Mothers' trauma reactions following preterm birth

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Papers I-III

Preface

My interest in premature infants evolved from my clinical work as psychiatric social worker at Rikshospitalet BUP. Preterm babies' begin their lives with limited physical skills in a Neonatal Intensive Care Unit (NICU) at the hospital. An early concern was how my knowledge from infant research could be implemented in way that would support nurturing parent-infant interaction to stimulate premature infants' healthy development. In my work I met preterm mothers and fathers who consulted me for practical and psychological advice during hospitalization with their premature child. In most cases, when they came to see me, parents had been hospitalized with their infant for more than a month. At the time, I had the impression that their experience with preterm labor had been both frightening and dramatic and had affected their bonding process with their premature infant. I therefore invited them to talk about their current situation as parents and their interactional experiences with the baby. Surprisingly, parents did not respond the way I expected. They articulated no obvious problems with parental or interactional issues. I reflected about this and started to ask questions about why these issues did not appear to be critical to the parents. It did not make sense to me that parents that had been through a very dramatic event showed very few emotional reactions afterwards.

In 2004 I arranged a meeting with the nurses in NICU at Rikshospitalet. In this meeting I learned that two of them were trained as observers in the Newborn Individualized Developmental Care and Assessment Program (NIDCAP). We started regular collaboration meetings and the idea of a pilot project emerged. The pilot project was realized in 2005. The NIDCAP observers wanted to implement the NIDCAP observation program in the NICU and I interviewed the mothers about their birth experiences, their bonding experiences with their child, and their parental internal working models of their child. I also screened them with

psychometric instruments to assess their mental health and gathered socioeconomic, family history, and medical information about pregnancy and birth. I interviewed the mothers approximately two weeks after birth. Through the pilot project period I realized that my earlier experience with preterm parents and the stories they told me more than a month after preterm birth contrasted with the stories mothers told me in the interviews approximately two week following preterm birth. The impact of participating in a research project may have had an effect on the mothers' presentation. Another assumption is that the research interview was performed as soon as possible after preterm birth and consequently was able to generate data about mothers' recent birth experiences. In the event of an unaddressed traumatic birth experience, I assumed that time was helping mothers to fade out the memory of their birth experience. The mothers I met in my research interviews were absorbed by their recent birth experience and wanted urgently to talk about their experiences and their impressions of their newborn child. The psychometric screening showed alarmingly high scores for mental health problems and 75% of the parents required regular support and consultations throughout their hospital stay. Sixty-nine percent of parents were referred for psychological treatment at different measurement points following hospitalization. In the pilot project I got the impression that the preterm birth had been traumatic to several of the mothers. The stories they told me about their childbirth and their bonding process with their child seemed to be influenced by their traumatic experiences. Again, my curiosity was aroused and I began planning a PhD research project as an extension of the pilot project.

Acknowledgements

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My first supervisor dr. med., professor Trond H. Diseth has been the most enthusiastic, caring and inspiring tutor from the beginning. At the time this study was initiated, he was the head of the department at Rikshospitalet BUP where I was working. He gave his support from day one and has never stopped encouraging this project. He has generously shared his knowledge in research and trauma. His support has been of the greatest importance and he cannot be thanked enough.

My second supervisor dr. philos., professor emeritus Stein Bråten has generously shared some of his considerable knowledge in infant psychology with me. His creativity and playfulness in science has also been refreshing and inspiring. His concern and belief in me has been

consolidating in tough times, especially when work load has been high. I am grateful for his participation in this project.

My third supervisor dr. psychol., professor Per Nerdrum has been my internal supervisor at Høgskolen i Oslo og Akershus (HIOA). He has given me his support all through the work with this dissertation and has made an substantial effort in initiating structure and focus in this study. He has generously shared his time and knowledge and also shared up and downs in this period. He has challenged me theoretically, in research matters and in project planning. I am grateful for his engagement, support and important contributions to my learning process.

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The financial support from Regionssenter for barn- og unges psykiske helse (RBUP Øst og Sør) and Rikshospitalet in the initial phases of this study project was essential and I am grateful that their support made this project possible. HIOA, Department of Health Sciences, Institute of nursing, Master Programme in Mental Health care is the main source for financial support in this project. By offering me the position as research fellow I was able to finish this project. I am most grateful for this opportunity and for all financial support.

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My dear friends, I am grateful that you have been there and shared thoughts, worries and celebrations with me through this project.

Abbreviations

BUP	Barne- og Ungdomspsykiatrisk Poliklinikk (Child and Adolescent Psychiatric: CAP, outpatient clinic)
GA	Gestational Age (Weeks of Pregnancy)
GHQ	General Health Questionnaire
HIOA	Høgskolen i Oslo og Akershus (The University College of Oslo and Akershus)
IES	Impact of Event Scale
IVF	In Vitro Fertilization (Assisted Fertilization)
IVH	Intra Ventricular Haemorrhage following birth
NICU	Neonatal Intensive Care Unit
NIDCAP	the Newborn Individualized Developmental Care and Assessment Program
PA	Postterm Age
PCERA	Parent Child Early Relational Scale
PP	Postpartum
PTSD	Posttraumatic Stress Disorder
PTSR	Posttraumatic Stress Reaction

RBUP Øst og Sør	Regionssenter for barn- og unges psykiske helse (The Center for Child and Adolescent Mental Health, Eastern and Southern Norway)
STAI	Spielberger State Trait Anxiety Inventory

Summary

Background

This study was developed from the desire to contribute to the prevention of developmental disturbances in preterm children. The focus that emerged from the pilot study was to explore preterm birth as a possible traumatic experience for the mother that may influence the early mother-infant relationship. This study has been theoretically inspired by theories developed in modern infant psychology and attachment theory.

Objectives

The aim of this study was to explore maternal mental health reactions following preterm birth both short and long term with a special focus on posttraumatic stress reactions. Secondarily, we wished to identify predictors of maternal mental health outcomes. Thirdly, our aim was to explore the impact of the different physical complications, social influences and maternal mental health reactions on early mother-infant interaction at 6 and 18 months' postterm age (PA).

Methods

In a socio-economic low risk middle class sample, 29 mothers of 35 premature children born before the 33rd week of pregnancy were assessed within two weeks' postpartum (T0), two weeks after hospitalization (T1), 6 months' post-term (T2), and 18 months' post-term (T3). The standardized psychometric measures Impact of Event Scale (IES), General Health Questionnaire (GHQ) and State Anxiety Inventory (STAI-X1) assessed maternal mental

health outcomes. Interactions at six and 18 months' PA were studied in 33 preterm mother-infant dyads. The Parent-Child Early Relational Assessment Scale (PCERA) was used to assess the mother-infant interaction.

Results

The maternal mental health reactions following preterm birth with the exception of state anxiety, decreased from T0 (2 weeks' postpartum) to T1 (2 weeks from discharge from the hospital), but remained high and stable at T3 (18 months' PA). We identified the time period between T0 and T1 to have a statistically significant main effect on mental health outcomes (*Paper II*).

The prevalence of posttraumatic stress reactions (PTSR) at T0 and T3 was 52% and 23%, respectively. Depression decreased from 24% at T0 to 8% at T3. Anxiety decreased from 17 % at T0 to zero percent at T3. The results from the IES subscales, intrusion and avoidance, revealed that 66% of the mothers reported intrusions at T0 while only 28% reported avoidance. A high percentage (34%) of the intrusion reported at T0 was in the severe range. At T3 31% of the mothers reported intrusion while 12% of the mothers reported avoidance.

The regression analysis revealed that the physical complication variables which showed statistically significant associations with lower levels of mental health reactions following preterm birth were:

1. Planned caesarean and infection in pregnancy that were significantly associated with lower levels of traumatic mental health reaction in IES at T0 (*Paper I*).
2. Bleeding in pregnancy significantly that was associated with lower levels of psychological distress in GHQ at T0 (*Paper I*).

The conditions that showed statistically significant associations in regression analysis with higher degrees of maternal mental health reactions following preterm birth were:

1. Low gestational age (GA) and parity that significantly were associated with high levels of state anxiety (STAI-X1) at T0 (*Paper I*).
2. Maternal trait anxiety (STAI-X2) that showed significant associations with high degree of psychological distress (GHQ) at T0 (*Paper I*).
3. Preeclampsia, IVH (grade 1 and 2), and mothers' age that showed a significant association with higher degrees of traumatic stress reaction (IES) at T3 (*Paper II*).
4. Mothers' previous psychological treatment that showed a significant relation with higher levels of psychological distress (GHQ) at T3 (*Paper II*).
5. Maternal trait anxiety (STAI-X2) that showed significant associations with higher levels of state anxiety (STAI-X1) at T3 (*Paper II*).

A significant association between "Bleeding in pregnancy" and lower quality of mother-infant interaction was found in six of eight of the PCERA scales at T3 (*Paper III*). "Number of children in the family" showed a significant association with lower quality of mother-infant interaction at T3 on one of the eight PCERA scales (*Paper III*). Trait anxiety (STAI-X2) showed significant association with better interactional quality in mother-infant relationship at T3 in two of eight PCERA scales (*Paper III*).

Conclusions

The results of an explorative study like ours will contribute knowledge in a field with limited knowledge. Further, the results may contribute to the forming of new hypotheses for more systematic exploration. In addition the results may contribute to professionals' understanding

of mothers with preterm births and their relation with their preterm babies, what they need from professionals and treatment programs. Our results suggest that early physical complications in pregnancy may lead to lower levels of psychological distress (GHQ) and have a negative impact on mother-infant interaction at 18 months' PA. Further, a significant association between higher levels of maternal mental health reactions following preterm birth and better quality in mother-infant interaction at 18 months' PA were detected. Low GA, parity, trait anxiety, preeclampsia, IVH (1 and 2) and mother's earlier psychological treatment seem to be significantly associated with higher levels of psychological distress and anxiety following preterm birth. These conditions seem to activate distress and anxiety and have an impact on mothers' mental health reactions following preterm birth.

In our discussion of the study results we have suggested that:

1. Early warning signs of pregnancy complications may disturb the mother's bonding process with her unborn child.
2. Traumatic stress reactions may have an impact on mothers' abilities to improve their mothering capacities to meet the preterm babies' needs for extra supportive caregiving.
3. The high levels of intrusion revealed in our study may be interesting in terms of a possible posttraumatic growth effect from the traumatic event that a preterm birth is likely to be.

List of papers

Paper I

Misund, AR, Nerdrum, P, Diseth, TH. Maternal mental health in women experiencing preterm birth. BMC Pregnancy and Childbirth 2014; 14:263.

Paper II

Misund, AR, Nerdrum, P, Bråten, S, Pripp, AH, Diseth, TH. Long-term risk of mental health problems in women experiencing preterm birth: a longitudinal study of 29 mothers. Annals of General Psychiatry 2013; 12:33.

Paper III

Misund, AR, Bråten, S, Nerdrum, P, Pripp, AH, Diseth, TH. A Norwegian prospective study of preterm mother-infant interactions at six and 18 months and the impact of maternal mental health reactions, pregnancy and birth complications. Resubmitted.

1. Introduction

1.1 Background

The aims of this research project reflect the recommendations described in "The National Mental Health Research Program for Children and Adolescents in Norway" [1] that highlights the importance of cross sectional early intervention programs for prevention and early identification of children at high risk for developing mental health problems.

Prevention of developmental disturbances in preterm children was initially an objective taken into account. We assumed it was essential to explore the complexity of factors influencing the early parent-infant relationship in dyads with preterm offspring [2, 3]. We expected an exploration of the relation between maternal post-trauma reactions, postpartum depression and anxiety following preterm birth to be valuable both to primary health care staff and the maternity ward. We assumed that results from our study could be a contribution toward development of routines for assessing mothers' mental health following preterm birth. In particular, we believed that the maternity ward would benefit from the knowledge of both short-term and long-term mental health reactions following preterm birth when examining the mother's psychological reactions following preterm birth. Finally, we found it advisable when necessary for an adequate early intervention program to contribute to sound development for both the mother and her relation with her newborn to be instituted as a result of an early evaluation in the maternity ward.

