WEIGHT DEVELOPMENT AND FEEDING IN EARLY CHILDHOOD: THE ROLE OF TEMPERAMENT AND BEHAVIOR PROBLEMS

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Susan Garthus-Niegel
Oslo, June 2009

Abstract of the Dissertation
Weight Development and Feeding in Early Childhood: The Role of Temperament and Behavior Problems
Susan Garthus-Niegel

In recent decades, childhood obesity has been greatly increasing worldwide. The rapid increase in obesity rates among children is alarming because of the serious consequences for health. Besides demographic and genetic factors, in older children and adults there is considerable evidence that temperament, personality traits, and psychopathology play a role in the etiology of obesity. Yet, in younger children, evidence is scarce.

The aim of this dissertation is therefore to investigate the role of child temperament and behavior problems in weight development and feeding in early childhood, namely, from birth to age 3 years. For this purpose, I used data from the nationwide Norwegian Mother and Child Cohort Study (MoBa). Sample sizes varied between approximately 11,000 and 30,000 mother-child dyads for the respective sub-studies.

For the studied age span, I did not find much support for an association between child psychological factors on the one hand and feeding and weight development on the other hand. Still, whether or not a child was fully breastfed for 6 months was associated with a more difficult temperament. Moreover, the Internalizing subscale "somatic complaints" was negatively correlated with the BMI at child age 18 months. The validity of the latter association is doubtful, however.

This study fills a gap in prior knowledge, as it examined the relationship between temperament and behavior problems with weight development and breastfeeding over a previously unaddressed time period, i.e., from birth onwards in a large-scale population study with a multiwave longitudinal design. It appears that the children in the present study are still too young, in that a causal process between child psychological factors and weight has not yet had enough time to unfold. Further research should follow up the sample in order to shed more light on that process. Furthermore, future studies should include additional important variables, such as other nutrition, number of children in the family, parental feeding practices, and parental characteristics.

LIST OF PAPERS

Paper I

Niegel, S., Ystrom, E., & Vollrath, M. E. (2007). Is difficult temperament related to overweight and rapid early weight gain in infants? A prospective cohort study. *Journal of Developmental and Behavioral Pediatrics, 28,* 462-466.

Paper II

Niegel, S., Ystrom, E., Hagtvet, K. A., & Vollrath, M. E. (2008). Difficult temperament, breastfeeding, and their mutual prospective effects: The Norwegian Mother and Child Cohort Study. *Journal of Developmental and Behavioral Pediatrics, 29,* 458-462.

Paper III

Niegel, S., Hagtvet, K., & Vollrath, M. E. (2009). A prospective study of weight development and behavior problems in toddlers: The Norwegian Mother and Child Cohort Study. Manuscript submitted for publication.

1. BACKGROUND

1.1 Overweight in Children

In recent decades, childhood obesity has been increasing steadily worldwide (Adair, 2008). In Norway, body weight in childhood increased evenly across the entire weight spectrum by 1 unit of the body mass index (kg/m2) (BMI) between 1975 and 2000 (Sosial og helsedirektoratet, 2002). In 2000, close to 22% of all newborns in Norway weighed more than 4 kg (Sosial og helsedirektoratet, 2002). Today, around 19% of Norwegian children and adolescents are above the 90th weight-for-height percentile according to the 1971-1974 references (Juliusson et al., 2007).

In children it is difficult to determine overweight, because average weight-for-height ratios change rapidly as children grow. Therefore, applying standard cut-off values, as with adults, is not possible. The most accurate way to determine overweight or obesity is to measure skinfold thickness at different locations (triceps, subscapularis) (Juliusson et al., 2007). However, this measurement is costly and impractical for large population studies. A cheaper and widely accepted approach is the use of age and sex-adjusted percentile cut-offs of the body-mass index (BMI), a weight-for-height ratio with weight in kilograms as the numerator and height in meters squared in the denominator. Although in children different percentile cut-offs have been applied across studies (Baird et al., 2005), the 85th age- and sex-adjusted BMI percentile is widely accepted today as the definition of overweight, cautiously labeled “at risk for overweight” and the 95th percentile as the definition for “obesity” (Cole, Bellizzi, Flegal, & Dietz, 2000).

Overweight and obesity are a result of energy imbalance over a long period of time. Energy balance again is determined by calorie intake and physical activity. Several large studies on nutrition in children and adolescents document that the consumption of energy dense food containing sugar and fat is too high, whereas the consumption of food containing high levels of fiber (fruits and vegetables) is too low (Sosial og helsedirektoratet, 2002; St Onge, Keller, & Heymsfield, 2003).

The rapid increase of rates of obesity in children is alarming because of the serious consequences for health. Although many parents, particularly mothers, prefer a cherubic child to a thin child (Baughcum, Burklow, Deeks, Powers, & Whitaker, 1998), childhood obesity implies a range of serious health risks. Firstly, obese children are at high risk of obesity in adulthood (Daniels et al., 2005). Moreover, obesity has adverse effects on many health parameters, such as blood pressure, cholesterol, triglycerides, and insulin resistance. These parameters in turn increase, among other things, the risk for cardiovascular disorders and type 2 diabetes later in

life (World Health Organization, 2008). In addition, thickening of the arteries, high blood pressure, fatty streaks in the arteries, and even diabetes type 2, formerly considered exclusively as an adult disease, have been observed increasingly often during childhood (Daniels et al., 2005; Daniels, 2006).

1.2 Predictors of Childhood Overweight

1.2.1 Genetic and demographic factors

Poor health, including obesity, is transmitted between generations. Twin and adoption studies give evidence of a strong genetic pathway for obesity (Farooqi, 2005); children of obese mothers are more likely to become obese later in life. Among environmental transmitters, low socioeconomic status has been regarded as a major culprit (Kahn, Wilson, & Wise, 2005; Serbin & Karp, 2004). Mothers transfer a risk for obesity to their child through both the prenatal environment and the environment that they create after their child has been born. One aspect of maternal transfer of risk to her child is through maternal health and health-related behaviors, such as prenatal nutrition (Chapman & Scott, 2001). Moreover, smoking, drinking, and substance abuse have also been shown to have negative effects on infants' physical growth (Oken, Levitan, & Gillman, 2008).

1.2.2 Child psychological factors: Temperament and behavior problems

Child temperament appears very early in life and captures differences in reactivity and self-regulation (Rothbart & Bates, 2006). Infants and children can be distinguished in terms of their activity and energy level, mood, impulsivity (approach), sociability (withdrawal), biological rhythmicity, persistence, and high-intensity pleasure. In spite of remarkable changes in their manifestation, temperamental traits are relatively stable and predictive of adult personality (Caspi, 2000). *Child behavior problems* are maladjusted traits and states, such as depression, anxiety, or acting out behavior, often summarized under the labels of internalizing and externalizing behavior problems (Achenbach, 1989). Internalizing problems affect the child's inner world (e.g., anxiety, depression, feeling socially excluded). Externalizing problems include disruptive, noncompliant, aggressive, and deceitful behaviors as well as inattention. They are related to the child mental disorders of Attention Deficit/Hyperactivity Disorder (ADHD), Conduct Disorder, and Oppositional-Defiant Disorder (American Psychiatric Association, 1994).

Behavior problems are partly predicted by and partly overlap with temperament traits (Frick, 2004), yet the relationship between behavior problems

and temperament is not clear-cut (Nigg, 2006). Four basic models have been suggested: a) A spectrum or common cause model assumes that psychopathology reflects the same underlying structure as temperament but that psychopathology presents an extreme of commonly occurring child behaviors that have reached problematic levels; b) A vulnerability or resilience model states that certain temperament types predispose to, while others protect from, certain kinds of behavior problems in some contexts but are inconsequential in others; c) A pathoplastic effect model theorizes that temperament may alter the course of a disorder once it occurs; whereas to the contrary, d) A scar effects model theorizes that pathological processes may alter temperament. So far, there is empirical support in the literature for the first two models in particular.

Obesity is caused to a large extent by behavior, namely, eating too much while being too little physically active. Behavior, in turn, is influenced by temperament or personality traits as well as by psychological problems. In adults, there is substantial evidence for an association between obesity and personality traits and obesity and psychopathology. Data from large epidemiological studies show that obese adults score higher on measures of impulsiveness (Kakizaki et al., 2008), and show a pattern of antisocial and conduct-related personality traits (Goldstein et al., 2008). In addition, they suffer more often from anxiety and depressive disorders (Petry, Barry, Pietrzak, & Wagner, 2008).

