

# **Biological vulnerability and developmental resilience in infancy:**

*The influence of temperament, breast feeding and pacifier use*

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## Abstract

Title: Biological vulnerability and developmental resilience in infancy: The influence of temperament, breast feeding and pacifier use.

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**Background:** Biological vulnerability at birth increases the risk for poor development across the life-course. However, a small number of these vulnerable infants show normative development. What characterises these infants is, as of yet, unknown. In order to shed light on this issue, the current study aimed at investigating developmental resilience among infants with a biological vulnerability, and to see whether temperament, breast feeding, and pacifier use moderated this relationship. **Method:** A sub-sample (31 127 births) within the Norwegian Mother and Child Longitudinal Cohort Study (MoBa) was selected based on the completion of items included in the study. Biological risk was defined as one or more of the following: low birthweight, birth complications, low Apgar score 5 minutes after birth, unplanned caesarean and being referred to a specialist. Developmental resilience was defined as above average development at 6 months, using items adapted from the Ages & Stages Questionnaire (ASQ). **Results:** A cumulative effect of risk was found, the less biologically vulnerable the infant were the higher the odds of showing developmental resilience. What promoted developmental resilience differed for low risk and high risk infants. For low risk infants, having an easy temperament such as being easy to sooth and to seldom cry was associated with developmental resilience. For high risk infants, however, being breast fed was associated with developmental resilience. Pacifier use at bedtime was associated with developmental resilience for females only. These findings were still present after controlling for mother's age and the parents level of education and income. **Conclusion:** The moderating role of temperament, breast feeding and pacifier use on infants being biologically vulnerable and their development, depends on the degree of biological risk and, to a lesser extent, gender.

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# 1. Introduction

Biologically vulnerable infants are at greater risk for developmental delay and poorer psychosocial functioning across the life course. In the prenatal period and the first few years of life there is a rapid brain growth (Rutter & Rutter, 2000). As early as six months of age, the brain has reached half of its full grown weight, while the rest of the body first reaches this developmental level at year ten. During the first few years of life the developing brain is especially sensitive to insults. However, the plasticity of the brain can adjust for damage in one area of the brain by letting another part of the brain take over the functions from the damaged area. For example children that have suffered congenital left-hemisphere damage prior to 6 months of age score within the normal range on language measures at 5-6 years of age (Bates et al., 2001). Adults that had a lesion in the same areas due to cerebrovascular incidents had severe language impairments from 6 months to 16 years after the incident, indicating that the plasticity is greater at an early age. The plasticity comes at a cost, and may increase the chance of general difficulties at a later stage in development (Rutter & Rutter, 2000).

In the next section what the literature reports regarding the impact of biological risk on infant development and psychosocial functioning will be presented. Then the term resilience will be introduced and discussed. Further, what the literature says about temperament, breast feeding, pacifier use, and gender in relation to infant development and psychosocial functioning will be presented. What has been presented so far in the introduction will then be linked to the current study and the research questions will be stated.

## 1.1 Biological vulnerability

In early childhood infants with biological vulnerability, such as low birth weight, are at greater risk for delay in motor and cognitive development (Laucht, Esser & Schmidt, 1997). For example low birth weight infants are at risk for health problems (Stein, Siegel & Bauman, 2006), learning disability (Hagen, Palta, Albanese & Sadek-Badawi, 2006., Johnson & Bresalu, 2000), behavioural problems, ADHD or ADD symptoms (Elgen, Sommerfelt & Markestad, 2002., Martel, Lucia, Nigg & Breslau, 2007, Stein et al., 2006),

and being less sociably competent (Tessier, Nadeau, Boivin & Tremblay, 1997). In adolescence, youth who were low birth weight infants have an increased risk of having neurosensory impairments, behavioural problems and psychiatric disorders such as ADD, anxiety symptoms, and relational problems (Doyle & Casalez, 2001., Indredavik, Heyerdahl, Kulseng, Fayers & Brubakk, 2004).

Low birth weight is not the only factor constituting biological vulnerability. Other factors indicating a biological vulnerability include being born preterm (Fily et al., 2006., Marlow, Wolke, Bracewell, Samara & EPICure Study Group, 2005., Wood et al., 2000), birth complications (Berk, 2000., Laucht et al., 1997., Punamaki et al., 2006), low Apgar score (Finster & Wood, 2005., Thorngren-Jerneck & Herbst, 2001, Weinberger et al., 2000), and seeing a health specialist (Barker & Tremblay, in press). Still, when we look closer at these studies we find a small number of children with biological risk that defy the odds and show normative development and psychosocial functioning. These children show resilience.

## 1.2 What is resilience?

Resilience has been defined in various ways which has led to confusion among clinicians and researchers. In an attempt to clarify the varied definitions used, Sverre Torgersen and Trine Waaktar (2007) identified three ways to understand resilience. The first view defines resilience as a trait of nature. According to this view, resilient children will bounce back from adversity the same way grass will continue to grow once the stone blocking the sun is removed. The problem I find with this view is that it is confined to good functioning once adversity has been removed. What about the children living under constant adversity but still show good psychosocial functioning and normative development?

The second view refers to resilience as a process. According to Torgersen and Waaktar, in this view all elements such as individual factors, environmental factors, protective factors, and even the outcome can be called resilience. Although I believe resilience to be a process along with Michael Rutter (1985, 2000), Suniya Luthar (2000, 2006), and others (Borge, 2003., Kim-Cohen, Moffitt, Caspi & Taylor, 2004; Yates, Egeland & Sroufe, 2003), my view of the resilience process does not comply with the interpretation by Torgersen and Waaktar. It is my understanding that the promotive or protective factors are not the same as resilience,

but are elements that influence the process. Resilience is never directly measured, but is inferred based on measuring risk and positive outcome (Borge, 2003).

The third view described sees resilience as a personality trait. This is the preferred definition by Torgersen and Waaktar. The problem I see with narrowing resilience to a personality trait is the vast research demonstrating the influence of environmental factors on a child's adaptation. Studies such as the Rochester longitudinal study, The Maryland longitudinal study and the Philadelphia study, illustrates that the cumulative effect of risk is a better predictor of psychosocial adjustment than individual factors such as temperament and competence (Sameroff, 1998., Sameroff, Gutman & Peck, 2003). Another point is that although children show resilient behaviour at one point in time, it is not given that they will remain resilient later. So, although personality or temperament factors influence a child's adaptation to the environment, this is not enough to explain or define the concept of resilience.

Although Torgersen and Waaktar claim resilience to be a personality trait, they agree that the common goal for all researchers, regardless of how they define resilience, is to identify the process between being exposed to adversity and positive adaptation. Another unifying point is that most definitions include that showing resilience constitutes evidence of good adjustment in face of adversity (Kim-Cohen et al, 2004). So, resilience is the process where individuals show positive adaptation despite significant adversity (Luthar, 2006). What is defined as a positive outcome can range from normative development and psychosocial adaptation to the absence of psychopathology.

### **1.2.1 Resilience in the current study**

In the current study, resilience is defined as above average development at 6 months given biological vulnerability. Developmental resilience is a measure of an infant's general development including motor, language and cognitive skills. It is hard to distinguish the various developmental areas this early in life as the expression of one area might depend on another. For example, one observation indicating cognitive abilities is when the infant picks up a toy and explores it. However, to be able to do this, the infant needs to have the relevant motor skills. This is why the various development areas are not measured separate but included in a general development score. In order to avoid confusion of what is meant by

resilience, the term developmental resilience is used when referring to resilience in the current study. However, when discussing previous literature, what is meant by resilience will vary from study to study. What constitutes resilience in these studies will be specified.

Since resilience was introduced in the scientific literature during the 20<sup>th</sup> century, numerous studies have tried to pinpoint factors promoting normative development (Luthar, 2006).

Temperament is one factor that has been widely investigated to this end. In the early years of resilience research, resilience was thought of as an individual trait. Although some still claim resilience to merely reflect temperament (Torgersen & Waaktar, 2007), the majority of resilience researchers recognise resilience as a process that can be influenced by, but not restricted to, temperament.

## 1.3 Temperament

Infants show individual differences in the way they behave and react (Shiner & Caspi, 2003). This individual difference can be described as temperament. Temperament can be traced as far back as fetal activity (DiPietro, Hodgeson, Costigan & Johnson, 1996, DiPietro et al., 2002., DiPietro, Costigan & Pressman, 2002). For example, DiPietro and Colleagues (2002) found that fetal motor activity measured at week 24, 30, and 36 could predict temperament attributes related to regulative behaviour when the child was 1-2 years of age.

Temperament is seen as the biological core and the earliest expression of personality (Rothbart & Posner, 2006). There are many ways to define temperament. In the current study, temperament is described as the biologically based individual differences in reactivity and self regulation, which can be seen through emotionality, motor activity, and attention (Rothbart & Posner, 2006). Reactivity refers to how responsive infants are to changes in stimulation. Reactivity is modulated by the processes included in self-regulation. Put simply, temperament is the individual differences in the way we behave and react to what happens around us.

### 1.3.1 Infancy and temperament

As it is hard to describe personality traits in infants, researchers have often categorized temperament as “easy” or “difficult/fussy”, based on the famous New York Longitudinal



Study (NYLS; Chess & Thomas, 1992). In the NYLS, nine dimensions of infant temperament was found (activity level, rhythmicity, approach or withdrawal, adaptability, threshold of responsiveness, attention span and persistence, intensity of reaction, quality of mood, and distractability). Through parent interviews, Thomas and Chess found that these dimensions clustered into three temperament types: easy temperament, difficult/fussy temperament and slow-to-warm up. An easy tempered infant would quickly acquire regular routines during infancy, would be cheerful, and adaptable to change. An infant with difficult/fussy temperament would show irregular routines, be rarely positive, respond poorly to change, and show intense moods. An infant that was slow-to-warm up would withdraw from others, be inactive, adapt slowly to change, and be negative. Of these three temperament types, it is the construct of difficult temperament that has been most frequently studied (Rothbart & Posner, 2006).

Having a difficult temperament in early childhood has been related to poorer adjustment and psychopathology in later childhood and adulthood. For example, difficult temperament measured by parents when the infant was 1.5 years old was associated with behavioural problems rated by both parents and teachers when the children were 11-12 years of age (Guerin, Gottfried & Thomas, 1997). Findings from the Dunedin longitudinal study revealed that a difficult temperament at age 3 was associated with antisocial personality disorder, alcohol dependence, and more suicide attempts at the age of 21 (Caspi, 2000). In addition, early difficult temperament was related to later relational problems with partner including conflict, less trust and intimacy problems. This group also left school earlier, had a higher unemployment rate, and were more likely to be involved in a life of crime. This study did not differentiate between biological and psychosocial vulnerability, so we do not know whether the results would look the same for infants with a biological vulnerability only.

Having an easy temperament such as seeking social contact, seldom crying, and being easy to sooth, has been associated with better cognitive development among infants with socioeconomic (SES) deprivation (Kim-Cohen et al, 2004). It has also been associated with less internalising behaviour such as anxiety (Kagan & Snidman, 1999., Tschann, Kaiser, Chesney, Alkon & Boyce, 1996), less externalising behaviour such as behavioural problems (Guerin et al., 1997., Smith & Prior, 1995., Tschann et al., 1996), and less learning problems (Werner, 1993).

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Going through 17 longitudinal studies investigating resilience, Werner (2005) concluded that having an easy temperament promoted child development and functioning. The problem with these studies is the same as for studies investigating difficult temperament; they did not include biologically vulnerable infants, or did not distinguish the outcome variable for infants with only a biological vulnerability. This means that we still do not know whether an easy temperament can function as a protective factor for infants with a biological vulnerability. However, if we look at the mechanisms in how temperament influences development, we might be able to predict the effect of temperament on infants with a biological vulnerability.

The quality of the interaction between caregiver and the infant is central for the infant's development (Smith & Ulvund, 1999). The child learns basic skills such as turn taking and how to regulate emotions through the interaction with the caregiver. It is by influencing this parent-child interaction that temperament influences infant development (Prior, 1992). This view is in line with the transactional model, which is commonly used to understand the interaction between nature and nurture and how they shape the infant's development (Smith, Cowie & Blades, 2003).

The transactional model postulates that there is a reciprocal interaction between the infant and the caregiver (and the environment in general) over time. For example, an infant with an easy temperament will smile and often search for social contact. This will invite the caregiver to interact with the infant in a positive way. The caregiver's positive response will reinforce the infant's social behaviour which again will elicit positive response from the caregiver. They find themselves in a good circle. The parent feels competent in the role as a parent when given positive feedback from the infant. This makes it easier for the parent to relax and take time to give the infant cognitive and social stimulation. A difficult tempered infant will, by the frequent crying and being hard to soothe, elicit stress and frustration in the caregiver. This might lead the parent to spend most of his/her time and energy on calming the infant and less time on stimulating the infant's cognitive and social skills.