The foci of the present study are mental health reactions in women experiencing preterm birth and the ensuing quality of mother-infant interaction; limited resources prevented us from including the fathers. However, the roles potentially played by the father both as sensitive or distancing partner to the mother and as an interacting companion to the preterm infant would

have brought important perspectives to our study. Not only might fathers share in the psychological distress, depression and anxiety following childbirth [4], but they may also contribute to reducing maternal health problems by being sensitive and consoling companions, or –if distancing themselves –by aggravating such problems [5, 6]. As for the infant, not only might fathers supplement the mother-infant dyad by engaging with them, transforming the dyad into a triad, but the father might also engage in dyadic interaction with the preterm infant. A beautiful example of this was video- recorded by van Rees and De Leeuw 1993 [7]. Here we see a baby girl, born three months pre-term, in reciprocal contact with her father at three weeks, and again three weeks later engaging in a barely audible duet "AH…ah…AH…aa…AH…aa.." with her father (subjected to spectrographic analysis by Schögler and Trewarthen 2007) [8]. Thus, not only may the sensitive father later emerge as an important attachment figure for the infant, but also throughout the entire process, contribute to relieve the mother of some of the felt stress by being a caretaking companion to her and to the infant.

The aim of our study was specifically to explore maternal mental health reactions following preterm birth both short and long term with a special focus on posttraumatic stress reactions. Secondarily, our aim was to identify predictors of maternal mental health outcomes. The third aim was to explore the impact of different physical complications and maternal postpartum mental health reactions on early mother-infant interaction at 6 and 18 months postterm age.

1.1.1 Maternal mental health reactions following preterm birth; psychological distress, posttraumatic stress reactions/disorder, anxiety and postpartum depression

In this thesis maternal mental health reactions following preterm birth refers to psychological distress. In this thesis psychological distress is widely used as a collective term for anxiety,

depression, posttraumatic stress reactions, and posttraumatic stress disorder. In this study the term psychological distress refers to the information collected by the use of psychometric instruments included in this study. These psychometric instruments are well validated and designed to collect information about mental health reactions like anxiety, depression or posttraumatic stress reactions. The psychometric instruments measure mental health from the quantity of psychological attributes that best are representing the mental health reactions [9]. The threshold for clinical concern is referred to as clinical important distress.
Psychological distress were also differentiated into more specific terms for mental health. The standard diagnostic classification of mental disorders used by mental health professionals is both the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V; American Psychological Association 2013) [10] and the WHO's International Classification of Diseases, Tenth Edition, Clinical Modification (ICD-10-CM) [11]. The psychometric tools used in this study consisted of questions that collected information that were sufficient to fill the criterion in ICD-10 for tentative diagnosis of anxiety, depression, and posttraumatic stress reaction/disorder. The term tentative in this thesis indicates that the diagnoses are not confirmed by a clinical interview with the person.

Stress following preterm birth is a term that has been used in substantial studies and seems often to have been used interchangeably to psychological distress. Stress in a perinatal phase can be a useful response in a situation that is experienced as a transition phase into parenthood and also to high threat. Stress activates adrenalin and noradrenalin and improves the ability to cope with new challenges and with acute treats [12, 13]. However, diagnostically stress and psychological distress may differ from each other. For instance acute stress disorder is defined to occur and resolve within four weeks of the trauma. The symptoms are mixed with depression, anxiety, despair, over activity and withdrawal and none of the symptoms

predominate for long. Posttraumatic stress disorder occurs after four weeks of the trauma and a group of symptoms like disturbing recurring flashbacks, avoidance or memories of the event and hyperarousal are represented [10]. The term posttraumatic stress reaction is used in this thesis when clinical important posttraumatic stress have been detected with psychometric tools, or the criterion for the tentative diagnosis of posttraumatic stress reaction was fulfilled. Anxiety can be caused by high stresses such as preterm childbirth and is characterized by chronic excessive worry accompanied by three or more of the symptoms; restlessness, fatigue, concentration problems, irritability, muscle tension, and sleep disturbance [14]. Postpartum depression (PPD) should include at least five of nine symptoms in a two week period; sadness, low energy, changes in sleeping or eating patterns, restlessness, worthlessness or guilt, loss of concentration, recurrent thoughts of death with or without plans of suicide [10]. Different from postpartum blues PPD lasts for more than two weeks.

This study has gathered information about maternal mental health following preterm birth and used psychometric tools and the criterion for the ICD-10 diagnosis. The depression diagnosis has been adjusted to the pregnancy and birth context and the postpartum depression term is well defined. The posttraumatic stress disorder term has not been adjusted in the same way and there is an ongoing discussion about PTSD and its application to birth [13]. Childbirth was excluded from the PTSD criteria's in DSM until 1994 (DSM-IV) when the significance of individual valuation of the event first was acknowledged. Until then childbirth was seen as a normative event by which many women were significantly distressed. It is common agreed that PTSD symptoms following birth are similar to PTSD symptoms following other trauma incidents [15].The results from research on postpartum PTSD have given reason to assume that due to postpartum factors hyperarousal symptoms and negative moods are naturally higher. [13, 15]. Until measures developed especially for postpartum PTSD have been

validated against clinical interviews and sensitivity, specificity, and appropriate cut-off are available, it is recommended to be aware of the difficulties in measuring postpartum PTSD [13].

1.1.2 Preterm birth

The prevalence of preterm births have been reported to be 5-9 % of all births in Europe and developed countries. Multiple births account for 15-20% of all preterm births [16]. The development of mental health and cognitive problems in prematurely born infants has been the main focus in the field of preterm birth for several decades. At the starting point of this study, several studies reported that premature infants had developed significant long-term learning difficulties, as well as emotional and behavioral problems [3, 17, 18]. Knowing that the parent-infant interaction is likely to have an impact on children's development, we assumed that maternal mental health and the severity of the child's medical risk factors were significant contributors [2, 19-21]. Follow-up studies of term babies for example, had shown that persisting parental depressive symptoms were an important predictor of children's dysfunction [22, 23]. Postpartum depression had also been frequently investigated and the predictors reported were prior maternal psychiatric disorder, higher percentage of psychiatric disorder in the family, as well as poor social support, marital problems and higher levels of stress during pregnancy [24].

Only a limited number of studies had explored the nature of mothers' mental health reactions following preterm birth, and their impact on mother-infant interaction. An even smaller number of studies had investigated maternal posttraumatic stress reactions following preterm birth and impact on early mother-infant interaction [25, 26].

As we knew that an unaddressed trauma reaction may dispose for a posttraumatic stress disorder (PTSD) with long term effects on maternal mental health [27], one of our assumptions was that PTSD is likely to affect the mother-infant interaction in a negative way.

The association between maternal mental health, pregnancy, birth, infant complications, and early mother-infant interaction following preterm birth has to our knowledge still not been explored. However, several studies have explored the impact of perinatal complications on maternal mental health following birth [28-32]. Blom et al. 2010 found that certain perinatal complications such as preeclampsia, hospitalization, emergency caesarean, and fetal distress predicted higher depression outcomes in a sample of the normal population [32]. In pregnancy assessment of fetal anomalies Kaasen et al. 2010 reported that postpartum maternal distress was predicted at the time of assessment in pregnancy (> 22 GA), as well as the severity and ambiguity of the anomaly [31]. Further examination of determinants with an impact on early preterm mother-infant interaction is essential.

1.1.3 Maternal psychological distress following preterm birth

The maternal experience of giving preterm birth has been described as a psychological trauma [25, 33-36]. For mothers, the experience of giving preterm birth and the subsequent experiences in the NICU, may cause substantial psychological distress. The transition process to parenthood may be disrupted by the preterm birth. The process of transition into motherhood is described by Daniel Stern 1998 as a significant lifelong mental shift in mothers' mindset. The mothers' responsibility for infants survival, growth, thrive and intimacy that natural follows a childbirth have to be shared with the medical staff at the NICU and the mothers' have to face the possibility that their child will be delayed in his/hers

development or have handicaps in their transition into motherhood. These are possible obstacles for mothers' that are trying to develop their motherhood identity [37].

Several studies have examined the prevalence of maternal mental health problems following preterm birth both short and long-term [25, 38-44]. However, the main research foci in these studies have been maternal postpartum stress reactions [40, 41, 44, 45] and maternal coping mechanisms [46]. The prevalence of postpartum psychological distress has been reported to be significantly higher among preterm mothers compared to mothers undergoing term births [41]. Clinical important psychological distress of 37% in early postpartum period and 29% long-term were reported for mothers with term births in a Norwegian study [4, 47]. However, our knowledge about the nature of maternal psychological distress such as that detected by these studies is limited [38, 39, 42-44]. Stress is known as a psychological phenomenon that may be experienced as anxiety, depression and/or trauma reactions [38, 42, 44].

The co-morbidity of anxiety and depression in posttraumatic stress reactions is well known, but the knowledge of trauma related stress reactions following preterm childbirth is still limited [42]. There are several studies that have focused on depression [32, 43, 48-50], and others that have focused on depression, distress, and anxiety [6, 44, 51, 52]. The prevalence of PPD following childbirth has been reported to be between 8-15% in epidemiology studies [53-56]. PPD following preterm birth has been reported to be high, up to 40% in the early perinatal period [50]. The prevalence of generalized anxiety is reported to be 4,5% in a lifetime perspective and 1,9% in a twelve month perspective in Oslo for the period 1994-1997 [57]. Postnatal generalized anxiety has been less focused. A few studies have reported a prevalence between 4.4-8.2% [58].However, the studies that include trauma reactions are still

few. In brief, several of the studies including trauma reactions are in general small, non-randomized and have used different measurements of trauma [25, 38, 39, 42, 59-66].

1.1.4 Maternal posttraumatic stress reactions following preterm birth

A study by Affleck et al. 1991 detected that a considerable share of mothers showed symptoms of trauma 6 and 18 months following preterm birth. In addition, they reported painful memories from the postnatal period [67]. However, it was in the first decade of this century that more systematic studies of maternal posttraumatic stress reactions following preterm birth were conducted [25, 26, 39, 42, 68, 69]. These studies were small, used different measures of trauma reactions and lacked randomized designs. It is evident that larger scale studies are required.

About 30% of all women are known to report their labor as traumatic, while only 3.1% in community samples and 15.7% in at-risk samples develop PTSD after giving birth [70, 71]. Why women develop PTSD following birth and others not is not fully explored. However, the identified risk factors in at-risk samples were; current depression and infant complications, and in community samples; current depression, history of psychopathology and labor experiences such as interactions with medical staff [71]. A systematic review also identified obstetrical emergencies, psychological difficulties in pregnancy and previous traumatic experiences as risk factors [72]. Both term and preterm deliveries are reported as likely to involve certain features such as intense fear, helplessness, pain and loss of control that might predispose for traumatic stress reactions [24, 73]. Reports from two studies point out that the stay in the NICU following preterm birth brings additional psychological distress and has a traumatizing impact on parents [65, 74]. In addition, descriptive studies have found that mothers showed long-term symptoms of trauma reaction [25, 39, 63, 68, 75].

The highest prevalence of significant trauma reactions among preterm mothers is reported in a small intervention study (n=25) with a control group (n=25) by Jotzo and Poets in 2005. They detected a significant difference in trauma reactions between the intervention group and the control group that received no psychological intervention during hospital stay. In the control group 76% reported trauma reactions at discharge from the hospital compared with only 36% in the intervention group [39]. Kersting et al 2004 reported that preterm mothers showed significantly higher levels of traumatic experience, depressive symptoms and anxiety than mothers with term births. In the preterm group no significant reduction in levels of traumatic experience was found 14 months after birth [42]. A later comparison study by Kerstin et al. 2009 has reported that maternal posttraumatic stress was higher in women with late pregnancy termination (n=62) than in women with very low birth weight preterm births (n=42). The levels of clinical case scores from posttraumatic stress reactions in the preterm group were high: 29.9% two weeks postpartum, 7.1% 6 months postpartum, and 14.3% at 14 months postpartum [76]. Pierrehumbert et al. 2003 found in their study of 50 families with preterm babies (25-33 gestation weeks) and 25 control families with full term infants that parental posttraumatic stress reaction was an essential predictor of the child's problems at 18 months postterm age [25]. Muller-Nix et al. 2004 found significant lower prevalence of posttraumatic stress disorder (PTSD) in 25 mothers with full term births compared with 47 mothers with preterm births (> 34 gestational age). At 6 months postterm age 31.9% of the preterm mothers reported PTSD in comparison with only 4% of the term mothers [26].

