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Posttraumatic stress, anxiety, and depression in mothers after preterm delivery and the associated psychological processes

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Abstract

Background Mothers of preterm infants report traumatic, anxious and depressive symptoms in the postpartum period. Many studies have focused on biological, social, and life circumstance factors to explain the emergence of these symptoms. The process model proposes to focus on psychological processes, which are mechanisms underlying mental disorders. However, the psychological processes underlying the onset of traumatic, anxious, and depressive symptoms in postpartum mothers of preterm infants had not yet been investigated. The aim of this study was to identify the most common symptoms experienced in the first few days after delivery and determine whether processes of anhedonia, brooding rumination, and worry are related to posttraumatic stress (PTS), anxiety, and depression symptoms.

Methods A sample of 106 mothers was screened for PTS, anxiety, and depression symptoms within the first 10 days after their preterm delivery. Anhedonia, brooding rumination, and worry were also assessed as psychological processes. Student's *t*-tests were performed to identify the most severe manifestation reported. To explore the relationship between psychological processes and symptoms, multiple linear regressions were performed on each symptom.

Results Descriptive analysis shows that 75.5% of mothers reported a pathological symptom level for at least one of PTS, anxiety, or depression. Being alert and worrying are the predominant manifestations experienced in the first few days after preterm birth. Multiple linear regression showed that PTS symptoms were associated with worry and brooding rumination; anxiety symptoms were associated with worry, reminiscence pleasure and a deficit in consummatory pleasure; and depressive symptoms were associated with worry and a deficit in consummatory pleasure.

Conclusions Our findings support the transdiagnostic nature of psychological processes and suggest that anhedonia, brooding rumination, and worry may be relevant targets for psychological interventions to concurrently treat PTS, anxiety, and depression symptoms. Behavioral activation could be an effective intervention to target these dysfunctional processes and thus improve maternal symptoms.

Keywords Anhedonia, Mental health, Postpartum, Preterm birth, Rumination, Worry

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Introduction

Prematurity is defined as birth before the 37th week of amenorrhea. It is a significant factor in neonatal morbidity and mortality [1]. It is a perinatal complication that also involves a significant risk of morbidity and mortality for the mother [2]. These perinatal stress factors related to preterm birth make it a risk factor for the onset of psychopathological symptoms in postpartum mothers [3, 4]. Assessments of mothers' psychological profiles after preterm delivery highlight the presence of posttraumatic stress (PTS), anxiety, and depression symptoms [5–7]. A systematic review of PTS symptoms in mothers of preterm infants showed that the prevalence of a pathological level of symptoms ranged from 18 to 45% and that 77.8% of mothers had potential posttraumatic stress disorder (PTSD) [8]. The prevalence of anxiety ranges from 50 to 75% depending on the study [9–11], and the prevalence of depression is around 40% [12]. Some studies show a predominance of depressive symptoms over anxiety symptoms [9, 13, 14], while others show the opposite pattern [7, 10]. Thus, the results regarding the predominance of these symptoms are contradictory.

Concerning the factors that influence maternal symptoms, a systematic review reported that social and circumstantial factors such as younger maternal age, being a housewife, being married, higher maternal education, young gestational age, and caesarean section increase the risk of developing PTS symptoms [8]. A recent meta-analysis found no circumstantial, biological, or social factors to be significantly associated with postnatal symptoms of anxiety or depression in mothers after preterm birth, except the length of the child's hospitalization, which was associated with anxiety [15]. These data highlight the inconsistencies in the factors contributing to the development of maternal symptoms. However, it is essential to gain a better understanding of this process in order to guide and adapt therapeutic strategies.

Kinderman's team [16–18] introduced a model suggesting that the development of mental disorders is better explained by the disruption of psychological processes than by biological, social, or circumstantial factors. A psychological process is a mechanism underlying both mental disorders and a range of social problems [16]. A psychological process can be cognitive, emotional, or behavioral. Applied to mothers of preterm infants, this model suggests that postpartum disorder may arise from dysfunctional psychological processes.

The literature on the psychological processes related to the emergence of PTS, anxiety, and depressive symptoms in mothers after a preterm birth is sparse. However, the transdiagnostic effect of rumination and worry on PTS, anxiety, and depressive symptoms are now well documented [19–24]. Rumination and worry are two expressions of the psychological process of Repetitive Negative Thinking (RNT) [22, 24]. They are dysfunctional processes affecting cognitive and emotional information processing. Brooding rumination is the process of focusing on negative aspects of oneself or negative interpretations of one's life, usually related to the past and present. Worry has a similar processing mode to rumination, with the difference being that thoughts concern negative future events or their possible undesirable consequences. RNT was found to be associated with anxiety and depression in both pregnant and postpartum mothers [25]. In a sample of postpartum mothers, brooding rumination was found to predict the severity of depression symptoms at 1 month postpartum [26]. Antenatal worrying predicted anxiety and depression in both late pregnancy and the postpartum period [25]. Thus, it is hypothesized that these processes could partly explain the emergence of PTS, anxiety, and depressive symptoms in mothers of preterm infants.