In children and adolescents of school age, associations between behavior problems and temperament on the one hand, and overweight and obesity on the other hand have been found in both clinical and in community studies. However, clinical studies with treatment-seeking obese children tend to be biased in the direction of higher psychopathology (Gibson et al., 2008; Hwang et al., 2006; Mustillo et al., 2003; Tanofsky-Kraff et al., 2004). Emotional problems, peer and social problems (internalizing), and disruptive behavior, conduct problems, and aggressive problems (externalizing) have been found to be associated with obesity or to predict obesity at a later age in community studies, too (Agras, Hammer, McNicholas, & Kraemer, 2004; Hampson, Goldberg, Vogt, & Dubanoski, 2006; Hasler et al., 2004; Hwang et al., 2006; Mustillo et al., 2003; Pine, Cohen, Brook, & Coplan, 1997; Pulkki-Raback, Elovainio, Kivimaki, Raitakari, & Keltikangas-Jarvinen, 2005; Richardson et al., 2003; ter Bogt et al., 2006). Moreover, a recent review study shows comorbidity between ADHD and obesity (Cortese, 2008).

However, it is not certain that the same associations also are present in young and very young children. Adolescence poses separate problems, characterized by puberty and related weight gain, a heightened self-awareness and awareness of one's

own body, the desire to be attractive to the other sex, and a higher risk of experiencing psychological problems. In contrast, smaller children have a less developed self-awareness, more diffuse body image, and less control over their own nutrition and physical activity. In addition, the rates of childhood obesity increase as children become older; accumulating body fat requires prolonged overnutrition in relation to energy expenditure. Yet, evidence regarding the relation of behavior and weight in smaller children is scarce. With respect to cross-sectional associations between child overweight and behavior, I could locate only four community studies examining the cross-sectional association between overweight and behavior problems in children between 3 and 5 years (see Table 1). Three of these studies found contemporaneous associations between overweight/obesity and behavior problems (Datar & Sturm, 2004; Sawyer et al., 2006; Sugimori et al., 2004) and the other study found none (Lawlor et al., 2005). The lowest age at which a cross-sectional association was found was 3 years (Sugimori et al., 2004). A single small laboratory study examined the association of infant temperament assessed at age 12 weeks with skinfold thickness and percentage of body fat at age 2-3.5 years in 30 healthy infants, i.e., the longitudinal association of infant temperament with young childhood fatness. Distress to limitations was positively correlated with the percentage of body fat in early childhood (Wells et al., 1997). However, this study did not report cross-sectional associations.

Table 1

Studies on the Relationship of Temperament and Behavior Problems with Overweight or Weight Development in Children under the Age of 6 Years

Study	Population, N	Age of children	Measures behavior problems, temperament	Weight measures, classification	Statistics	Results for both sexes	Results for boys	Results for girls
Sugimori et al. 2004	Japan, community, 8170 children	3 yrs to 6 yrs	Self-constructed temperament scale: enthusiastic, tantrums, competitive, sociable, voluntary	Anthropometry BMI, overweight >= 90th percentile (%ile)	Group comparison	Children overweight at age 3 and 6 prone to tantrums	Valid for boys	Not valid for girls
Sawyer et al. 2006	Australia, community, 4983 children	4 yrs to 5 yrs	Strength and Difficulty Quest., parent-reported and teacher-reported	Anthropometry BMI, overweight >= 85th %ile, obese >= 95th %ile	Group comparison, ANOVA	Not computed	Overweight & obese boys had teacher-rated total difficulty +, hyperactivity +, conduct problems +, emotional symptoms 0 (adj. Background var.)	Ow. & obese girls had 0 emotional symptoms, + peer problems (parent reported), and + conduct problems teacher-reported (adjusted)
Datar & Sturm 2004	USA, community, 9949 children	5 yrs to 7 yrs	Teacher SRS, externalizing, internalizing, parent-reported internalizing (4 items from SRS)	Anthropometry, BMI, overweight >= 95th %ile	Group comparison, odds ratio. longitudinal regression	Not computed	Age 5: overweight boys, 0 externalizing, 0 internalizing (teacher-rep.),0 internalizing, parent-rep. age 7: ov. age 5 overw. 0 new behav. problems	Age 5: overweight girls, + externalizing, + internalizing (teacher-rep.), + internalizing (parent-rep), adj. age 5 y. overweight 0 new behavior problems
Lawlor et al. 2005	England, community cohort, 2875 children	5 yrs to 14 yrs	Maternal reports of CBCL	Anthropometry, BMI, overweight >= 85th %ile, no obese group	Multiple logistic regression	Not computed	Age 5: overweight boys 0 behavior problems Age 14: ow. Boys 0 behavior problems	Age 5: overweight girls, 0 behavior problems. age 14: ow. 2.01 (OR) on behavior problems (adjusted)

Table 1 continued

Authors	Population, N	Age of children	Measures behavior problems, temperament	Weight measures, classification	Statistics	Results for both sexes	Results for boys	Results for girls
Agras et al. 2004	USA, 150 normal infants from community hospital	2-4 weeks to 9.5 yrs	Child Behavior Questionnaire at age 5 yrs	Anthropometry, BMI, overweight >= 85th %ile	Logistic regression, recursive partitioning	Persistent temper tantrums over food (age 2) and active temperament and high scores on anger/frustration (age 5) predicted overweight at 9.5 yrs	Not computed	Not computed
Wells et al. 1997	England, 30 healthy infants	12 weeks to 2-3.5 yrs	Maternal report on Infant Behavior Questionnaire, observation diary, diet at age 2-3.5 yrs	Anthropometry, skinfold thickness, percentage body fat (at 2-3.5 yrs)	Correlation and regression	Fussiness + total food intake, carbohydrate intake, distress to limitations + percentage fat	Not computed	Not computed
Darlington et al. 2006	England, health clinic sample, 75 infants	Birth to 8 weeks	Maternal report on Infant Behavior Questionnaire	Anthropometry, weight residuals (week 8 regressed on birth weight); norms for fast, normal and slow weight gain	Chi2, ANOVA, regression	Fear predicted slower weight gain, distress to limitation predicted fast weight gain, data controlled for sex	Not computed	Not computed
Carey 1985	USA, 200 normal infants from middle-class, private practice	6 mths to 12 mths	Maternal report on Infant Temperament Questionnaire	Anthropometry, 6 and 12 mo, 30th %ile greatest weight for length increase	Chi2	Infants in the 30th %ile group highest weight-for-length gain had more negative mood and were more difficult	Not computed	Not computed

Two further studies approached the issue indirectly, by addressing *rapid early weight gain during the first year of life*, rather than overweight. Rapid early weight gain is a risk factor of obesity later in childhood (Stettler, Zemel, Kumanyika, & Stallings, 2002) and can therefore serve as a cue for the role of temperament in infant weight development. The first study (Carey, 1985) found that 200 6-month-old infants from a private pediatric practice who scored high on the temperamental dimension of difficultness (fussiness) (Bates, Freeland, & Lounsbury, 1979) gained more weight during the following 6 months than "easy" children, those with low scores on difficultness. The second study (Darlington & Wright, 2006) investigated 75 healthy infants and found that distress to limitations (age at assessment time not known) was related to faster weight gain during the first weeks of life. Although the results of studies on infants converge, the total evidence is still weak, because the studies investigated small, non-representative samples. Further studies addressed the association of temperament or behavior problems with *overweight* in the general child population. An intensive laboratory study following 150 newborns up to age 9.5 years (Agras et al., 2004) assessed infant feeding behaviors at age 2-4 weeks and monthly until the child was weaned from breast and bottle, as well as eating behaviors such as rapid eating, picky eating, and tantrums over food at ages 2, 3, 4, and 5 years; child temperament was assessed at five years with the Child Behavior Questionnaire (Rothbart, 1981). An active temperament at age 5, and high scores on anger/frustration (high approach and impulsivity) predicted overweight at 9.5 years of age. Persistent temper tantrums over food at age 2, which in turn correlated with high anger/frustration and low soothability, independently predicted later overweight as well.

1.3 Mechanisms Mediating between Temperament and Weight in Children

Little is known about the direction of the causal relationship between child temperament or behavior problems and overweight, or the mechanisms that mediate between them. Two major hypotheses have been put forward: The first states that temperamental/personality characteristics influence the child's eating behavior and levels of physical activity, which in turn lead to later weight gain (Agras et al., 2004; Carey, 1985; Wells et al., 1997). The argument is that because temperament develops from birth and shows continuity over time (Caspi, 2000; Caspi, Roberts, & Shiner, 2005), it may have an important role in the development of subsequent behavior relating to both feeding and physical activity patterns (Wells et al., 1997). I will dub this hypothesis the "health behavior hypothesis" in the following sections. The second

hypothesis claims that obesity leads to stigmatization, peer rejection, and psychological distress, and seriously hampers the child's functioning in the social domains of life, including performance at school (Judge & Jahns, 2007; Schwartz & Puhl, 2003; Zeller, Reiter-Purtill, & Ramey, 2008). I will call this hypothesis the "stress hypothesis." These two hypotheses will be considered in turn in the following.