1.1. 5 Postpartum maternal mental health and mother-infant interaction in preterm dyads

The maternal stress reaction following preterm birth, has been highlighted as a risk factor in preterm dyads in several studies [40, 41, 44, 77-79]. The impact of postpartum depression on preterm mother-infant dyads has also been explored [80, 81]. As we already have pointed out, the maternal posttraumatic stress responses following preterm birth [39, 42, 63] and their impact on mother-infant interactions are only explored in a minor range [25, 26].

Several explanations of interactional problems in preterm dyads are advanced: the premature infant's immaturity, disruptive brain development, early separation experience, and parents' affective experience. Unresolved maternal grief following preterm birth is another factor that research has found to be associated with mother-infant attachment quality. Feelings of grief are common among mothers of premature infants [82]. Persistent feeling of grief is assumed to affect the mother's parental sensitivity and her parental skills in responding contingently to the preterm infant's signals. One study found that maternal grief resolution and interaction quality were independent predictors of attachment security The relative risk of developing insecure attachment was found to be 1.59 (95% CI: 1.03-2.44) when mothers reported unresolved grief [82].

In addition, research on preterm mother-infant interactions has reported that preterm mothers of less socially competent infants showed more stimulating interactional behavior and were emotionally more withdrawn with their child [26, 83-87]. High levels of stimulating behavior have been viewed as mothers' way of compensating and adjusting for the premature infant's immaturity [85]. Some studies on the other hand have found no difference in mother-infant interaction between preterm and full term dyads [88-93] and other studies have reported that

preterm babies did not display any interactional problems until 6 months postterm age (PA) [84, 92-94].

The impact of parental posttraumatic stress reactions on parent-infant interactions has been reported in only two studies so far. The Muller-Nix et al. [26] study explored the influence of PTSR and PTSD on early mother interaction with 47 premature infants' (gestation age (GA) < 34) and 25 infants born at term. The preterm mothers were assessed by the Care Index to be more distressed, less sensitive, and more controlling than term mothers at 6 months postterm age (PA). The results of this study showed a correlation between the mother's traumatic experiences and her interactional behavior with her premature infant. The infant's perinatal risk factors and maternal interactional behavior on the other hand correlated less. Most interestingly, these authors found that mothers' interaction behavior had improved at 18 months PA and no longer differed from term mothers' interactional behavior. When correlated with mothers' traumatic experiences, however, the premature infants' interactional behavior differed from that of term infants. The premature group with highly distressed mothers was significantly more compulsively compliant than full term dyads at 18 months. The premature group with mothers with little distress was significantly more passive than infants with highly distressed mothers or full term mothers. In sum, it was reported that the mothers' levels of distress had a higher impact on preterm infants' interactional behavior than socio-economic variables.

The Pierrehumbert et al. [25] study examined the effects of parental posttraumatic reactions measured by the perinatal PTSD questionnaire (PPQ) on sleeping and eating problems of the children in 50 families with a premature infant (GA 25-33), and in a control group of 25 families with full term infants. Perinatal risks such as those indicated by the Apgar index, gestational age, weight, head growth, electroencephalogram, ultra-sonogram, and ventilation were evaluated during hospital stay. The parents were interviewed at the time their infants

were 18 months PA age. The symptom check list, a 30 minute-long, semi-structured interview, was used to explore interactional items such as parents' perception of their children's present health and behavior problems. In sum, the study reported that high levels of perinatal risks only predicted children's problems to some extent. It was the intensity of parental posttraumatic reactions that predicted children's sleeping and eating problems.

Good quality of mother-child interaction has been acknowledged to improve the infant's emotional, behavioral, and cognitive development. The interaction quality has in addition been related to the child's physical health [95, 96]. Associations between emotions that facilitate parental self-efficacy and a positive parent-infant interaction have been reported [97]. It is evident that both premature infants and term infants need interactions with sensitive, contingent, predictable, and caring parents to achieve physiological and psychological regulation [98, 99]. It has been shown that parents' internal working models of the child represent a significant impact on the attachment process. Studies have further reported that parents' prenatal working models of the fetus are positively associated with the quality of later parent-infant interaction [100, 101]. Parents' attachment representations have been found to be strongly correlated with the child's attachment strategy [102, 103]. An unresolved parental trauma from abuse or loss is assumed to result in the exhibition of frightening behavior and outbursts at times, representing a distorting impact on the child's internal working model. Such parental behavior will most certainly be a significant contribution to the child's development of an insecure attachment strategy [104, 105].

Several studies have used PCERA as an assessment tool for examining the mother-infant interaction in preterm dyads [80, 82, 106-109]. One of these studies has examined how maternal postpartum depression and mother-infant interaction influences the child's cognitive function at 16 months [107]. They found that maternal depression at 4 months was associated with the child's lower cognitive function at 16 months. For mothers with fewer depressive

symptoms, they found that support given to the mother had a strengthening effect on children's cognitive function. They discovered no significant influence between the quality of the interaction and the child's cognitive function.

Korja et al. 2008 assessed the prevalence and the background factors of maternal depressive symptoms following preterm birth and their relation with the quality of mother-infant interaction [80]. They revealed a prevalence of depression assessed by the Edinburgh Postnatal Depression Scale (EPDS) in mothers of very preterm infants of 12.6%. The postnatal signs of depression associated negatively with the interaction quality of mothers and their preterm infants at 6 and 12 months PA. Mothers with depressive symptoms showed less positive affective involvement and communication with their preterm infants compared to non-depressed mothers of preterm infants.

1.1.6 Pregnancy, birth, infant health complication, and the postterm effect on maternal mental health

Some studies have also explored the postterm effect on maternal mental health [28-32]. Blom et al. 2010 found that certain perinatal complications such as preeclampsia, hospitalization, emergency caesarean, and fetal distress predicted higher depression outcomes in a normal population sample. In pregnancy assessment of fetal anomalies, Kaasen et al. 2010 reported that postpartum maternal distress was predicted from the time of assessment in pregnancy (> 22 GA), as well as the severity and ambiguity of the anomaly.

1.1.7 Research on infants' behavior and mother-infant interaction

The theories evolved from research on infant behavior and the significance of mother-infant well-synchronized interaction for infant development [81, 110-112] have been an inspiration

for this dissertation. Infant research began in the 1980's and contributed to a scientific shift from intrapsychological processes to *intersubjectivity* in the field of psychology [113].

The philosophical base for the theory of intersubjectivity is existentialism. In existentialism the subjective experience is viewed as essential. The French philosopher Jean-Paul Sartre (1905-1980) has postulated that human existence in the world and ontology[1] are essential for existentialism. Our development into a self and who we are, that he refers to as essence, comes second [114].

What goes on between two or more subjects is the focus in the theory of intersubjectivity. In attempts to explore the psychology of two-or-more-persons, the two-person-psychology has been that which has been explored most, while the triads and quartets are less examined [113]. Our study is like most studies in this field, an exploration of a two-person dyad. First, the mother's mental health following preterm birth was analyzed, and then the impact of maternal mental health on mother-infant interaction was explored. The complexity of human development and behavior in the two-or-more-persons psychology is understood as a result of influences from emotional, cognitive, biological, interactional, social and cultural factors and has implications for research [113]. Our research has, similar to the two-or-more-persons psychology, gathered a broad range of information and also observed mother-infant interaction that has been assessed with the Parental Relational Assessment Scale (PCERA). PCERA is a research tool that has been developed in modern infant research and is influenced by the theory of intersubjectivity [115].

The Norwegian psychologist Anne-Lise Løvlie Schibbye 2009 [116] has pointed out that Hegel's dialectic theory is close to existentialism and contributes a perspective on

[1] "The difference between epistemology and ontology in part is the subject that is being studied by each. In ontology, the study of being or existence and questions of what kinds of entities exist are studied. In epistemology, the study of knowing and how we come to know and questions about what knowledge is and how knowledge is possible are studied (plato.stanford.edu)".

intersubjectivity that broadens our view of self and relationships. In dialectic theory, causality is seen as circular and reciprocal, which means that man does not have a predictable, quantifiable nature. Man's development is seen as non-linear and will consequently not fit into a positivistic paradigm. To understand humans it is significant that we study human beings in context and in relationships. The idea is that we are influenced by each other and by context in a continuous transactional process.

Our study has used quantitative and statistical analysis to find predictors and associations. Is it possible to use quantitative methods in dialectic theory and an intersubjective frame? It is my view that quantitative methods can be used to examine human features or "the self" as long as "the self" is studied in context or relationships. Daniel Stern 2008, a well-known infant researcher, states that quantitative and qualitative methods alternate as optimal descriptors. A linear or nonlinear model contributes different descriptions. He reminds us that linear models will only describe what happens for certain stretches in a span of time, while a nonlinear model will be better for describing other stretches [113]. In our research we aimed to explore mothers' mental health reactions following preterm birth. In this session we focused on the mother alone. In addition however, we collected information about the mother's situation both in her family, health, and social contexts, and used the information as a shelter when assessing the mother's mental health reactions following preterm birth. Next, we went from focusing only on the mother to include the results of this exploration in the examination of the two-person interaction between mother and infant.

The Norwegian professor emeritus and author of research methodology Thorleif Lund claims that both quantitative and qualitative information should be considered based on the philosophical assumption of critical realism [117]. In my view, critical realism with its philosophical base represents an adequate research methodology for dialectic theory and intersubjectivity. Both dialectic theory and the perspective of intersubjectivity integrate

knowledge from both qualitative and quantitative research and modern infant research. The knowledge, however, is used to understand the self and relationships, and the interchange between two or more persons in a circular and transactional way. In dialectic theory and intersubjectivity, the researcher is seen as a contributor to the reality being studied. We always observe the other in a mutual interaction with us. Like critical realism, dialectic theory and intersubjectivity assumes that it is not possible to study human beings as separate objects. It is not exclusion but inclusion of different views that is essential to understand the individual in the situation [116].

Daniel Stern 2008 emphasizes that attachment research can be an example of how complex the research must be to explore certain aspects of human behavior [113]. Like most other studies, attachment research has to now mainly explored the attachment strategy between two persons. The study of behavior in triads and larger groups will expand the number of variables and their interactions. Stern 2008, however, points out that the research data might become less linear and less predictable, but argues that it need not be so: " Both individuals and groups can behave in very ritualized (even stereotyped) ways where the next sequence is highly predictable" [113]. The challenge, he claims, is to understand spontaneous changes in a moment of time that he terms "a turning point moment". "A present moment" is a moment of time in which things come together unpredictably, and opens up the possibility for change. Also Husserl [118] focused on the present moment and referred to it as a special mode of being. Levinas [119] formulated the face-to-face position and highlighted this position as affording the meaning of contact with others [81].

Synchrony is a significant concept in research on mother-infant interaction. The concept is used across multiple fields to capture the phenomenon of timed relationship [81]. In mother-infant research synchrony is often referred to as an intricate "dance" that goes on between mother and child in their interaction. This dance is essential for assessments in research, such

as the one we have done in our study using the PCERA, and in clinical work. It can be observed in short interaction sequences of mother-infant interactions, and capture essential underlying qualities in their relationship based on experience with the other's behavioral pattern and interaction rhythms. Other significant concepts in mutual interaction like sensitivity and responsiveness can be studied on their own. The concept of synchrony, however, brings together all the qualities of interaction. Synchrony is a time-based construct that corresponds both to existentialism and dialectic theory that suggest human existence is defined by the experience of time and relations with others [81].

2. Aims and research questions

With reference to this review, exploration of the specific nature of maternal stress following preterm birth is essential to expansion of scientific knowledge of maternal mental health reactions following preterm birth. In early mother-infant interaction, it is likely that mothers' emotional state will influence interactional quality. The mother-infant interaction has considerable impact on a child's development and perhaps even more so for a child requiring special support such as a premature infant. The growing attachment between mother and child is known to influence the infant's development of social, motor, cognitive, and emotional skills. At this stage we are still in need of preliminary scientific exploration of both maternal and paternal mental health reactions following preterm birth, and their impact on early parental-infant interaction. Explorative studies are needed to identify further directions for empirical investigations on a larger scale that will generate more knowledge about significant associations.

Consequently, the general aim of this dissertation was to explore the impact of maternal mental health reactions following preterm birth on mother-infant interactions. Limited resources in the study prevented inclusion of the fathers who are important attachment figures to preterm infants.