Anhedonia as psychological process is an impairment of the ability to experience pleasure in relation to past, present, and future pleasant events. As a psychological process, anhedonia refers to patterns of information processing (e.g. I don't enjoy things as much as I should), while as a symptom, it refers to psychological states (e.g. I have lost interest in my appearance). Anhedonia as process has been identified as a common substrate for anxiety and depression, and contributes to explaining the strong comorbidity observed between these two disorders [27]. Studies show that a high level of anhedonia at the start of treatment for depression is associated with poorer outcomes [28, 29]. The effect of anhedonia on PTS symptoms has also been demonstrated [30]. PTS symptoms are associated with dysregulation of the neuronal reward circuit [31]. Perceived stress is also associated with a reduction in hedonic capacities [32, 33]. Stanton et al. [34] demonstrated that the physiological circuitry and psychological reward mechanisms underlying individuals' hedonic capacity are impaired by stress. It is important to note that a dysfunction in the reward system constitutes a vulnerability for the onset of a major depressive disorder [35]. These findings suggest that preterm birth, a stressful situation, may alter a mother's hedonic capacity and predispose her to the onset of psychological disorders. In other words, anhedonia could partially explain the emergence of PTS, anxiety, or depressive symptoms in mothers of preterm infants.

No data on the mental health of Cameroonian mothers after a preterm birth has been published. However, the prevalence of preterm birth in Cameroon is estimated to be 27.6% [36]. In Cameroon, mothers are often involved in caring for their newborns, including preterm babies, very soon after delivery. It has been shown that mothers' symptoms after preterm delivery are related to the adverse interactions with their infant and adverse

outcomes on the infant [37–39]. Anhedonia, brooding rumination, and worry have been documented to affect the onset and severity of PTS, anxiety, and depressive symptoms. Thus, the involvement of these processes in mothers' mental health after a preterm birth should be investigated.

The purpose of this study was to examine the mental health of mothers following preterm delivery in Cameroon. Specifically, the study aimed to (1) identify the most common symptoms experienced in the first few days after delivery, and (2) determine whether anhedonia, brooding rumination, and worry are related to PTS, anxiety, and depression symptoms. First, the severity of anxiety and depressive symptoms was compared to identify the predominant set of symptoms in the first days after a preterm birth. Within the same scale, items were compared to identify the most severe manifestations reported. Considering the stressful nature of preterm birth and the relatively early timing of symptom assessment, we hypothesized that anxiety symptoms would be the dominant manifestations in the first few days after preterm delivery. Second, the relationship of anhedonia, brooding rumination, and worry to postpartum mothers' PTS, anxiety, and depressive symptoms in the first days after preterm birth was examined using multivariate analyses. We hypothesized that PTS, anxiety, and depressive symptoms after preterm birth would be associated with the psychological processes examined in this study (see Fig. 1).

Method

Participants and procedures

This cross-sectional study was conducted in a cohort of mothers ($N = 106$) who delivered before 37 weeks of amenorrhea at Laquintinie Hospital and Bonassama District Hospital in Cameroon between March 2021 and February 2022. To be eligible, mothers had to be French-speaking and at least 21 years old,[1] and provide written informed consent for participation. The research was presented to participants as a study about psychological difficulties after preterm birth.

Eligible mothers were invited to participate in this study within the first 10 days after their preterm delivery. Assessments were administered individually either in a consulting room, near the baby's incubator or crib, or at the mother's hospital bed. The characteristics of the participants are shown in Table 1. One hundred and six mothers between the ages of 21 and 45 were recruited. Their babies were born at 27 to 36 weeks of gestation.

Data collection was approved by the Ethics Committee of the University of Douala, the Ethics Committee of the University Hospital of Liège and the Ethics Committee of the Faculty of Psychology, Speech Therapy, and Education Sciences of the University of Liège. Written informed consent was obtained from all participants in this study.

Measures

Posttraumatic stress symptoms

PTS symptoms were screened with the French version of the *Posttraumatic Stress Disorder Checklist for DSM-5*

