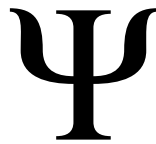




**DET PSYKOLOGISKE FAKULTET**



***A review of cortisol production and child care attendance:  
The promotion of positive child development***

HOVEDOPPGAVE

*profesjonsstudiet i psykologi*

**Susann Mikkelsen**

Høst 2009

## Abstract

Extensive evidence exist, demonstrating an association between cortisol and child care attendance. Cortisol is regarded as a valid and reliable measure of stress. This review aim to summarize findings regarding child care and cortisol. The results reveal a trend of atypical levels of cortisol seen in children attending non-parental group-based child care, in particular encompassing children below age three. Long-term effects are evident in some children, resulting in a down regulation of the HPA-axis. Enduring elevations in cortisol production are associated with increased susceptibility for mental illness and compromised child development. Prolonged cortisol increases demonstrate to be facilitated by an interplay of factors concerning child characteristics, the organization of the child care facility and caregiver-child relationship. The need for cultural specific knowledge about child care and its influence on children is explained, along with suggestions for the organization of parental and non-parental care to promote individualized child development.

Studier viser at stresshormonet kortisol henger sammen med bruk av barnehage. Denne review har som mål å oppsummere kortisolfunn på barnehagebarn. Resultatene viser økt forekomst av atypiske kortisolverdier hos barn i barnehager, spesielt barn under tre år. Langtidseffekter hos et utvalg av disse barna viser en nedregulert HPA-akse. Vedvarende atypiske kortisolverdier er assosiert med forhøyet risiko for utvikling av psykiske lidelser og negativ utvikling hos barnet. Økt kortisol produksjon over lengre tid påvirkes av ulike faktorer ved barnet, barnehageomgivelsene og forholdet mellom omsorgsgiver og barn. Behovet for kulturspesifikk kunnskap om barnehager og hvordan disse påvirker barna utbroderes, i tillegg til forslag til organisering av foreldreomsorg og av barnehagen på måter som fremmer positiv utvikling hos det enkelte barn.

## A Review of Cortisol Production and Child Care Attendance: The Promotion of Positive Child Development

During the last three decades an increasing number of young children and infants in the developed countries have entered various non-parental group-based child care arrangements at an earlier age and on a more extensive basis than ever seen (UNICEF, 2008). Accordingly, concerns are being raised regarding the timing and extensiveness of child care, related to possible influences upon child development. In response to the modern work requirements and parents need for non-parental care, the Nordic governments in particular have initiated a substantial outbuilding of governmental-regulated public and private child care systems, to include the majority of the child population (Datta Gupta, Smith & Verner, 2008). The Norwegian government have granted every child from age one with a legal right to attend child care (Ot.prop.52. 2007-2008). This has resulted in a major increase in children below age three experiencing non-parental child care. Recent figures show extensive child care attendance in 65% of the one year olds and 87,2% of the Norwegian child population between age 1 and 5, usually for 41 hours per week or more (SSB, 2008).

The Norwegian child care system is internationally upheld as an example for other nations to follow, due to its high quality service compared to other developed countries (St.meld. Nr 41, 2008-2009). Political discourse and governmental reports and documents have effort fully underlined the quality features characterizing the Norwegian child care system. In convincing parents about the positive outcomes associated with non-parental child care, referrals include literature indicating that child care in the Scandinavian countries in particular, promote language acquisition and cognitive development (St.meld. Nr 41, 2008-2009, St.meld. Nr 27, 1999-2000). Additionally inferences are made from the very same results, that group-based child

care offers (even) higher quality and will lead to a healthier child development than most parental care arrangements do (St.meld. Nr 41, 2008-2009). Research are insupportable of these proclaims, underscoring the pervasiveness of parents influence on child development (Fosse, 2009; Roisman et al.; 2009, Belsky, 2001), and showing tendencies towards a decline in child care quality as i.e measured by staff educational level which is declining (UNICEF, 2008) . The latter development is not surprising and can be explained by the fast forwarded inclusion of the youngest children in full time group-based child care arrangements, without concurrent emphasis upon factors known to affect quality (caregiver/child ratio, caregiver level of education, play area per child, group size, caregiver sensitivity). The inclusion of younger children in formal child care, appear to have been forged nearly without considering international research regarding non-cognitive outcomes of non-parental group-based child care upon the youngest children. Additionally, research performed in non-Scandinavian countries is often dismissed as inapplicable due to perceived differences in the conceptualization and practice of quality (St.meld.41. 2008-2009).

The psychological influence of child care has been a long debated and researched issue internationally, but is yet to receive similar attention in the Nordic countries (St.meld. Nr 41, 2008-2009). A recent contribution from Denmark, demonstrating that attending Danish non-parental child care arrangements and parental care is neutral in facilitating non-cognitive development, is a positive exception. Additionally, more than thirty hours a week in non-parental child care, was associated with deteriorations in child outcomes (Gupta & Simonsen, 2008). These findings are unique and equally important, as it is one of the few linking modern child care attendance in high quality Nordic child care settings, to negative child development. Accordingly, there have been a broader focus internationally, investigating positive and negative effects of non-

parental group-based child care, focusing mainly on attachment, language and cognitive issues, whereas the two latter domains have repeatedly demonstrated to be positively associated with non-parental child care (Vandell, 2004; Broberg, Wessel, Lamb & Hwang, 1997).

Recently, physiological measures have been incorporated more extensively into the body of child care research (see Vermeer & van IJzendoorn, 2006 for a review). Physiological measures are of particular importance due to the extraction of more non biased information about internal states, which can be difficult to deduce from behavior (Kirschbaum & Hellhammer, 1994). An example is provided by children classified as avoidant insecurely attached, who often show great discrepancies between displayed behavior and physiological reactions (Ahnert, Gunnar, Lamb & Barthel, 2004; Quas, Hong, Alkon & Boyce, 2000). The importance of using multiple indicators when studying child development needs to be emphasized, due to the fact that children will vary in both their experiences of different physiological states and behavior (Ursin & Eriksen, 2004), indicating that single measures can be poor indicators of physiological reactivity, psychological functioning and behavior. Cortisol is found to be affected by physiological states such as hunger and motor activation, and there have been reported concerns regarding sampling methods, influencing the percent recovery of the sample volume (Harmon, Hibel, Romyantseva & Granger, 2007).