Specifically, we asked the following questions:

1) What is the risk of mental health problems in women experiencing premature birth?
   a) How is the prevalence of anxiety, depression, and PTSR/PTSD displayed?
   b) Which elements show significant associations and predict the maternal mental health outcome?

2) What is the longitudinal risk of mental health problems in women experiencing preterm birth?

   a) How are maternal mental health reactions displayed over time?

   b) What is the main effect of time on maternal mental health reactions?

   a) Which elements show significant associations and predict the maternal mental health outcome?

3) How are mother-infant interactions influenced longitudinally by maternal mental health reactions following preterm birth?

   a) Do differences in maternal mental health status show significantly different outcomes in interactional quality measured by PCERA?

   b) Which elements show significant associations and predict interactional quality measured by the PCERA?

3. Methods

3.1 Study design

This study employed quantitative research methods to explore the research questions. The study design included a semi-structured interview performed by a psychiatric social worker that was included to explore the variables in more detail. The semi-structured interview was not used for the purpose of a qualitative analysis, but was used to assure the validity of the quantitative data that were collected in this interview. A prospective cohort and longitudinal, observational design was chosen [120]. The cohort in this study was mothers who delivered preterm and their preterm babies.

The aim of his study was to detect the prevalence of maternal mental health reactions following preterm birth in the preterm group and to explore a range of selected bio-psychosocial factors to detect possible associations between variables concerning the preterm birth incidence and maternal mental health following preterm birth, as well as the quality of early mother-infant interplay. An explorative and longitudinal design that included a small number of participants was chosen, as the field is its beginning of developing an evidence base.

Paper I describes a prospective cohort and observational study[120]. The data sources included questionnaires (psychometric and socio-demographic variables), semi-structured interviews (pregnancy, childbirth, child's health, psychosocial and family strain variables), and medical charts (childbirth and child's health variables). The prospective cohort and observational design were applied to explore the nature and the degree of the psychological distress and to identify the predictors of maternal mental health outcomes following a preterm birth.

The studies described in *Paper II and III* were prospective longitudinal and observational studies of repeated observations of the same variables over long periods of time.

Questionnaires (psychometric and socio-demographic variables), semi-structured interviews (pregnancy, childbirth, child's health, psychosocial and family strain variables), medical charts (childbirth and child's health variables) at four points (T0; 2 weeks postpartum (PP), T1; 2 weeks postterm age (PA), T2; 6 months (PA), T3; 18 moths postterm age (PA)), and videotaped observations and assessments of mother-infant interaction at two points (T2 and T3) were data sources.

3.2 Participants in the study

Paper I: Study period: Two periods of measurement in June 2005 to July 2008.
Study group: Twenty-nine mothers of a total of thirty-five premature children born before the 33rd week of pregnancy (Figure 1) at a highly specialized neonatal intensive care unit (NICU). Socio-demographic and physical characteristics of the study group are described in detail in Table 1.
Paper II and *III*: The same study group as in *Paper I* was measured at four time points. For the flowchart of cases see Figure 2.
Both twins and singletons and their mothers were included. Three families with singletons dropped-out from the study. Exclusion criteria were: mothers of severely ill babies that the medical staff estimated to have poor chance of survival, and non- Norwegian speakers.

Figure 1. Flowchart of cases in *Paper I*.

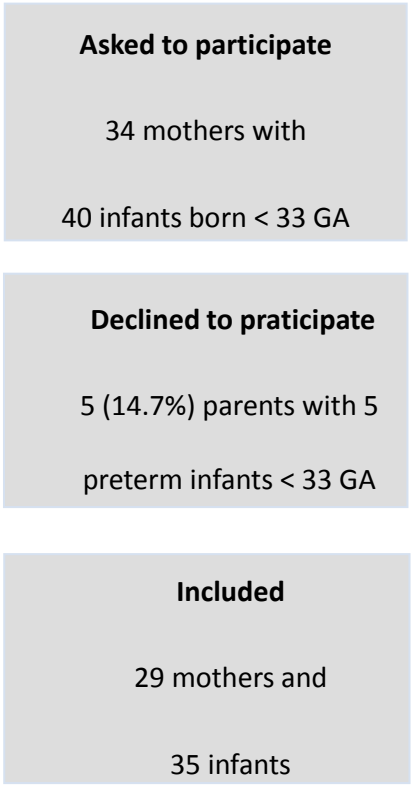


Table 1

Socio-demographic and physical characteristics of the mothers given preterm birth and their children

Mothers	**n=29**
Age; mean (SD)	33.7 (4.3)
Education > 12 years; n (%)	26 (89.7)
Single parent; n (%)	0 (0)
Unemployed; n (%)	4 (13.8)
Previous psychological treatment; n (%)[a]	8 (27.6)
Chronic illness; n (%)[b]	2 (6.9)
Tot. no. of children; mean (SD)	1.7 (0.8)
Previous pregnancies; mean (SD)	1.1 (1.5)
Previous childbirths; mean (SD)	0.5 (0.7)
First time mothers; n (%)	18 (62.1)
IVF pregnancy; n (%)[c]	8 (27.6)
Bleeding in pregnancy; n (%)	19 (65.5)
Preeclampsia; n (%)	4 (14.3)
Pregnancy infection; n (%)	12 (41.4)
Cesarean emergency; n (%)	14 (48.3)
Cesarean planned; n (%)	3 (10.3)
Vaginal birth; n (%)	12 (41.4)
Breech birth; n (%)	3 (8.6)

Children	**n=35**
Girl; n (%)	17 (48.6)
Boy; n (%)	18 (51.4)
Twin; n (%)[d]	14 (40.0)
Gestational age (weeks);	
Median (range)	29 (24-32)
Mean (SD)	28.5 (2.6)
Birth weight (kg);	
Median (range)	1.2 (0.6-2.0)
Mean (SD)	1.2 (0.4)
Apgar score at 1 minute; median (SD)	6.3 (2.3)
Apgar score at 5 minutes; median (SD)	7.6 (2.0)
Apgar score at 10 minutes; median (SD)	8.3 (1.0)
Mechanical ventilation > 24 hours; n (%)	8 (22.9)
Oxygen supply > 28 days; n (%)	19 (54)
IVH grade 1 and 2; n (%)[e]	5 (14.3)
IVH grade 3 and 4; n (%)[e]	2 (5.7)
Surgery	4 (11.4)
Infection	7 (20.0)
Patent ductus arteriosis	6 (17.1)

[a] Everyone who had been in psychotherapy as a child or as an adult was registered

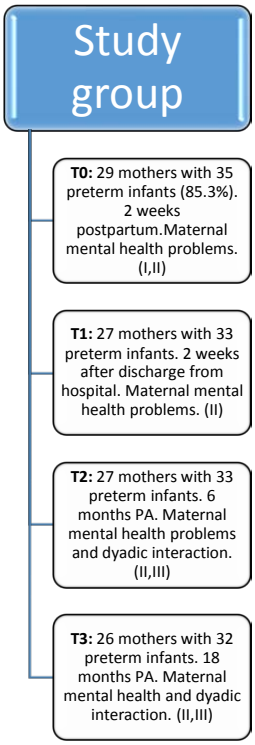
[b] Diabetes and Crohn's disease [c] In Vitro Fertilization (Assisted Fertilization)

[d] Two of the twins were raised as singletons as their twin siblings were still born.

[e] Intra Ventricular Haemorrhage following birth

Figure 2: S Flowchart of cases in *Paper II* and *Paper III*. Design, and outcome variables.

Roman numerals refer to paper. Percentages refer to inclusion rate.



3.3 Data collection

4.3.1 Enrollment of participants

Enrollment of the study group was performed through registration of every new infant born on the maternity ward or an inpatient in the NICU in the period of data collection at T0. The families were informed about the study protocol in the NICU and parental consent was obtained after oral and written information was provided.

3.3.2 Procedure

The protocol included four assessment points: 2 weeks PP (T0), 2 weeks PA (T1), 6 months (T2), and 18 months PA (T3); socio-demographic factors, pregnancy, childbirth information, psychosocial and family strain variables were collected in an semi-structured interview with the mother at all four points. Data about the pregnancy, birth and child's health were collected from medical charts at T0 and T1. Psychometric self-report questionnaires were filled out at every measuring point (T0, T1, T2, T3) before the interview to prevent the interview from influencing answers. The evaluation of the psychometric self-report questionnaires was communicated and discussed face to face or on the telephone with the mother shortly after the interview. In that way we double-checked that our assessment was representative of the mother's experience of her mental state when she had reported clinically important distress that needed to be addressed. Mother-infant interaction was recorded in a play-therapy room at the child- and adolescent psychiatric clinic at the hospital at the same time mother attended the semi-structured interview. The best time for the free play video recording session was carefully planned with the mother to attain optimal conditions for a situation that could be representative for their interaction. For instance the children's level of alertness and satisfaction (sleep/nutrition) as well as mothers' evaluation of representativeness were addressed. Mothers with twin babies needed for instance special planning like a babysitter

that could assist mother when the babies needed breaks from the interview room or when the other sibling attended in the free play setting with mother. When mother was not able to bring an assisting baby sitter we were able to find alternative ways to combine interview and care for the babies. For the video-recording the mother and infant were placed on a soft mat on the floor with age-appropriate toys. The mothers were instructed that: "This is a time for free play with your infant. You can use the toys, or you can play without the toys. Try to play as you usually play or interact with your infant at home". For four dyads, the video-recordings were conducted in their homes.

3.3.3 Outcome (dependent variable) measures

In *Paper I and II* psychometric measurements and tentative clinical diagnosis based on the clinical diagnostic guidelines in the ICD-10 Classification of mental and behavioral disorders [121] were used to assess maternal mental health following preterm birth. In *Paper III* the Parent-Child Early Relational Assessment Method (PCERA) was used to assess the mother-infant interaction.

It is essential that the instruments used in a research project measure the phenomenon one intends to study as accurately as possible. Two main concepts to assess an instrument are reliability and validity. Reliability in self-report questionnaires such as IES, GHQ and STAI, and diagnostic assessment tools like PCERA refers to a consistent measure of a construct across time, individuals and situations. The validity of the instrument is assessed by its content and construct validity. The content validity should be assessed both by professional and real life experts in the actual field. Construct validity assesses the consistency of the relation of the measure to the concepts that are measured. Construct validity is based on the theoretical foundation and testing of psychometric measures. Internal consistency can be assessed statistically by pairwise correlations between items with Cronbach's alpha.

Maternal mental health problems were assessed using the following standardized psychometric instruments: General Health Questionnaire (GHQ), Impact of Event Scale (IES), and State/Trait Anxiety Inventory (STAI-X1/X2).

Traumatic stress reactions were assessed by the 15-item version of the Impact of Event Scale (IES) [122, 123]. The threshold for clinical concern was defined as an IES score $\geq$19, while scores below 19 and above 8.6 were defined as within a medium level of concern, and scores less than 8.5 as within low concern [124]. The concept of clinical concern also referred to as clinically important stress related cognition and behavior, is meant to serve as a clinical guide. The levels are not keyed to a particular diagnosis. The threshold for clinical range was established by averaging independent assessments from clinicians [124]. In this study, the stress factor was defined as *"Preterm childbirth"*. The IES-15 has two subscales measuring symptoms of intrusive psychological distress (7 items) and avoidant cognition and behavior (8 items). The scoring range for each item is 0 (not at all) to 5 (very much). A subscale score of 0-8 usually denotes minor responses, 9-19 moderate responses and scores ≥20 denote severe responses. Split half reliability (r = .86) and test-retest reliability (total score r = .87; Intrusion r = .89; Avoidance r = .79), as well as high Cronbach's alphas for the subscales (Intrusion = .78); Avoidance = .82) have shown that the IES has sound psychometrics [122]. Several studies have demonstrated the validity of IES and its sensitivity to change over time with different populations [125].

Posttraumatic stress symptoms were defined as a case score in IES intrusion and/or IES avoidance $\geq$9. IES has been thoroughly validated and is one of the key psychometric assessment methods in traumatic stress research [122, 123].