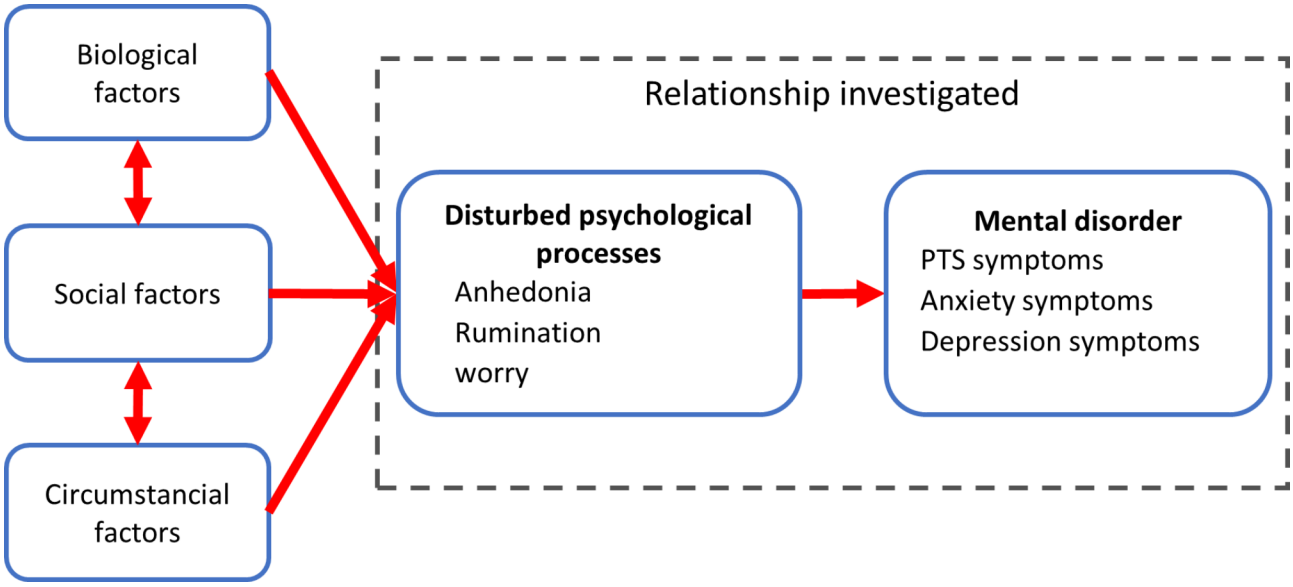

Fig. 1 : Role of psychological processes in the genesis of postpartum symptoms (inspired by Kinderman's model)

[1] Age of civil majority in Cameroon.

Table 1 Participants' sociodemographic characteristics, antecedents, and perinatal parameters

Variables	*n* (%)	Mean (SD)
Age (years)		28.8 (5.16)
≤ 25	33 (31.1%)	
26–30	39 (36.8%)	
> 30	34 (32.1%)	
Education (years)		12.51 (3.18)
Primary education (≤ 6 years)	10 (9.4%)	
Secondary education (7–13 years)	56 (52.8%)	
Higher education (> 13 years)	40 (37.7%)	
Monthly income (CFA francs)		
< 50,000	49 (46.2%)	
50,000–100,000	40 (37.7%)	
> 100,000	17 (16%)	
Marital status		
Single	31 (29.2%)	
In a relationship	53 (50%)	
Married	22 (20.8%)	
Other children		1.22 (1.23)
Primiparous	41 (38.7%)	
Multiparous	65 (61.3%)	
Antecedent perinatal complications		
Yes	33 (31.1%)	
No	73 (68.9%)	
Delivery		
Vaginal	69 (65.1%)	
Caesarean	37 (34.9%)	
Pregnancy conception		
Unplanned	43 (40.6%)	
Planned	63 (59.4%)	
Prematurity level (weeks)		32.88 (2.1)
Extremely preterm (≥ 27 weeks)	3 (2.8%)	
Very preterm (28–31 weeks)	19 (17.9%)	
Late preterm (32–36 weeks)	84 (79.2%)	

(PCL-5) [40]. The PCL-5 is a self-report measure that assesses the 20 DSM-5 symptoms of PTSD with 20 items. Items are scored from 0 (not at all) to 4 (extremely) to assess symptom severity. The cut-off of ≥ 32 points was used to identify participants with a pathological level of PTS symptoms, as recommended by Ashbaugh et al. [39] for the French version. For this sample, the McDonald's ω was 0.86.

Anxiety and depression symptoms

Anxiety and depression symptoms were screened using the French version of the *Hospital Anxiety and Depression Scale (HADS)* [41]. The HADS has two subscales: the anxiety subscale (HADS-A), which assesses the severity of anxiety symptoms, and the depression subscale (HADS-D), which assesses the severity of depressive symptoms. The HADS consists of 14 items, 7 for each subscale. Every item is scored from 0 to 3 depending on the presence and severity of the symptom assessed. According to Lépine [42], a score of 7 or less indicates low-level anxiety or depression; a score between 8 and 10 indicates a moderate level of anxiety or depression; and a score of 11 or more indicates a high level of anxiety or depression. In this sample, the McDonald's ω was 0.61 for the HADS-A[2] subscale and 0.72 for the HADS-D subscale.

Anhedonia

Anhedonia was assessed using the *Savoring Beliefs Inventory (SBI)* [43]. The SBI is a self-report questionnaire of hedonic capacity. It is composed of 24 items divided into three subscales: Reminiscence Pleasure (RP), Consummatory Pleasure (CP) and Anticipatory Pleasure (AP), which refer to the past, present, and future, respectively. Each subscale consists of 8 items and each item is evaluated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). In this sample, a McDonald's ω of 0.80 was found for the RP subscale, 0.60 for the CP subscale[3] and 0.74 for the AP subscale.