The glucocorticoid cortisol, have been the physiological measure most extensively studied in children attending non-parental child care. It is commonly obtained non-invasively from the children's saliva, using cotton dental rolls whom the children are asked to place in their mouths long enough for sufficient saliva to be absorbed. Cortisol is produced in the human brain in a typical circadian pattern, which is characterized by its highest elevation 30 minutes after wake up, followed by a steep decline throughout

the early day and smaller but steady declines in the afternoon until nadir (the lowest level) is reached around midnight (Kirschbaum & Hellhammer, 1994). The diurnal pattern is established around three months of age in the human infant, although researchers somewhat disagree about the stability of the diurnal rhythm in the youngest children (Gunnar & Donzella, 2002). Cortisol is the end product of the physiological stress response regulated by the hypothalamic-pituitary- adrenocortical (HPA) axis. The production of cortisol is triggered when the individual encounters obstacles in the environment which are perceived to be exceeding available coping resources, rendering adaptation less likely (Ursin & Zahl-Begnum, 1993). This underscores a dependency between emotions, cognitive appraisal and physiological reactions, entailing differentiability in stress thresholds and coping mechanisms (Ursin & Eriksen, 2004; Ursin & Zahl-Begnum).

Cortisol increases are necessary on an immediate basis to ensure survival, memory and learning (Zola-Morgan & Squire 1990, in Bremner, 1999), and the organism is capable of sustaining notable increases in glucocorticoids such as during life threatening situations (Charney, 2004). Prolonged elevations of cortisol have demonstrated to be counterproductive, potentially damaging circuits and cerebral structures, and have been correlated with impaired psychological performance from childhood through to adult life (Goodyear, Park, Netherton & Herbert, 2001). Cortisol is known in particular to adversely affect the hippocampus and the amygdala in children (Carrion, Weems & Rice, 2007). The hippocampus and the amygdala are involved in memory, learning and emotion processes and of particular vulnerability due to extensive brain development during childhood (Carrion et al.). It has also been suggested that repeated elevations in glucocorticoids may play a role in the etiology of anxiety disorders, forecasting possible long term consequences on psychological health of experiencing extensive non-parental

child care during the first years of life (Risborough & Murray, 2006; Schulkin, Gold, & McEwen, 1994). The study of Roisman et al. (2009) support the concern for long term implications of prolonged elevations in cortisol early in life and a possible down regulation of the HPA-axis. Evidence demonstrates that insensitive caregiving and the experience of extensive non-parental child care before age three, is separately and additively, creating physiological circumstances in the adolescent, mimicking those found in adults with experience of pervasive abuse or neglect during childhood (Roisman et al.). Studies with maltreated children and adults point to increased risk for mental illness and negative development (Teichner, Samson, Polcari & McGreenery, 2006 in Cow, 2008; Tarullo & Gunnar, 2006). The implications of such similarities for further physiological and psychological functioning are not clear, due to lack of longitudinal data on the relationship between caregiver sensitivity, child care experience and long term physiological reactions encompassing adolescence.

Recent research has yielded evidence that children are experiencing a stress hypo-responsive period during infancy and childhood, involving a dampening of cortisol production related to stress inducing events, despite stress related behavior such as crying, anger, despair, anxiety and fear (Gunnar & Cheatham, 2003; Gunnar & Donzella, 2002; Gunnar, Broderson, Krueger, & Rigatuso, 1996). Even when experiencing an unfamiliar environment without mother present, or after a physical examination and inoculation, circumstances which normally trigger glucocorticoid production, cortisol increase remain blunted (Goodyear, Park, Netherton & Herbert, 2001). It appears that experiences during infancy and childhood need to be pervasively negative in order to significantly affect production of glucocorticoids, and most researchers are of the opinion that attending non-parental group-based child care does not constitute of such pervasiveness.

This review is an attempt at getting a better understanding concerning the physiological findings from children attending non-parental group-based child care, with particular emphasis on the physiological effects upon infants and children below age three and possible relations to child development. Seventeen studies concerning the relationship between cortisol and non-parental group-based child care in children between 0-6 years of age are examined. No studies includes relative/family care and cortisol measures, and one study examines home based child care and production of cortisol. Three studies are review articles and will be elaborated more extensively. The remaining 13 studies have been performed with children attending center based child care, mainly in the USA, although studies from other countries are present as well.

#### Method

Studies examining the relationship between children in non-parental child care and cortisol production were identified by searching electronic databases (PubMed, and PsychInfo) in May/June 2009. Non-parental care was defined as the child being cared for by other than its parents for several hours on a regular basis, thereby excluding studies concerning short time experimental separation from parents. The following single and combined search terms were used: day care, child care, non maternal care, non parental care, family child care, relative care, cortisol, stress, HPA axis. The search retrieved articles from 1983 to 2009. No studies including cortisol measures and relative care were identified. One study was retrieved concerning home-based child care and cortisol measures. The remaining studies included in this review consist mainly of research with center based child care, particularly from the USA . All the identified studies including non-parental child care and measures of salivary cortisol were used, with publication year from 1997 to 2009. Two studies (Lundberg, 1983 &1993) using



urinary samples of cortisol were omitted due to reported measurement differences concerning cortisol in saliva and urine (Yehuda et al. 2003) 2003). Studies focusing primarily on school aged children (child care, pre- school, formal school) were excluded as this review is limited to investigating studies concerning children below school age, and children below age three where possible<sup>1</sup>. Additionally, all references from the selected papers were researched looking for supplementary studies not identified on line, and complementary searches were performed in Grey literature with on line search engines (Google and Google Scholar). Important characteristics of the selected studies are shown in Table 1.

## Results

### *Diurnal patterns of cortisol production*

The earliest studies on physiological measures and non-parental group-based child care, surprisingly demonstrated that cortisol production during child care seemed to deviate significantly from the expected diurnal pattern (Tout, de Haan, Campell & Gunnar, 1998; Dettling, Gunnar & Donzella, 1999). The findings from this review confirm this.