Psychological distress, psychopathology and overall well-being were assessed by the General Health Questionnaire (GHQ) that is a widely used screening instrument showing acceptable and well established reliability and validity. The reported Cronbach alpha coefficient for the GHQ is a range of 0.82 to 0.86. The reliability coefficients reported in several studies have been between 0.78 and 0.95. The instrument has been translated into 38 different languages. When correlated with the global quality of life scale, the GHQ showed negative correlation. This demonstrates the inverse relationship with an increase in distress leading to a decrease in quality of life [126-129]. The GHQ is designed to detect psychiatric disorders in community settings and non-psychiatric clinical settings. GHQ-30 was chosen as we wanted to focus on psychological and psychosocial problems instead of somatic symptoms. GHQ-30 was derived from the original GHQ-60 version by eliminating questions that reflected symptoms one would expect to be present in subjects with solely somatic illness. The GHQ-28 version was considered to be unsuitable for our study of a normal population as it includes questions that are concerned with somatic symptoms and severe depression [130]. GHQ-30 contains 30 items covering symptoms that reflect distress and psychopathology in five dimensions corresponding to anxiety, feelings of incompetence, depression, difficulties in coping, and social dysfunction over the past 2 weeks [130]. Each question is answered on a four point scale. The answers to each item may be treated both as Likert sum scores with weights (0-1-2-3) and a possible scale of 0-90, and as case sum scores with weights (0-0-1-1) and possible range 0-30 [126, 128]. In Norway the GHQ-30 has been used in several studies [128, 131-135]. Clinically important psychological distress was defined as case total scores $\geq$6 for GHQ-30 [127]. The case score in GHQ is based on the assumption that a clinically meaningful threshold in the dimension of distress assessed by GHQ can be found. A

case score in the person's GHQ score refers to a clinical cut-off point for clinically significant disorder. The threshold for psychiatric case identification with GHQ is based on the prevalence of symptoms that exceeds the probability of case with 50% in an independent psychiatric assessment [126].

Maternal anxiety was assessed by the Spielberger State Trait Anxiety Inventory (STAI-X1 and STAI-X2) [136, 137]**.** The construct validity for both STAI state and trait anxiety has shown to be high. The high test-retest reliability correlations for trait anxiety range from 0.73 to 0.86. STAI trait anxiety has shown a reasonable reliability coefficient of 0.62. STAI-X1 is a measure of state anxiety levels reflecting subjective feelings of tension, apprehension, nervousness and worry. STAI-X2 is a measure of trait anxiety that refers to individual differences in anxiety proneness, i.e. in the tendency to see the world as dangerous and threatening, and the frequency with which anxiety states are experienced. STAI-X1 has a 20 item and a 12 item version and both were used in our study. Ten items from the 20 item version overlap in the two versions (item no: 1, 2, 3, 5, 7, 11, 12, 13, 14, 15). A common 10 item STAI version was constructed for our analyses. STAI-X2 consists of 20 items. For the STAI-X1 10 item version, clinically important state anxiety was defined as a STAI score $\geq$20 (corresponding to and $\geq$ 40 for 20 item version). Clinically important scores in STAI-X2 were defined as > 40. The clinical range was established with mean STAI scores from a normal population (n= 4818) compared with mean STAI scores of Neuropsychiatric patient (n=461). The clinical sample showed mean scores above 40, while the normal population showed mean scores that in general were lower than 40. The STAI-X1 and X2 are reliable and widely used self-evaluation questionnaires employed in several studies with similar populations [136].

Assessment of mother–infant interaction at 6 and 18 months postterm age (PA): The mother-infant interaction quality was assessed by the Parent Child Early Relational Scale (PCERA) [115]. The PCERA scale has been used in several studies to explore the quality of preterm mother-infant interactions [80, 82, 106-108, 138]. The PCERA is a reliable and valid standardized evaluation of parent-infant interaction [139]. The parent and infant are observed and video recorded in four 5 minute sequences: 1) feeding, 2) structured task, 3) free play, and 4) separation-reunion. In this study only the free play situation was recorded, out of both practical and economic reasons. The free play situation was selected as it was the most appropriate for the age of the participating babies. The original version of the instrument and manual from 1985 [115] was used.

A Finnish PCERA trainer made the assessment. The coder was unaware of backgrounds and clinical status. Additionally, to estimate the inter-rater reliability from the study data, 20% of the PCERA assessments were double-scored by another Finnish trained coder. The study data was assessed by calculating the mean of the agreement percentage of the raters' overall agreement. Agreement equal or above 80% is considered good, 50-80% is considered moderate, and lower than 50% is considered poor. The mean of inter-rater agreements was 80.3% in 6 months PA and 81% in 18 months PA.

3.3.4 Explanatory (independent) variables

Socio-demographic factors (*Paper I-III*): Questions were chosen from Parental Account of Children's Symptoms, Norwegian version (PACSNO) [140]. We recorded

information about parents living together or not, family size, housing standard, urban or rural living, level of education, working situation and family economy.

Pregnancy, childbirth, and the child's health information were collected from medical charts and a semi-structured interview with the mother.

Psychosocial and family strain (*Paper I-III*): A semi-structured interview based on the Vailant questionnaire [141] which poses fundamental questions about the individual differences in confronting life's stresses were used to collect information about psychosocial strain. A clinical global assessment of Chronic Family Difficulties (CFD) [142, 143] was based on all parental information available from an interview about the previous and present family situation, strain or difficulties such as economy, housing, employment, network support, practical care for children, possible marital and family discord, and the physical and mental health of all family members.

3.3.5 Tentative clinical diagnosis of anxiety, depression and PTSR/PTSD

Tentative clinical diagnosis of anxiety, depression and PTSR/PTSD based on the clinical diagnostic guidelines in the ICD-10 classification of mental and behavioral disorders [121] was assessed independently by a psychiatrist. The assessment was based on all information available in a clinical perusal of the psychometric self-reports IES, GHQ and STAI of each of the 29 preterm mothers, and blinded to the physical and socio-demographic characteristics of the mothers and their children. The tentative diagnosis were not used in the statistical analysis as dependent variables, but used in independent t-test analysis and in descriptive statistics for prevalence purposes.

3.4 Statistics

Correlations between continuous variables were assessed with Pearson's or Spearman's correlation coefficients as appropriate (*Paper I-III*).

Forward stepwise linear regression analysis was used to identify possible predictors of mental health and psychological distress (*Paper I-II*), and of the PCERA (*Paper III*) within the study group.

A random intercept linear mixed model for repeated measurements with fixed effects of follow-up time was used in *Paper II* to analyze the psychometric outcome variables longitudinally. (In repeated measurements an effect variable is recorded for different persons at different time points. A model for repeated measurements takes into account the dependency in repeated measurement, e.g. the same person is assessed at different time points or the assessment of different individuals is dependent because they are "clustered", for instance, repeated measurements of pupils that belong to different classes or schools or patients from different hospitals. A fixed effect in an experiment means that all possible variables of interest are present in the model. A random effect means that the model only contains an incidental sample of variables. In a random intercept model the intercepts of the variables are assumed to vary in the model; for instance high or low levels and different groups or individual characteristics. This model is designed to measure the mean effects of variables and the random effects of variables which in this case is the possible variation of effects that can occur between the participants [144, 145].

Differences in the PCERA outcome (*Paper III*) were analyzed using independent-samples t-test. Differences in the quality of mother-infant interactions measured by the PCERA scales were explored with independent-samples t-test. Clinically important case scores (0=no,

1=yes) from the maternal psychometric and tentative diagnostic means at four time points (T0, T1, T2, T3) were used as the grouping variable.

Values of continuous variables were presented as means (SD) or if skewed, as median and range. Categorical variables were given as proportions and percentages.

A careful check of the model assumptions including an investigation of residual plots did not reveal any violation of the assumptions. Statistical analyses were performed in the SPSS version 18 (*Paper I*), 19 (*Paper II*), and 20 (*Paper III*). Two-sided statistical tests were applied and a 5% statistical significance level was chosen.

3.5 Ethical consideration

Ethical considerations are essential in studies that include children as participants. Informed consent is difficult to attend to for small children. In this study the newborn babies' participation was restricted to an interaction situation with their mothers that was intended to be similar to an ordinary free play situation. The purpose was to assess the interaction quality and avoidance of unnecessary strain for the baby was attended to. The method used in this study to evaluate the mother-infant interactional quality has been used in several studies of parents and their infants and is a well-assessed method.

By thoroughly considering the necessity of questions, questionnaires, and how the interview was carried out, we made efforts not to increase the burden of the participants. We assumed that the mothers attending this study were likely to have experienced several traumatic incidents recently and our procedure had to reflect the utmost regard for their situation. Written informed consent was obtained from participants prior to the study start. The study protocol was approved in May 5th 2005 and April 19th 2007 by the Norwegian National

Committee for Research Ethics (S-05068 and S-07096b) and April 1st 2005 and March 12th 2007 by the Data Inspectorate (12360 and 07/1088). The study protocol was carried out in accordance with the Declaration of Helsinki. Informed written consent was obtained from the parents.

For ethical reasons, the mothers who reported clinically significant mental health problems were assessed for and referred to adequate psychological treatment. In this study, we detected clinically important mental health problems in mothers at four points, from the time of birth to 2 years postpartum. A no referral procedure could have caused unnecessary suffering for both mother and child.

The commissioner for the Protection of Privacy in Research at Oslo University Hospital approved the data storage.

4. Main results

4.1 Summary of Paper I

Mental health in women experiencing preterm birth.

The aim of the study was to explore the degree of psychological distress, anxiety, and trauma related stress reactions in mothers who have experienced preterm birth. Secondarily, we wanted to identify possible predictors of maternal mental health problems.

Twenty-nine mothers of 35 premature children born before the 33rd week of pregnancy were assessed within two weeks after giving birth. The standardized psychometric methods Impact of Event Scale (IES), General Health Questionnaire (GHQ) and State Anxiety Inventory (STAI) assessed mental health problems. The predictors for maternal distress, anxiety, and trauma related stress reactions were pregnancy variables, preterm delivery, Gestation Age, maternal trait anxiety and parity. In addition, maternal prevalence of mental health problems was assessed by clinical diagnoses.

Our study revealed a high prevalence (52%) of posttraumatic stress responses in the mothers. The proportion of Intrusion case score were 65.5%, while the proportion of Avoidance case score was 27.6%. The percentage of anxiety and depression reported was 28% and 17% respectively. Twenty-one percent of the mothers had more than one diagnosis. We detected significant associations between several physical variables: planned Caesarean section, gestational age, birth weight, Apgar score, need for mechanical ventilation, patent ductus arteriosis (PDA), neonatal surgery, and in addition, mother's education, trait anxiety, parity and maternal mental health outcome variables. The predictors for maternal distress, anxiety, and trauma related stress reactions in the preterm group were infection in pregnancy, planned Caesarean section, gestational age, maternal trait anxiety, and parity.

Based on our findings we suggest an early examination of mothers' psychological reactions to preterm birth at the maternity ward. An early intervention should be considered while the child still is in the neonatal intensive care unit.

4.2 Summary Paper II

Long-term risk of mental health problems in women experiencing preterm birth: A longitudinal study of 29 mothers.

Long-term mental health outcomes in women experiencing preterm birth were explored. Interactional, main effect variables and predictors were identified.

29 mothers of 35 premature children born before the 33rd week of pregnancy were assessed within two weeks postpartum (T0), two weeks after hospitalization (T1), 6 months postterm (T2), and 18 months postterm (T3).
The standardized psychometric methods Impact of Event Scale (IES), General Health Questionnaire (GHQ) and State Anxiety Inventory (STAI-X1) assessed maternal mental health outcomes.

Maternal mental health problems except state anxiety decreased from T0 to T1, but remained high and stable until T3. We identified the time period between T0 and T1 to have a significant main effect on mental health outcomes. The prevalence of PTSR (first or sole diagnosis) was reduced from 21% at T0 to zero at T3. PTSD on the other hand increased from 14% at T0, to 30% at T1, and to 23% at T3. The prevalence of PTSR and PTSD at T0 and T3 was 52% and 23%, respectively, when co-morbid diagnoses were included. Depression decreased from 24% at T0 to 8% at T3. Anxiety decreased from 7% at T0 to 4% at T1, and no prevalence was found afterwards.

Increased maternal mental health problems were significantly associated with mother's age, previous mental illness, parity, trait anxiety, preeclampsia, Caesarean section, and infant's IVH grade 1 or 2. Other physical problems such as vaginal delivery, planned Caesarean section, bleedings in pregnancy, and the newborn infant on CPAP for less than 5 days were inversely associated with maternal mental health problems. The predictors of higher levels of mental health problems were preeclampsia, previous maternal mental illness, age, trait anxiety, and infant's postnatal intra ventricular haemorrhage. Pregnancy bleedings predicted lower levels of mental health problems.