This perspective is strengthened by findings from the Kauai Longitudinal Study (Werner, 1993). They found that infants with an easy temperament (active and sociable infants without distressing sleeping and feeding habits) elicited more positive response from caregivers at age 1, and from other adults at age 2 years old, than children with a difficult

temperament. In later years the children with easy temperament had a wider network of caring adults that they relied on.

However, it is not always an easy temperament that will elicit the best environment for development. A classic study by deVries (1984, cited in Chess & Thomas, 1992) found that among the Masai of east Africa, having an easy temperament was associated higher mortality. The study took place during the severe sub-saharan drought in 1974, which resulted in a shortage of food. The Masai were a warrior tribe, valuing strength and fierceness. Infants with a difficult temperament were seen as possessing these traits. In addition, the Masai infants' were fed on demand so the infants that made a lot of fuss would get fed more often. Infants that were calm and seemed content were given less attention. This study illustrates the importance of a good fit between the infant's temperament and the environment. Thomas and Chess referred to the good fit between the infant and the caregiver as "goodness of fit". In the western society, having an easy tempered infant will increase the chances of a goodness of fit, as these are traits that the society values in a child.

### **1.3.2 Temperament and biological risk**

So, do infants with no risk have an "easier" temperament than infants with a biological risk? A study by Coll and colleagues (1992) illustrates how temperament can be influenced by biological risk. They found that preterm infants and infants with intraventricular hemorrhage (IVH) differed from term infants on temperament traits at 3 and 7 months of age. Compared to full-term infants, preterm infants were less sociable, smiled less often and uttered less positive vocalisations when exposed to objects and toys at three and seven months of age. Infants with IVH were less sociable at 3 months, and at 7 months they smiled less often and uttered less positive vocalisations in response to objects. Overall there was a lack of stability in temperament for preterm infants whereas for infants with IVH there was a moderate to high stability. This indicates that infants need more time to recover from perinatal insult than from being born preterm.

However, more recent studies have found that being preterm or being born with low birth weight did not affect temperament at 6 months (Weiss, John-Seed & Wilson, 2004). The difference in results can be due to the difference in the samples and the measurement of temperament. The sample selected by Coll and colleagues had lower birthweight and

gestational weeks. As the infants in the study by Coll and her colleagues had a greater biological vulnerability, it could be argued that the difference in results were due to this. Coll and colleagues measured temperament by observing the infants response to different stimuli, whereas Weiss and her colleagues based temperament on maternal reports. This is another possible explanation. However, regardless of the differing results, these studies illustrate that whether an infant's temperament is affected by biological risk depends on the degree and type of biological insult.

Some researchers have used difficult temperament as a risk factor for developmental difficulties as they believe it to reflect cerebral damage in the neonatal period (Brennan, Hall, Bor, Najman & Williams, 2003., Jaffee, 2007). If a difficult temperament is a marker of biological damage, temperament can directly as well as indirectly affect infant development.

Individual factors such as temperament are not the only factors important for infant development. Factors related to the infant's environment such as breast feeding and pacifier use are also prominent factors.

## 1.4 Breast feeding

It is recommended by the World Health Organisation to exclusively provide the infant with breast milk in the first 6 months. In Norway breast feeding is common. In the first week after birth, 96% of women breast feed. At 6 months 7% of women breast feed exclusively and 80% partially breast feed (Grøholt & Nordhagen, 2005). Breast milk has been associated with better psychomotor, cognitive and neurobehavioural development (Anderson, Johnstone & Remley, 1999., Feldman & Eidelman, 2003., Gale & Martyn, 1996., Lucas, Morley, Cole, Lister & Leeson-Payne, 1992., Vohr et al., 2006).

As breast feeding mothers have been found to be older, more educated, and have a higher socioeconomic status, whether the beneficial effect of breast feeding can be attributed to these factors have been questioned (Horwood & Fergusson, 1998). Studies that control for these factors, find that the effect of breast milk decreases or disappears (Furman et al., 2004., Gale & Martyn, 1996., Slykerman et al., 2007). These studies remind us that other environmental factors can affect the relationship between breast feeding and infant

development. The implication is that we must utter care when interpreting results and inferring causal relations.

The next question to be answered is what aspect of breast feeding account for the beneficial effect? Is it the nutritious value of the breast milk or the process of breast feeding? A study frequently cited regarding this issue, is a study of preterm infants by Lucas and his colleagues (1992). As Lucas and his colleagues had found breast feeding to be associated with better infant development in previous studies, they were curious to find out whether this effect was due to the human milk itself (1990). In order to see whether the positive association between breast feeding and cognitive development was related to the process of breast feeding or the breast milk itself, Lucas and his team compared mothers who fed the infant breast milk by a tube with infants that did not receive breast milk. They found that the children who had consumed breast milk had a higher cognitive development score (IQ score) at age 7 to 8 years and that the score was related to dosage of breast milk (more milk, higher IQ score). The results remained the same after adjusting for mother's education and social class. This study illustrate that there is a nutritious effect of breast milk enhancing cognitive development in biologically vulnerable infants. Can we see the same beneficial effect of breast feeding for infants with no biological vulnerability?

A recent study of Scandinavian children with no biological risk found similar results to Lucas and his colleagues (Angelsen, Vik, Jacobsen & Bakketeig, 2001). The study found that children being breast fed for at least 6 months had a higher cognitive score at one year and five years of age. Although the same trend was seen for motor development, it failed to be significant.

The literature is divided regarding motor development and breast feeding. Some find breast feeding to significantly promote motor development (Dee, Li, Lee & Grummer-Strawn, 2007., Vestergaard et al., 1999.), whereas others fail to find this association (Rogan & Gladen, 1993., Temboury, Otero, Polanco & Arribas, 1994., Paine, Makrides, & Gibson, 1999). Does breast feeding have a stronger beneficial effect on cognitive development than motor development?

In breast milk there is a high content of long chain polyunsaturated fatty acids, especially docosahexaenoic and arachidonic acid. Studies have found dietary long chain polyunsaturated fatty acids to be associated with gain in brain weight and mental

development in infants (Birch, Garfield, Hoffman, Uauy & Birch, 2000., Xiang, Alfvén, Blennow, Trygg & Zetterström, 2000). However, infants drinking breast milk, whether through breast feeding or given donor breast milk, have been found to show slower physical growth in the early postnatal period than infants drinking formula (Boyd, Quigley & Brocklehurst, 2007). This might explain why breast milk seems to have a stronger effect on cognitive development than motor development in the early years.

So far we have seen that breast milk seems to be beneficial for cognitive development, and this effect is seen in infants with and without biological vulnerability. The studies presented so far have shown the beneficial effect on cognitive development up to 8 years of age. What about cognitive function as an adult?

Gale & Martyn (1996) set out to see whether breast feeding was related to adult intelligence. They found that exclusive breast feeding in infancy was associated with higher IQ scores as an adult. Being bottle fed was associated with higher IQ scores than a combination of bottle feeding and other foods. However the association between breast feeding and IQ scores disappeared when they adjusted for maternal age at birth, father's occupation, pacifier use, number of older siblings, birth weight, and weaning at one year.

Participants with low and normal birth weight were analysed together in this study, but only 32 of 994 participants had a low birth weight (<2500g). As earlier studies have shown that breastfeeding is beneficial to infants with and without biological risk, this doesn't necessarily constitute a problem. The study does not refute the beneficial effect of breast feeding in infant's and children's development, but it indicates that breast feeding cannot predict adult intelligence.

Recently it has been reported that whether breastfeeding promotes later cognitive development (intelligence) depends on the genetic variation in fatty acid metabolism (Caspi, et al., 2007). This can explain why studies have failed to find an effect of breast feeding on adult cognition, as the beneficial effect of breast feeding only is present in individuals with a certain genetic makeup. Maybe this finding can explain the varied results regarding motor development as well. To discuss this further is out of the scope of this article. What we can take from this is that there is a complex interplay between genetic and environmental factors regarding infant development.

So, there is a nutritious effect of breast milk, what about factors associated with the process of breast feeding? Do they play a role in enhancing infant development? Looking at preterm infants, Feldman and Eidelman (2003) investigated the mother-infant interaction in order to grasp the indirect effects of breast feeding. They found that maternal affectionate touch moderated the relationship between breast milk and cognitive development. Infants who received mostly breast milk (>75% of nutrition) in their neonatal period and who frequently were shown affection via touch by their mothers, showed better cognitive development at 6 months and had a more mature neurodevelopment at 37 weeks. In addition, they were more alert during social interactions. Similar to previous research, they also found that breast milk in itself enhanced development. However, the effect was strongest when combining substantial amount of breast milk and affectionate touch. This study shows that in addition to directly enhancing development through its nutritious value, breast milk can also indirectly affect development by improving maternal mood and mother's interaction with the infant.

In the policy statement of 2005, the American Academy of Pediatrics (AAP) concluded that breast milk enhances the infant's health, developmental and psychosocial outcomes not only in preterm infants but also for infants born to term. However, a prospective study comparing infants being small for gestational age to normal sized infants, found that breast feeding significantly promoted development at three and a half years but only for infants small for gestational age (Slykerman et al., 2005). This indicates that breast feeding is more important for infants with a biological vulnerability than for no-risk infants regarding normative development.

## 1.5 Pacifier use

Pacifiers have commonly been used during the early months of life to help calm the infant. Through non-nutritive sucking infants can regulate distress and sooth themselves. However, there has been a debate regarding whether pacifier use can be detrimental either directly or indirectly to the infants health or development. A prospective longitudinal study in England found a relationship between frequent pacifier use at 4 and 6 months of age and health problems during this period such as wheezing, ear-ache, vomiting, fever, diarrhea, colic, and seeing a general practitioner or being admitted to hospital (North, Flemming, Golding & the ALSPAC study team, 1999). However, the direction of the association remains unclear as

they did not control for whether the health issues came before or after pacifier use. It can very well be that an infant that cries a lot, whether it is because of pain or having a difficult temperament, is more likely to be given a pacifier to calm themselves down. Indeed, temperament seems to play a role in how easily infants can regulate themselves by pacifiers when distressed. Riese (1995) found that infants that took longer to soothe by pacifier use at 9 months of age were more likely to be rated as active, rhythmic, approachful and adaptable.

When it comes to infant development, few studies have investigated the impact of pacifier use. Most studies have focused on the association between pacifier use and the development of crossbite (Larsson, 2001., Lindsten, Larsson & Øgaard, 1996), Sudden Infant Death Syndrome (SIDS; Li et al., 2007), or breast feeding (Howard et al., 2003). One study that investigated infant development, found an association between frequent pacifier use and developmental delay at 6 months (Barros et al., 1997). However, when they adjusted for breast feeding duration, the association between frequent use of pacifier and developmental delay disappeared.

Although pacifier use does not seem to directly affect development, it can indirectly do so by interfering with breast feeding. In fact, it has been shown that early exposure to pacifier use can contribute to breastfeeding problems, and thereby indirectly affect health and development (AAP, 2005., Howard et al., 2003., Victoria, Behague, Barros, Olinto & Weiderpass, 1997). In a randomized study investigating the effect of pacifier use on breast feeding, it was found that pacifier use in the first 4 weeks after birth was detrimental to breastfeeding duration and increased the likelihood of substituting breast milk with other food (Howard et al., 2003).

However, not everyone is convinced that pacifier use is associated with early weaning in normal infants. A study by Victoria and colleagues (1997) found that pacifier use was associated with early weaning for mothers who had problems with breast feeding. For mothers who were confident about nursing, however, pacifier use was less likely to affect infants. This indicates that other factors than pacifier use can explain breast feeding problems. A Canadian study provides support to this notion (Kramer et al., 2001).

Kramer and colleagues randomly allocated the mothers into either the group where pacifier use was encouraged or the group where it was recommended to avoid pacifier use and



alternative ways of calming the infant were given. When randomized allocation was ignored, a strong association between pacifier use and early weaning was found. However, when analysing the data with randomized allocation, they found no association between pacifier use and breast feeding problems. This suggests that pacifier use can be a marker of breast feeding problems but not the cause.

For infants with a biological vulnerability, such as being born preterm, the situation might be different. In the policy statement from the American Academy of Pediatrics (AAP, 2005), it was concluded that pacifier use can be beneficial for preterm infants as it provides oral training and can improve their sucking ability when breast fed. This indicates that we cannot automatically assume that what promotes development for no-risk infants will be the same for at risk infants.

## 1.6 Gender differences in infant development

In the first few years of life girls are more robust than boys, have a lower death rate, and are less vulnerable to developmental problems (Berk, 2000). This is illustrated by a longitudinal cohort study of children aged 1-5 years (To et al., 2004). The study aimed at determining social and environmental factors associated with poor development over a 2 year period. After a 2 year follow up, they found that being male was associated with poorer motor and social development.