During non-parental care, mid-morning cortisol levels have been measured to be similar, lower or mainly higher than home levels. Mid-afternoon levels tend to be significantly higher during non-parental care than home levels on non-child care days (Geoffroy, Cote, Parent & Seguin, 2006; Vermeer & Ijzendoorn, 2006; Roisman et al, 2009). The review of Geoffroy et al. demonstrate a modest mean effect size for increased cortisol in children attending non-parental care (.72), although not homogeneous ( $d=0.09$  to  $1.91$ ), and the authors call for other factors such as quality, age and temperament in order to explain the substantial variability. In the review of Vermeer

---

<sup>1</sup> In most countries this refers to children under 5 years of age (Wikipedia, 2009)

& van IJzendoorn (2006) nine studies were identified investigating the relationship between cortisol production and center based child care in Europe and the USA.

Vermeer & van IJzendoorn conclude that children who experience center-based care are characterized by higher levels of cortisol when attending child care, although displaying the expected diurnal decline at home. Watamura Donzella, Alwing & Gunnar (2003) state that there seems to be no short term carry over effects of increased cortisol production during non-parental care as they compared children receiving exclusively parental care with children attending center based child care. The study by Lisonbee, Mize, Payne & Granger (2008) document within-child variability and found that only 29% of the children showed elevated levels of cortisol during child care day on both times of measurement (spring and winter). They also report that morning levels of cortisol reached moderate intraindividual consistency, whereas afternoon levels did not.

Research documents that cortisol levels in children attending child care more often than not fail to decrease as expected (Geoffroy et al, 2006; Vermeer & van IJzendoorn, 2006; Li & Shen, 2008 ). For many children the total cortisol levels are significantly elevated compared to expected levels or compared to actual home levels, often displaying an opposite pattern of the diurnal decline, with increased secretion during the day.

#### *Temporal aspects of cortisol secretion*

Two recently published studies have investigated the temporal aspect of elevated levels of cortisol provided by children attending non-parental group-based child care. Watamura, Kryzer & Robertson (2009) studied several child care centers ranged very high in quality. The elevated levels of cortisol obtained serve according to the authors as healthy adaptations to the challenges the children experience during non-parental group-

based care, as the levels return to normal during afternoons following group based care and during non child care days. Watamura et al. conclude that the underlying rhythm of cortisol secretion is not disturbed. Contrasting this, the only study to date that has examined the long term effects of child care (center based care in particular) and the response of the HPA-axis, concludes that more hours spent in non-parental care before age three is associated with a down regulation of the HPA-axis as seen in adolescence, characterized by lower levels of cortisol after wake-up (Roisman et al., 2009).

According to Roisman et al. the hypo activation involves a chronic reduced activation of cortisol in response to stress-inducing events, with probable negative effects on health. Additional studies have reported lower awakening levels in children attending child care, although with substantially less power (Dettling, Gunnar & Donzella, 1999; Dettling, Parker, Lane, Sebanc & Gunnar, 2000; Watamura, Sebanc & Gunnar, 2001; Lisonbee, Mize, Payne & Granger, 2008).

This contradicts the common assumption that children's reactions to the daily stresses and strains experienced during child care are healthy adaptations, and that non-parental care have only transient effects on child development.

### *Individual characteristics and cortisol production*

#### *Age*

Much worry has been expressed concerning the youngest children attending child care, but there has been little research to date to tell us more about how extensive non-parental care physiologically affects infants and toddlers under three years of age.

The research summarized in a review by Vermeer & van IJzendoorn (2006), concludes that the physiological effect of attending non parental care is most prominent for children younger than 36 months, who showed the highest production of cortisol during

time spent in non parental care. This parallels the study of Roisman et al. (2009) as it appears to be the youngest children that longitudinally are experiencing the physiologically most adverse effects of full time group-based non-parental care. The review of Geoffroy et al. (2006) presents a curvilinear pattern in cortisol production on days with non-parental care, where toddlers and preschoolers age 2-4 seems to be more susceptible for elevated cortisol production than younger or older children (Lisonbee et al, 2008; Bradley et al.; 2007 (review), Watamura et al, 2003 & 2001; Dettling, et al. 1999; Tout et al., 1998). Dettling et al. (1999) conclude that cortisol elevations in the younger children seem to be related to age, and not to center context as they compared two child care centers of different quality. Legendre (2003) report from studying French and Hungarian children that children show less increase in cortisol when attending groups with children about their own age, especially within 6 months of their own age. Geoffroy et al. (2006) indicate that infants seems to be physiologically unaffected by attending non-parental care. The study of adaptation to non-parental care by Ahnert et al. (2004) reported no relation between age and levels of cortisol.

### *Temperament*

Several studies have investigated the role of temperament in relation to cortisol production during non-parental care, but the findings are inconclusive (Vermeer & van IJzendoorn, 2006). The review of Geoffroy et al. (2006) reveals a small association between difficult temperament and elevated cortisol production for children attending non-parental care. More specifically effect sizes increases for individual characteristics involving aggressiveness, social fearfulness and emotional negativity supported by Ward, Alkon, Anders & Lee (2009) reporting that children classified with a difficult temperament show higher increases in cortisol production during non-parental child

care, than children characterized with other temperamental dispositions. Vermeer & van IJzendoorn (2006) report that impulsiveness, poor self-control, social fearfulness and aggression were associated with higher levels of cortisol in children attending non-parental care. In line with this Bradley et al. (2006) reports higher levels of cortisol in children with difficulties regulating negative emotions and behavior, high scores on social fearfulness, less involved in peer play and less socially competent. Dettling, Parker, Lane, Sebanc & Gunnar (2000) found that children in home-based child care arrangements that were characterized negative/under controlled temperament more often were experiencing increasing cortisol levels. In line with this, Watamura, Sebanc & Gunnar (2001) report that children with a more emotional negative temperament were more prone to experience less decrease in cortisol when they were resting compared to other resting children. Gunnar et al. (2003) report that children characterized as poorly controlled and aggressive were at risk for elevated levels of cortisol. Li & Shen (2008) report that fluctuations in cortisol from mid-morning to mid-afternoon is related to individual differences in internalizing dispositions. The study of Tout et al. (1998) also emphasize that at least for boys internalizing behavior are associated with increase in cortisol.

