deserves special considerations as a growing number of longitudinal studies has shown that mental burden during pregnancy is associated with a higher risk for postpartum depression [30, 31], negative consequences for the fetus, and the long-term development of the child [26–29, 55, 56]. Our results underline the importance of an early diagnosis and treatment of depression, anxiety, and elevated stress symptoms in inpatient women with pregnancy complications. Unfortunately, it is still a fact that only a small amount of women with a mental burden is recognized by medical staff in obstetric clinics. Consequently, the need of a sufficient psychological assessment and psychotherapeutic interventions is still underestimated [66]. Mental health questionnaires could be used to assess the necessity of

a professional mental health diagnosis and treatment indication. The presence of current or previous mental disorders in inpatient obstetric settings should also be examined as a matter of routine, because these women do need additional psychological and social support during pregnancy and the postpartum period.

Although hospitalized women due to PC reported a higher mental burden postpartum than women without PC, a general mother–infant bonding problem has not been proven. Research done on this issue is still sparse and further studies are needed to confirm this result and determine whether psychological interventions can prevent or attenuate negative influences of maternal mental health burden on fetus and child development.

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Author contributions HC, BA, and WK designed the study. HC performed the analysis and wrote the manuscript in consultation with BA. JJH, MS, NK, and WK revised the manuscript for critical input. All authors discussed the results and contributed to the final manuscript.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest and are solely responsible for the content of this article.

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