Male infants are also more vulnerable to biological risk factors such as having a low birth weight. For example, Johnson & Breslau (2000) found that low birthweight (less than 2500g) was associated with higher risk of reading and math disability at 11 years old for males only.

There are no gender differences found in temperament at 6 months of age (Weiss et al., 2004), and there seems to be no difference between males and females regarding genetic and environmental influences on temperament development (Silberg et al, 2005). However, Prior (1992) stresses that there is a gender difference when it comes to resilience. She argues that girls show better psychosocial functioning up to adolescence. As people react differently to temperament traits depending on gender, this might explain how girls do better in early

childhood. For example girls are viewed as more fragile which make others more inclined to help girls than boys.

In an Australian study, breast feeding was found to benefit cognitive development at 10-14 months of age for males but not for females (Paine et al., 1999). However, studies from other populations such as Scandinavia, US, and Spain have failed to find this gender difference (Angelsen et al., 2001., Rogan & Gladen, 1993., Temboury et al., 1994). So, whether breast feeding affects infant development differently for males and females remains unclear. When it comes to pacifier use, no gender differences have been found in the literature presented in this thesis.

In summary, previous research reports infant development to be influenced by temperament, breast feeding, pacifier use, and gender. Temperament affects infant development indirectly through the parent-infant interaction. An infant with an easy temperament, such as being easy to calm and seldom crying, is associated with a good parent-infant interaction. Breast feeding enhances infant development directly by the nutritious value of breast milk and indirectly through the bonding that takes place during breast feeding. How pacifier use affects infant development is unclear, but it is suggested that the effect is different for biologically vulnerable infants. Females are more robust during the first few years of life, but there seems to be only small or no gender difference regarding temperament, breast feeding and pacifier use.

In order to gain further knowledge about infant development with the goal of early intervention, research needs to focus on early development and pinpoint resilience factors among vulnerable infants. Previous studies have investigated infant development and the effect of temperament, breast feeding and pacifier use in infants with and without a biological vulnerability. However, the focus has been on the infants who show developmental delay or have health problems. To provide a resilience perspective in this area of research has, as of yet, not been done. The present study extends previous research by examining a resilience perspective on the effect of temperament, breast feeding or use of pacifier on development in infants with low and high biological risk as young as 6 months. This makes the present study unique.

## 1.7 The current study

The objective of the present study was to answer the following research questions:

1. Is there a cumulative effect of biological risk on infant development at 6 months?
2. Do temperament, breast milk, and pacifier use moderate the relationship between biological risk and normative development, and does the moderating effect differ depending on whether the infant's biological vulnerability is low or high?
3. Will the moderating role of temperament, breast feeding and pacifier use vary by gender?

Based on previous literature, it was expected to find that a greater number of infants with low biological risk would show developmental resilience, than infants with high risk. An easy temperament (such as being easy to calm, often smiles and laughs, seldom cries and whines), was expected to be a common characteristic of infants showing developmental resilience. Being breast fed and using pacifiers seldom were other characteristics expected for infants showing developmental resilience. Considering that which factors prove to be promotive can depend on degree of risk, it was decided to measure the moderating effect of temperament, breast feeding and use of pacifier across different levels of risk. In the early years of life, females are more robust than males. It was therefore expected that a greater number of female infants showed an above average development. Whether temperament, breast feeding and use of pacifier would differ between males and females was unknown, and therefore explored without preconception.

## **2. Method**

### **2.1 Participants**

Participants came from the Norwegian Mother and Child Cohort Study (MoBa; Magnus et al., 2006). The MoBa is an ongoing prospective longitudinal cohort study that began in 1999 targeting all women who give birth in Norway. From 1999 to 2005 the pregnancy cohort of the MoBa study included over 60 000 infants, and the participation rate for all invited pregnancies was 42.7 % (Magnus et al., 2006). The current study is based on births between year 2001 and 2006. Births from earlier cohorts were excluded due to attrition or incomplete reports. To be included in the current study, mothers had to have reported on the questions regarding the child's development at 6 months. Infants born preterm (<37 gestation weeks) were excluded from the analysis as there were no means to properly adjust their development scores. The sample was therefore reduced to 31 127 infants. Twins (n=343; 49% boys) were not excluded from the analysis as research has shown that when controlling for medical and social risk, there is no difference in morbidity rate and development between singletons and twins (Leonard, Piecuch, Ballard & Cooper, 1994). The study has been approved by the Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate.

At the time of birth, the mothers' age ranged from 14 years to 47 years (M=30, SD=4.5), and the age of fathers' ranged from 16 to 69 years (M=32.6, SD= 5.3). A majority of mothers' (77.4%), had completed 3 years of junior college or more and had a yearly income over 200 000 NOK (67%).

#### **2.1.1 The biological risk index and risk groups**

Infants were divided into 'no', 'low', and 'high' risk groups based on a selection of indices of biological risk. Biological risk factors included low birth weight (<2500g), birth complications, unplanned caesarean section, having a low Apgar score after 5 minutes (<6), and being referred to a specialist. These indices were chosen as they have been associated

with mortality and developmental problems. Each risk factor was given a value as indicated in table 2.1. Infants were divided into groups based on their total risk value score.

If an infant got a total risk value score of zero, they were put in the no-risk group (n=22378).

Infants with a risk value score of one or two were placed in the low risk group (n= 8107).

Infants with a risk value score of three or more constitutes the high risk group (n= 642).

Although the highest possible risk value score was eight, none of the infants had a risk value over six.

**Table 2.1.** *The table illustrate the risk value given each biological risk variable. The highest possible risk value was 8.*

	Risk value
Birth weight	
1501-2500g	1
0-1500g	2
Birth complications	1
Unplanned caeserean section	1
Specialist examination	
undecided	1
diagnosed	2
Apgar 5 minutes	
score 4-6	1
score 0-3	2

Information about the risk group variables was either taken from maternal reports at six months (Q4) or the MFR that was filled out by hospital personnel right after birth (see Appendix A for full overview of which questionnaire items were taken from).

Previously, a risk index has been primarily used to investigate the cumulative effect of environmental risk factors (Burchinal, Roberts, Hooper & Zeisel, 2000., Sameroff, 1998., Sameroff et al., 2003., Seifer, Sameroff, Baldwin & Baldwin, 1992). However, similar methods have been applied to biological risk factors (Candelaria, O'Connell & Teti, 2006). The value of using a risk index is that we get an estimate of how biologically vulnerable the infant is which again allows us to investigate whether there is a cumulative effect of risk on infant development.

**Table 2.2** *Socio-demographic profiles and descriptive data of the infants in the no-risk, low risk, moderate risk and high risk group (n=31127).*

	No-risk n (% down)	Low risk n (% down)	High risk n (% down)	Sign.
<b>Gender</b>				
Male	11099 (49.3%)	4252 (52.6%)	372 (58.1%)	p<.001
Female	11223 (50.3%)	3833 (47.4%)	268 (41.9%)	
Total	22322 (100%	8085 (100%)	640 (100%)	
<b>Nr of siblings</b>				
0	8508 (38.1%)	4414 (54.6%)	385 (60.1%)	p<.001
1	8644 (38.7%)	2414 (29.8%)	174 (27.1%)	
2	4085 (18.3%)	1004 (12.4%)	66 (10.3%)	
≥3	1111 (5.0%)	259 (3.2 %)	16 (2.5%)	
Total	22348 (100%)	8091 (100%)	641 (100%)	
<b>Multiple births</b>				
Singletons	21940 (98.3%)	7814 (96.7%)	601 (94.1%)	p<.001
Twins	384 (1.7%)	265 (3.3%)	38 (5.9%)	
Total	22324 (100%)	8079 (100%)	639 (100%)	
<b>Risk factors:</b>				
Birth weight				
> 2500g	22343 (100%)	7789 (96.2%)	575 (89.7%)	p<.001
1501-2500g	-	289 (3.6%)	63 (9.8%)	
>1500g	-	15 (0.2%)	3 (0.5%)	
Total	22343 (100%)	8093 (100%)	641 (100%)	
Birth complic.				
Yes	-	4697 (59%)	560 (87.9%)	p<.001
No	21698 (100%)	3264 (41%)	77 (12.1%)	
Total	21698 (100%)	7961 (100%)	637 (100%)	
Unpl. caesarean				
Yes	-	2248 (27.7%)	331 (51.6%)	p<.001
No	22374 (100%)	5856 (72.3%)	311 (48.4%)	
Total	22374 (100%)	8104 (100%)	642 (100%)	
Specialist referral				
No diagnose	22378 (100%)	5764 (71.1%)	103 (16%)	p<.001
Undecided	-	987 (12.2%)	84 (13.1%)	
Diagnosed	-	1356 (16.7%)	455 (70.9%)	
Total	22378 (100%)	8107 (100%)	642 (100%)	
Apgar 5 minutes				
Score 7-10	22321 (100%)	7913 (98%)	519 (81.2 %)	p<.001
Score 4-6	-	158 (2%)	91 (14.2%)	
Score 0-3	-	4 (0%)	29 (4.5%)	
Total	22321 (100%)	8075 (100%)	639 (100%)	

Note: compl. = complications, unpl. = unplanned

The distribution of gender, number of siblings, multiple births, the risk factors, parent's age, and mother's income were significantly different across the groups (table 2.2 & 2.3).

Parent's education level and father's income were not significantly different across groups (table 2.3), indicating a similarity in socioeconomic status. This finding was expected as the wealth fare system in Norway has made the economic and educational differences small. In Norway, education is paid by the government and there are equal opportunities for all Norwegians to get the degree they desire. In addition, all Norwegians are required by law to attend primary and junior high school, forcing all members of the society to have a certain level of common knowledge.

**Table 2.3.** *Describing the difference in socioeconomic status and age of parents across the two risk groups and the no-risk group.*

Variable	No-risk m (sd)	Low risk m (sd)	High risk m (sd)	Sign
<b>Age of parents</b>				
Mother	30.0 (4.4)	29.9 (4.6)	29.8 (4.5)	p<.01
Father	32.7 (5.2)	32.5 (5.4)	32.4 (5.1)	p<.05
<b>SES</b>				
Education*				
Mother	4.5 (1.2)	4.5 (1.3)	4.5 (1.2)	-
Father	4.1 (1.4)	4.1 (1.4)	4.1 (1.5)	-
Income**				
Mother	3.8 (1.3)	3.9 (1.3)	3.8 (1.2)	p<.001
Father	4.8 (1.3)	4.8 (1.3)	4.8 (1.4)	-

Note:

\* *Education:*

1) 9 yrs elementary school, 2) 1-2 yrs junior college, 3) 3 yrs occupational j.college, 4) 3 years junior college, 5) 4 years college edu, 6) >4 yrs university.

\*\* *Yearly income:*

1) no income, 2) below 150 000 NOK, 3) 150 000-199 999 NOK, 4) 200 000-299 999 NOK, 5) 300 000-399 999 NOK, 6) 400 000-499 999 NOK, 7) above 500 000 NOK.

## 2.2 Procedure and materials

An information folder containing two questionnaires and a consent form was sent to the pregnant women about 2 weeks before their routine pregnancy ultrasound examination (around gestation week 17-19). The women were informed of the voluntary nature of the project and that they could choose to withdraw at any time. The names of potential participants were collected from ultrasound laboratories in hospitals or gynaecologists from

the private sector. A third questionnaire was sent in gestation week 30, and the fourth when the infant was 6 months old. Health outcomes were also collected from the Norwegian Medical Birth Registry. For a more elaborate description of the procedure of the MoBa study and the various questionnaires used, see Magnus and colleagues, (2006) or visit the projects web site ([www.fhi.no](http://www.fhi.no)). Information in the present study used information from the first (Q1) and fourth questionnaire (Q4), and the Medical Birth Registry (MFR).

### **2.2.1 Measuring infant development**

The outcome variable was infant development at 6 months of age. The eleven items used in the Development Scale were from the Norwegian translation of Ages & Stages Questionnaire for six month old infants (ASQs; Janson & Smith, 2003). ASQs has been increasingly used in studies to estimate the developmental status of infants and children as well as in the clinic (Lando, Klammer, Jonsbo, Weiss & Greisen, 2005., Janson & Squires, 2004., Hamilton, 2006., Tsai, McClelland, Pratt & Squires, 2006). A good internal consistency has been reported for the total score of ASQ in the Norwegian population ( $\alpha = .79$ ; Janson & Smith, 2003). However, in the current study the internal consistency was only moderate ( $\alpha = .51$ ). The reason for this discrepancy in internal consistency is that we measure general development with only 11 items compared to 30 items in the ASQ. When the infant is as young as 6 months it is hard to distinguish development areas from each other as they to some degree are dependent on each other. This is why it was decided to look at the general infant development.