Ahnert, Gunnar, Lamb & Barthel (2004) found no relation between temperament, cortisol production and child's experience of adapting to non-parental care. The longitudinal study from Roisman et al. (2009) did not find any association between temperament and awakening level of cortisol in adolescence for children with non-parental care experiences, although it should be noted that temperament was only measured once at age 6 months, whereas other studies have measured temperament mainly in older children.

*Attachment and the transition to non-parental group-based care*

Ahnert et al. (2004) measured cortisol levels at home one week before the adaptation to a child care facility started, and then again several times during the adaptation with and without mother present. Cortisol levels remained steady, although somewhat enlarged during the adaptation phase when mothers remained present, but rose and exceeded baseline levels obtained at home with 75-100% during the first hour after drop off, when children were introduced to non-parental care without their mother present (after the adaptation phase). This trend lasted several days, and for many children the cortisol production was also significantly higher than home levels when measured 5 months after enrollment in a non-parental care setting, even though the children seemed to have adapted behaviorally (less crying, negative mood and negative behavior).

Ahnert et al. (2004) demonstrate that during adaptation to non-parental care, secure toddlers showed substantial lower rise in levels of cortisol than insecurely attached toddlers. Higher correspondence between observed behavior and levels of cortisol in securely attached children was reliably seen, whereas they showed more behavioral distress as cortisol levels increased. Insecurely attached children did not show behavior that paralleled cortisol production. Most of the infants and toddlers classified as insecure were categorized as avoidant and were according to the authors more prone to appear unaffected because of behavioral inhibition. The (somewhat surprising) conclusion of this study is that in mothers absence securely attached toddlers do not seem to regulate stress more effectively than insecurely attached toddlers. Roisman et al. (2009) report in their longitudinal study from birth to age 15 that children with mothers characterized as being insensitive showed lower levels of awakening cortisol than children with more sensitive mothers.

### *Sleep*

Watamura, Sebanc & Gunnar (2001) found that cortisol secretion was lower for children after napping, although the levels continued to rise during the afternoon as children were still attending non-parental care, and they concluded that napping delays the overall rising pattern when children attend child care and that the atypical rise in cortisol production is not explained by napping duration or quality. Older children seemed to benefit more from resting as they showed larger decreases in cortisol during the rest period than did younger children. Lisonbee et al. (2008) report that cortisol samples taken closer to the end of napping were lower (although still higher than mid-morning) than samples taken later in the afternoon. Rest quality was not found to be related to cortisol levels, although nap duration was. Ward et al. (2008) show that children and especially boys who were characterized as problem nappers had higher levels of cortisol than non problem nappers during non-parental care.

Lisonbee et al. (2008) report no association between rest quality and fluctuations in cortisol.

### *Gender differences*

Results pointing to effects of gender are sparse and inconclusive. Most studies report no associations between gender and cortisol production. According to Geoffroy et al. (2006) boys rated high on anxiety, impulsiveness and internalizing behavior were more prone to experience higher cortisol levels during non-parental care, as were girls scoring low on effortful control (inhibitory control). The study by Ward et al. (2008) show that boys have more trouble getting quality sleep during non-parental care, and these boys also show less decrease in cortisol production during child care days. Tout et al. (1998) found a negative correlation between median cortisol and age for boys attending a high

quality center care facility, and an association between behavior and cortisol where boys who played more solitary during child care showed lower cortisol levels than boys engaged in more group play.

### *Quality*

In the review of Vermeer & van IJzendoorn (2006) four in five studies have included children from high-quality centers only, and three of the studies were performed in the same child care center in the USA, which reached ceiling scores on nearly all quality scales. Vermeer & van IJzendoorn conclude that even in child care facilities characterized by high and very high quality, children showed the atypical pattern of increased levels of cortisol throughout the child care day. This conclusion is supported by the study of Watamura et al. (2009). Child care quality are often measured with the Early Childhood Environment Rating Scale (ECERS) and the Caregiver Interaction Scale (CIS). ECERS is a standardized quality rating instrument which includes seven-point scales measuring language, reasoning, and social and physical environment in the child care facility. CIS measures caregiver insensitivity, rated on four-point scales (Lisonbee et al, 2008). Geoffroy et al. (2006) report a negative relation between child care quality and change in cortisol, where children attending lower quality settings are experiencing the highest levels of cortisol during child care, and higher quality settings seems to slow down the increase or even reverse it to the expected diurnal decline. In line with Vermeer & van IJzendoorn, they emphasize that studies have only been performed in high quality settings, thereby excluding the possibility of comparing with children in low quality child care. Dettling et al. (2000) have performed the only study including children in home-based child care. They report that cortisol production throughout the child care day is associated with quality of focused attention/stimulation



provided by the caregiver. That is when children were receiving higher quality of focused attention, cortisol levels were more similar to the normal diurnal pattern with declining levels. Children experiencing lower quality home-based care were slightly more prone to show lower mid-morning levels of cortisol, but no difference in the mid-afternoon levels, whereas children attending center based care exhibited higher mid-morning levels compared both to children in home-based child care and children with no experience of non-parental care.