Rumination

Rumination was assessed with the French version of the *Mini Cambridge-Exeter Ruminative Thought Scale (Mini-CERTS)* [44]. The Mini-CERTS is a scale for assessing constructive and unconstructive thinking. It includes 16 items divided into two subscales: Abstract Analytic Thinking (AAT), with 9 items corresponding to brooding rumination, which is a kind of unconstructive thinking; and Concrete Experiential Thinking (CET), with 7 items corresponding to reflection, which is a constructive mode of thinking. The items are rated on a 4-point Likert scale ranging from 1 (almost never) to 4 (almost always). Only the AAT subscale was considered in this study. The McDonald's ω for the sample was 0.56 for the AAT subscale[4].

Worry

Worries were assessed with the French version of the *Penn State Worry Questionnaire (PSWQ)* [45]. The PSWQ has 16 items that are rated on a 5-point Likert scale ranging from 1 (not at all typical of me) to 5 (very typical of me). The validation of the French version reported good psychometric properties in terms of internal consistency and discriminant validity. In this sample, the McDonald's ω was 0.78.

[2] For HADS-A subscale, item withdrawal tests were performed, and any item did not significantly improve internal consistency.

[3] Idem for SBI-CP subscale.

[4] Idem for Mini-CERTS-AAT subscale.

Statistical analyses

All data analyses were performed using Jamovi (version 2.3). First, descriptive analyses were done to describe measures and correlations were calculated. Within each scale, items were compared with each other using Student's *t*-test to identify the most severe manifestation reported. To explore the relationship of the psychological processes of anhedonia, brooding rumination, and worry, with symptoms, multiple linear regressions were performed on PTS, anxiety, and depressive symptoms, respectively. Prior to the analyses, the absence of collinearity between the psychological processes was checked. Given the number of tests performed, the Benjamini and Hochberg [46] procedure was applied to each analysis to correct the *p*-value and thus control the false discovery rate. It is a procedure for controlling the false discovery rate when several independent statistics are calculated on the same sample. Only Benjamini-Hochberg corrected *p*-values are reported here.

Results

Descriptive statistics and psychopathology levels

Table 2 shows the frequencies, means and standard deviations for the measures. On the PCL-5, 29 mothers (27.4%) scored 32 or above, indicating a pathological level of PTS symptoms. On the HADS, 67 mothers (63.2%) reported moderate to severe anxiety, while 49 mothers (46.2%) reported moderate to severe depression. Eighty mothers (75.5%) reported a pathological symptom level on at least one of the three measures. The examination of the concurrent presence of traumatic, anxiety and depressive symptoms with scores above the cut-off showed that 46 mothers (43.4%) reported a pathological symptom level on at least two of the PCL-5, HADS-A and HADS-D measures. Nineteen (17.9%) reported a pathological symptom level on all three measures (PCL-5, HADS-A and HADS-D). Twenty-seven mothers (25.5%) had a pathological symptom level on two measures: 19.8% on anxiety and depressive symptoms, 4.7% on PTS and anxiety symptoms, and 0.9% on PTS and depressive symptoms.

PTS, anxiety and depression symptoms are positively related to rumination and worry and negatively related to consummatory pleasure. Anxiety and depression symptoms are also negatively related to anticipatory pleasure. Table 3 shows the matrix of correlations between the different variables of interest.

Predominant symptomatology

The comparison of HADS-A score (*Mean* = 8.82, *SD* = 3.71) and HADS-D score (*Mean* = 7.24, *SD* = 4.13) revealed that the overall HADS-A score was significantly higher than the HADS-D score ($t = 4.7$, $df = 105$, $p < 0.001$, Cohen's $d = 0.456$). To identify the most severe manifestations reported by mothers, each item was compared with the others on the same scale. For the PCL-5

Table 2 Descriptive data from the instruments used

Variables	*n* (%)	Mean (SD)	95% CI mean lower bound	95% CI mean upper bound
PCL-5– Posttraumatic stress		23.1 (14.8)	20.3	25.9
No acute stress (< 32)	77 (72.6)			
Acute stress (≥ 32)	29 (27.4)			
HADS– Anxiety		8.82 (3.71)	8.11	9.53
Low (< 8)	39 (36.8)			
Moderate (8–10)	34 (32.1)			
High (≥ 11)	33 (31.1)			
HADS– Depression		7.24 (4.13)	6.45	8.02
Low (< 8)	57 (53.8)			
Moderate (8–10)	25 (23.6)			
High (≥ 11)	24 (22.6)			
Co-occurrence	**46 (43.4)**			
PTS–Anxiety	5 (4.7)			
PTS–Depression	1 (0.9)			
Anxiety–Depression	21 (19.8)			
PTS–Anxiety-Depression	19 (17.9)			
Psychological processes				
RP		12.6 (9.84)	10.7	14.5
CP		10.9 (7.6)	9.44	12.3
AP		11.8 (8.46)	10.2	13.4
AAT		20.3 (4)	19.5	21.0
PSWQ		49.4 (8.86)	47.5	51.2

PCL-5, Posttraumatic Checklist for DSM-5; PTS, Posttraumatic stress; HADS, Hospital Anxiety and Depression Scale; RP, Reminiscence Pleasure; CP, Consummatory Pleasure; AP, Anticipatory Pleasure; AAT, Abstract Analytic Thinking; PSWQ, Penn State Worry Questionnaire