Although several studies confirm the validity of ASQ, other studies have questioned their findings (Rydz et al., 2007). The ASQ is found to have a good sensitivity, but lack specificity (Klammer, Lando, Pinborg & Gorm, 2005, Rydz et al., 2007). In other words, it is good for detecting children with developmental delay, but it includes many false positives. This might not come as a shock due to the instability and discontinuity of an infants' early development. The normative data from the Norwegian translation of ASQ are found to be similar to the original normative data from US, and may therefore be interpreted in the same way (Janson & Squires, 2004). The same strengths and flaws seen in US studies will therefore also apply in this sample.



In the current study, the mother would report whether her infant could perform the described behavior in each of the eleven items. The items reflected development in motor skills, cognition, communication and social skills. Examples of behaviors described in the items are; whether the infant would play with his/her feet while lying on his/her back, if the infant reached for a toy that was out of reach, whether the infant babbled, and whether the baby tried to “talk” to caregiver when the caregiver talks to the infant. All descriptions reflected the skills of an average 6 month old infant, meaning that the distribution would be linear and not normally distributed. The mother’s response was categorized into no (=0), seldom (=1), and yes (=2), and a total score was calculated for all the items (min=0, max=22).

### **2.2.2 Operationalising developmental resilience**

Before developmental resilience was calculated, a norm group was created. The norm group consisted of infants that had none of the following biological risk factors: low birthweight (<2500g), birth complications, unplanned caesarean, been referred to a specialist, low Apgar score (<7), and being born preterm (<37 gestation weeks). The norm group is identical to the no-risk group. The median development score (=21) from the norm group was set as the criteria for developmental resilience. We did not use the mean as the development scores were not normally distributed. The mean, however, had the same value (=21) as the median, so which average we would have chosen would not have mattered. So, when infants at risk are described as showing developmental resilience, it means that they have a development score higher than 21. Expecting vulnerable infants to show an above average development was strict. However, a strict cut off was intended as it will help us see which factors can enhance good, and not just adequate, development among infants with a biological vulnerability.

### **2.2.3 Temperament Scale**

Temperament was assessed by mothers using seven items adapted from fussy/difficult subscale of the Infant Characteristics Questionnaire (ICQ; Bates, Freeland & Lounsbury, 1979). These seven items were selected based on a factor analysis made by Japel and colleagues (2000). This selection of temperament items has been used in other studies based on data from the MoBa study (Niegel, Ystrom & Vollrath, 2007). Mothers were asked to rate how applicable various statements were to their own infant using a seven point Likert scale

where one was “totally agree” and seven was “totally disagree”. Assertions were phrased like; “the infant whimpers and cries a lot”, “the infant is easy to console when crying”, “the infant demands a lot of attention”, (Appendix A). The negative statements were reversed so that a high score indicated an easy temperament and a low score indicated a fussy/difficult temperament. A good reliability and validity of the ICQ has been reported (Bates et al., 1979). The internal reliability of the reduced ICQ temperament scale used in the current study was high ( $\alpha=.72$ ), meaning that the items measure the same construct.

#### **2.2.4 Breast feeding and pacifier use**

When the infant was 6 months old, the mothers were asked about breast feeding and the frequency of pacifier use. For Norwegian mothers it is common to either breast feed daily or to not breast feed at all. In the current study 80% of the mothers’ breast fed daily, less than 1% breast fed 1-3 times a week or 4-6 times a week, and 19% did not breast feed their infants at all. The Medical Birth registry of Norway report higher percentages of women breast feeding their infants at 6 months ( 87%; Grøholt & Nordhagen, 2005). Since a small number of mothers breast fed 1-6 times a week, breast feeding responses were grouped into “yes” (> once a week) and “no”.

Pacifier use was measured by providing the following options: “never or seldom”, “only at bedtime”, “often”, “most of the time”. As only a few infants used pacifier most of the time in the high risk group, we were forced to merge the responses “most of the time” and “often” to be able to do a separate hierarchical logistic regression for males and females.

#### **2.2.5 Control variables**

As previous research has shown that mothers’ age, income, and education can be possible confounding variables (Feldman & Eidelman, 2003., Gale & Martyn, 1996., To et al., 2004), we controlled for the influence of these variables .

### **2.3 Statistical analysis**

All analyses were conducted in SPSS version 14.0. In the preliminary phase, analyses were run to check for missing values and the normality of the data. To check the sampling

adequacy of the categorical data, chi square analysis (crosstabs) were used. To check for multicollinearity, Pearson's product-moment correlations were used in addition to the tests in the regression analysis. Due to violations of normality assumptions on some of the variables (i.e. temperament, mother's & fathers' education), a nonparametric test (Spearman's Rank Order Correlation) was performed in addition to the parametric test. As no difference was found between the parametric test and the non-parametric test, only the results from the parametric tests have been reported.

For the main analysis, hierarchical logistic regressions were used. This analysis was run with and without control variables. In the current study, the analyses was done separate for the low and high risk group. The reason is because when we explore main and interaction effects with one risk group, we lose information about differences within the risk group (Luthar, 2006). For example whether there are different factors promoting development for high risk children compared to low risk children will be lost unless the analyses are done separate for both groups.

### 3. Results

The results will be presented in the same order as the research objectives. This means that the effect of biological risk on developmental resilience will be presented first, and then the moderating role of temperament, breast feeding and pacifier use on this relationship. Gender differences will be addressed together with the control variables and the moderators.

Although all the analysis was done for the three groups (no, low and high risk), the focus will be on comparing the two risk groups.

Before addressing the hypothesis, relevant results from the preliminary analyses will be given. No outliers were found in the main analyses. As expected, there was no correlation between developmental resilience and the other variables (Appendix B). This indicates that the control variables and the moderators do not measure the same construct as the outcome variable. Using Cohen's guidelines interpreting correlations (1988), there were no moderate or high correlations between the moderators. However, there was a small negative correlation between pacifier use and breast feeding ( $r = -.17$ ,  $p < .01$ ), meaning that a more frequent use of pacifier was associated with less breast feeding. Parents' age, education level and income correlated with each other, and the strength of these relationships was mainly moderate or small. That the control variables are associated with each other does not affect the associations between the moderators and infant development as they only are controlled for in the analysis.

#### 3.1 The control variables

In the following section I will present findings concerning the relationship between the control variables and infant development. An overview of the findings can be seen in table 3.1. The variables that were associated with developmental resilience were: Maternal age, gender, mother's and father's level of education.

**Table 3.1** *The relationship between the control variables and developmental resilience. Results from the hierarchical logistic regression analysis. For the outcome variable, showing developmental resilience is the reference group.*

Variable (indicator)	N	Significance	Odds Ratio	CI
Sex (female)				
No-risk	16407	-	.98	.98-1.00
Low risk	5921	p=.05	1.11	1.00-1.24
High risk	470	-	1.05	.71-1.54
Age of mother				
No-risk	16407	p<.01	.99	.98-1.00
Low risk	5921	p<.01	.98	.96- .99
High risk	470	-	.98	.93-1.02
Mothers education				
No-risk	16407	p<.05	.97	.94-1.01
Low risk	5921	-	1.02	.97-1.08
High risk	470	-	1.01	.83-1.24
Fathers education				
No-risk	16407	-	1.00	.97-1.03
Low risk	5921	-	1.01	.96-1.05
High risk	470	-	.91	.78-1.07
Mothers income				
No-risk	16407	-	1.00	.97-1.03
Low risk	5921	-	.98	.94-1.03
High risk	470	-	.94	.79-1.13
Fathers income				
No-risk	16407	-	1.00	.97-1.03
Low risk	5921	-	.99	.95-1.04
High risk	470	-	1.11	.94-1.31

Maternal age was significantly related to developmental resilience in the low risk group, but not for the high risk group (table 3.1). When the analysis was done separately based on gender, mother's age was significant for no-risk (OR=.99, CI=.97-1) and low risk (OR=.97, CI=.95-.99) females only. In the low risk group, the odds of an above average development increased by 2% for female infants. Simply put, the younger the mother, the better the odds of an above average development for low risk infants.

If we look at the distribution (Appendix C), we find that the relationship between mothers' age and developmental resilience for females was normally distributed. Among infants with

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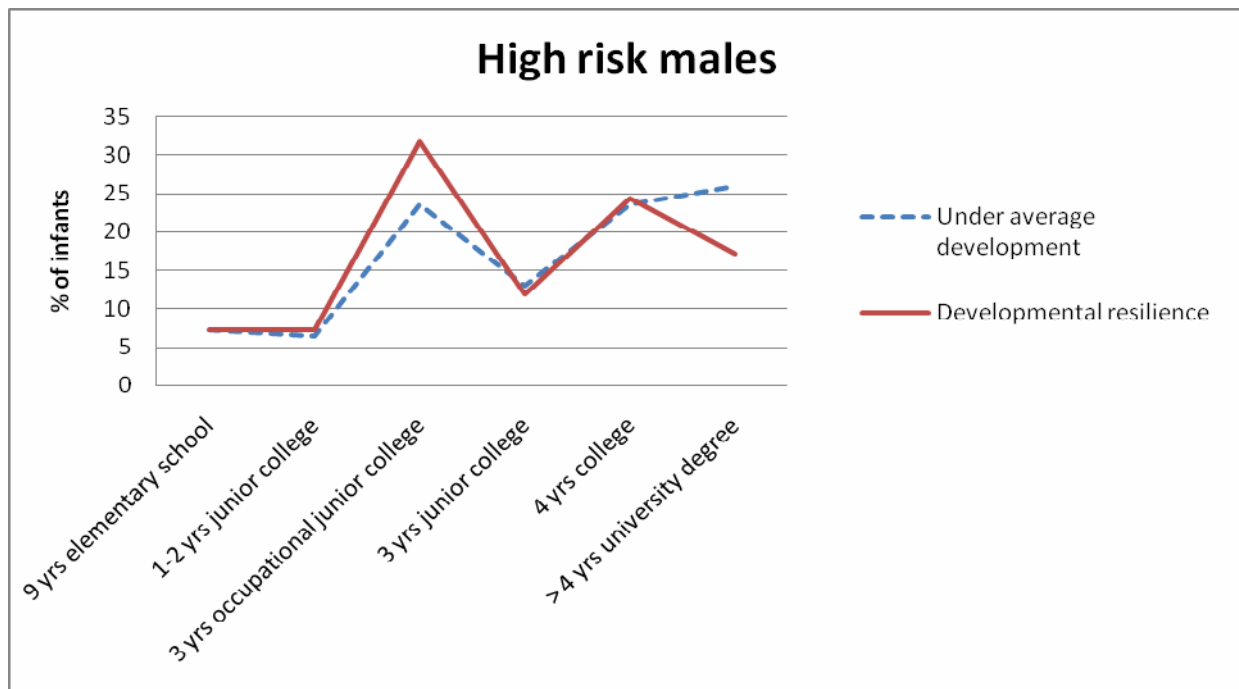
an above average development, a greater number of the mothers were younger. The same trend was seen in the high risk group. It is important to note, however, that most Norwegian women give birth later than other European countries and the USA. In the current sample, the mothers' median age at the time of birth was 30 years in all three groups whereas statistics from US show a median of 24.6 years (Mathews & Hamilton, 2002). So, a "young" mother in Norwegian terms may differ to what other countries call a "young" mother.

Gender differences in development at 6 months were close to significance in the low risk group. The odds of an above average development were 1.11 times higher for males than females in the low risk group. Looking at the frequency, there was a greater number of low risk males (53.2%) than females (46.8%) showing an above average development. However, this difference was not found significant by the Chi-Square, confirming the non significant results from the hierarchical logistic regression.

In the no-risk group, it was found that the odds of an above average development increased by 3% as the mothers' level of education decreased. A greater percentage of infants with under average development (62.3%), than above average development (60.7%), had mothers with a 4 year college degree or more (Appendix D).

For high risk males, a decrease in father's educational level increased the odds for an above average development ( $p < .05$ ,  $OR = .77$ ,  $CI = .61-.97$ ). As can be seen from figure 3.1, fathers that have an occupational junior college degree have a greater percentage of male infants showing developmental resilience than fathers with more than a 4 years university degree and fathers with less than 1-2 years of junior college. This association was not found for females.