1.3.1 The health behavior hypothesis

There are several studies of small children suggesting that temperament may temporally precede the development of overweight. Two of these studies were referred to above, but the outcome of these studies was not actual child overweight but rapid early weight gain (Carey, 1985; Darlington & Wright, 2006). A third study suggested as well that early temperament was related to early childhood fatness (Wells et al., 1997), but the sample was very small (N=30) and most of the mothers had high education, which severely reduces the generalizability of the results. A fourth study, also already mentioned above, provided evidence that difficult temperament may indeed precede the development of overweight but that it may take time until overweight is manifested (Agras et al., 2004). However, that study was also small and the sample unrepresentative. Prospective population studies are needed to establish whether this association holds in less selected samples and over time, as weight fluctuations are common in childhood.

1.3.1.1 Maternal behavior: Breastfeeding and child feeding strategies

If temperament causally precedes the development of overweight, we need to demonstrate the effect of mechanisms that mediate the relationship between child temperament / behavior and child overweight. An important candidate for such a mechanism is maternal feeding behavior, beginning with breastfeeding. There is a major consensus that breastfeeding is the optimal form of nutrition for human infants, involving innumerable health benefits, including psychological ones, such as a stronger attachment between the mother and the child and better child adjustment (Lawrence, 2000). The World Health Organization (WHO) recommends exclusive breastfeeding during the first 6 months of life, with the caveat that infants must be managed individually in the case of insufficient growth (Kramer & Kakuma, 2002). Specifically, numerous studies indicated that breastfeeding protects the child against later obesity (Harder, Bergmann, Kallischnigg, & Plagemann, 2005), although these finding have recently been called into question (Kramer et al., 2007).

Establishing and sustaining breastfeeding for 12 months can pose difficulties even for healthy mothers with healthy babies. Breastfeeding is influenced by physical,

psychological, and social factors in the mother, such as having undergone a Caesarean section, experiencing inflammation of the breasts, early return to work, or depression during the postpartum period (Hoddinott, Tappin, & Wright, 2008). Importantly, behavioral factors in the child play a role as well. One major way an infant can signal that it wants to be fed is by crying. Hunger crying has a slow onset, but so has crying due to discomfort and fatigue. Hence, it can be difficult to determine from the infant's type of crying alone whether he or she is hungry or is feeling another discomfort. A common concern of breastfeeding mothers is the fear of not having sufficient breast milk for their baby. As breastfed infants tend to cry more—at least initially—and need to be fed more often during the night (Drewett, 2007), mothers may actually start to feed formula or additional food in order to satisfy the perceived needs of her infant.

In a similar way, mothers may find it challenging to breastfeed infants that are high in negative emotionality and low in soothability and self-regulation. Because such babies fuss and cry a lot, their mothers may be tempted to introduce formula, sugary fluids, or solid foods earlier in order to soothe and calm their child. In a qualitative study of 14 low-income mothers for instance, solid foods were introduced to the child before the recommended age to prevent nightly crying and out of fear that the infant might be too thin (Baughcum et al., 2001). Similarly, an observational prospective study of over 700 mother-infant dyads showed that mothers of infants diagnosed with colic introduced additional foods earlier than mothers of healthy infants (Howard, Lanphear, Lanphear, Eberly, & Lawrence, 2006). Colic is a syndrome of repeated persistent infant crying during the first months of life without known reason. Colic may be difficult to distinguish from early manifestations of negative emotionality or difficult temperament and may thus mistakenly lead the mothers to introduce dietary changes such as earlier weaning. Thus, it is possible that infants with "difficult temperament" (Bates, 1987) that fuss and cry a lot are weaned too early—which again may imply a risk for later overweight.

Some researchers claim that breastfeeding reduces an infant's tendency to cry and fosters positive affect, activity, and less irritability. For instance, in an intensive laboratory study of 62 mother-infant dyads with assessments at infant age 1 and 3 months, more positive play interactions were observed in babies that were still predominantly breastfed at 3 months (Jones, McFall, & Diego, 2004). In a similar vein, another study of 50 mother-infant dyads that were observed in the home at child age 2, 6, and 12 weeks showed that babies still breastfed at age 12 weeks were rated as temperamentally "easier" by their mothers (Vandiver, 1997). In contrast,

Worobey (1998) found no temperamental differences among 40 breastfed and 40 non-breastfed 3-month-olds (Worobey, 1998).

Given the inconsistency of these results, the small size of the samples and the strong selection bias (most mothers had a higher-than-average education), as well as the fact that the research designs were only short term and temperament was measured only once, conclusions with regard to the direction of the association between breastfeeding and infant temperament are not warranted at this stage. In particular, evidence for a continuing influence of breastfeeding on temperament development across childhood appears to be thin. In support of this, a recent randomized trial (Kramer et al., 2008) showed no effects of prolonged breastfeeding on child behavior at child age 6.5 years. In this trial, 13,899 Belarus women were randomly assigned to receive an intervention that strongly promoted breastfeeding versus no intervention, that is, usual practice. At child age 3 months and across the child's first year, there were indeed strong differences between the two groups in rates of breastfeeding. However, there were no differences between the children's behavior scores at age 6.5 years (Kramer et al., 2008).

1.3.1.2 Child eating behavior

Children begin to develop the motor abilities to eat independently between their first and second year of life (Drewett, 2007). Around this time, they also develop distinct food preferences. In general, they tend to reject new foods and only come to accept them and to prefer them after repeated exposures. At the same time, children have a natural preference for sweet and fatty foods, i.e., palatable foods. Such foods have strong reward characteristics, relieving feelings of negative mood (Wurtman & Wurtman, 1995) and providing an immediate feeling of well-being and relaxation (Nguyen-Michel, Unger, & Spruijt-Metz, 2007). Already in infants, experimental studies have demonstrated a calming effect of sweet fluids (Barr et al., 1994). Palatable foods have been likened to addictive substances, with which they share neurobiological pathways in the brain (Acosta, Manubay, & Levin, 2008). Furthermore, they offset the normal regulation of appetite, leading to greater appetite and delayed satiety, thereby paving the way for overeating and obesity (Erlanson-Albertsson, 2005).

Obese children have a propensity for external eating, i.e., eating that is triggered by the smell and taste of food rather than by internal signals of satiety or hunger (Jansen et al., 2003). Moreover, they are inclined to emotional eating, i.e., eating when angry, upset, depressed, or anxious (Macht, 2008). One could speculate that emotional eating would also be related to certain temperamental traits in

children, particularly negative emotionality and impulsivity. In adults, emotional eating has been shown to be related to the traits of negative affectivity (Spoor, Bekker, Van, & Van Heck, 2007) and low conscientiousness (Heaven, Mulligan, Merrilees, Woods, & Fairooz, 2001), but in children such studies are not available.

1.3.2 The stress hypothesis

Whereas the health behavior hypothesis assumes that psychological traits related to emotional problems and poor self-regulation cause a pattern of overeating coupled with too little physical activity, the stress hypothesis claims that being overweight or obese causes negative psychological reactions that may surface as chronic traits (temperamental) or express themselves as behavior problems.

Obesity is a highly visible condition, and it is considered very unattractive in modern western societies. There is a serious stigma attached to obesity (Puhl & Latner, 2007). People who are obese are often perceived as being greedy and lacking in self-control; this is also true for children. Although the proportion of overweight children has strongly increased, stigmatization has increased rather than disappeared during recent years (Latner & Stunkard, 2003). Studies show that obese children are considered less likeable and less attractive, are less likely to be chosen as a best friend, and that they are teased, bullied, and rejected by their peers (Zeller et al., 2008). This bias against overweight children has been shown to be present already among 3-year-olds (Cramer & Steinwert, 1998). Even parents show negative attitudes towards children's overweight, ascribing negative characteristics, such as laziness, to heavier children (Davison & Birch, 2004). Obese children respond with a negative body image, greater weight and shape concerns, dissatisfaction with their own body, and a negative perception of their physical appearance and athletic competence (Allen, Byrne, Blair, & Davis, 2006; Franklin, Denyer, Steinbeck, Caterson, & Hill, 2006; Hayden-Wade et al., 2005). This in turn leads many of these children to feelings of lower global self-worth and, ultimately, depression (Franklin et al., 2006; Gibson et al., 2008). Moreover, obese children have poorer motor skills than their same-aged peers, putting them at a disadvantage in relation to leisure time activities and acceptance among peers (Graf et al., 2004a; Graf et al., 2004b). Again, this could contribute to a higher risk of being teased and rejected by their peers. As a consequence, obese children may turn to food in order to regulate their negative feelings and thus become involved in a spiral where negative affect leads to overeating, which in turn leads to weight gain, which again leads to rejection and negative feelings.