*Process quality – the relationship with caregivers and peers*

The most extensive study performed concerning properties in the environment and its relation to fluctuations in cortisol was performed by Sims, Guilfoyle & Parry (2006) in child care centers across Australia. The study is innovative in the way that it compares quality of different centers rating the centers on different parameters as stated by the Australian government (Quality Improvement and Accreditation System – QIAS) through observations on how the centers fulfilled the various principles of quality. The observations revealed that child care centers rated as unsatisfactory, satisfactory and of high-quality. This study is unique (to my very best knowledge) in that it has purposely included child care centers of both very low and high quality, and explicitly studying various aspects of process quality variables. Earlier research focused mainly on comparing centers of high and excellent quality, and most conclusions have been drawn on the basis of this material. Sims et al. report that children attending child care centers characterized as unsatisfactory showed no decline in cortisol production especially in centers scoring low on parameters concerning relationships with caregivers (such as respect for child, respecting individual needs, equal treatment), where as children in high quality centers showed the expected decline throughout the day. This has been

reported in other studies as well (Dettling et al., 1999, Dettling, 2000). Sims et al. conclude that satisfactory care according to QIAS is not good enough, as children in these centers also showed less decline than children in low quality centers. The researchers conclude that relationship between caregiver and child are the single most potent factor affecting quality. Watamura et al. (2009) assessed caregivers to be more sensitive towards girls than to boys, and that higher secretion of cortisol in the morning was related to greater caregiver sensitivity in the afternoon. Classroom climate was associated with cortisol production, although not for the specific child. The measures were obtained in a very high quality child care center. Lisonbee et al. (2008) report that children who are characterized by caregivers in child care center as being clingy/overdependent are experiencing increased cortisol levels during child care. Children with relationship conflicts with caregivers showed elevated levels of cortisol, but only during the arranged caregiver-child interaction session. Children whose relationship with caregivers were rated more closely were marginally associated with cortisol decrease. Caregivers more often rated their relationship with younger children as being less close and more conflicted than with older children.

Gunnar, Sebanc, Tout, Donzella & Dulmen (2003) report that peer rejection was associated with higher levels of cortisol and aggression among children in peer-group settings. This was evident both for boys and girls. They also noted that less aggression is tolerated from girls before they are classified as rejected by peers. Watamura et al. (2003) found that toddlers less involved in peer play showed larger increases in cortisol during child care day.

*Structural quality – the physical organization of the child care facility*

Legendre (2003) performed a study targeting variables in the environment that were

associated with cortisol secretion among children attending non-parental care in France and Hungary. He found that increases in cortisol were related to group size, age difference among children in each group, play area per child and numbers of caregiver in each group. Surprisingly it seemed that more than four caregivers would yield higher cortisol levels in the children, as would groups with more than 15 children with age range above 6 months. Area per child in playrooms less than 5m were also related to rise in cortisol (Legendre, 2003). Lisonbee et al. (2008) reported larger cortisol increases across the day, lower morning cortisol levels as well as higher afternoon levels in children attending larger groups. Larger groups more often had caregivers/teachers that were rated more insensitive to children's needs. Also during the challenge task included in the study, and the interaction session with caregiver, children from larger groups showed greater increases in cortisol both during the sessions and afterwards. Dettling et al. (2000) did not find any association between group size and levels of cortisol in their study of children attending home-based child care or center based child care.

### Discussion

A robust finding of child care specific fluctuations in cortisol production is emerging from this review. It seems fair to conclude that for children aged 0-6, attending non-parental group-based child care is a major risk factor in producing atypical levels of cortisol during childhood, encompassing in particular 1-3 year olds. For some children there seems to be a more enduring alteration of the HPA-axis continuing into adolescence (Roisman et al., 2009). Although the children's levels of cortisol are significantly higher during non-parental group-based child care than at home with family, levels are not exceeding average levels of cortisol in young children

dramatically (see Figure 1 for reference values).

Researchers have to some degree explained the atypical fluctuations in cortisol for this particular age range (1-3 years) by referring to toddlers experiences of more interindividual conflict than older children who are more skillful in play, and infants, who do not engage extensively in peer play (Watamura et al. 2003; Legendre, 2003; Watamura et al. 2001; Dettling et al. 1999; Tout et al. 1998). This explanation warrants further analysis, as the results from this review and other studies emphasize multiple factors both within the child, in the environment and between child and caregivers, in order to more fully explain the physiological effects of non-parental group-based child care.

#### *A hypo responsive stress reaction and the role of age and attachment*

According to some researchers, children are hyporesponsive to stress reactions during childhood, rendering them less likely to produce elevated levels of cortisol in reaction to stressful events (Gunnar & Quevedo, 2007, Gunnar & Cheatham, 2003, Gunnar & Donzella, 2002, Gunnar, Broderson, Krueger, & Rigatuso, 1996). The establishment of a hyporesponsive period in glucocorticoid susceptibility is helpful to explain why infants experiencing non-parental care do not show physiological reactivity with atypical cortisol fluctuations during the day, whereas toddlers and in some degree older children do. The child care experience may not be aversive enough for infants to affect cortisol production during their first year of life, as the hyporesponsive period is confined to the first 18 months of age, although hypothesized to last throughout childhood (Gunnar & Donzella, 2002). It may also be true that infants being placed in non-parental group-based child care, elicit more care behavior from caregivers, such as holding, cuddling and comforting, because they are regarded as more helpless than

toddlers, thereby increasing the opportunities for sensitive and caring interaction, which is associated with cortisol decrease (Roisman et al., 2009, Dettling et al. 1999). Toddlers may appear more independent (and often claim to be) than infants, thereby elicit less sensitive caregiving responses. Studies have confirmed the latter, whereas caregivers report having a closer and less conflicting relationship with older children than with toddlers (Lisonbee et al. 2008). Older children (3-6 years) in contrast to toddlers, are often oriented towards peers (von Tetzchner, 2002). They have probably reached a level of independence and proficiency in relational skills, which make them more apt to handle the stress and strains of non-parental group-based care without extensive caregiver support. This is confirmed by findings demonstrating that social competence is associated with less increase in cortisol during non-parental child care (Dettling et al. 1999).

Still, various older children (3-6 years) continue to show atypical levels of cortisol during child care, which plausibly reflect individual variations in physiological reactions and in psychological mechanisms. Such variations are demonstrated to be partly produced by the parent-infant attachment relationship (Weinfield, Sroufe, Egeland & Carlson, 2008). Studies indicate that children with insecure attachments do not exhibit the typical glucocorticoid hyporesponsiveness towards stressors in general (Gunnar et al. 1996), and to non-parental group-based child care in particular (Ahnert et al. 2004). These findings are in line with some researchers suggestion that protection of the developing brain from the potential damaging effects of glucocorticoids during infancy and childhood is one possible function of attachment (Gunnar et al. 1996; Goodyear, Park, Netherton & Herbert, 2001).