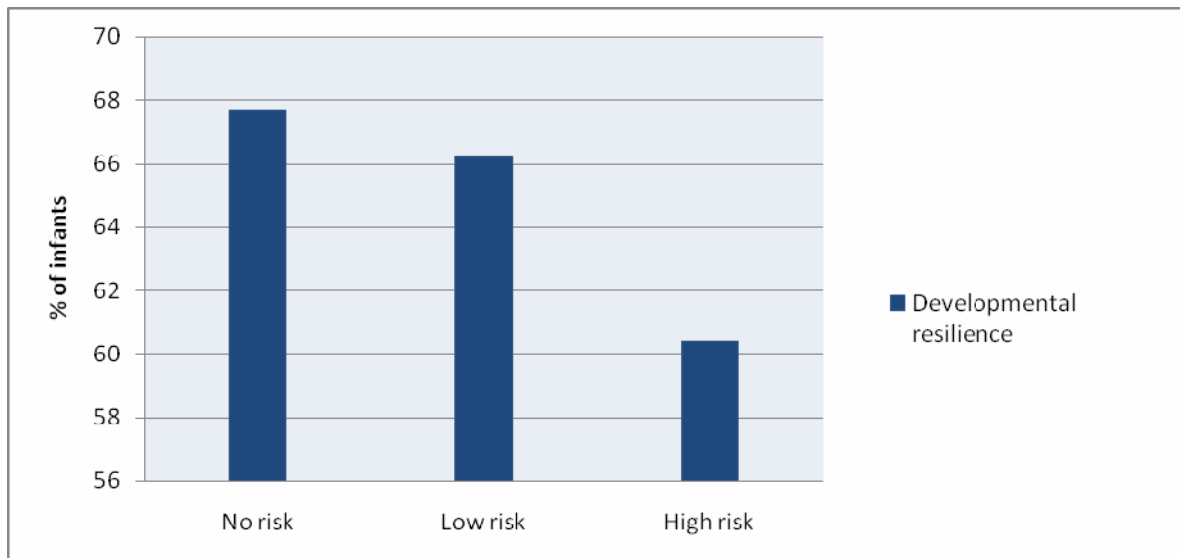
**Figure 3.1.** The figure illustrates a father-son association focusing on fathers' level of education and high risk male infants development at 6 months of age. The percentage of male infants showing and not showing developmental resilience is presented in the figure.



### 3.2 Is there a cumulative effect of biological risk on infant development at 6 months?

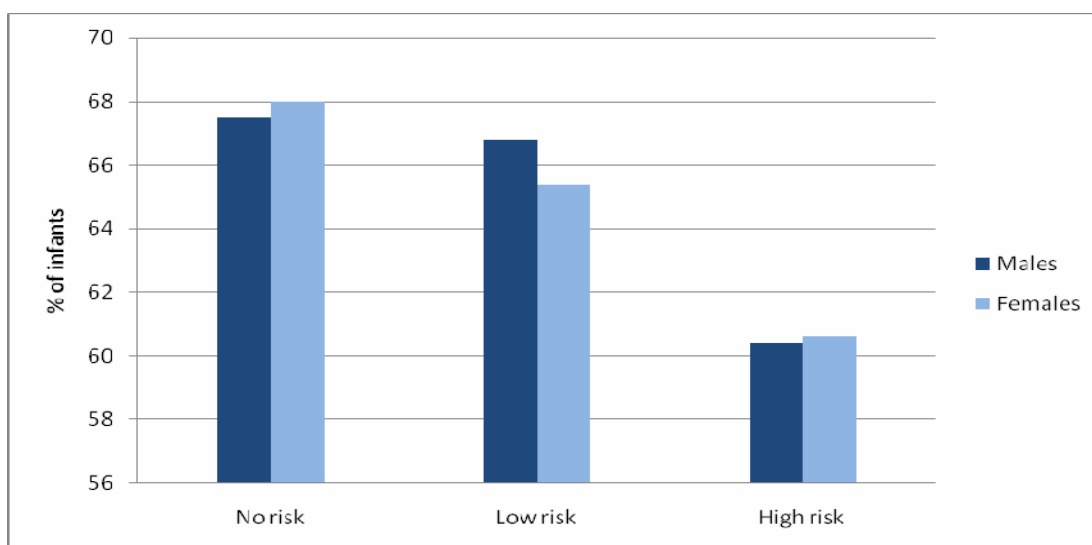
Yes, a cumulative effect of biological risk was found. Controlling for sex, mothers age, and parents education and income, compared to infants with high biological risk, the odds of showing an above average development was 1.35 times for infants with no-risk ( $p < .01$ , OR= 1.35, CI=1.12-1.62) and 1.25 times for infants with low risk ( $p < .05$ , OR=1.25, CI=1.04-1.51). As illustrated in figure 2, there was a cumulative effect of risk meaning that there were fewer infants showing an above average development when the degree of risk increased.

**Figure 3.2.** *The percent of infants with an above average development in the no risk, low risk, and high risk group.*



Similar trend was found for males and females. For males, compared to the high risk infants, the odds of an above average development were 1.34 times for males with no risk ( $p < .01$ ,  $OR = 1.34$ ,  $CI = 1.05-1.72$ ) and 1.33 times the odds for low risk males ( $p < .05$ ,  $OR = 1.33$ ,  $CI = 1.03-1.71$ ). For females, compared to high risk females, infants in the no risk group ( $p < .05$ ,  $OR = 1.35$ ,  $CI = 1.03-1.78$ ) had 1.35 times the odds of an above average development. In contrast to males, infant development for low risk females was not significantly different from the high risk female's development.

**Figure 3.3.** *The percent of males and females in the no risk, low risk, and high risk group with an above average development.*





### 3.3 What factors influence the development of resilience?

This section investigates the moderating role of temperament, breast feeding and pacifier use respectively. Before I go on to describe these effects, an overview of the results is illustrated in the table below.

**Table 3.2.** *The association between temperament, breast feeding and pacifier use and infant development at 6 months. Results from the hierarchical logistic regression analysis (n= 22378). The reference group for the outcome variable was infants showing developmental resilience.*

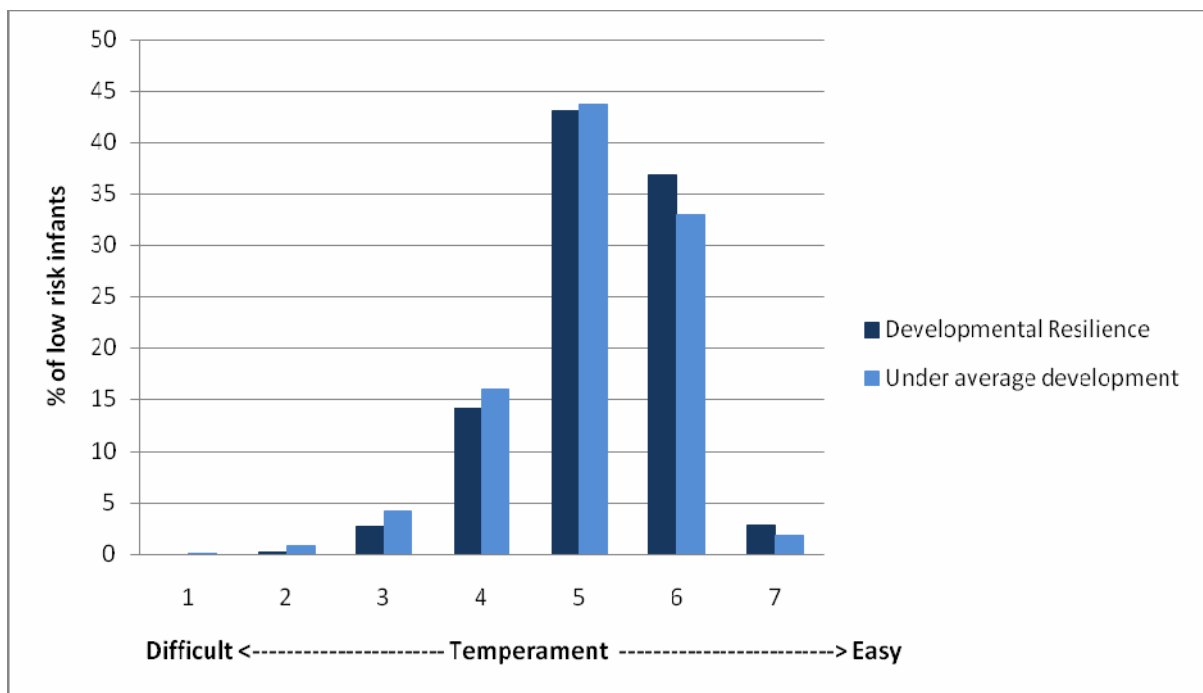
Variable (indicator)	N	Significance	Odds Ratio	CI
<b>Temperament</b>				
No-risk	16407	p<.001	1.03	1.02-1.03
Low risk	5921	p<.001	1.03	1.02-1.04
High risk	470	-	1.03	1.00-1.06
<b>Breast feeding (Yes)</b>				
No-risk	16407	-	.98	.90-1.08
Low risk	5921	-	1.03	.90-1.18
High risk	470	p<.05	.63	.41-.98
<b>Pacifier use (Often)</b>				
Seldom/never				
No-risk	16407	-	1.02	.94-1.10
Low risk	5921	-	.99	.87-1.13
High risk	470	-	.93	.58-1.48
Bedtime				
No-risk	16407	p<.01	1.13	1.04-1.22
Low risk	5921	p<.05	1.19	1.04-1.36
High risk	470	-	1.27	.80-2.03
Often				
No-risk	16407	p<.05	1	
Low risk	5921	p<.05	1	
High risk	470	-	1	

### 3.3.1 Does an easy temperament enhance developmental resilience at 6 months?

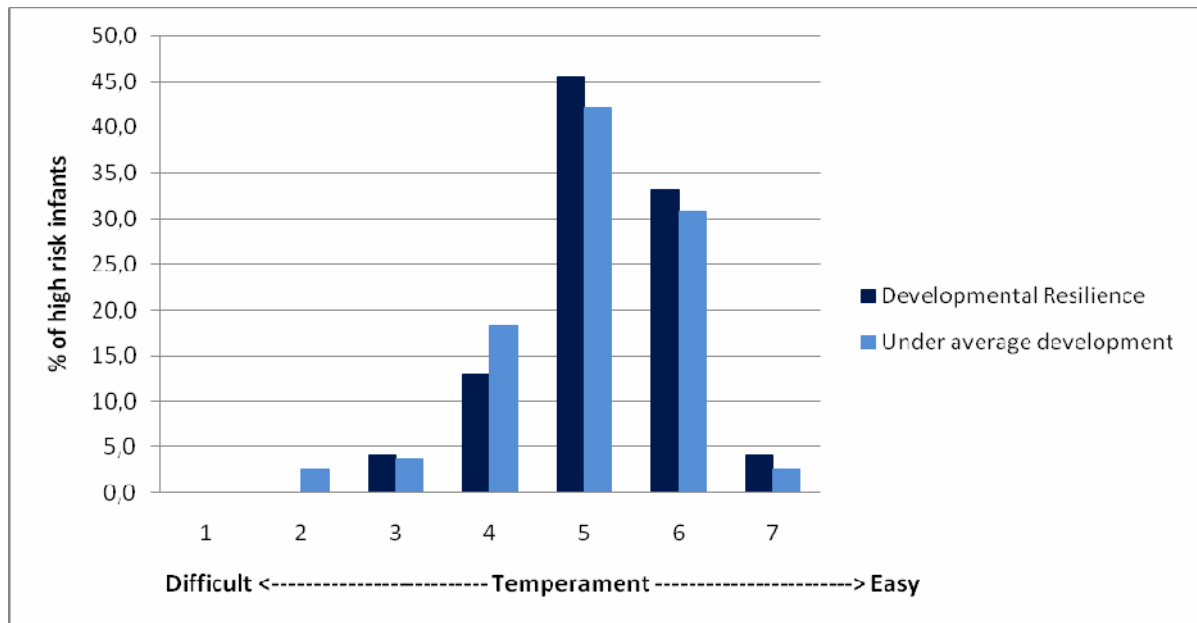
As the temperament becomes easier, the odds of showing developmental resilience at 6 months will increase by 3% in the low risk group (table 3.2). For infants with high biological risk, temperament failed to be significant. The trend for infants with above average development to show an easier temperament, however, was present in all three groups. For low risk infants, an easy temperament was more frequently found among infants showing developmental resilience than infants with a poorer development (figure 3.4). Very few infants were found to have a difficult temperament. The same results were found when the analysis was done separate for males and females.