2. OBJECTIVES

The overall aim of my doctoral dissertation project is to contribute to the understanding of weight development and feeding in early childhood by examining the role of child temperament and behavior problems. This study addresses a gap in prior knowledge, as it examines the relationship between child psychological factors and weight development and feeding from birth to age three years, so that early periods of risk can be discovered. Moreover, this is the first large population study addressing this issue. Its great statistical power provides the possibility to control for a variety of important medical confounders and increases the generalizability of the results. This work further extends past research through its longitudinal design, which enables me to address crucial questions concerning causal direction. Figure 1 depicts a conceptual model of the study as a whole. Embedded in this model are my three sub-studies, represented by Papers I, II, and III. The specific aims of those papers are:

2.1 Paper I

Given the sparse knowledge on behavioral risk factors for overweight in early infancy, the aim of Paper I is to examine whether fussy/difficult temperament is associated with overweight at birth or at the age of 6 months. In view of the findings from two small, earlier studies, I also wanted to address whether fussy/difficult temperament predicts rapid early weight gain from birth to 6 months of age.

2.2 Paper II

In order to advance knowledge about the supposed association between breastfeeding and difficult temperament, Paper II investigates a) whether difficult temperament and breastfeeding are associated cross-sectionally at child age 6 and 18 months, and b) whether there is evidence for any of two causal pathways: first, that breastfeeding influences the development of temperament, or second, that temperament influences the continuation of breastfeeding.

2.3 Paper III

Paper III addresses the concurrent and prospective relationships between relative weight and behavior problems in toddlers between age 18 and 36 months. No prior studies have addressed this early period in child development. Examining the

concurrent associations between child behavior problems and weight may help determine the point in time at which a potential relationship emerges. Examining the cross-lagged pathways from behavior problems to weight and weight to behavior problems over time allows me to examine their co-development and to shed light on their causal sequence.

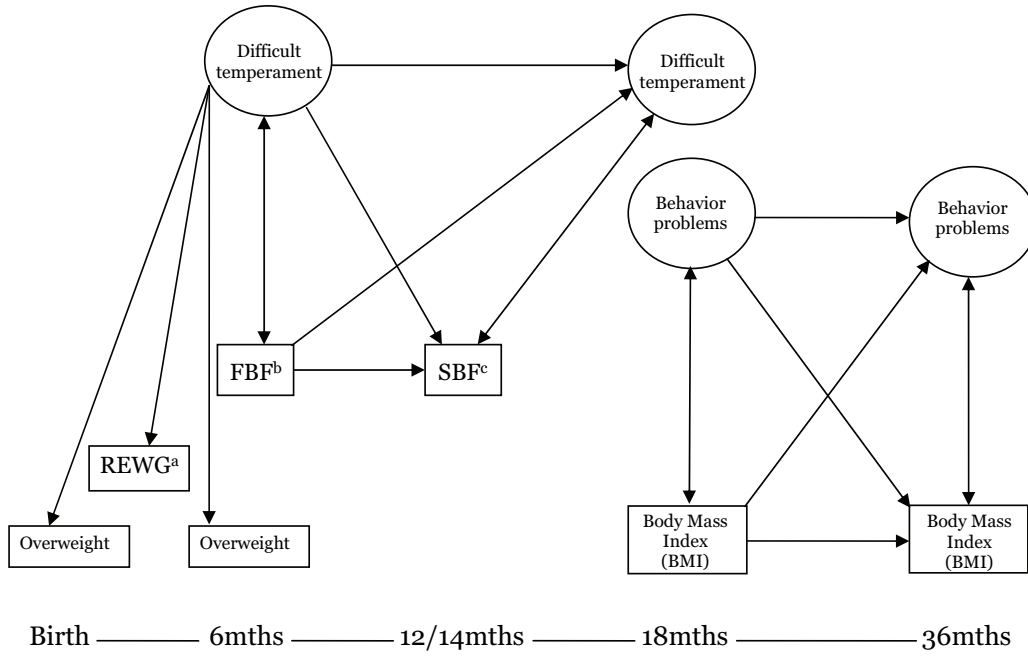

Figure 1. Conceptual model of the study.

a = rapid early weight gain, b = full breastfeeding, c=sustained breastfeeding

3. METHODS

3.1 Design and Participants

The data for this study were provided by the Norwegian Mother and Child Cohort Study (MoBa), carried out by the Norwegian Institute of Public Health (Magnus et al., 2006). The overall aim of MoBa is to study a large number of demographic, physical, genetic, and mental health exposure and outcome variables, particularly in mothers and children. The study also included some information on fathers, although this was based on a single questionnaire assessment only. The target population comprised all women who gave birth in Norway; there were no exclusion criteria. All (except 2) hospitals and maternity units in Norway with more than 100 births annually were included in the study. Recruitment started in 1999 and lasted until the end of 2008, when the goal of including 100,000 pregnant women was achieved. As the MoBa study is a collaborative study initiated a couple of years before I set out to write my dissertation, I want to highlight that I was not involved in the planning of the study, choice of instruments, or collection of data.

Together with appointments for ultrasound scanning in week 17-18 of pregnancy, the women received a postal invitation including an informed consent form, the first questionnaire, and an information brochure. In addition, a consent form and questionnaire were sent to the father. In Moba, the pregnancy is the unit of observation. Thus, a woman may participate in the study more than one time. A participant is defined as a woman who has sent in written, informed consent to participate. Participants can choose to withdraw at any time or to be deleted from the study.

When they attended the ultrasound examination, participating women were referred to the laboratory for blood and urine samples. If they were present and consented, fathers gave a blood sample, too. At the birth of the child, another blood sample was taken from the mother, plus a sample of the umbilical cord.

The first questionnaire (Q1), received by the Moba participants in pregnancy weeks 13-17, asked for information on outcomes of previous pregnancies, medical history before and during pregnancy, medication, occupation, exposures at the workplace and at home, lifestyle, and mental health. A food frequency questionnaire (Q2) was sent to Moba participants around week 22 of pregnancy. A third questionnaire (Q3) was sent at 30 weeks, covering the women's health status during pregnancy as well as changes in work situation and work habits. A fourth questionnaire (Q4), sent out when the child had turned 6 months, had a focus on child health and nutrition as well as on maternal disorders, well-being, and mental

health. Questionnaires dispatched at child age 18 months (Q5) and 3 years (Q6) had a main focus on the child's developmental status. New questionnaires are planned for child age 5, 7, and 8 years. The single questionnaire for fathers covered exposures at work, lifestyle, and medical history. Figure 2 provides an overview of the data collection.

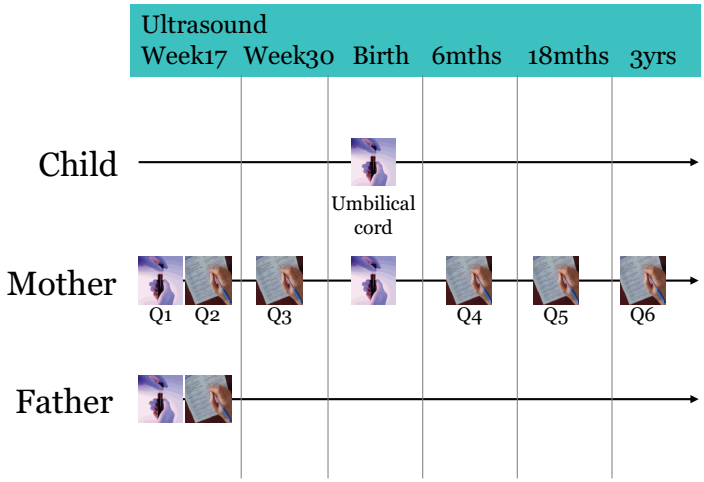

Figure 2. Data collection for the Norwegian Mother & Child Cohort Study (MoBa).

The total recruitment rate of MoBa was 40.3%. Once the women agreed to participate, response rates during pregnancy varied between 91 and 95% (Q1 – Q3). After birth, the response rates dropped to 86% for the 6-months (Q4), 75% for the 18-months (Q5), and 62% for the 3-years questionnaire (Q6) (Magnus, 2007).