The prevalence of maternal mental health problems remained high; emphasizing the importance of effective interventions.

4.3 Summary Paper III

A Norwegian prospective study of preterm mother-infant interactions at six and 18 months and the impact of maternal mental health reactions, pregnancy and birth complications.

Pregnancy complications, maternal mental health reactions following preterm birth and the possible impact on early mother-infant interaction at 6 and 18 months postterm age (PA) were explored. Predictors of mother-infant interaction at 18 months PA were identified.

In a socio-economic low risk middle class sample, 33 preterm mother-infant (<33 GA) interactions at 6 and 18 months PA were studied. The parent-child early relational assessment scale (PCERA) was used to assess the mother-infant interaction.

Mothers with clinical important case scores in the Impact of Event Scale, the General Health Questionnaire, and PTSR/PTSD diagnosis at 2 weeks postpartum (PP) showed significantly

better outcome scores in the PCERA scales at 6 and 18 months PA than the mothers without clinical case scores.

Psychometric means correlated significantly with mother-infant interactional quality at T2 and T3. High GHQ Likert and case scores and high STAI-X2 sum and case scores correlated significantly with high scores in six PCERA scales at T3.

Maternal and infant physical variables; parity, family size, acute caesarean, apgar scores and infant stroke correlated significantly with mother-infant quality at T3. The strongest correlations were inverse between the pregnancy complication “Bleedings in pregnancy” and six of the PCERA scales.

“Bleedings in pregnancy” predicted lower quality in preterm mother-infant interaction in six PCERA scales, while high “Maternal trait anxiety” predicted higher interactional quality in two PCERA scales at 18 months PA.

Our study detected a correspondence between early pregnancy complications and lower quality of preterm mother-infant interaction, and an association between high levels of maternal mental health problems and better quality in preterm mother-infant interaction. The Cronbach alpha coefficients for calculating the internal consistency of PCERA subscales in our study were satisfactorily and were .95,.86,.86, .90,.87,.85,.80,.86 for PS1-PS8 at six months PA (T2), and .89,.81,.82,.92,.89,.75,.73,.79 for PS1-PS8 at 18 months PA (T3).

5. Discussion

5.1 Methodological considerations

This discussion of methodological issues is based on the critical realism paradigm. The revised validity system [146] first operationalized by Cook and Campbell [147] is used for considering the validity of this study. Critical realism based on Cook and Campbell's system has included reliability as a part of their validity system and does not address reliability in particular [117, 148].

The term inference in critical realism is used about knowledge that is asserted on the basis of research [146-148]. The term is essential for assessing the level of validity as validity is seen as dependent exclusively on inferences or knowledge claims. It is a basic assumption in critical realism that there are real entities or processes that exists independently of the researchers mind [117]. The quality of research depends on how successfully it is in describing aspects of this reality. In critical realism causal laws are seen as "tendencies" of things and uncertainty of validity in scientific results is highlighted. To assess the validity of a research one has to be aware of the source of errors. The critical realism tradition assumes that observable scientific knowledge always include a complex and incomplete correspondence between states and processes that are not always open for observation [117, 149]. The research procedures themselves, similarly to the empirical methods, the data, and the empirical results, are from the above mentioned reasons not seen as a basis for assessing validity [117, 148].

5.1.1 Study design

The explorative design and the small number of participants in this study represents limitations and the results should not be generalized from. One should note that this study design is not sufficient to decide causality. The study was designed to be explorative to

generate new hypothesis. The sample is small and the participants are Norwegians and represent upper or middle class. The results may not be generalizable to populations with lower sociodemographic status or to other cultures.

The main strengths of the present study are the interdisciplinary design and the inclusion of both a cross-sectional and a longitudinal design in addressing maternal mental health reactions and the early mother-infant interaction following preterm birth. Data were collected from different disciplines; medicine, psychology and social and behavioral science. The cross-sectional design was chosen because of the explorative design, but represent a limitation for causality. A longitudinal design such as the one we used in *Paper II and III* contributes to strength of the stability in the findings by the inclusion of several points of measurement. The study design and the stability of our findings were strengthened by the well-established reliability and validity of the commonly used psychometric instruments (IES, GHQ, STAI).

Critical realism suggests that interdisciplinary and methodological pluralism are used for exploring the complexity and interaction between phenomena in the social sciences. Data were collected from different disciplines and knowledge platforms such as medicine, psychology and social and behavioral science. In addition, different research tools were applied. In interdisciplinary research the aim is to provide a possible new frame of understanding and attempt to cross traditional boundaries between disciplines and theories [150, 151]. The aim of our explorative study, however, was not to provide a possible new frame of understanding, but on the other hand, we aimed to collect data relevant for exploring complexity and interaction between the phenomena we studied.

The semi-structured interview, medical charts, self-report questionnaires, and the report in addition to the discussion with the mothers about the results of the psychometric and the

tentative psychiatric evaluation all contributed to a multi-informant approach as information was attained from several sources.

The assessments of video-taped observations of the mother-infant interaction belong within an intersubjective frame. Assessments are carried out from the observations of interactional phenomena "as in lived everyday life" that are recognized by their phenomenological description and thereafter quantified in a classification system. A classification system for quantifying an evaluation of an observed relational phenomenon has some qualitative methodological aspects concerning the phenomenological description. The method uses concepts and statistical analysis representative of quantitative methods; however one can argue that on a continuum the methods we used would be close to a qualitative approach. The homogeneity of the study group in terms of socio-demographic background and distress related to it represents a limitation in this study. On the other hand, homogeneity ensured that our results were controlled for high-risk socio-economic background variables as no one in our study group reported any serious socio-economic problems in the semi-structured interview we used for data collection.

5.1.2 Validity

"*Statistical validity* refers to how statistically significant or reasonably strong the relationship between variables is [117, 147]. Significant results were found on every scale, including subscales in our study and the statistical test estimates for important predictors such as goodness-of-fit measures, p-value estimates, and internal consistency which all indicated significant results. Statistical methods like linear regression used in *Paper I-III* are based on p-value and goodness of fit (r^2) and are dependent on sample-size [152]. A large sample with strong statistical power reduces the probability of making a type I (reject null hypothesis when true) and type II (fail to reject null hypothesis when false) errors. With a small sample

size, even considerable divergences may remain unexplored [153]. This study has a small sample size, but demonstrates power through strong correlations between the variables and acceptable level of variance (r^2). However, the statistical power of our study is uncertain.

Before regression analysis, residuals, outliers and tendency toward multicolinearity were explored. Scatterplots of independent variables showed no major deviations from normality. No outliers were detected. In addition, no high intercorrelations among independent variables indicated multicollinearity. Reliability of measures may be a threat to statistical conclusion validity. Unreliability of measures increases standard errors of estimates that are critical for inferring differences between statistics such as means for different scales used in this study (GHQ, IES, STAI, PCERA) [147]. The *inter-rater reliability* between the scores of two different coders of the PCERA was checked in this study and found to be satisfactory [154, 155]. With inter-rater reliability of scores done by assessments of interactional behavior we have assessed two coders' accuracy in coding the same interactional behavior and checked the scores for subjective bias. Using measures with high inter-correlations such as those used in this study indicates a minimum of measurement error introduced by the coders and the statistical power for these analyses is therefore not substantially reduced.

Internal validity refers to the certainty of inferring that causal relationship exists at the operationalized level [117]. This means that a causal association is detected between independent and dependent variables. Selection bias may threaten internal validity. As already mentioned our study was not designed to detect causal relationships, but to detect associations between outcome and possible risk factors to form further hypotheses that can be tested for causality. The study group in this study may represent a treat to internal validity. It was a homogeneous group that was not normally distributed regarding SES variables. A large sample better distributed on SES variables from the same period would have reduced the chances for selection bias in our study. On the other hand, a more normally distributed

population including participants with high risk socio-economic backgrounds possibly could have created sources of bias by contribution of risk factors other than preterm birth itself [26, 84, 156]. The rate of twins in our sample was 40% and this rate is about twice as high as estimated in normal populations [16]. In this sample there was no indications of significant differences between participants with singletons or twins that needed to be addressed in the analysis. The inclusion of both singletons and twins may, however, represent a treat to internal validity. Possible difference in parental challenges in caring for a singleton baby versus twin babies may be a source of error.

Another possible limitation to internal validity is the high prevalence of previous psychological treatment in our sample, 27.6%. Concerns regarding representativeness and source of error could be addressed, especially since a history of maternal psychiatric problems is detected as one of the predisposing risk factors for developing PTSD following birth [70]. In this study the mothers were interviewed about psychosocial strain issues [141] and in this interview the information about earlier psychological treatment in childhood or adultery was revealed. Only one of the mothers had been receiving long-lasting psychological treatment for more than 6 months. The others had received short interventions in a stressful life situation. Besides the high prevalence of earlier psychological treatment in our sample, we found no other indication of mental distress that had an impact on their psychosocial function in everyday life before the actual preterm birth incidence.

Our study group may have contributed to uncertain internal validity. However, high risk socio-economic backgrounds have been controlled for. One of the characteristics of our preterm sample was the mothers' relatively high age that might count for some of the low risk SES tendency, as higher age may be associated with better education and having a better income than younger mothers in their twenties. The most obvious explanation of our sample

being undistributed could be traits of the district from which the participants were enrolled. This area has some of the highest income levels in the country.

The wide ranges for time of data collection, especially short time after delivery may also represent a limitation to internal validity. The time difference at T0 that has a range from 4-30 days may represent a significant difference when assessing mental health reactions following preterm birth. We know that the mental health reactions are at the highest level short after delivery. The reason for the wide time difference was the mothers' medical state following preterm birth. Until their medical state allowed it they were not able to attend the semi-structured interview. Severity in mothers' medical state would have an impact on internal validity. The time difference at T1 is ranged between 0.2-4.7 months, due to the differences in discharge from the hospital. The discharge from hospital represented a change for the parents as they now where on their own with caring for the baby. We did not foresee the wide time difference that occurred as some of the babies were discharged much earlier than expected. This wide time difference may represent a limitation to internal validity as the time after the delivery event may have been more significant for the mental health assessment for instance.

We had a relatively high response rate in our study that should be preventive for selection bias. Research has shown that low ranking on SES variables is linked to high response rate [157], which raises the question of whether a low SES sample contributed to the high response rate.

Construct validity refers to which extent the items that are operationalized measure the construct in question [117, 146]. The validity of the instrument is assessed by its content and construct validity. *Content validity* should be assessed both by professional and real life experts in the actual field. *Construct validity* assesses the measure's consistent relations to the concepts that are measured [146]. Construct validity is based on theoretical basis and testing

of the psychometric measures. *Internal consistency* can be assessed statistically by Cronbach's alpha which indicate the degree a psychometric test is measuring the construct it is designed to detect. The construct validity of the self-report questionnaires IES, GHQ, STAI, the diagnostic tools, and assessment tools such as PCERA depend on an overall consistency of the measures of constructs across time, individuals and situations. The construct validity that has been reported for IES, GHQ, STAI, and PCERA are strong [122, 126, 158-160]. In *Paper I-III* different versions of STAI-X1 were used and a new 10 item scale was created for comparison reasons. The construct validity of the new scale is necessary to address. The items in STAI-X1 are well validated, but a shorter version like the STAI-X1 10 items that was created for comparison reasons has not been validated, and we cannot be certain that the STAI-X1 10 items have sufficient construct validity to measure the state anxiety levels that STAI-X1 12 and 20 items is validated to do. The validation of each item however, indicates that the items used in the existing scales do measure important features of the phenomena in question, which supports construct validity.

In this study, we aimed to explore the prevalence of PTSR/PTSD and used IES 15 items that is the most commonly used measure for PTSR/PTSD. We used tentative clinical diagnosis for the purpose of descriptive statistics. They may represent a treat to construct validity as the diagnosis were set without a clinical interview that could have confirmed, adjusted or rejected the diagnosis, When considering the construct validity of IES 15 items one limitation is that IES 22 items was not used as it includes 7 more items to evaluate hyper arousal [125]. On the other hand hyperarousal is found to be higher in the perinatal period and the cut-off level is therefore under consideration [15]. Both the IES 22 and 15 item have been found valid and reliable in detecting PTSD [122, 125].