**Figure 3.4.** *Temperament scores for infants with low biological risk (a) and high biological risk (b). The higher the score, the easier temperament.*

a) Low risk group



*b) High risk group*

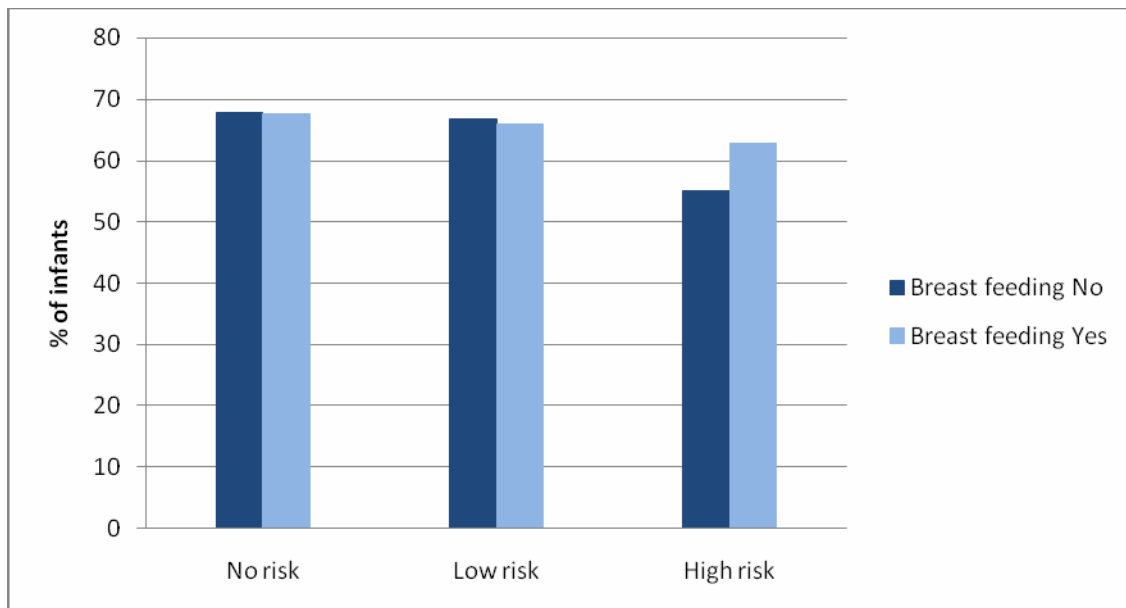


All in all, there were few infants with a low score on the easy temperament scale. Only 3.8 % of the low risk infants had a score below 4 compared to 81 % above. There were 14% of the low risk infants that had a temperament score of 4. This means they had an average temperament, neither a difficult nor an easy temperament. In the high risk group, 5.2 % had a difficult temperament, 15% had an average temperament, and 79.8% had an easy temperament. So even in this group, there were few infants showing a difficult temperament.

### 3.3.2 Is breast feeding associated with developmental resilience at 6 months?

Breast feeding was associated with infant development, but only for infants with a high biological risk. For infants with no or low risk, there was no difference in breast feeding between the ones who had a development score above or under average (table 3.2). The odds of showing developmental resilience were lower for infants not being breast fed (table 3.2). Of high risk infants showing developmental resilience, 62.9% (n=278) were breast fed compared to 55.1% (n=97) not being breast fed (figure 3.5). So there were still a lot of infants showing resilience, whether or not breast fed. The importance is in the significance of the difference. No significant results were found when the analysis was done separately for males and females. The trend, however, was similar.

**Figure 3.5.** *Percent of at risk infants showing developmental resilience, and no-risk infants with an above average development, that were and were not being breast fed.*



### 3.3.3 Use of pacifier, risk, and infant development

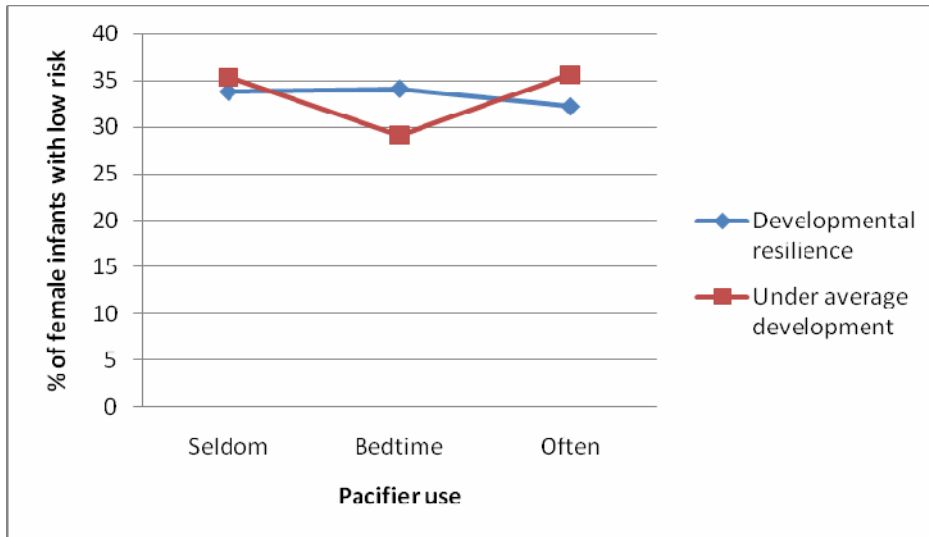
There was a relationship between how frequently an infant used a pacifier and an infant's development at 6 months. The odds of developmental resilience for low risk infants using a pacifier only at bedtime were 1.19 times the odds of an infant using a pacifier most of the time (table 3.2). In the no-risk group, the odds of having an above average development were 1.13 times greater for infants using pacifier at bedtime than those using it more often. Although the difference between using a pacifier often or only at bedtime was significant for the no-risk and low risk group, the odds were small. There was no significant difference in pacifier use between infants having an above or under average development in the high risk group. Nonetheless, the trend was similar.

For males, pacifier use had no significant impact on development. For all female infants on the other hand, there was a significant difference in pacifier use for infants with an above and under average development. The odds of an above average development were 1.2 times the odds for no-risk females using pacifier only at bedtime ( $p < .05$ ,  $OR = 1.2$ ,  $CI = 1.06-1.35$ ) than no-risk females with a more frequent pacifier use ( $p < .05$ ,  $OR = 1$ ). For female infants with low risk the odds of showing developmental resilience were 1.3 times the odds when using a pacifier only at bedtime, ( $p < .05$ ,  $OR = 1.3$ ,  $CI = 1.05-1.55$ ), than using a pacifier most

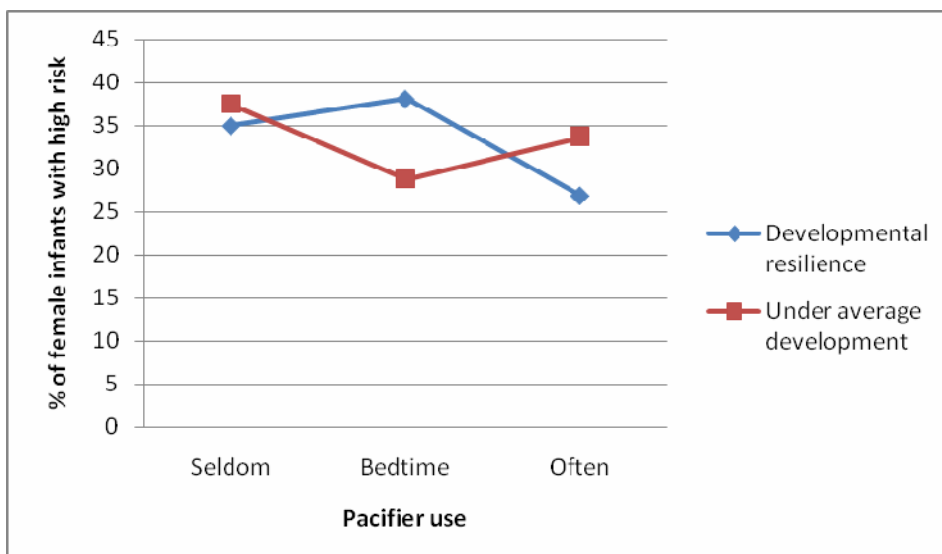
of the time ( $p < .05$ ,  $OR = 1$ ). Females in the high risk group did also show a significant difference between pacifier use and development. High risk female infants using pacifiers only at bedtime had 2.47 times the odds of showing developmental resilience ( $p < .05$ ,  $OR = 2.47$ ,  $CI = 1.17-5.19$ ) than females with a more frequent pacifier habit. The difference between females showing and not showing developmental resilience was larger for the high risk group than for the low risk group, suggesting that a moderate pacifier usage is more important for female infants with a high risk (figure 3.5, a & b).

**Figure 3.6.** *The effect of pacifier use on low and high biological risk female infants' development.*

*a. The effect of pacifier use for females with a low biological risk.*



*b. The effect of pacifier use for females with high biological risk.*



## **4. Discussion**

### **4.1 Main findings**

There are four main findings that I would like to highlight: 1) There was a cumulative effect of biological risk, 2) The moderating effect of temperament and breast feeding on infant development depended on degree of risk: Easy temperament increased the odds of developmental resilience at 6 months of age for infants with low biological risk, whereas breast feeding increased the odds of developmental resilience for high risk infants, 3) To only use pacifiers at bedtime increased the odds of developmental resilience for females but not males.

#### **4.1.1 A cumulative effect of biological risk**

The first aim was to explore the effect of multiple biological risk factors on infant development. The odds of showing an above average development at 6 months were found to be greater for infants with low risk than infants with high risk. This indicates a cumulative effect of biological risks, as the lower the biological risk the greater the development. This phenomenon has been well established in risk and resilience research. Most researchers have investigated cumulative risk using an environmental risk index (Sameroff, 1998., Sameroff et al., 2003., Seifer et al., 1992). However, some researchers have included both environmental and biological risk factors in their research (Candelaria et al., 2006., Laucht et al., 1997).

In an extensive longitudinal study in Germany, a cumulative effect of biological risk factors such as low birthweight, preterm birth, low Apgar score were found for motor and cognitive development at three months, two years and four-and-a-half years (Laucht et al., 1997). The same trend was seen for multiple psychosocial risks (such as parents low education level, psychiatric history of parents, marital discord, low maternal age), and for infants that had a mix of biological and psychosocial risks.

The way Laucht and colleagues divided their biological risk groups differed from the current study. Instead of dividing the biological risk groups based on one biological risk such as low

birth weight (Laucht et al., 1997, 2001), the current study made a risk index based on several risk factors. It is important to replicate findings using a variety of methods. As the current study applied a different risk index to what has previously been used, the current findings strengthen previous findings of a cumulative risk.

A more recent study investigating the cumulative effect of biological risk and infant development in preterm infants found a cumulative effect of neurobiological risks (such as intraventricular bleeds, respiratory distress, and blood infections) at hospital charge and mental and motor development at 4 months of corrected age (Candelaria et al., 2006). These findings were present even after controlling for the effect of psychosocial risks. Similar to the current study, this study illustrates the importance for early intervention programmes to target biological risks.

#### **4.1.2 The difference in findings between low and high risk infants**

The second research goal was to investigate the moderating role of temperament, breast feeding, and pacifier use on the relationship between biological risk and developmental resilience. Surprisingly, the effect of temperament and breast feeding differed between the low and high risk group, indicating that these groups are qualitatively different. Pacifier use on the other hand had the same effect in both risk groups, however only for females.

##### ***Easy temperament promotes developmental resilience in low risk infants***

Infants with low biological risk that were easily calmed, often smiled and were content most of the time, had greater odds of developmental resilience at 6 months. This is consistent with previous research showing an association between an easy temperament and better psychosocial development (Guerin et al., 1997., Kagan & Snidman, 1999., Kim-Cohen et al., 2004., Smith & Prior, 1995., Tschann et al., 1995., Werner, 2005). However, that the same results were not found in the high risk group in the current study, is not consistent with these studies.

According to Thomas and Chess, it is through the goodness of fit that an easy temperament enhances development (Chess & Thomas, 1992). How do we explain that this goodness of fit does not apply to high risk infants? One explanation is that as the infants in the high risk

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group already were exposed to such a high level of adversity, it would take more than just a good infant-caregiver interaction to promote development.

Another explanation is that the parents expected the infants in the high risk group to be more difficult and therefore were able to better adjust to the child's needs. A parent that does not understand why their infant frequently cries and is fussy might blame their own parenting skills and feel uncertain about how to care for their infant. This uncertainty might result in the parent spending less time with the infant, thereby lessening the time stimulating infant development.

However, recent studies of stereotyping behaviour have found that mothers tend to view and behave more negatively towards infants they believe are preterm regardless of the infant's actual behaviour and characteristics (Stern, Karraker, McIntosh, Moritzen & Olexa, 2006). This stereotyping of preterm infants may compromise infant development as the negative view of the mother may become a self-fulfilling prophecy. Although none of the infants in the current sample were born preterm, the same process might be applied to infants with a large biological vulnerability. If the mothers' had this negative view of the infants with a high biological risk, then whether or not the child had an easy or a difficult temperament would not make a difference to how they were perceived and treated by their mother.

In the current study, few infants can be said to have had a difficult temperament. In the low risk group 3.8% of the infants had a difficult temperament whereas in the high risk group 5.2% of the infants showed a difficult temperament. In the no-risk group the number was even lower (2.7%). This indicates that the odds of having a difficult temperament increases with degree of biological vulnerability. Does this mean that a difficult temperament is a marker of biological risk? Some researchers have used difficult temperament as a marker of perinatal insult (Brennan et al., 2003., Jaffe, 2007). So, how can we explain the results from the current study if we view a difficult temperament as neurological damage?