For my doctoral dissertation studies, I used data from Q1, Q4, Q5, and Q6 (see Appendix) as they became available across a three-year period. I also used data from the Medical Birth Registry of Norway (MBRN), which records every pregnancy lasting at least 12 weeks. The MBRN contains data on parental marital status, the pregnancy, maternal health, the birth, and the child.

3.2 Measures

3.2.1 Background variables

In order to control for possible confounders, a number of background variables were included in the analyses of the present study. Information regarding

child sex, infant gestational age, mode of birth, and maternal parity was retrieved from the MBRN. If an entry in the MBRN was missing, maternal self-reports served as a secondary source of information. Information regarding maternal age, BMI (both before and after pregnancy), diabetic status, smoking and education, paternal education, formula feeding, and external day care for the child was retrieved from the respective questionnaires. Diabetic status was self-reported and treated as a dichotomous variable with no differentiation between frank and gestational diabetes (the latter occurring first during pregnancy). Postpartum smoking (after pregnancy) was equally treated as a dichotomous variable, with smoking defined as 1 or more cigarettes a day.

3.2.2 Weight related variables

In Norway, newborns' weight and length are registered in the hospitals and in the MBRN at birth. After that, all children are regularly measured and weighed by specialized staff at public health centers up to 6 years of age. These measurements are recorded on a health chart of which the mother retains a copy. For the present study, data on infants' birth weight and length were retrieved from the MBRN, whereas data on weight and length at the age of 6, 18, and 36 months were retrieved from maternal reports copied from the health charts.

In Paper I, the main outcome measures were infant overweight status at birth and 6 months of age, and rapid early weight gain between birth and 6 months of age. In the absence of a standard definition for childhood overweight below the age of 2 years (Cole et al., 2000), I applied a commonly used cut-off point for overweight status at birth and 6 months of age (Baird et al., 2005), the 85th percentile of weight-for-length (weight in grams divided by length in centimeters). In a similar vein, a standard definition of rapid early weight gain is missing. Again, I chose a cut-off value for rapid early weight gain that is frequently used by other researchers in the field: the 85th percentile in weight-for-length gain between birth and 6 months.

In Paper III, children's weight was adjusted for their length as well. However, in Paper III weight was treated as a continuous variable, and BMI rather than crude weight-for-length was used, as the children were older at this time point.

3.2.3 Breastfeeding

At child age 6 months mothers reported retrospectively (a) what type of milk they had fed the child during each month, (b) whether and what other kinds of fluids they had fed the child during the first week of life, and (c) whether, when, and what kind of solid foods they had introduced to the child. This information was used to

define a group of "fully" breastfed children (binary variable) that according to the WHO definitions include both exclusively and predominantly breastfed children (World Health Organisation, 1991). As I did not have information on fluids other than milk given to the child in the period between the second week of life and child age 6 months, it was not possible to define an exclusively breastfed group. Infants in the fully breastfed group had been breastfed for 6 months and had not received any complementary formula or solid foods.

At child age 18 months, mothers reported retrospectively (a) what kind of milk they had fed the child when the child was 12-14 months old, (b) what other fluids they had fed the child, and (c) what kind of solid foods they had fed the child. This information was used to define a group of children who were continually breastfed (binary variable). In line with the recommendations of the WHO (Michaelsen, Weaver, Branca, & Robertson, 2003), children in this continued breastfed group had been breastfed for the entire first year of their lives.

3.2.4 Difficult temperament

At child age 6 months, mothers reported on their child's temperament by answering the 7-item "Fussy/Difficult" scale of the Infant Characteristics Questionnaire (ICQ) (Bates et al., 1979). This scale assesses infant difficultness as perceived by the primary caregiver. The 7 items used in the present study were selected on the basis of a previously published factor analysis (Japel, Tremblay, McDuff, & Boivin, 2000). On a 7-point rating scale, mothers rated their babies' usual mood and temperament. In Paper I, an average score was calculated, with higher scores reflecting greater infant difficultness. In Paper II a latent factor representing difficult temperament was obtained by using confirmatory factor analysis.

At child age 18 months, mothers reported on their child's temperament by responding to 3 items from the emotionality subscale of the Emotionality, Activity, and Sociability Scale (EAS) (Buss & Plomin, 1984). This scale assesses children's proneness to distress and their tendency to become easily and intensely upset as perceived by the primary caregiver (Buss & Plomin, 1984; Rothbart & Bates, 2006). Negative emotionality presents a broad factor in the structure of temperament and is closely related to Fussiness/difficultness (Rothbart & Bates, 2006). The three items of the EAS subscale had been selected from the full scale in a previous study of 921 Norwegian 18-month-old children (Mathiesen & Tambs, 1999) by means of multiple linear regression analysis. The three-item score correlated with the full score at r= 0.95. Responses were given on a 5-point rating scale, with higher scores reflecting a greater extent of negative emotionality. A latent factor representing difficult

temperament (or negative emotionality) at age 18 months was constructed by using confirmatory factor analysis (Muthén & Muthén, 2006).

3.2.5 Behavior problems

At child ages 18 and 36 months, behavior problems were assessed using several items from the Child Behavior Checklist/1½-5/LDS (CBCL/1½-5/LDS) (Achenbach & Rescorla, 2000). The items at my disposal represented subscales of the Internalizing and of the Externalizing scales. Internalizing problems reflect problems within the self, such as emotional reactivity, anxiety, depression, somatic complaints without known medical cause, and withdrawal from social contacts. Externalizing problems, in contrast, represent conflicts with other people and their expectations (Achenbach & Rescorla, 2000). Items of the following subscales were assessed: "emotionally reactive," "anxious/depressed," and "somatic complaints" (Internalizing scales), plus "attention problems" and "aggressive behavior" (Externalizing scales). The item selection procedure was based on consensus among specialists in clinical and developmental psychology and aimed at representing each subscale with items that were both clinically and theoretically relevant for Internalizing and Externalizing behavior. Mothers reported the extent to which they agreed with the behavioral statements using the following 3-point Likert scale: 1 = not true; 2 = somewhat or sometimes true; 3 = very true or often true.

3.3 Statistical methods

Statistical analyses were conducted with computer software SPSS for Windows Version 14.0 (SPSS Inc., 2005) and Mplus Version 4.2 (Muthén & Muthén, 2006).

3.3.1 Binary logistic regression

In Paper I, multivariate analyses were conducted employing binary logistic regression. The dependent variables – the infants' weight-for-length and change in weight-for-length – were transformed to dichotomous variables to capture overweight status and rapid early weight gain, respectively. The independent variables were partly continuous (for example, temperament) and partly dichotomous (for example, diabetic status). I used the forced entry procedure in which all predictor variables are tested in one block to assess their predictive ability, while controlling for the effects of other predictors in the model.

3.3.2 Structural equation modeling

In analyses for Papers II and III, I used structural equation modeling (SEM). SEM is a statistical comparison of a pre-specified theoretical model with a variance and covariance matrix of the observed data (Bollen, 1989), with the aim of determining the extent to which a theoretical model is supported by the sample data. SEM integrates regression analysis, path analysis, and confirmatory factor analysis within a single data analytic framework. This type of modeling has several advantages as compared to more traditional multivariate approaches, such as: a) control of random error through the estimation of latent variables, b) combined estimation of measurement and structural models, c) test and comparison of alternative causality models, with overall modification indices that specify the ability of specific models in explaining observed variance and covariance structures, and d) opportunity to test complex relationship structures, including both mediating and moderating variables (Loehlin, 1998).

One of the main objectives of this study was to find causal direction, i.e., to find evidence for the health behavior and/or stress hypothesis. Therefore, cross-lagged panel analysis (CLPA) was a feasible approach to analyze the data. CLPA enables the researcher to detect causal priority among a pair of variables, while simultaneously estimating several regression analyses and controlling stability effects (Taris, 2000). More specifically, we employed a two-wave, two-variable cross-lagged panel model in Paper II and two two-wave, three-variable cross-lagged panel models (separate for Internalizing and Externalizing problems) in Paper III.

4. RESULTS

The overall aim of this doctoral dissertation was to contribute to the understanding of weight development and feeding in early childhood by examining the role of child temperament and behavior problems. This study extends past research, as it examines a potential relationship between temperament and behavior problems with weight development and breastfeeding over a previously unaddressed time period, i.e., from birth onwards, in a large scale population study with a multiwave longitudinal design.