The validity of the PCERA can be questioned since only one of four PCERA situations for assessment was used in this study. Construct validity has been established for the free play

situation [159, 160], but it is still questioned whether a five-minute recording of mother-infant interaction can replace yearlong observation [161]. Video recordings allows us to thoroughly analyze interactions several times and in short and slow sections that can identify areas of strength and of concern in the interchange between mother and child [162].
In addition, it is a limitation for construct validity that the video-procedure of PCERA could not be followed for the four dyads that were recorded in their homes and not in the clinic, as were the others. On the other hand, these dyads would not have participated if the recordings were not made in their homes.

This study included SES variables such as education, income level and employment. Maternal level of education has been evaluated as one of the best indicators of SES [163], and has shown strength through ethnic groups and cultures [164]. Most interesting for this study, the maternal level of education has been detected as the best SES variable for prediction of the mother's interactional behavior towards her young child [165].

External validity refers to which extent the results are stable through variations in people, settings, treatments, and outcomes [146]. The longitudinal design in *Paper II and III* contributes to stability of the findings. The cohort used to study mothers with preterm births and their children represents several obvious limitations. The sample size is small and the homogeneity of the study group in terms of socio-demographic background and distress related to it are both limitations to representativeness. Gender and gestational age at birth were well balanced in our study group. The participants came from well-defined geographic areas, were recruited consecutively in the study and both single and multiple births were included. The response rate was high thus minimizing selection bias. However, the exclusion of severely ill babies with very small chances of survival in the preterm group could affect selection bias. On the other hand, the impact of maternal grieving following the death of a

preterm baby would represent a significant difference from our study group, though grieving mothers would have been interesting as a comparison group.

The present study describes a small preterm group of mothers with higher educational attainment, greater age, higher socioeconomic status, higher number of twins and higher rate of previous psychological treatment than we would assume to have been found in a typical population of mothers who deliver preterm in our country. In addition, we had an exclusion criterion that ruled out non-Norwegian speakers, as the interview run in this study required a satisfactory understanding of constructs. This exclusion criterion of non-Norwegian speakers represents a threat to external validity. Our results therefore must be viewed in relation to a sample of Norwegian speakers. Four (10%) non-ethnic mothers were included in this study. Three of them had Norwegian as their second language.

The moderating role of treatment on the mother's psychometric outcome was not examined. For instance 27.6% in our preterm sample had received IVF treatment to become pregnant. 49% of the mothers in this study received psychiatric treatment during the study period during the survey period. As mentioned earlier, the mothers who reported clinically significant mental health problems were assesses for and referred to adequate psychological treatment. Adequate psychological treatment prescribed was psychological support, family oriented therapy, psychotherapy, psycho-pharmacy, and two mothers received mother-infant oriented treatment. The influence and effectiveness of these different psychological approaches was not assessed in our study. On the other hand, they did not report any information that the treatment program did not work satisfactorily. A couple of the participants had psychological problems that occurred after preterm birth and were still lasting at 18 months post term age. From the available information the treatment program they received seemed appropriate.

The small sample size and the selection of participants to the study group in this study raises methodological questions concerning representativeness. A randomized design and a higher number of participants to strengthen the study power would be preferable and would have contributed to a more random sample. However, with a randomized design the study period would have to have been extended considerably since the number of preterm births at the Hospital in which this study was performed was limited. A randomized design, however, would have raised some significant ethical issues, as the study group was offered follow up by participation in the study and the follow up included services from the Clinic for Child- and Adolescent Psychiatry in the Hospital and was referred for psychiatric treatment when recommended.

Our given resources and limited number of preterm births in nearby hospitals were obstacles in this study to obtain a higher number of participants and consequently a larger statistical power. If we had conducted a study to assess the difference between preterm (case) and term (control) births on prevalence of maternal mental health, we would have needed more participant. From available research, it could be expected a 25% prevalence of clinical important psychological distress among term mothers up to 6 months following birth [4, 32, 47, 71, 166] and a 40% prevalence among mothers giving preterm birth [32, 39, 167]. Estimated sample size to find differences would then be 150-165 persons in each group. Such a study was not possible given our resources and the number of preterm births in nearby hospitals. Instead, we did a smaller explorative study on only preterm birth. The precision of the estimates in our study, that is a reflection of the statistical power, is expressed by the confidence intervals. Overall, the standard error of our estimates were relatively high and confidence intervals were correspondingly wide. This reflects the somewhat low precision of our estimates due to the limited number of participants [153].

Initially, we intended to include a control group. A Norwegian study had used comparable psychometric instruments 0-4 days after birth on 127 mothers in a normal population in Southern Norway [47, 168]. After thorough consideration we decided not to use this control group in our study. We were able to adjust for significant sociodemographic and clinical differences between the two samples, but it was not possible to adjust statistically for the limitation of 7-9 year difference in intervening period between the recruiting of the two groups. A comparison would therefore have serious limitations and we decided that the results from this study only would serve as a valuable prevalence reference of clinical important psychological distress in a larger population study in Norway.

5.1.3 Validity in sum

The aim of this study was to detect associations to explore and form new hypotheses. Further research is necessary to detect "tendencies" that may contribute to new knowledge or inference in this field. Our study has not detected any causal relationships and cannot therefore be generalized. The strength in our explorative design was that we gave priority to a broad perspective to assess several important aspects of mental health problems, such as psychological distress, anxiety, and trauma-related stress and tentative clinical diagnosis to explore the prevalence of mental health problems. The inter-disciplinary perspective and the multi-informant approach strengthened the external validity of this explorative study. Different approaches will strengthen the validity of the findings when results are consistent across scientific borders and using different methods of data collection.

Even though the study has several validity issues and low statistical power, the study design is adequate for the explorative purpose of this study and the associations detected are significant and interesting for further research. There will, however, always be an uncertainty that we

have missed important associations due to our small sample size and that essential factors are left out in our analysis.

5.2 Discussion of the main findings

The findings described in *Paper II* showed a correspondence between early pregnancy complications and lower levels of maternal mental health problems. The results in *Paper III* revealed an association between early pregnancy complications and lower quality of preterm mother-infant interaction.

The results reported in *Paper I-II* showed high levels of maternal posttraumatic stress reactions following preterm birth. Several predictors were detected. In *Paper III* a correspondence between high levels of maternal mental health problems and better quality in preterm mother-infant interaction were found.

In *Paper III* we detected an association between high levels of maternal mental health reactions and better quality in the mother-infant interaction at 18 months' postterm age (PA). The proportions of maternal mental health reactions was assessed to fill the criteria for PTSR (52%), anxiety (17%), and depression (24%) at two weeks postpartum (PP). At 18 months PA the prevalence was 23% PTSD and 8% depression. The prevalence of anxiety and depression is similar to normal population in epidemiological studies. The prevalence of PTSR/PTSD is comparable to results in a few other studies of PTSR/PTSD following preterm birth and following childbirth for high risk samples. It seems appropriate to assume that the association found between high levels of maternal mental health problems and better quality in mother-infant interaction at 18 months' PA mainly is an association between maternal trauma reactions and better quality in mother-infant interaction. An association between early

physical pregnancy complications and lower levels of the mother-infant interaction quality at 18 months' PA was also revealed. These results described in *Paper III* are interesting to discuss from different angles as no other studies have reported similar results.

In this discussion, the notion of attachment is used also for infants less than two years of age. The reader should be aware that an infant under two years of age has not yet formed an attachment pattern, but shows signs of attachment in interactional behavior with significant others.

5.2.1 Traumatic intrusion and parental attachment pattern.

Kersting et al. 2009 have reported that they found high levels of maternal case scores using the Impact of Event Scale (IES) following preterm birth, e.g. 14.3% at 14 months' postpartum [76]. Most interesting for our study, they found high levels of intrusion and low levels of avoidance similar to those in our study. Kersting et al.'s suggestions for understanding this result are based on the fact that preterm mothers are faced with the traumatizing reality of the preterm baby on a daily basis while caring for their infant. They are constantly confronted with medical and supportive measures for the infant.

Interestingly, traumatic intrusion measured by IES-15 subscale at 7 days PP was found by Coppola et al. to be significantly associated with insecurely attached mothers, but not with the securely attached mothers [169]. The suggestions Coppola et al. made from their results are interesting for our research as we detected high levels of intrusion in the severe range. Coppola et al. presumed that insecure mothers experiencing the event in an intrusive way are gaining access to additional emotional resources. Gradually, intrusive memories bring necessary information of the traumatic event to awareness in accordance with the person's ability to process a traumatic event. In the end, the person will gradually achieve a grasp of

the event in its entirety. In addition, they assumed that insecure mothers needed cognitive and emotional reorganization and an update of their mental representations. For instance, they may need to process their parental expectations regarding the baby, the birth, how to master their paternal role, and perhaps most importantly, to understand what was actually happening to them. According to Coppola et al., secure mothers do not need access to intrusive memories to adjust well to the event. The results from the Coppola et al.'s study of 40 dyads represents an alternative view for our study as we detected that a total of 62.9% of the mothers in our study had intrusive scores measured by IES-15 subscale at 2 weeks PP. Coppola et al.'s finding offers a new perspective through which to understand our results, but new questions arise as well. The high prevalence of intrusion found in our study may be essential for understanding the association found between high levels of maternal mental health problems and good quality mother-infant interaction in our study.

5.2.2 Posttraumatic stress reactions and the impact of memory in processing trauma

With regard to explanations that can make sense of our findings of high levels of maternal posttraumatic stress reactions following preterm birth being associated with higher levels of interactional quality in mother-infant interaction, essential contributions have come from memory research. Horowitz in his psychodynamically informed information-processing approach to PTSD [170-172] has drawn our attention to the impact of memory on processing traumatic events. His approach is a contribution to understanding how a traumatic event can contribute to posttraumatic growth, and among other things, describes a potential impact on early mother-infant relationships.

A traumatic event experience normally requires change in mental representations and Horowitz argues that we have an internal drive making our mental models coherent with new information. A traumatic event is likely to bring about mental changes. These changes bring about intrusions, such as flashbacks and nightmares that tend to occur in the denial phase of the traumatic event. Intrusions are seen as the mind's way of regulating the incoming information in tolerable doses. A complete change in mental schemas takes time. During the process of change, the active memory tends to repeat its representation of the traumatic event in a way that causes emotional distress. The importance of intrusion in processing the traumatic event has been highlighted by Horowitz. The avoidance phase, on the other hand, take place when a person's inhibitory control is too strong and the processing of the trauma reaction is beginning to slow down. Horowitz proposes that intrusions such as the ones we detected in our study are necessary for a successful recovery from a traumatic event. The idea of mentally processing a traumatic event to make sense of it also is essential for posttraumatic growth models [172]. Painful emotions following a preterm birth experience could in this way be seen as serving an important purpose in helping parents to find some meaning in the situation, and also for the transition into parenthood [173].

5.2.3 Posttraumatic stress reactions and posttraumatic growth

Posttraumatic growth (PTG) is a concept that theoretically is interesting for understanding why high levels of maternal posttraumatic stress reactions can be related to positive mother-infant interchange. PTG refers to the benefit or growth that people can experience from a trauma incidence. It is a new perspective on psychological trauma, but the research field has produced a growing number of studies [174-176]. The concept assumes some level of life threat and existential struggle [177]. PTG has been focused on both as a trauma outcome and

a coping strategy. Several studies have reported that many people experience positive psychological growth after struggling with a trauma. [178]. The process of psychological growth is described as a process of reconfiguration, which requires distress and automatic cognitive processes. These processes are understood as attempts to reconcile the trauma with personal representations, or to find a way to make sense of what has happened [179]. In other words, in PTG, intrusion plays an important role for a person's ability to make sense of a traumatic incidence. The experience of being of help to others is highlighted as important for the person [180].

An established relationship between PTG and PTSD would have been beneficial for our study. However, no systematic relation between PTG and PTSD was revealed for adults in a review paper [174]. Other review papers, however, have found significant associations between PTG and PTSR for children and adolescents [175]. Also one study that examined the link between PTG, emotional intelligence, PTSD, and resilience in parents undergoing corrective surgery support revealed that PTG was positively associated with emotional intelligence, self-efficacy, resilience and PTSD [176]. Another study that supports the idea of PTG being associated with high levels of stress exposure is the Taubman-Ben-Ari and Findler study [181]. They found that mothers of preterm twins reporting the highest levels of negative feelings toward their infants were the ones that showed the lowest level of mental health reactions. Nevertheless, one year after birth they reported the greatest personal growth. The younger and the less educated the mother was, the more growth she reported. Interestingly, the preterm group that had been exposed to the most stressful circumstance in this study contained those who showed the highest levels of personal growth.