If we consider difficult temperament as an additional risk factor and believe in a cumulative effect of risk, we would expect a difficult temperament to have the same or a greater impact on infant development for high risk infants than low risk infants. This is not consistent with the current findings. If we believe that there is a limit to the cumulative effect, however, we could argue that the additional risk of a difficult temperament does not affect the infant



development in the high risk group as their risk is already so great that an additional risk has no effect.

There is not one explanation that can account for why an easy temperament only enhances infant development for infants with a low biological risk and not infants with a greater biological risk. However, the current findings question the importance of an easy temperament in promoting infant development. This said, it is possible that if we followed the children for a longer period of time, the impact of an easy temperament would be more prominent. As the Dunedin study has shown, temperament measured as early as 3 years of age has a great influence on development across life-course (Caspi, 2000).

### *Breast feeding promotes developmental resilience in high risk infants*

In the current study breast feeding was associated with developmental resilience for infants with a high biological risk, but not for no-risk or low risk infants. This indicates that breast feeding is more important for infant development when the infant has a high biological risk than a low or no risk. This is consistent with a study by Slykerman and her colleagues (2005). They found breast feeding to be beneficial for development at 3.5 years for children that were small for gestational age, but not for normal sized children.

Our findings are also consistent with a meta-analysis of 20 studies investigating the relationship between breast feeding and cognitive development (Anderson et al., 1999). This meta-analysis found that the gain in cognitive development from breast feeding was greater for low birth weight infants and preterm infants than infants with normal birth weight and born to term.

Furman and her colleagues (2004), however, found that providing very low birth weight (VLBW) infants with breast milk had no effect on cognitive or psychomotor development at 20 months of age. This is inconsistent with the findings from the current study, where it was the high risk and not the low risk infants that were found to benefit from breast feeding.

Furman and colleagues investigated infants that had a birthweight lower than 1500g. In the current study, only 18 infants had very low birth weight (< 1500g). This means that the effect of breast milk might depend on the type and degree of insult. For example, it is possible that breast milk is more beneficial for low birth weight infants than for VLBW infants. Perhaps the VLBW infants have not yet developed the substances needed to take advantage of the beneficial nutrients in breast milk.

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Another possible explanation is that the difference between low risk and high risk infants regarding breast feeding can be due to genetic variation in fatty acid metabolism. A recent study by Caspi and his colleagues (2007) found that whether breast feeding benefited cognitive development (IQ) depended on the genetic variant of FADS2. The gene expression of FADS2 is regulated by several substances, one of them being long-chain polyunsaturated fatty acids (LC-PUFAs) found in human milk. As there was a large sample size in the current study, however, it would be a great coincidence for one variant of the FADS2 to be largely represented in the high risk group and another in the low risk group unless it was related to one type of biological risk that was largely represented in one of the risk groups.

In the current study, there was a significant difference between the low risk and high risk group regarding how many had a low birth weight, birth complications, unplanned caesarean section, referred to a specialist, and low Apgar score. However, all these biological risk factors were represented in both risk groups, and can not explain the difference in results.

The findings from the current study are inconsistent with research indicating that breast feeding promotes infant development for no-risk infants (Angelsen et al., 2001., Rogan & Gladen, 1993., Paine et al., 1999., Temboury et al., 1994., Vestergaard et al., 1999). One explanation for the inconsistent results is the difference in how development was measured and the age frame.

Previous literature measured motor and cognitive development separately with the Bayley Scales of Infant Development (Angelsen et al., 2001., Rogan & Gladen, 1993., Temboury et al., 1994., Paine et al., 1999., Vestergaard et al., 1999). In the current study maternal reports of infant development were chosen as it would be difficult to test 31127 infants with an extensive developmental test such as the Bayley Scales of Infant Development. At 6 months of age it is hard to distinguish motor and cognitive abilities as the expression of cognitive abilities depend on motor skills. A total development score that included motor, language, and cognitive development items was therefore used in the current study.

Most of the studies found breast fed infants to have a greater gain in cognitive than motor development (Angelsen et al., 2001., Rogan & Gladen, 1993., Temboury et al., 1994., Paine et al., 1999., Vestergaard et al., 1999). Since cognitive and motor development was not separated in the current study, the gain in cognitive development might have been covered

up by the lack of gain in motor development. If this explanation was true, however, it would be necessary to examine if the same applied to the high risk group.

As discussed earlier, high risk infants seem to receive a greater benefit from breast feeding. So although cognitive and motor development items were included in the total development score, breast feeding might have remained significant in the high risk group as the benefit from breast feeding is stronger and could overcome the mixed total score.

The results might have been different if the infants were measured at a later time. In the study by Rogan and Gladen (1993), they measured cognitive and motor development at 6, 12, 18, and 24 months of age. Although they measured cognitive and motor development separate with Bayley tests, no association between breast feeding and cognitive and motor development was found at 6 months. At 24 months of age however, breast feeding was found to be significantly related to better cognitive and motor development scores. This indicates that having separate scores for motor and cognitive development would not have made any difference in the current study.

Another possible explanation for the current findings is that there is a qualitative difference between the high risk infants being and not being breast fed. Breast feeding requires that the infant is good at sucking. Perhaps the high risk infants getting breast fed were better at sucking, indicating that they were less biologically vulnerable than the other infants in the high risk group.

That breast feeding benefits high risk infants and not low risk infants raises more questions than it answers. However, it adds to the literature of varied findings regarding the benefit of breast milk. The implications of these findings are that we cannot take for granted that breast feeding has the same effect on infants with different degree of biological risk.

#### **4.1.3 Frequency of pacifier use and gender differences**

The third research goal was to explore whether there were any gender differences in how temperament, breast feeding and pacifier use affected infant development at 6 months in at risk infants. The only result that differed based on gender was the use of pacifier. To exclusively use pacifiers at bedtime was found to increase the odds of developmental resilience for females but not males. It was the use of a pacifier when going to sleep that was

beneficial for females, and not seldom or frequent use of pacifier. This finding was consistent across all groups.

Using pacifier during sleep has been found to reduce the risk for sudden infant death syndrome (SIDS; Hauck, Omojokun & Siadaty, 2005., Li et al., 2007). When an infant dies without a known cause, it is called SIDS. Sucking on a pacifier during sleep regulates the cardiac autonomic control both during sucking and non-sucking periods (Franco, Chebanski, Scaillet, Groswasser & Kahn, 2004). Infants that frequently use a pacifier when going to sleep have lower sympathetic activity and higher parasympathetic tonus. This can explain how infants can benefit from pacifier use during sleep. However, it does not explain the gender difference that was found.

Being given a pacifier at bedtime might be a marker of a specific parenting environment that benefits infant development for females but not males. Male and female infants are perceived and treated differently by strangers as well as their caregivers (Condry, Condry, & Pogatshnik, 1983., Karraker, Vogel & Lake, 1995., Servin & Bohlin, 1999). Even in Scandinavia where gender equality has been greatly promoted for many years, the mothers have different expectations for young males and females (Servin & Bohlin, 1999).

Another explanation is that male and female infants get treated differently as they behave differently. During the prenatal development, sex hormones influence the brain's development and may account for the difference in male and female brains (Rutter & Rutter, 2000). In addition to the physical difference, female infants have a more robust development the first few years of life. At 6 months, female infants are better at regulating their own emotions compared to male infants (Weinberg, Tronick, Cohn & Olson, 1999). Perhaps only getting a pacifier at bedtime is a marker of being better at regulating emotions. If so, the gender difference could be due to females being better at emotion regulation. If this explanation is accurate, pacifier use is only a third variable and the real association would be between emotion regulation and infant development.

Another finding that indicates that males and females are treated differently is the association between father's educational level and their son's development. The higher the fathers educational level, the lower the odds for developmental resilience for their sons. That the same was not found for female infants indicates a difference in how fathers relate to male and female infants in Norway.

The father-son association is quite surprising as it would be logical to think that as the father got more educated, he would be better at providing for his son. However, the relationship is not linear and it is having a father with an occupational education that is associated with developmental resilience for high risk males. In Norway the salary for occupational work such as plumbing or being a mechanic is high. One possible reason might therefore be that fathers with an occupational education have a more stable economy (as they have worked for longer) and they might also take more time for their sons. A doctor for example cannot be as flexible in taking time off work as a plumber. Another possible explanation is that the occupational working fathers are more family oriented than the highly educated fathers. That this relationship was only found for high risk males and not low risk males, indicating that the father-son relationship is especially important for infants with a high biological vulnerability.

There is no clear explanation why pacifier use at bedtime was significantly associated with developmental resilience for females and not males, or that father's education level was related to their son's development. However, the implication of these findings is that we need to explore the underlying mechanisms of pacifier use during sleep and infant development, and why father's education level was associated with infant development for high risk males only. These findings illustrate the importance of checking for gender difference when exploring factors associated with infant development.

## 4.2 Limitations

### *Selection bias*

As the participation rate in the MoBa study was 42.7% (Magnus et al., 2006), there was a possible selection bias. At 6 months, however, the response rate was 87%. This indicates that once the women chose to participate, most of them continued to participate in the project. Still, a selection bias might have occurred.

In particular, disadvantaged mothers with infants showing a difficult temperament might have been underrepresented. Compared to what has been found in U.S. studies (Bates et al., 1979), the current study found few infants that had a difficult temperament. In addition, the range of temperament scores was restricted. This can be due to selection bias or a difference

in culture. If a difficult infant temperament is seen as a temperament trait, it is possible that what Norwegian mothers view as “difficult” or “fussy” might differ from the norms in the U.S. society.

### *Parental behaviours not controlled for*

Parental behaviours such as smoking, drinking, or antisocial behaviour between birth and 6 months were not taken into account. A study by Slykerman and her colleagues (2007) confirm the importance of controlling for parental behaviours. They found that maternal and postnatal factors, such as maternal smoking during pregnancy and in the infants first year, low levels of satisfaction in parenting and high levels of stress associated with parenting, were associated with poorer development at 12 months. In addition to these factors, other studies have found maternal depression to present a risk for poorer infant development (To, et al., 2004).

### *Low number of items in the Temperament Scale*

There was a low internal reliability between the temperament items, questioning whether the items measure the same construct. The temperament questionnaire the items were adapted from (ICQ), had a good internal reliability and adequate validity (Bates et al., 1979). The poor internal consistency of the current items is therefore most likely related to the low number of items. In the current study, the low number of items is made up for by the large sample size. Random errors will cancel each other out due to the sample size instead of a large set of items. As the temperament is adapted from ICQ, we can assume that the temperament scale used in the current study reflects the same construct measured by ICQ, and that it is a reliable and valid measure. However, caution is still advised when interpreting the results regarding temperament.

### *Reporter bias: can we trust maternal reports?*

Most of the information in the present study was based on maternal reports. How mothers view their child’s behaviour will be coloured by their own personality and background as well as what they view as socially acceptable in the community they live. In Norway, breast feeding is greatly promoted through the media as well as at health stations, for example by the internationally renowned Norwegian obstetrician Dr. Gro Nylander (Andrews & Johansen, 2007., Munch, 2005., Nylander, 2002). This makes it harder for mothers to report

lack of breast feeding. However, it is logical to think that as the questionnaire was anonymous, the fear of reporting socially undesirable behaviour is low. It can also be assumed that the mothers accepting to be part of the study were motivated to further research and were therefore inclined to tell the truth. When it comes to pacifier use, there is no strong tradition against it in the Norwegian community and thereby it is not assumed to be affected by reporter bias.

Relying on maternal reports when it comes to child temperament and behaviour has been criticised for over 70 years (Kagan, 1998). The critics claim there are several reasons why maternal reports may not be trusted. One criticism is that only a modest to moderate correlation between parent and observer reports has been found which illustrate that they view and rate the children differently. However, different measurements are often used for parents and observers, making the comparison difficult.

Seifer and his colleagues (1994) tried to overcome this obstacle by making similar temperament questionnaires for parents and observers. The temperament was scored by observing the child in three situations. They found that the scores from the parents and observers showed a modest to moderate correlation. Based on this it was concluded that maternal reports were a poor source of infants' temperament. Some researchers agree with their conclusion (Kagan, 1998), whereas others strongly disagree as they believe other factors can explain the lack of consistency between parents and observers (Rothbart & Bates, 1998).

Studies show that mothers' personality traits, such as being optimistic or extroverted, affect their rating of their children's temperament (Bates et al., 1979., Heinonen et al., 2006). However, a different rater will also be influenced by their own personality and background. For example the gender of a child will affect the rater's interpretation of their temperament characteristics and behaviour (Condry et al, 1983). So, we are all subject to our own background when interpreting others.