It is mentionable that some studies included in this review, demonstrate that the cortisol elevations in the youngest children are uniquely associated with age and are not

explained by quality, child or caregiver characteristics (Dettling et al., 1999). This underscores the possibility that for children below a certain age or point of maturity, non-parental group-based child care constitute an independent risk factor in producing elevated levels of cortisol unrelated to contextual indicators such as different aspects of quality (i.e caregiver sensitivity). It seems plausible that a child is required to reach a certain maturational level to effectively cope with the demands of being in group based child care. The results from this review supports such an age threshold. It is demonstrated repeatedly that children above three years of age appear physiologically more apt to tolerate non-parental group-based child care attendance, than younger/less mature children and children with insecure attachment relationship and/or certain temperamental dispositions, as older children consistently show lower increases in cortisol than children below three years of age.

As the findings concerning infants appear inconclusive, it should be mentioned that cortisol is not purposeful as the sole measure concerning stress reactions. Research using other stress parameters may reveal different findings, as would non-physiological measures as well. Cortisol is additionally found to vary extensively during the first year of life despite the presence of a diurnal rhythm, rendering it less reliable as a stress measure for this particular age group. (Silva, Mallozi & Ferrari, 2007). Accordingly it seems prematurely to conclude that infants are not physiologically (and therefore not psychologically) compromised by attending non-parental group-based child care, but more research is needed in order to clarify the picture more thoroughly.

### *Temperament*

The results from this review supports the hypothesis that some children regardless of age, are more susceptible to exhibit the most adverse physiological effects of child care.

There seems to be an emerging trend, that children with certain temperamental dispositions characterized by social fearfulness/shyness, emotional affectivity, aggression and lack of effortful control, are in greater risk of displaying atypical levels of cortisol when attending non-parental group-based child care, than children with other temperamental dispositions. Research on temperamental differences have concluded that children characterized with a hard to handle temperament often display undesirable ways of relating to other children and adults (Dettling et al.1999; Dettling et al. 2000; Gunnar, Tout, de Haan, Pierce, & Stansbury, 1997). The relational strategies of these children may lead them to experience more physiological stress, than children with easier temperamental dispositions and more favorable ways of approaching others. Temperamentally compromised children may react to the demands of child care by turning inwards, engage in less peer play and thereby fail to experience mastery in relating to others, or react with disruptive behavior, often causing children and adults to behave less sensitive towards them (De Schipper, Tavecchio & van IJzendoorn, 2008; Gunnar, Sebanc, Tout, Donzella & Dulmen; 2003, Watamura et al, 2003). Either strategy may facilitate increased levels of cortisol, and research support this notion (Gunnar & Donzella, 2002).

Several researchers conclude that the the neuroendocrine consequences of inhibited, fearful temperament in particular, depend upon the security of the child's relationship with the parent in order to help assist the child in coping with threatening events (Cow, 2008; Ahnert et al. 2004) . This is in line with the earlier reported buffering role of the caregiver, and it is plausible that when parents are not present, children with difficult temperamental dispositions are in particular need of an responsive and available substitute caregiver to efficiently cope with the demands of non-parental group-based child care. A study of nine months old infants support the importance of caregiver

characteristics in relation with child characteristics and physiological reactivity. Children with the more reactive and negative temperaments were the ones exhibiting the largest elevations in cortisol towards an insensitive and cold babysitter (Gunnar, Larsson, Hertzgaard, Harris & Brodersen, 1992).

As the findings regarding temperamental differences and cortisol production are not conclusive, this may be explained by difference of measurement as researchers have used several ways to conceptualize temperament. Time(s) of measurement is also crucial, as temperamental differences will have different behavioral correlates as the children mature, and the behavior seen in temperamentally compromised infants may not be the same seen in older children, who have mastered other skills, thereby creating more opportunities for behavioral diversity than for infants.

### *Quality*

The findings from this review clearly demonstrate that in studies conducted within child care facilities characterized by excellent quality, atypical fluctuations in cortisol production are still evident, although in a lesser degree than in lower quality child care facilities (Watanabe et al. 2009, Vermeer & IJzendoorn, 2006). The very few studies performed with child care institutions of lesser than excellent quality (although exceptionally few were rated low quality), have reliably shown that lowered quality is associated with higher elevations of cortisol secretions throughout the child care day (Sims, 2006, Dettling et al, 2003). It is mentionable that several studies included in the current review have not included measures of quality in their research design. This is interesting because substantial evidence exist, underpinning the association between quality and children's experience of child care attendance in relation to cortisol secretion.



The conceptual meaning of quality in general and regarding child care in particular, refers to value ridden assumptions about perceived requirements necessary to sustain a good life for the child and to promote positive child development. Cultural differences and custom practices will therefore yield strong influences upon how scientists operationalize the concept of quality. Different assumptions about the nature of quality affect measurement variables, findings and interpretations, and provide cultural specific knowledge about the quality status of the child care facility.

Quality is often divided into two domains consisting of process quality and structural quality. The two facets of quality are seen as interdependent, although they have often been studied separately.

#### *Process quality and cortisol production*

Process quality refers to the child's experiences with peers, caregivers and material, in addition to health and security issues. The findings regarding process quality in the current review, demonstrate a robust relationship between caregiver-child relationship and cortisol production (Lisonbee et al. 2008). Sims et al. (2006), demonstrate that caregiver characteristics such as respect for the child, respecting individual needs and equal treatment of all children is crucial in dampening increases in cortisol production during child care (Sims et al.). In line with his, Dettling et al. (2000) demonstrate that quality of focused attention/stimulation provided by the caregiver is vital in decreasing levels of cortisol in the child during child care and in producing the expected diurnal pattern. These findings give further support for the buffering role of the adult, and put emphasis on the potential long term positive effects of sensitive and responsive caregiving in fostering a physiologically normal cortisol secretion, thereby avoiding chronic elevations in glucocorticoids in children attending non-parental group-based

care,

The child's relationship with peers is regarded as another aspect of process quality. Although children attending non-parental group-based child care are assumed to be extensively preoccupied with peers, very few studies including cortisol have incorporated such measures in their design. Evidence exist demonstrating that rejection by peers severely increase the risk of producing atypical patterns of cortisol (Gunnar et al. 2003). An explanation for this point to relational strategies that increase the risk of being rejected, such as aggression or internalizing behavior. If managing peer relationship appropriately is challenging for some children, it seems plausible that attending a child care arrangement will be perceived as stressful and affect physiological stress reactions.