The results of this study correspond with our findings in many ways. We did not assess personal growth or positive or negative feelings towards the infant explicitly, but looked at the relational outcome for the mother-infant dyad, which is another way of assessing the

mother's feelings towards her child and how she is coping with parenthood. While we detected a connection between early bleeding in pregnancy and low levels of maternal mental health outcomes following preterm birth, and further, an association between low levels of mental health reactions and lower quality in mother-infant interaction, this study revealed that mothers with low maternal mental health levels had the greatest personal growth one year after the preterm birth.

In our study, we detected that mothers with the highest levels of mental health reactions following preterm birth (mostly posttraumatic stress reactions), attained the best outcome in the mother-infant interaction assessed by the PCERA at 18 months PA. With reference to the PTG theory and the high levels of intrusion among our participating mothers at 2 weeks' PP, we may emphasize that they successfully had been processing the traumatic event by the time the mother-infant interaction was assessed at 18 months' PA. According to the PTG theory, it is possible that the mothers in our study could have experienced posttraumatic growth and one could assume that PTG had had a positive effect on mother-infant interaction. However, the prevalence of PTSD among the mothers at 18 months' PA in our study was 23%, which is quite high. As research has shown a possible association between PTSD and PTG, I would like to hypothesize the connection even further and ask: could it be that high levels of intrusion is the most important factor for PTG and for enabling mothers to make extra efforts to support their infants in the mother-infant interaction?

5.2.4 Parental sensitivity to the preterm infant's signals

The concept of sensitivity is essential in early mother-infant literature and is necessary to address when discussing our study results. The mother's level of sensitivity is assumed to play an essential role for the interactional quality in the mother-infant relationship and is

taken into account in several of the eight PCERA scales we have used for assessment of mother-infant interactional quality. In addition the impact of maternal sensitivity on the attachment between mother and infant represents an interesting perspective, but is not examined in our study.

The study results contributing to the knowledge of mother-infant interaction following preterm birth [182] are inconsistent and most are based on small cohorts (< 50 dyads); only a few larger studies (50-150 dyads) exist. On one hand, studies have reported preterm mothers to be more active, intrusive, and less sensitive towards their infants than term mothers [26, 83-87]. On the contrary, it is interesting that 5 out of 18 studies have revealed fully capable, supportive and emotionally available mothers showing equal or even higher interactional quality than term dyads [182]. One study from 1981 observed that preterm mothers and in particular mothers who were separated from their children immediately after birth touched and attended more to their children than full-term mothers [183, 184]. In addition two older studies and one recent study have reported that mothers of infants born with low GA and weight and serious medical problems were more caring compared to mothers with healthier preterm babies' [185]. It is interesting for our study that several other studies have found that preterm mothers have shown considerable effort to compensate for preterm difficulties and have been observed as fully capable in supporting their infant's development [183-187]. It has been proposed that dependent on parents' resources, prematurity actually may stimulate greater parental care and investment instead of increasing disinterest and non-attachment [186].

While these studies have found intensified effort from the mothers to support their preterm babies, the present study has identified an association between good quality mother-infant interaction and high levels of maternal mental health problems following preterm birth. On the other hand, research on the association between mothers' capacity for sensitivity to the

child's signals and the child's development of an attachment pattern is explored and found to be associated in many studies [188] as well as the relation between maternal attachment organization and maternal level of sensitivity to a preterm baby's needs [169].

5.2.5 Evolution theory and the bonding process with a preterm infant

Evolution theory has addressed the importance of parental bonding with a preterm infant. The PCERA assessment of mother-infant interaction at 18 months PA in our study showed mean values in the area of no concern in five scales, and in the area of moderate concern for three scales. The idea of compensatory care in evolution theory [187] could represent a perspective that may explain these findings. The compensatory care theory assumes that parents will increase their parental caregiving behavior to reduce the impact of dangerous events for sick and high-risk infants. The theory of compensatory care does not offer a sufficient explanation of the association we found between high levels of maternal mental health reactions following preterm birth and better quality mother-infant interaction. From an evolutionary perspective, it is beneficial for preterm infants that the level of parental bonding is high. The quality of early parent-infant interaction is known to have a mediating effect on infant development and to a preterm infant with a perinatal risk status it is probably even more essential [83, 185, 189]. According to evolution theory the parents' capacity for bonding will be depend on the caregiving resources to which they have access [190, 191]. One recent study for instance has reported that the parental investment and bonding efforts with preterm infants were higher than for full-term infants in affluent countries with adequate resources [185].

Evolution theory acknowledges that psychological processes such as emotional distress following a traumatic preterm birth experience may have an impact on the parents' bonding with their premature infant [192]. One study has reported that parents of high-risk premature

infants that were initially highly emotional affected, anxious and worried, developed a string bonding with their infant at 6 and 18 month [193]. On the contrary bonding difficulties and emotional detachment are reported for parents who initially have shown withdrawal of parental emotions [185].

These results can be associated with our findings. High levels of affection may be associated with our findings of high levels of mental health reactions following preterm birth. In addition withdrawal of parental emotions initially may be associated with our findings that bleeding early in pregnancy was associated with lower mental health reactions following preterm birth and lower mental health reactions were later found to be associated with lower levels of mother-infant interactional quality.

5.2.6 Main findings in sum

High levels of traumatic intrusions represent an interesting perspective to our findings in *Paper III*; May high levels of intrusions following preterm birth intensify mother's effort to support their preterm babies and contribute to a better mother-infant interaction? Mother's ability to sensitivity and level of bonding with her preterm baby may be complementary factors for understanding our findings.

5.3 Implications

5.3.1 Implications for clinical practice

This study has focused on the importance of a holistic understanding and the investigation of bio-psychosocial conditions that can be thought to influence the mother's psychological

reactions and the mother-child interaction. Mothers with early complications in pregnancy are a possible at-risk group. More minor traumatic reactions following preterm birth can be another indicator that mothers may have need of helping measures that can contribute to development of good interaction with their child. High levels of traumatic reactions and a high level of intrusion appear to provide good indications of positive development of the mother-child interaction. There is, in any case, grounds to consider helping interventions of a practical nature that can relieve parents with necessary everyday tasks. The extra activation in caregiving behavior that high levels of intrusion seem to encourage can drain the mother of energy over time. This scenario can be part of the reason that mothers with prematurely born children or seriously ill children experience periods of fatigue when the child is past the critical phase and they can relax more and allow their own feelings to arise. Prevention of such periods will in my view involve practical helping interventions.

Mothers with depressive reactions to premature birth will require different interventions than mothers with traumatic stress reactions. We know that depression can have an extremely negative effect on mother-child interaction and hinder the child in its development, and that helping interventions are necessary [80, 194-196]. That which is interesting for clinical practice and that can be seen in experiences with this study is the observation I made that mothers seldom spoke about their own psychological reactions following premature birth. A clinical interview with this as the main focus would perhaps have uncovered something else, but on the basis of my prior experience, it appears that mothers have their focus on their child in this situation. It can also be a sensitive topic for mothers to focus too much on themselves and their own problems when they have a child that is struggling to survive after premature birth. When the mothers were asked to fill out screening measures, this information immediately arose. It can also be thought that it can be difficult to thematize psychological

reactions after premature birth for clinicians encountering mothers who either experience the topic as sensitive or possibly also as less important in the specific situation.

5.3.2 Theoretical implications

One of the findings in our study for which we have little theoretical support is the connection between early "Bleeding in pregnancy" and a lesser degree of psychological reactions following birth, and the connection between "Bleeding in pregnancy" and lower quality of mother-infant interaction. The theoretical understanding I have turned to for support in trying to understand this connection is attachment theory and its focus on danger in the formation of different patterns of attachment. If bleeding early in a pregnancy is perceived as a sign of danger and a possible risk of losing the baby, this can be thought to influence the mother's early contact with and early attachment to the baby in utero. Preparations for the child to come can be suspended and the emerging contact with the unborn child can stop completely or partially. Anxiety that the child may die before or after birth can to different extents paralyze the mother's ability to connect with the child. As I understand this, this anxiety is a protection mechanism humans require against the pain the loss of a child will involve for us. When the child survives despite the difficulty and needs extra care from the parents in order to thrive it will be necessary to help the mother and child when they are to establish a good relationship that can provide the child with good opportunities for development. The mother can require help to cope with and work through her anxiety, but most probably the best help will be that which aids her in mastering the establishment of a healthy and good quality interaction with her child. As I see it, it is in this parent-child relation wounds can be healed and anxiety overcome.

The importance of a high degree of intrusion is an interesting theoretical perspective on premature birth that this thesis has attempted to illustrate. This study can be a contribution to the thinking around posttraumatic growth (PTG). The interesting point is that traumatic reactions we found in this study are connected to topics such as evolution and survival for a child born too early. It can appear here as though nature supplies the activation required and that trauma reactions and intrusion especially play an important role for this activation. A high degree of intrusion appears to ensure the premature child the extra care it needs from the mother in order to obtain the best possible developmental conditions.

5.3.3 Implications for future research

The greatest limitation of this study is that it is small and that the number of participants is few. Even though the study is small, there are several interesting findings that have emerged from it. The goal of the study has been to explore a phenomenon in which there is the need for more knowledge. The ambition has not been greater than that the results of this study can be productive of hypotheses. In light of this, there will be the need for systematic exploration of the hypotheses that can be derived from this study. A small hypothesis-producing study such as this one can in any case have qualities that larger randomized studies do not have with regard to the development of an evidence base for knowledge about mothers' psychological reactions to premature birth and the importance these reactions can have for the early mother-child interaction. Larger randomized studies will not be able to address "big questions" in this field without the prior broader exploration of the field for important connections. Our study has provided a contribution to the development of an evidence base in this field. Future investigations should ensure that also fathers are included in exploratory studies such as this one.

The results of our study have contributed the following hypotheses:

1. There is a possible association between low GA, parity, trait anxiety, preeclampsia, IVH (1 and 2), mothers' previous psychological treatment and higher levels of psychological distress and anxiety following preterm birth.
2. Maternal trait anxiety (STAI-X2), preeclampsia, IVH (grade 1 and 2), mothers' age, mothers' previous psychological treatment, and maternal trait anxiety (STAI-X2) seem to be associated with higher levels of mental health reactions following preterm birth.
3. There is a possible association between low levels of maternal mental health problems following preterm birth and "Planned caesarean section" and early "Bleeding in pregnancy".
4. Warning signs like "Bleeding in pregnancy" may disturb pregnant women's transition process into motherhood.
5. An association between high levels of posttraumatic stress reactions and better quality in mother-infant interaction seems to be possible.
6. High levels of intrusion following preterm birth may intensify mothers' efforts to support their preterm babies and contribute to a better mother-infant interaction.

6. Conclusive remarks

In summary, knowledge from several research fields has been used in this attempt to make sense of the association we revealed between high levels of maternal posttraumatic stress reactions following preterm birth and a positive mother-infant interaction pattern at 18 months' PA. Perspectives from the field of attachment, the impact of maternal sensitivity, maternal mourning, memory processes following trauma, PTG and evolution are all contributing views. However, none of these perspectives has offered any understanding of the association between early physical complications in pregnancy and lower quality of mother-infant interaction at 18 months' PA. Our first assumption in *Paper III* that maternal anxiety for a dangerous pregnancy outcome may hinder the mother in her attachment process to the unborn child is still our only suggestion for understanding this result.

Critical realism contributes a broad view for understanding and interpreting the study results. In this discussion section, I have examined several possible explanations of one of our study results that I view as the key result that integrates the other results in our study.

The validity of our study results would have been strengthened if we had examined the influence of the methodological issues that we have discussed. However, the phenomenon that we aimed to study was examined in a minor range and our study aimed to explore possible associations contributing to a broader understanding of maternal mental health reactions following preterm birth and the impact on early mother-infant interaction. The perspectives that our study has brought about should be explored further in future studies. The inference or knowledge claims asserted from future studies will depend on how successfully aspects of maternal mental health reactions and early mother-infant interactions following preterm birth are described.

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