Table 3 Correlation matrix

	PCL-5		HADS-A		HADS-D		RP		CP		AP		AAT	
PCL-5	—													
HADS-A	0.534	***	—											
HADS-D	0.478	***	0.612	***	—									
RP	−0.054		−0.003		−0.157		—							
CP	−0.266	**	−0.280	**	−0.375	***	0.588	***	—					
AP	−0.167		−0.218	*	−0.288	**	0.580	***	0.563	***	—			
AAT	0.401	***	0.305	**	0.229	*	−0.056		−0.266	**	−0.150		—	
PSWQ	0.370	***	0.400	***	0.320	***	−0.115		−0.226	*	−0.263	**	0.471	***

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

PCL-5, Posttraumatic Checklist for DSM-5; PTS, Posttraumatic stress; HADS, Hospital Anxiety and Depression Scale; RP, Reminiscence Pleasure; CP, Consummatory Pleasure; AP, Anticipatory Pleasure; AAT, Abstract Analytic Thinking; PSWQ, Penn State Worry Questionnaire

scale, Student's *t*-tests showed that the score for the item *Being superalert or watchful or on guard* was significantly higher than the scores for all the other items on that scale (Table 4). The mode in this item was the maximum score, with 36 mothers (34%) scoring 4 = *Extremely*; for the other items of the scale, the mode was the minimum score, with the majority of mothers scoring 0 = *Not at all*. For the HADS, the score for the item *Worrying thoughts go through my mind* from the HADS-A subscale was significantly higher than those of all other items of the entire HADS (Table 5). The mode in this item was the maximum score, with 45 mothers (42.5%) scoring 3 = *A great deal of the time*. For all other anxiety and depression items on the HADS scale, the majority of mothers scored the minimum of 0 or 1.

Symptoms and psychological processes

To investigate the relationship between psychological processes and symptoms, we conducted a multilinear regression with the Benjamini-Hochberg correction. As expected, the results show that the three psychological processes examined here are related to PTS symptoms [$F(5, 100) = 6.03$, $p < 0.001$, $R^2 \approx 0.24$], anxiety symptoms [$F(5, 100) = 6.67$, $p < 0.001$, $R^2 = 0.25$] and depressive symptoms [$F(5, 100) = 5.4$, $p < 0.001$, $R^2 \approx 0.22$].[5] Psychological processes related to each symptom scale are reported in Table 6. The analyses revealed that an increase in AAT score and PSWQ score is associated with an increase in PTS symptoms ($t = 2.427$, $p = 0.017$; and $t = 2.09$, $p = 0.039$, respectively). An increase in RP score and PSWQ score is associated with an increase in anxiety symptoms ($t = 2.363$, $p = 0.02$; and $t = 2.907$, $p = 0.004$, respectively). A decrease in CP score is associated with an increase in anxiety symptoms ($t = -2.368$, $p = 0.02$). A decrease in CP score is associated with an increase in depressive symptoms ($t = -2.732$, $p = 0.007$), as does an increase in PSWQ score ($t = 2.087$; $p = 0.039$).

Discussion

Most studies on mothers of preterm infants have focused only on symptom prevalence. This study is the first to investigate dysfunctional psychological processes in a population of mothers of preterm infants in Africa. We hypothesized that anhedonia, brooding rumination, and worry would be processes underlying symptoms in mothers after preterm delivery. Our findings can be summarized into three main points. First, the prevalence of PTS, anxiety, and depressive symptoms in Cameroonian mothers of preterm infants suggests that they are at high risk of experiencing postpartum symptoms. These results are consistent with previous studies [8, 12, 15]. Second, the results revealed that psychological processes are

[5] P-values mentioned here are Benjamini-Hochberg corrected values.

Table 4 Comparisons of item P17 with other PCL-5 items

Measure 1	Measure 2	t statistic	df	*P*-value	Cohen's d
P17	P1	5.22	105	< 0.002	0.507
	P2	7.87	105	< 0.002	0.764
	P3	7.25	105	< 0.002	0.705
	P4	5.57	105	< 0.002	0.541
	P5	5.67	105	< 0.002	0.551
	P6	4.19	105	< 0.002	0.407
	P7	6.79	105	< 0.002	0.659
	P8	6.79	105	< 0.002	0.659
	P9	6.36	105	< 0.002	0.617
	P10	7.94	105	< 0.002	0.772
	P11	3.75	105	< 0.002	0.364
	P12	6.81	105	< 0.002	0.661
	P13	5.95	105	< 0.002	0.577
	P14	6.42	105	< 0.002	0.624
	P15	8.26	105	< 0.002	0.802
	P16	10.19	105	< 0.002	0.990
	P18	6.51	105	< 0.002	0.633
	P19	6.46	105	< 0.002	0.627
	P20	2.11	105	< 0.02	0.205