4.1 Summary of Paper I

As there is meager knowledge about behavioral risk factors for overweight in early infancy, the purpose of Paper I was to examine whether fussy/difficult temperament is associated with overweight at birth or at the age of 6 months and whether fussy/difficult temperament predicts rapid early weight gain from birth to 6 months of age.

All analyses were adjusted for potential confounders, such as infant's sex, formula feeding, maternal age, BMI, and diabetic status, and parental education.

There were no positive associations between fussy/difficult temperament and overweight status. On the contrary, at birth, fussy/difficult temperament was negatively associated with infants' overweight status. However, this association was relatively small. At the age of 6 months, fussy/difficult temperament was not associated with infants' overweight status at all. There were no gender differences in these associations.

There was a small positive overall association between fussy/difficult temperament and rapid early weight gain. A separate analysis for girls and boys showed that this association was statistically significant only for girls and not for boys. However, the effect size was very small and only became statistically significant due to the large size of the sample, i.e., its great statistical power. Therefore, I chose to cautiously conclude that difficult temperament does not influence rapid early weight gain during the first 6 months of life in a relevant way.

4.2 Summary of Paper II

Even though it is an important issue, particularly as being breastfed is considered protective of the later development of overweight, little is known about the relationship between breastfeeding and difficult temperament. The aim of Paper

II was to examine: a) whether difficult temperament and breastfeeding were associated between child age 6 and 18 months, and b) whether there was evidence for either direction of co-development: that breastfeeding influences temperament development or that temperament influences the continuation or cessation of breastfeeding.

At age 6 months, children with a difficult temperament were less likely to be fully breastfed. The point-biserial correlation yielded a negative cross-sectional association between difficult temperament and breastfeeding status of rpb = – 0.15 ($p<0.000$). After adjusting for infant sex, gestational age, birth weight, delivery by Caesarean section, being in external day care, as well as maternal parity, age, education, and smoking status, the point-biserial correlation dropped to rpb = – 0.11 ($p<0.000$).

At age 18 months difficult temperament and breastfeeding were no longer associated after adjusting for background variables, temperament and breastfeeding at 6 months. The crossover effects from breastfeeding at 6 months to difficult temperament at 18 months and from difficult temperament at 6 months to breastfeeding at 12-14 months were statistically significant but too small to be of scientific or practical importance. The results of this prospective structural analysis suggested two conclusions: 1) There is no indication that breastfeeding affects the development of difficult temperament in infants after the age of 6 months, and 2) there is also no indication that difficult temperament affects maternal breastfeeding behavior after the age of 6 months.

4.3 Summary of Paper III

The purpose of Paper III was to examine the concurrent and prospective relationships between relative weight and behavior problems in toddlers between the ages of 18 and 36 months, a topic that has not been addressed previously. Examining the concurrent associations between child behavior problems and weight can help to determine the age at which the relationship found in older children begins to emerge. Furthermore, examining the cross-lagged pathways from behavior problems to weight and weight to behavior problems over time allows the examination of their co-development and sheds light on their causal sequence.

All analyses were adjusted for child sex and maternal BMI and education and carried out separately for the Internalizing and Externalizing domains. The latent factor somatic complaints from the Internalizing domain was markedly negatively correlated with the BMI at child age 18 months as suggested by the unadjusted bivariate results but was much less so at child age 36 months. This indicates that

there is no co-development between BMI and somatic complaints over and above their initial association at 18 months. Contrary to expectations, there was no association between the other latent factor from the Internalizing domain, negative emotionality, and the child's BMI at any time point. Similarly, the latent factors attention problems and aggressive behavior from the Externalizing domain had no noteworthy cross-sectional associations with the child's BMI.

With regard to the longitudinal analyses the results suggested no difference in the size of the cross-lagged effects. In fact, the size of the cross-lagged effects was rather small, implying that child behavior problems and child BMI did not influence each other over time.

4.4 Synopsis

In this doctoral dissertation, little evidence was found for child psychological factors playing a major role in weight development and feeding below the age of three years. Still, whether or not a child was fully breastfed for 6 months was associated with a more difficult temperament. Moreover, "somatic complaints," a subscale of the Internalizing domain of child behavior problems, was clearly negatively correlated with the BMI at child age 18 months. Over and above these cross-sectional associations, no indication of any co-development was found. Consequently, answers regarding the causal direction could not be deduced.

5. DISCUSSION

It is nearly 4 years ago that I started working on this study. During this time I learned a lot. In a sense, Papers I – III embody important landmarks of that learning process, as they represent my knowledge at the various stages. Looking back from where I stand now, there are some things I would do differently today. I will describe these where relevant in the following sections.

5.1 Interpretation of the Results

5.1.1 Child psychological factors and weight development

Besides the more obvious relationship between obesity and energy imbalance, obesity has also been linked to temperament, personality traits, and psychological problems. In adults, there is considerable evidence for an association between obesity and personality traits as well as psychopathology (Goldstein et al., 2008; Kakizaki et al., 2008; Petry et al., 2008). Likewise, in adolescents and children of school age, associations between temperament and behavior problems on the one hand, and overweight and obesity on the other hand have been found (Agras et al., 2004; Gibson et al., 2008; Hampson et al., 2006; Hasler et al., 2004; Hwang et al., 2006; Mustillo et al., 2003; Pine et al., 1997; Pulkki-Raback et al., 2005; Richardson et al., 2003; Tanofsky-Kraff et al., 2004; ter Bogt et al., 2006). Yet, it is not certain that the same associations are present in younger children, too. In pre-school age children, there are very few studies that investigated this issue; those that were conducted yielded inconsistent findings (Agras et al., 2004; Datar & Sturm, 2004; Lawlor et al., 2005; Sawyer et al., 2006; Sugimori et al., 2004). Moreover, with regard to toddlerhood and infancy, to our knowledge only three studies have been conducted (Carey, 1985; Darlington & Wright, 2006; Wells et al., 1997). One of the latter studies found that infant temperament at age 12 weeks could predict skinfold thickness and percentage of body fat at age 2-3.5 years (Wells et al., 1997). The other two studies approached the subject indirectly. Rather than predicting overweight, a more difficult temperament predicted an increased weight gain (Carey, 1985; Darlington & Wright, 2006).

In light of the knowledge gap concerning young children, one aim of the present study was to examine whether and to what extent child psychological factors play a role in weight development during the first three years of age. The evidence for either temperament or behavior problems having a major influence on that process below the age of three years was limited. Only “somatic complaints” (a subscale of the

Internalizing domain of behavior problems) was negatively correlated with BMI at child age 18 months.

Thus, the results of this study diverge from the few earlier findings (Carey, 1985; Darlington & Wright, 2006; Wells et al., 1997), although some studies with older children had null findings as well (Lawlor et al., 2005; Sawyer et al., 2006). Why did the present study not uncover similar associations despite the enormous power of the study? I will now discuss possible reasons.

One issue is the uncertain generalizability of the previous studies. Whereas one study is rather old, being published 24 years ago (Carey, 1985), the other two studies were fairly small (Darlington & Wright, 2006; Wells et al., 1997). Moreover, the absence of additional publications on this topic gives rise to the suspicion that there is a publication bias, as null findings can be more difficult to publish.

As indicated above, according to the health behavior hypothesis, it is assumed that psychological factors determine eating behavior and level of physical activity and thus corresponding weight gain (Agras et al., 2004; Carey, 1985; Wells et al., 1997). In adults, emotional eating (eating when angry, upset, depressed, or anxious) has been linked to negative affectivity (Macht, 2008; Spoor et al., 2007). However, in the present sample it is highly likely that the children are too young for behaviors such as external and emotional eating. At that age, parents and other caretakers (e.g., kindergarten personnel) still decide much regarding the selection of food that children consume. Children therefore have little control over their own nutrition. For instance, in one study it was shown that by the middle of the second year of life, 20% of all food consumed by toddlers was still fed by the mother (Negayama, 1993).

The stress hypothesis on the other hand argues that overweight and obesity may lead to stigmatization, peer rejection, and psychological distress, and may seriously hamper a child's functioning in the social domains of life (Judge & Jahns, 2007; Schwartz & Puhl, 2003; Zeller et al., 2008). Stigmatizing and bullying have been found in children as young as 3 years of age (Cramer & Steinwert, 1998) but to my knowledge not in younger children. On the contrary, in low-income and minority groups, chubby babies are often considered healthier and more beautiful (Baughcum et al., 1998; Johnson, Clark, Goree, O'Connor, & Zimmer, 2008). In general, mid-range body sizes are considered to be the most acceptable, but the range of acceptable sizes for infants is wider than that for older children (Lucas et al., 2007; Rand & Wright, 2000).