Whether we see maternal reports as valid depends on what we set as the golden standard. Is the observer report the golden standard? What about predictability? In a longitudinal study where mothers rated their children's temperament between the age of 3 and 12 years, it was found that the maternal reports were significantly associated with the child's self-assessed temperament 17 years later (Pesonen, Räikkönen, Keskivaara & Keltikangas-Järvinen,

2003). Other studies show how maternal reports of difficult temperament predict later psychosocial functioning (Caspi, 2000., Guerin et al., 1997., Smith & Prior, 1995., Tschann et al., 1996., Werner, 2005). Although maternal reports are good at predicting later child behaviour and development, it does not mean that they measure temperament per se. They could measure other factors influencing infant development such as the mother-child interaction. To further discuss this topic is out of the scope of this thesis. I will therefore end this topic by pointing out that maternal reports are still seen as useful. In the end most researchers agree that the best approach is not to exclude maternal reports, but to include other approaches in addition to maternal reports (Kagan, 1998., Rothbart & Bates, 1998).

### 4.3 Suggestions for future research

Future research should continue to explore possible moderators between infants with a biological risk and developmental resilience in infancy. As it was found that different factors were associated with infant development depending on level of risk, future research should focus on exploring differences within the risk group. This is consistent with previous recommendations in resilience research (Luthar, 2006).

In general, multiple sources of information should be used in order to increase the reliability and validity of the findings. Although it is hard to control for all possible confounding variables, I would recommend controlling for maternal smoking during and after pregnancy, maternal stress and depression, and satisfaction in parenting, in addition to the control variables in the current study. These factors have been found to influence infant development in previous studies (Slykerman et al., 2007., To et al., 2004). Future research also needs to address how infant temperament affects infant development and why an easy temperament enhances development for low risk and not high risk infants.

When investigating why an easy temperament promotes infant development for low risk infants and not high risk infants, I recommend including a greater number of items in the temperament scale to increase reliability. Also, in order to find out whether the maternal report is tainted by the mother's own personality, I advise controlling for the mothers personality.



Regarding breast feeding and pacifier use, future research should continue to explore the difference within a risk group in order to grasp the different effect breast feeding and pacifier use has on infant development. Longitudinal studies are needed to investigate the long term effect of breast feeding and pacifier use for biologically vulnerable infants, as studies have found that biological risk factors have less impact on later development and psychosocial functioning (Laucht et al., 1997).

With the MoBa data we have the opportunity to follow these infants as they grow older and address the questions generated in the present study. But it is also important to investigate these issues in different samples in order to grasp to what extent the findings apply to other populations.

## 4.4 Implications

The findings from the present study stress the importance of investigating individual variations within a risk group. That an easy temperament enhances developmental resilience in low risk infants, and breast feeding does the same for high risk infants, implies that these groups are different. This has consequences for intervention programs, as there seem to be different mechanisms promoting developmental resilience depending on degree of biological vulnerability.

Another important aspect of the current findings is the gender difference found regarding pacifier use. That whether the use of pacifier at bedtime enhances infant development or not depends on gender has implications for when we seek to help biologically vulnerable infants. If the finding is true, it implies that different interventions are needed to promote infant development in at risk infants depending on the infant's gender. The effect of pacifier use on infant development is useful knowledge, as it is easy to implement. What parents need to know is to which child they should give the pacifier to and when.

Sunya Luthar (2006) has stressed the importance of exploring differences within risk groups, so this is not a new thought. However, what is unique in the present study is to explore differences within a biological risk group from a resilience perspective, where the children are as young as 6 months old. Also, the findings from the current study are strengthened by the prospective nature of the design, the large sample size and the new biological risk index.

The current study adds to the literature by confirming a cumulative effect of biological risk by using a new biological risk index. Further this study illustrates that different factors enhances development depending on the degree of biological risk, and it indicates that there are possible gender difference regarding whether pacifier use is beneficial for infant development.

## 4.5 Conclusion

The current study has illustrated the importance of investigating differences within biological risk groups and the value of making separate analysis based on gender when looking at infant development. Whether temperament, breast feeding and pacifier use will promote infant development will vary depending on the degree of biological vulnerability and gender.

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## Appendix A: Items used in the current study

**Table A.1** Biological Risk factors

	<b>Form/ questionnaire</b>	<b>Item number</b>	<b>Reported by</b>
Birth weight	Q4	2	Mother
Birth complications	Q4	8	Mother
Unplanned caesarean section	Q4	7	Mother
Specialist examination	Q4	28	Mother
Apgar score	MFR	-	Health personnel

**Table A.4.** Overview of the questionnaire form used to gather information about the control variables, infant development, temperament, breast feeding, and pacifier use.

	<b>Form/ questionnaire</b>	<b>Item number</b>	<b>Reported by</b>
Gender	Q4	1	Mother
Number of siblings	MFR	-	Health personnel
Multiple births	MFR	-	Health personnel
Age of parents	MFR	-	Health personnel
Education	Q1	50	Mother
Income	Q1	79	Mother
Development	Q4	35	Mother
Temperament	Q4	44	Mother
Breast feeding	Q4	17	Mother
Pacifier use	Q4	40	Mother



**Table A.2.** Development items were all taken from Q4 (number 35) filled out by mothers when the child was 6 months old. The response categories were: "Yes, often", "Yes, infrequently", "no not yet", and "I don't know".

Development items	
1	Does your child play with his/her feet when lying on his/her back?
2	Does your child lift his/her body from the floor with straight arms when lying on his/her stomach?
3	Does your child roll over from his/her back to stomach?
4	When you talk to your child does he/she try and talk with you?
5	Does your child babble and make sounds when he/she lies alone?
6	Do you know how your child feels by listening to the sounds he/she makes ( <i>for example satisfied, hungry, angry, in pain</i> )?
7	Does your child smile at you when you smile at him/her ( <i>without touching or tickling the child and without showing him/her a toy</i> )?
8	When you call your child does he/she turn toward you one of the first times you say his/her name?
9	When you give your child a toy does he/she hold it or put the toy in his/her mouth?
10	Does your child reach for a toy or something else that is on the table in front of you when he/she sits on your lap?
11	When your child examines a toy does he/she hold it with both hands?

**Table A.3.** Temperament items from Q4 (number 44). Filled out by mothers when the child was 6 months old. The response categories were: "Disagree completely", "disagree", "disagree somewhat", "Neither agree or disagree", "Agree somewhat", "Agree", and "Agree completely".

Temperament items	
1	The child whimpers and cries a lot
2	The child is usually easy to console when he/she cries
3	The child is easily upset and begins to cry
4	The child usually screams angrily and loudly when he/she cries
5	The child demands a lot of attention
6	The child usually plays well alone when left to himself/herself
7	The child is so demanding the he/she would be a considerable problem for most parents

## Appendix B: Correlation matrix of all variables

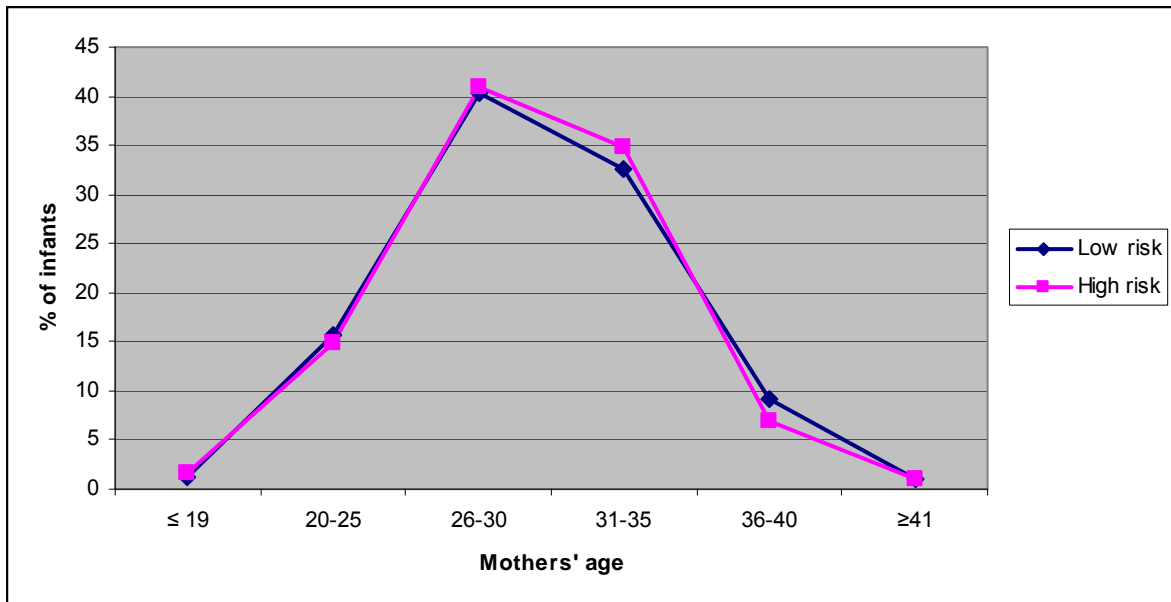
**Table B.1.** Correlation matrix of all variables included in the analysis.

	1	2	3	4	5	6	7	8	9	10
<b>1.Sex</b>	-									
<b>2.Maternal age</b>	.01	-								
<b>3.Education mother</b>	.01	.25**	-							
<b>4.Education father</b>	.00	.22**	.50**	-						
<b>5.Income mother</b>	.01	.35**	.40**	.27**	-					
<b>6.Income father</b>	.00	.30**	.21**	.32**	.30**	-				
<b>7.Temperament</b>	.04**	.08**	.04**	.02**	.04**	.05**	-			
<b>8.Breast milk</b>	.01*	.11**	.22**	.17**	.11**	.07**	.02**	-		
<b>9.Pacifier</b>	.06**	-.12**	-.06**	-.05**	-.03**	-.03**	-.04**	-.17**	-	
<b>10.Development</b>	.00	-.03**	-.02*	-.01	-.02**	-.01	.07**	.00	-.01	-

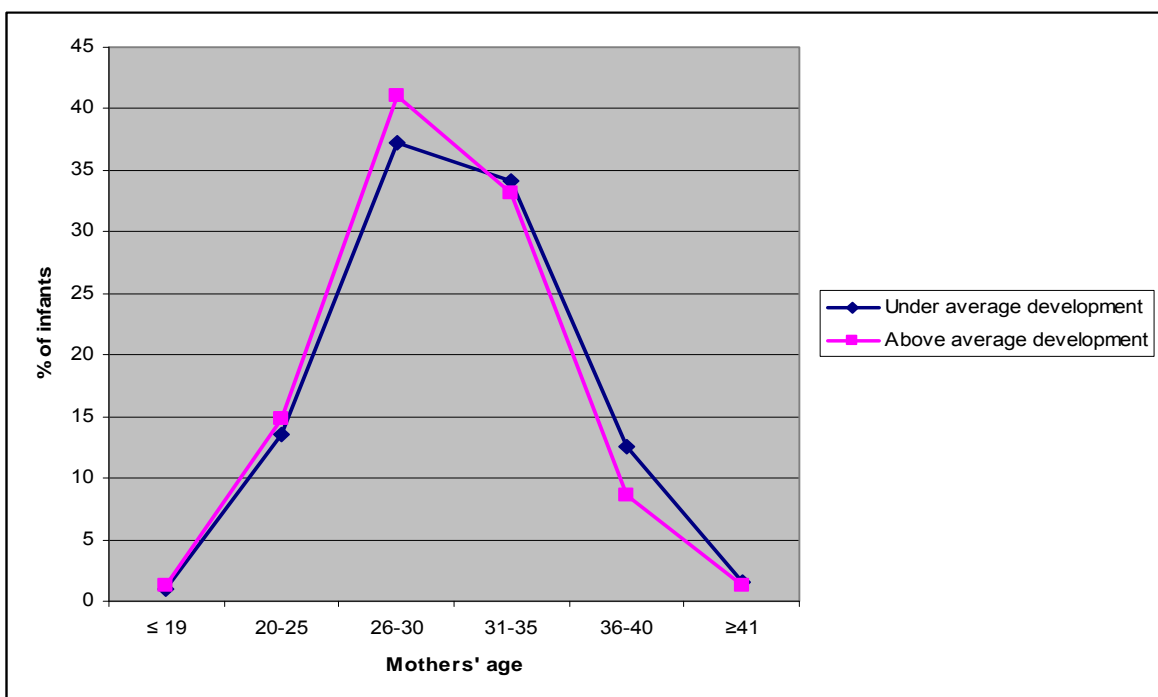
Note: \*  $p < .05$ , \*\*  $p < .001$

## Appendix C: Maternal age

**Figure C.1** Percent of low and high risk infants in showing an above average development based on mothers' age.



**Figure C.2.** Percent of low risk female infants showing an above and under average development based on mothers' age.



## Appendix D: Mothers' education level

**Figure D.1.** Illustrates the percentage of no-risk infants with under and above average development based on their mothers' education level.