Note. H_a μMeasure 1– Measure 2 > 0

P-values are Benjamini-Hochberg corrected values

Item P17: "*Being superalert or watchful or on guard.*"

Table 5 Comparisons of item H3 with other HADS items

Measure 1	Measure 2	t statistic	df	*P*-value	Cohen's d
H3	H1	5.32	105	< 0.001	0.516
	H2	7.24	105	< 0.001	0.703
	H4	4.86	105	< 0.001	0.472
	H5	11.44	105	< 0.001	1.111
	H7	8.08	105	< 0.001	0.785
	H8	6.24	105	< 0.001	0.606
	H9	8.13	105	< 0.001	0.790
	H10	12.06	105	< 0.001	1.171
	H11	8.69	105	< 0.001	0.844
	H12	4.94	105	< 0.001	0.480
	H13	12.01	105	< 0.001	1.167
	H14	8.56	105	< 0.001	0.831

Note. H_a $\mu_{\text{Measure 1– Measure 2}} > 0$

P-values are Benjamini-Hochberg corrected values

Item H3: "*Worrying thoughts go through my mind.*"

related to a large proportion of the variance in PTS, anxiety, and depressive symptoms in mothers after preterm delivery. Anhedonia, brooding rumination and worry are related to symptoms in Cameroonian mothers of preterm infants. Third, the results show that psychological processes are associated with multiple symptoms simultaneously, supporting the transdiagnostic nature of dysfunctional psychological processes [21, 27, 47].

Mothers' symptoms a few days after preterm delivery

The prevalence of postnatal symptoms in this study was estimated at 27.4% for PTS symptoms, 63.2% for anxiety symptoms and 46.2% for depressive symptoms in mothers a few days after preterm delivery. The prevalence of PTS symptoms is similar to the prevalence of between 28% and 32.5% previously reported in studies conducted in Canada and Iran during the first 10 days after a preterm delivery [48, 49]. However, it is substantially lower than the 71.1% observed in a study conducted in the USA [7]. This discrepancy may be attributable to the fact that Shaw et al. (2014) examined all traumatic events associated with infants' Neonatal Intensive Care Unit (NICU) hospitalization rather than focusing solely on the traumatic event of preterm delivery. The prevalence of

Table 6 Significant factors of the multiple linear regressions for every set of symptoms

Variables	*Factors*	*Estimate*	*SE*	*95% CI*		*t*	*P-value*	
				Lower	*Upper*			
PCL-5 (PTS)	Intercept	-85.906	9.014	-264.735	92.923	-0.953	0.343	
	RP	0.1853	0.177	-0.1668	0.5373	1.044	0.299	
	CP	-0.4049	0.232	-0.8645	0.0546	-1.748	0.083	
	AP	-0.0491	0.204	-0.4533	0.3550	-0.241	0.810	
	AAT	**0.9162**	**0.377**	**0.1673**	**16.651**	**2.427**	**0.017**	*
	PSWQ	**0.3198**	**0.153**	**0.0162**	**0.6235**	**2.090**	**0.039**	*
HADS-A (Anxiety)	Intercept	25.555	22.333	-18.754	69.864	1.144	0.255	
	RP	**0.1039**	**0.0440**	**0.0167**	**0.1911**	**2.363**	**0.020**	*
	CP	**-0.1359**	**0.0574**	**-0.2497**	**-0.0220**	**-2.368**	**0.020**	*
	AP	-0.0574	0.0505	-0.1575	0.0428	-1.136	0.258	
	AAT	0.0822	0.0935	-0.1034	0.2678	0.879	0.382	
	PSWQ	**0.1102**	**0.0379**	**0.0350**	**0.1855**	**2.907**	**0.004**	**
HADS-D (Depression)	Intercept	40.815	25.500	-0.97754	91.406	1.601	0.113	
	RP	0.0553	0.0502	-0.04430	0.1549	1.102	0.273	
	CP	**-0.1790**	**0.0655**	**-0.30900**	**-0.0490**	**-2.732**	**0.007**	*
	AP	-0.0578	0.0576	-0.17213	0.0565	-1.003	0.318	
	AAT	0.0308	0.1068	-0.18104	0.2427	0.289	0.773	
	PSWQ	**0.0904**	**0.0433**	**0.00445**	**0.1763**	**2.087**	**0.039**	*

*Significant at $p < 0.05$ and **Significant at $p < 0.01$

PCL-5, Posttraumatic Checklist for DSM-5; PTS, Posttraumatic stress; HADS, Hospital Anxiety and Depression Scale; RP, Reminiscence Pleasure; CP, Consummatory Pleasure; AP, Anticipatory Pleasure; AAT, Abstract Analytic Thinking; PSWQ, Penn State Worry Questionnaire

anxiety we found is consistent with the findings of previous studies, which reported that approximately half of mothers of preterm infants experience pathological levels of anxiety within the first two weeks after birth [7, 10, 11]. As for depression, the prevalence found in this study is similar to the results of several studies assessing depressive symptoms within 2 weeks after preterm delivery [7, 10, 48], which reported a prevalence ranging from 35.6 to 43%. Furthermore, these data are in line with a systematic review of the literature that reported a prevalence of depression corresponding to 40% in mothers of preterm babies [12]. However, in the week after delivery, Trumello et al. [11] reported a depression prevalence of 68% for mothers whose children were born between 28 and 31 weeks and of 60% for mothers whose children were born between 32 and 36 weeks of pregnancy. The higher proportions may be attributed to the Italian version's 8/9 cut-off point, which is lower than the usual cut-off point of 9/10 or above recommended by the authors of the Edinburgh Postnatal Depression Scale (EPDS) [50].