#### *Structural quality and cortisol production*

Structural quality regarding child care, reflects the organization of the environment, such as group size, age range, play area, caregiver-child ratio, and caregiver training. Research concerning structural quality and cortisol measures have not been extensively elaborated, although there seems to exist certain presumptions about different aspects of structural quality necessary for children to experience child care of high quality regardless of scientific findings (UNICEF, 2008). The current review demonstrates less risk for elevated cortisol production under the following structural circumstances in child care facilities: Smaller groups, comprising of 15 children or less with four or less caregivers, age range between the children in a group no more than six months and play area including at least 5 m<sup>2</sup> per child (Legendre, 2003).

### *Sleep*

Another issue that is hardly investigated is the importance of sleep and rest during child care. Sleep or rest provide the children with a break from the demands of non-parental group-based child care, which seems of particular importance especially for vulnerable children or for children attending child care of less than optimal quality as these factors are more strongly associated with cortisol increase. According to research, sleep during child care appear to benefit most children at least physiologically, particularly the older children. Older children may display a more prominent decrease in cortisol as older children are considered to be less hyporesponsive and more susceptible to contextual influences in glucocorticoid production. Particularly children who struggle with their sleep demonstrated higher levels of cortisol. Problem nappers were usually younger and more often characterized with a hard to handle temperament (Ward et al., 2008). The results points to a precaution regarding children's need for rest/sleep, which seems be individually based and related to child characteristics, physiological reactivity and age.

### *The promotion of positive child development*

#### *Family intervention*

The robust results emerging from this review is that cortisol production appears to be both related to child characteristics and to some degree context sensitive. Two paths of intervention that warrant further investigation in order to promote positive development for the child, and to prevent possible neurotoxic effects of prolonged elevations of cortisol on the brain ,seems beneficial to pursue. The first path incorporates family interventions which seems warranted as additional studies are concluding that family factors are more potent to child development than influences from non-parental child

care (Roisman et al., 2009, Belsky, 2001). As more hours spent away from the primary caregiver during the first years of life are associated with less sensitive mother-child interactions, increased risk of developing an insecure attachment (Belsky, 2001) and the development of a compromised stress regulation (Roisman et al.), it seems of considerable importance to ensure opportunities for parents to care more extensively for their young children. Accordingly, children appear to be ready to initiate child care attendance on an individual basis. The maturational level of the child in conjunction with child characteristics, may comprise a crucial threshold in timing the initiation to non-parental group-based child care.

More parental time with children and greater flexibility between work and family life warrants the elaboration of extensive parental and child care financial and funding arrangements. Additionally flexible agreements with employers must be standardized to ensure all parents equal rights to chose whatever care and employment arrangement they find most appropriate for their child. This intervention is thought to be implemented on a societal level, influencing macro system components such as governments, corporations, social movements and mass media in order to ensure equal access to opportunities and benefits (Dalton, Elias & Wandersman, 2007). The Nordic countries such as Norway with one year paid maternity leave have already paved the way for extensive parental time with child and early promotion of child development. This review supports the notion that the childhood population will benefit additionally from even more flexible ways for parents to arrange their lives, both regarding work, child care and family, to promote psychological health and well-being in their children.

Because most children will attend non-parental child care during childhood, it is conceivable that parents are provided wider access and insight into the child care facility. This may lead to increased opportunities for continuity concerning the care of

the individual child. Examples exist in Norwegian child care system where families are welcome to eat meals together in the child care facility and join the child care group on excursions or whenever the parents have the time to do so. For this to happen, second-order change is necessary to alter the societies and the shared values of its population (Dalton et al.), because there seem to exist a strong diversion between parental labor and care and formal child care, somewhat preventing the child from experiencing continuity and cooperation from different caregivers all pursuing the goal of positive child development.

#### *Child care intervention*

The second path in preventing adverse effects of prolonged cortisol increases and to promote positive caregiver-child relationships concern the formal child care service. Appropriate organization of child care facilities to benefit children with various needs seems necessary, as this review support the translational nature of stress and children that are placed in non-parental group-based child care contexts. It is plausible that effort need to be drawn towards the caregivers providing non-parental care, as well as the structural properties in organizing the child care arrangement, as both factors are seen to interplay with child characteristics and cortisol production.

The Norwegian government have been accredited internationally for its child care system, comprising of a strong emphasis on both structural and relational aspects of quality (St.meld.41, 2008-2009; Unicef, 2008). As other countries are encouraged to organize the formal child care service on similar grounds, I find it necessary to illuminate certain recent features of the Norwegian child care system that appear to be associated with quality decline. In Norway there has been a trend towards developing enlarged child care centers over the last few years (Winsvold & Gulbrandsen, 2009,

Tollefsrud, 2007), an understandable response to governmental obligations to offer child care to the entire Norwegian child population aged 1-5 (St.meld.41, 2008-2009). A one sided focus upon available spaces has been prevalent in this process, downplaying the importance of quality severely, and the use of international research to support the child care organization have appeared to be of little significance. Modern Norwegian child care centers are often catering for more than a hundred children, including enlarged and changing child and staff groups. Caregivers and children may move around in the center as they wish, playing with whom they want and using whatever toys they find desirable (Winsvold & Gulbrandsen). Although this is fitting with the prominent societal view, especially fronted in the Scandinavian countries, where the child is seen as an individual agent, with implicit rights to influence their environments, it is likely that environmental challenges will probably leave numerous children with less capacity for interacting successfully with peers and caregivers, thereby increasing the likelihood for experiencing elevated levels of cortisol and negative child development. Governmental reports emphasize on the contrary and in line with results presented in this review, that smaller groups are necessary for sensitive, responsive caregiving (St. meld. 41, 2008/2009). Additionally the children's need for tranquility is emphasized, which seems less likely to be attended to in large groups. International research support the concern that large child-care groups constitute a negative effect for cortisol production in most children (Lisonbee, Mize, Payne & Granger, 2008, Legendre, 2003). More favorable levels of cortisol are seen in child groups with less than 15 children, ideally no more than 6 months apart in age.