Besides the young age of the current sample, the population might differ in other respects as well. Many of the studies referred to above were conducted in the United States and the United Kingdom, where overweight may be more prevalent. In

Norway, birth weight has decreased considerably since a peak in 2000 (Skjærven, 2009). Moreover, there has been a major improvement in infant nutrition in recent years. Together with the increased frequency of breastfeeding, sugar intake has decreased significantly (Øverby, Kristiansen, Andersen, & Lande, 2009). If the weight variation is smaller in Norway and extreme cases of overweight are lacking, it might then be more difficult to detect strong associations between weight and child psychological factors.

Another issue concerns the construct "rapid early weight gain." As there is no clear existing definition for rapid early weight gain (Baird et al., 2005), it is difficult to determine whether I actually investigated this during the right time frame. Two other studies found that temperament predicted rapid early weight gain. In one, rapid early weight gain was defined as a bigger weight gain between birth and 8 weeks of age (Darlington & Wright, 2006), whereas in the other, it was between 6 and 12 months of age (Carey, 1985). In other studies, rapid early weight gain even comprised a period up to 2 years of age (Monteiro, Victora, Barros, & Monteiro, 2003; Toschke, Grote, Koletzko, & von, 2004).

Of course, it would have been viable to measure temperament more broadly. Although at 6 months only one temperament dimension ("fussy/difficult") was available, by 18 months and beyond, "emotionality" short scales for "activity" and "shyness/sociability" were also at hand. In a Finnish study, a research group created a type representing the child's difficult temperament consisting of high negative emotionality, high activity, and low sociability (Raikkonen, Katainen, Keskivaara, & Keltikangas-Jarvinen, 2000). Another study with some of the same researchers found a borderline significance for the prediction of adult BMI by low sociability in children aged 6 to 12 years (Pulkki-Raback et al., 2005). It was hypothesized that low sociability could be an indicator of problems in cooperating with peers, which in turn might lead to more solitary, sedentary activities and less physical activity.

In addition, child behavior problems were measured using a restricted number of items. Unfortunately, only short scales were available, and one dimension ("withdrawn") was altogether absent from the questionnaire. Nonetheless, it remains speculation as to whether a broader assessment of behavior problems would have yielded stronger associations between child behavior problems and BMI. Interestingly, the subscale "somatic complaints" was clearly negatively related to BMI. However, looking closer at the selected items from the short scale, questions are raised considering their validity in the given context. At the age of 18 months, the subscale "somatic complaints" was represented by merely one item: "Doesn't eat well." At the age of 36 months it was represented by the following 4 items: "Doesn't

eat well"; "Constipated, doesn't move bowels"; "Stomach aches or cramps (without medical cause)"; "Vomiting, throwing up (without medical cause)". Given the content of the selected items, a negative association with BMI seems unsurprising, since these are closely linked to the child's actual diet, metabolism, and weight. Other studies also found flaws with the construct validity of the "somatic complaints" subscale, because real physical symptoms may be confused with the symptomatology that reflects psychosocial disturbance (Drotar, Stein, & Perrin, 1995; Friedman, Bryant, & Holmbeck, 2007; Perrin, Stein, & Drotar, 1991).

5.1.2 Temperament and breastfeeding

There is a major consensus that breastfeeding is the optimal form of nutrition for human infants, with innumerable health benefits including psychological ones (Lawrence, 2000). Among other benefits, breastfeeding has also been suggested to protect the child against later obesity (Harder et al., 2005), although such findings have recently been called into question (Kramer et al., 2007).

Establishing and sustaining breastfeeding can pose difficulties even for healthy mothers and babies. Physical, psychological, and social factors in the mother, as well as behavioral factors in the child may play a role. With regard to the latter it has been hypothesized that mothers may introduce formula, sugary fluids, or solid foods earlier to fussy infants in order to soothe and calm them. A qualitative study published in 2001, for instance, found that solid foods were introduced to the child before the recommended age to prevent nightly crying and out of fear the infant might be too thin (Baughcum et al., 2001). In a similar vein, an observational prospective study among mother-infant dyads showed that mothers of infants diagnosed with colic introduced additional foods earlier than mothers of healthy infants did (Howard et al., 2006). Since colic (repeated persistent infant crying during the first months of life without known reason) may be difficult to distinguish from early manifestations of negative emotionality or difficult temperament, it may mistakenly lead the mothers to introduce dietary changes, such as earlier weaning. Consequently, it is possible that infants with a difficult temperament who fuss and cry often are weaned too early, which in turn may imply a risk for later overweight.

Alternatively, it has been hypothesized that breastfeeding may have a positive influence on the child, i.e., that it reduces the infant's tendency to cry and fosters positive affect, activity, and less irritability. For example, a small laboratory study observed more positive play interactions in babies that were still predominantly breastfed at 3 months (Jones et al., 2004). Moreover, another study showed that babies still breastfed at age 12 weeks were rated as temperamentally "easier" by their

mothers (Vandiver, 1997). In contrast, Worobey (1998) found no temperamental differences among breastfed and non-breastfed 3-month-old infants (Worobey, 1998) and another study failed to show a long-term effect of breastfeeding on child behavior (Kramer et al., 2008).

In summary, earlier findings have been inconsistent, sample sizes predominantly small, and designs have been short term, with temperament being only measured once. It has therefore been difficult to determine to what extent, and in which direction, temperament and breastfeeding are associated. Hence, two further aims of the present study were to examine whether: a) difficult temperament and breastfeeding are cross-sectionally associated at child age 6 and 18 months, and b) whether there is evidence for either direction of co-development, i.e., that breastfeeding influences temperament development or that temperament influences the continuation or cessation of breastfeeding. With regard to the first research question, I found that a more difficult temperament was associated with whether or not a child was fully breastfed for 6 months. However, with regard to the second research question, over and above this cross-sectional association, I did not find any indication of co-development between the two.

It is often easier to demonstrate a psychological influence on a behavioral outcome measure than on a somatic one (Taylor, 2008). For instance, there is a stronger association between personality and smoking than between personality and actual heart attack. Similarly, whereas there was no clinically significant association between child psychological factors and weight development, I found a small cross-sectional effect between difficult temperament and breastfeeding status at 6 months of age. However, the effect size was not very big, and I found no further co-development between temperament and breastfeeding after 6 months.

In the United States, where many of the referenced studies were conducted, breastfeeding frequency is still quite low. Less than 25% of American mothers follow the breastfeeding recommendations of medical authorities. Women are nearly ashamed to breastfeed publicly, and some even experience harassment for doing so (Forbes, Adams-Curtis, Hamm, & White, 2003). In contrast, in Norway breastfeeding frequency is rather high. Nearly every woman at least tries to breastfeed her newborn baby. In recent years the breastfeeding frequency has even increased. In 1999 (when recruitment for the present study started) breastfeeding frequency at 12 months was 36%, by 2007 it had increased to 46% (Øverby et al., 2009). Breastfeeding is facilitated by the long maternity leave and, after mothers return to work, an additional leave of up to two hours per day for breastfeeding. More than that, breastfeeding in Norway is highly socially desirable, to such a degree that some

mothers feel pressured to breastfeed and almost stigmatized if they feed formula (Vik, 2009).

As Norway represents a special population when it comes to breastfeeding, it is possible that culture acts as a moderator with regard to an influence of temperament on breastfeeding status. Strong expectations from health authorities and the social environment may play a bigger role in determining whether, and for how long to breastfeed, than the child's temperament does.

It is perhaps not surprising that I did not find evidence for further mutual influence of temperament and breastfeeding after controlling for the initial association at 6 months of age. Another large study also failed to demonstrate a long-term effect of breastfeeding on child behavior (Kramer et al., 2008). Unfortunately, temperament was not measured before 6 months of age. Thus, lacking information about the direction of the relationship between temperament and breastfeeding before that time, the issue of causal priority remains unsolved.

5.2 Methodological Considerations

Beyond the general discussion, there are some remaining methodological issues. In the following sections, I will try to discuss those within the frame of the validity typology proposed by Shadish, Cook, and Campbell (Shadish, Cook, & Campbell, 2002).

5.2.1 Statistical conclusion validity

Statistical conclusion validity is the validity of the existence and size of covariation between variables, i.e., the researcher has to examine whether the variables of interest are associated and, if they are, how strongly (Shadish et al., 2002). The attempt to answer these questions correctly is challenged by two possible sources of error: To reject the null hypothesis when in fact it is right (Type I error rate), and (2) to maintain the null hypothesis when it actually is wrong (Type II error rate). A common problem in studies is a lack of power, possibly leading to Type II error. However, in the present study the opposite is true, and there is a danger of too much power. As the null hypothesis is never exactly true and any sample is slightly different from the population value, rejection of H0 is virtually certain in such a large sample (Tabachnick & Fidell, 2007). Thus, associations must not only be statistically significant but also clinically significant. Consequently, these considerations led to the conclusion that difficult temperament does not predict rapid early weight gain (Paper I).