The respective prevalence of PTS, anxiety and depressive symptoms is higher than those in community samples of postpartum mothers [51–56]. This finding suggests that preterm birth is a stressful event that increases the risk of postpartum disorders in mothers [3, 8, 9].

Few previous studies provide data comparing the prevalence of anxiety and depression in mothers following preterm birth, and those results are inconsistent. In our study, the predominance of anxiety over depression is also supported by the fact that mothers of preterm newborns report *being alert* and *worrying* as the main manifestations during the first days after delivery. These results are in line with two studies assessing anxiety and depression in the first two weeks after preterm delivery [7, 10]. Trumello et al. [11] found equivalent prevalence in the first week postpartum, which is inconsistent with this study. However, those authors used a cut-off point of 8/9 for the EPDS, which is lower than the standard cut-off point of 10. This may have contributed to an increase in the rate of depression, making it similar to that of anxiety. In sum, Cameroonian mothers of preterm infants report PTS, anxiety, and depression, with a higher prevalence for anxiety symptoms.

Psychological processes underlying symptoms

For anhedonia, our findings indicate that a deficit in consummatory pleasure has a transdiagnostic effect, associating it with the severity of both anxiety and depressive symptoms. This effect on depressive symptoms is in accordance with the findings of Wu et al.'s [57] study, in which depressed people showed a greater consummatory pleasure deficit than healthy individuals. According to Stanton et al. [34], the deficit in consummatory pleasure may be associated with a disruption of the physiological reward circuits due to the stress of the preterm birth. Our results suggest that anhedonia is a target for intervention to improve both anxiety and depressive symptoms simultaneously. These results are in line with the literature suggesting that addressing anhedonia

would improve engagement in depression treatment [58]. Behavioral activation, mindfulness-based cognitive therapy, and mental imagery therapy are potential treatments to improve anhedonia. Indeed, in a randomized controlled trial conducted by Cernasov et al. [59], participants with anhedonia were assigned to receive either behavioral activation therapy or mindfulness-based cognitive therapy. A significant reduction in anhedonia was reported in both groups. Similarly, Webb et al. [60] found that, in adolescents, behavioral activation not only reduced anhedonia but also increased neuronal sensitivity to affectively salient stimuli, including those related to reward. Two studies have also demonstrated the effectiveness of mental imagery therapy in reducing anhedonia [61, 62].

This study found that reminiscence pleasure is significantly associated with anxiety. This suggests that mothers with higher hedonic capacity in relation to past events are more likely to experience anxiety about the stressful situation of preterm birth than mothers with lower hedonic capacity. Based on the mothers' discourse during clinical interviews, it can be hypothesized that these mothers are comparing their current situation, which is stressful due to the preterm birth, with their past situation, where they felt less stress. Nevertheless, further research may be required to better understand the relationship between reminiscence pleasure and anxiety in mothers who have experienced preterm delivery.

The findings showed that brooding rumination is associated with the severity of PTS symptoms, but not anxiety or depressive symptoms. These findings support previous research indicating that a reduction in rumination following an intervention is associated with a decrease in PTS symptoms but not in anxiety and depressive symptoms [63]. The significant relationship of brooding rumination with PTS symptoms is also consistent with the findings of a systematic review that confirmed the predictive effect of brooding rumination on PTSD [20]. In our study, we assume that thoughts about preterm birth may act as mediators for the generation and maintenance of PTS symptoms caused by rumination. These thoughts likely include the fact that preterm birth is known to be a major cause of illness and death in newborns [36, 64]. This hypothesis could be tested by future research. According to the study by Schaich et al. [65], training in concrete, experiential thinking could be beneficial in countering the negative effects of rumination on PTS symptoms. This would allow mothers to address specific negative thoughts about preterm birth with factual information about their current situation and that of their baby.

Our findings indicate that worry is associated with the severity of PTS, anxiety, and depressive symptoms, which is in line with the results of previous research [22, 66, 67]. These findings also support the transdiagnostic nature of worry reported by the mother during the perinatal period [25]. Hong [68] has shown that worry can affect the severity of anxiety and depressive symptoms, which may be mediated by the perception that coping efforts to deal with the identified stressful event are not effective. An intervention should address worry, which is a transdiagnostic dysfunctional process common to PTS, anxiety, and depressive symptoms among mothers of preterm infants. Once again, behavioral activation and mental imagery are also potential interventions [69–71]. The selection of activities for behavioral activation interventions and the choice of images for mental imagery interventions should be adapted to the specific characteristics and needs of the population of mothers of preterm infants. The Kangaroo Mother Care, for example, could be proposed to mothers based on the principles of behavioral activation.

Limitations

This study has several limitations that may affect the quality of the results and their interpretation. First, it should be noted that in this study the HADS-A subscale, the CP subscale, and the AAT subscale showed insufficient internal consistency. This may explain why our results did not replicate some of the findings of previous studies. The subscales' low internal consistency suggests that certain items were not understood by Cameroonian French-speaking people in the same way as French speakers in France, with whom the scale was translated and validated. For example, the item *Je peux rester tranquillement assise à ne rien faire et me sentir décontractée* (*I can sit at ease and feel relaxed*) of the HADS-A subscale may be culturally interpreted as indicating laziness rather than an absence of anxiety. In other words, because of nuances in local word meanings, some items do not assess the behaviors they are supposed to. This explanation highlights the need to translate and validate local versions of these scales.

The cross-sectional design of the study does not allow the assertion that the psychological processes of anhedonia, brooding rumination and worry are responsible for the onset of PTS, anxiety and depressive symptoms, as in the Kinderman model [17]. As the measurements were taken cross-sectionally, the design only allows the assertion of a relationship between psychological processes and symptoms without temporal specification. Studies with a longitudinal design would provide an opportunity to investigate the effect of psychological processes on the onset and maintenance of symptoms.

It will also be interesting in future research to set up a control group with mothers of full-term babies. This will allow us to assess the real impact of preterm birth in terms of prevalence and severity of symptoms. It would

enable any differences observed between the two groups to be more accurately attributed to prematurity or full term. Finally, the sample size in this study is not large and therefore limits the generalizability of the results.

Conclusion

Despite its limitations, this study reveals the psychological distress experienced by mothers of preterm infants in Cameroon during the first 10 days after delivery. It also points to the presence of psychological vulnerability associated with dysfunctional psychological processes in mothers. Given the early involvement of mothers in the care of their preterm newborns, it can be concluded that poor mental health is also a significant threat to the survival and well-being of preterm newborns. Numerous studies have shown that postnatal psychological problems in the mother can have a deleterious impact on the quality of maternal care. The more anxious and depressed mothers are, the more their interactions with their babies are affected [72]. In addition, compared with mothers of full-term babies, mothers of preterm babies have more difficulty breastfeeding and stop breastfeeding earlier [73].

Health professionals should therefore pay particular attention to the early identification of PTS, anxiety, and depressive symptoms after a preterm delivery, and medium- and long-term follow-up seems necessary. Early interventions should also help prevent babies from developing complications due to their mothers' mental health problems [3, 8, 12]: complications related to the quality of maternal care [74, 75] and the quality of the mother-infant relationship [13].

Brooding, worrying and consummatory pleasure have been shown to be associated with maternal symptoms. According to Kinderman's [17] model, they could be involved in the onset of these symptoms. Interventions targeting these psychological processes may help to reduce symptoms and improve mothers' well-being after a preterm birth. Behavioral activation has beneficial effects on anhedonia, rumination and worry [59, 60, 63, 69, 76]. It seems to be a relevant option to offer to mothers of preterm infants. Future studies could focus on designing and testing a form of behavioral activation therapy adapted to the needs and specific characteristics of the population of mothers of preterm infants.

Abbreviations

AAT	Abstract Analytic Thinking
AP	Anticipatory Pleasure
CET	Concrete Experiential Thinking
CP	Consummatory Pleasure
EPDS	Edinburgh Postnatal Depression Scale
HADS	Hospital Anxiety and Depression Scale
HADS-A	Anxiety subscale of Hospital Anxiety and Depression Scale
HADS-D	Depression subscale of Hospital Anxiety and Depression Scale
Mini-CERTS	Mini Cambridge-Exeter Ruminative Thought Scale
NICU	Neonatal Intensive Care Unit
PCL-5	Posttraumatic Stress Disorder Checklist for DSM-5
PSWQ	Penn State Worry Questionnaire
PTS	Posttraumatic stress
PTSD	Posttraumatic stress disorder
RNT	Repetitive Negative Thinking
RP	Reminiscence Pleasure
SBI	Savoring Beliefs Inventory

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Author contributions

G. N. designed the study, analyzed the data, and drafted the manuscript. S. B. designed the study, participated in statistical analyses, and critically revised the manuscript. E. N. designed the study and revised the manuscript. B. M. and O. G. provided data for the study. All the authors read and commented on drafts of the paper and approved the final manuscript and its submission.

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Data availability

The dataset supporting the conclusions of this article is available in the OSF repository, [unique persistent identifier and hyperlink to dataset in http://osf.io/x7zjd].

Declarations

Ethics approval consent to participate

Approval was obtained from the Ethics Committee of the University of Douala (2362 CEI-Udo/08/2020/T), the Ethics Committee of the University Hospital of Liège (2020/211) and the Ethics Committee of the Faculty of Psychology, Speech Therapy, and Education Sciences of the University of Liège (1920 – 115). Written informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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