In Paper I, I tried to follow the medical tradition of using a common cut-off value to define overweight. However, the methodological literature shows clearly that dichotomization of quantitative measures often leads to substantial negative consequences (MacCallum, Zhang, Preacher, & Rucker, 2002). Statistical conclusion validity may be threatened by loss of effect size and power, as well as spurious statistical significance and overestimation of effect size. In the present study, however, analyses were also conducted with weight-for-length and weight-for-length gain as continuous variables. These analyses did not yield different results.

In Paper I, I also used listwise deletion of cases when values were missing. However, imputation of missing variables usually yields superior closeness to the estimates and thereby enhances statistical conclusion validity when compared to listwise deletion or use of sample mean. Part of this difference is due to listwise deletion and use of sample mean narrowing the sample variance. Missing modeling takes care of the true variance in the population to a greater extent (Newman, 2003). Having learned that, I imputed missing (dependent) variables in the next papers (Papers II & III), using the expectation-maximization algorithm (Muthén & Muthén, 2006). Nevertheless, this is not unproblematic either. As the participation rate in MoBa is rather low (40.3%), the estimated model may represent a population that is not identical with the population from which the sample is derived. As a result, a possible sample bias may decrease the generalizability not only across populations but also to the original one (K. A. Hagtvet, personal communication, June 03, 2008).

5.2.2 Internal validity

Internal validity refers to inferences about a causal relationship between variables. To support the inference three conditions must be met: (1) The cause has to precede the effect, (2) the cause is related to the effect, and (3) there is no other plausible cause for the observed effect (Shadish et al., 2002).

Given the contrasting assumptions of the health behavior vs. the stress hypothesis, in Papers II & III I employed cross-lagged panel analysis (CLPA), which aims to assess causal priority among a pair of variables (Taris, 2000). With help of this design I could establish temporal precedence (condition 1). Yet, condition 2 was not met, since after controlling for the cross-sectional associations at measurement point one, no further associations were found. Consequently, I could not demonstrate any causal relationship. However, it is important to note that this does not rule out a causal relationship altogether. CLPA assumes a congruence of measurement and causal lags. The interval between the observations must be approximately the same length as the true causal lag, i.e., the period that it takes for the cause to take effect.

The larger the discrepancy, the lower the chance that CLPA will reveal the underlying causal process (Taris, 2000). In the present study, the interval between the observations is possibly too small. As argued above, the children in the present study might still be too young, such that a causal process between child psychological factors and weight has not yet had enough time to unfold.

5.2.3 Construct validity

Construct validity is the validity of inferences about the higher order constructs that represent sampling particulars (Shadish et al., 2002). Therefore, construct validity concerns two related levels: (1) the explication of theoretical constructs, and (2) the operationalization of those theoretical constructs. In this discussion, particularly the latter seems relevant.

As in other large studies, MoBa uses several short form versions of scales. The usage of short forms is mainly due to their practical advantages, such as reduced burden for the respondent and the possibility of administering an increased number of scales. Specifically, in the present study, short versions of ICQ, EAS, and CBCL scales were used. In order to maintain construct validity, different approaches were applied. Factor analysis served to select items from the ICQ (Japel et al., 2000). In contrast, the short form of the "emotionality" subscale of the EAS was derived by means of multiple linear regression analysis (Mathiesen & Tambs, 1999). With regard to CBCL, item selection was based simply on consensus among specialists in clinical and developmental psychology. The factor analytic approach seeks to find the best indicators for measuring a uni-dimensional construct. in the previous Paper II. In that paper, at child age 6 months, difficult temperament was measured by 7 items of the ICQ, whereas at child age 18 months, difficult temperament was measured by 3 items of the "emotionality" scale from the EAS. It is possible that, to a certain degree, two different constructs were measured. It is also conceivable that the construct measured at 18 months was somewhat narrower. Still, the two latent factors were clearly related over time. However, there is a danger of ending up with a narrower construct. The regression approach, on the other hand, seeks to represent a scale in the best way. This approach gives more consideration to the width of a construct. At the same time, it risks enhancing minor sub-dimensions within a scale. The last approach relies on face validity, i.e., on how a measure or procedure appears (Fink, 1995). This is clearly the least favorable approach of the three.

A related problem concerns measurement invariance over time. In Paper III, I tested whether the CBCL factor structure was satisfactorily equivalent at child age 18 and 36 months. This could be confirmed. Unfortunately, I did not do the same thing

Another potential threat against construct validity in the present study is a mono-method bias. When all operationalizations use the same method, there is a danger that the method is part of the construct actually studied (Shadish et al., 2002). Therefore, as all the information about child temperament and behavior problems relied on maternal ratings, it is possible that the mother's evaluation of the child in part reflects her own characteristics. For instance, it has been argued that the mother's perception of the child as difficult reflects her own negative emotionality or negative attitude towards the child, rather than a purely within-child characteristic (Bates, 1983; Pulkki-Raback et al., 2005). At the same time, however, mothers may be considered the best informants on their children's behavior, as they often know them best and have the opportunity to observe them in a wide variety of settings (Prior, 1992). This issue touches also upon external validity, or in other words, on how far one can generalize the results across methods (e.g., paternal or external observatory ratings).

5.2.4 External validity

External validity deals with inferences about whether a relationship between variables holds over variations in people, settings, treatments, and measurement variables (Shadish et al., 2002). As mentioned above, external validity concerns generalizing across methods. More than that, external validity also concerns generalization to the target population and generalization across populations.

With regard to the former, MoBa represents a population-based cohort study, where nearly all members of the population were invited to participate. Whereas this enhances the generalization greatly, external validity is again threatened by the relatively low participation rate of 40.3%. Magnus (2006) indicates that there is a possible selection bias related to low recruitment or loss to follow-up, with women of higher socioeconomic status being overrepresented in the study. However, in a comparable study from Denmark, the Danish National Birth Cohort, participation rate was even lower (30%); still, odds ratios on selected associations were not biased (Nohr, Frydenberg, Henriksen, & Olsen, 2006).

With regard to the latter, I argued previously that the Norwegian population might differ from other populations in some aspects. For instance, in Norway birth weight has decreased and infant nutrition has improved considerably in recent years (Skjærven, 2009; Øverby et al., 2009). Moreover, breastfeeding frequency is noticeably high in Norway (Øverby et al., 2009), and as such, one has to be cautious when generalizing the present results to other populations.

6. IMPLICATIONS AND FUTURE DIRECTIONS

The aim of this doctoral dissertation was to contribute to the understanding of weight development and feeding in early childhood by examining the role of child temperament and behavior problems. I found little evidence for child psychological factors playing a major role in weight development and feeding below the age of three years. Still, whether or not a child was fully breastfed for 6 months was associated with a more difficult temperament. Moreover, the Internalizing subscale "somatic complaints" was negatively correlated with the BMI at child age 18 months. With regard to the latter association, however, validity questions have been raised. Over and above these cross-sectional associations, no indication of any co-development was found.

To my knowledge, this is the first large scale population study with a multiwave longitudinal design that examines this issue at such an early age using advanced statistical methods. For overweight to manifest, there must be an energy imbalance over a long period of time. It appears that the children in the present study are still too young, such that a causal process between child psychological factors and weight has not yet had enough time to unfold. I therefore propose that future studies focus on the age span between 3 and 6 years, for which clear evidence is also lacking. This age span includes the period of adiposity rebound (when the BMI normally increases after having declined to a minimum), which is a critical period for the development of obesity (Williams & Goulding, 2009). Following up the children of this sample may shed more light on the causal priority between child psychological factors on the one hand and feeding and overweight on the other hand. In other words, it may yield more evidence for either the health behavior or the stress hypothesis. Further, as children grow, they acquire more control over what they eat (Negayama, 1993), and thus I suggest including other nutrition in future studies as well. More than that, introducing a family perspective might be useful. Earlier studies showed that, for example, the number of children in a family, parental feeding practices, and maternal affectivity are closely linked to a child's diet (Hampson, Tonstad, Irgens, Meltzer, & Vollrath, in press; Ystrom, 2009). As diet is important in weight development, these variables ought to be included in future studies on the relationship between child psychological factors and overweight.

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