Results from this review point to the importance of the caregiver-child relationship in order to promote typical levels of cortisol, and the foremost important factors are the sensitivity, availability and stability of the caregivers in each child group. The education

of caregivers appear beneficial, and several well-documented programs exist in order to facilitate sensitivity towards young children. To promote caregiver stability, a positive work environment is of importance, and sick leave and staff turnover needs to be addressed continuously, keeping in mind that for children displaying individual risk factors such as temperamental difficulties and/or insecure attachment bonds, contextual influences yield stronger predictive value for negative child development. Additionally it is advisable to create routines to ensure that the concept of sensitivity and a positive relationship with the children is encompassing the complete organization of the child care facility to provide every child with beneficial developmental contexts. Such extensive focus on sensitivity need not be instead of education and learning, which are vital ingredients in at most formal child care arrangements, and an area of priority for the majority of authorities in the developed countries (Unicef, 2008). Accordingly evidence exist demonstrating that lower emphasis on preacademic skills is not related to academic performance upon school entry (Lewis, 1995, in Maccoby & Lewis, 2003).

### Conclusion

It seems fair to conclude that for children aged 0-6, attending non-parental group-based child care is a major risk factor in producing atypical levels of cortisol during childhood. As this review is emphasizing, the observed cortisol elevations experience by a substantial number of children attending non-parental group-based child care, seem more severe and the factors creating them more complex and potent than anticipated.

On the basis of the results presented in this review, sensitive and responsive caregiver-child relationships in particular, appear to be essential to reduce enduring increases in cortisol levels and to promote positive child development. To better understand the specificity of different cultural practices and where to put effort

regarding promotion of child development, it is necessary to produce scientific evidence applicable for the setting that is studied in particular. No recent research exists in Norway or other Scandinavian countries to account for the relationship between structural, relational and physiological factors among children attending group-based child care in th 21<sup>st</sup> century. These topics are in immediate need to be researched extensively, as the organization of the child care systems despite being characterized by high quality, seem somewhat pervasive and inflexible to accommodate to the individuality of each child that appears necessary to decrease the risk of prolonged child care specific elevations in cortisol.



## References

- Ahnert, L., Gunnar, M.R., Lamb, M.E & Barthel, M. (2004). Transition to child care: Associations with infant-mother attachment, infant negative emotions, and cortisol elevations. *Child Development* 75(3), 639-650.
- Belsky, J. (2001). Emanuel Miller Lecture. Developmental Risks (Still) Associated with Early Child Care. *Journal of Child Psychology and Psychiatry*, 42 (7), 845-859.
- Belsky, J. & Pasco Fearon, R.M. (2002b). Infant–mother attachment security, contextual risk, and early development: A moderational analysis. *Development and Psychopathology* 14 (2), 293-310
- Belsky, J. & Pluess, M. The Nature (and Nurture?) of Plasticity in Early Human Development. *Perspectives on Psychological Science*, 4(4), 345-351.
- \*Bradley, R.H. & Vandell Lowe, D. (2007). Child care and the well-being of children. *Archives of Pediatrics and Adolescent Medicine*, 161, 669-676.
- Bremner, J.D. (1999). Does stress damage the brain? *Biological Psychiatry*, 45, 797-805
- Broberg, A. G., Wessels, H., Lamb, M. E., & Hwang, C. P. (1997). Effects of day care on the development of cognitive abilities in 8-year-olds: A longitudinal study. *Developmental Psychology*, 33, 62-69.

Carrion, V. G., Weems, C.F. & Rice, A. (2007). Stress Predicts Brain Changes in Children: A Pilot Longitudinal Study on Youth Stress, Post traumatic Stress Disorder, and the Hippocampus. *Pediatrics* 119(3), 509-516.

Charney, D. S. (2004). Psychobiological Mechanisms of Resilience and Vulnerability: Implications for Successful Adaptation to Extreme Stress. *Focus* 2(3), 368-391.

Cow, S. (2008). Toward a neuroscience of attachment. Cassidy, J. & Shaver, P.R. (Eds.) *Handbook of Attachment: Theory, Research and Clinical applications* (pp. 241-268). New York: The Guilford Press.

Dalton, J.H., Elias, M.J. & Wandersman, A. (2009). What is community psychology. *Community Psychology: Linking Individuals and Communities* (pp. 2-33). Belmont, CA: Thompson Higher Education.

De Schipper, J.C., Tavecchio, L.W.C. & van IJzendoorn, M.H. (2008). Children's attachment relationships with day care caregivers; Associations with positive caregiving and the child's temperament. *Social development* 17(3), 454- 470.

\*Dettling, A. C., Gunnar, M.R. & Donzella, B. (1999). Cortisol levels of young children in full-day childcare centers: relations with age and temperament. *Psychoneuroendocrinology* 24 (5), 519-536.

\*Dettling, A. C., Parker, S.W., Lane, S., Sebanc, A. & Gunnar, M.R. (2000). Quality of care and temperament determine changes in cortisol concentrations over the day for

young children in childcare. *Psychoneuroendocrinology* 25(8), 819-836.

Datta Gupta, N., Smith, N. & Verner, M. (2008). The impact of Nordic countries family friendly policies on employment, wages, and children. *Review of Economics of the Household*, 6, 65-89.

Fosse, R. (2009). Ingen gener for psykiske lidelser. *Tidsskrift for Norsk Psykologforening*, 46, 596-599.

\*Geoffroy, M-C., Cote, S.M., Parent, S. & Seguin, J.R. (2006). Daycare attendance, stress and mental health. *Canadian Journal of Psychiatry*, 51, 607-615

Goodyer, I.M, Park, R.J., Netherton, C.M. & Herbert, J. (2001). Possible role of cortisol and dehydroepiandrosterone in human development and psychopathology. *The British Journal of Psychiatry*, 179, 243-249.

Gunnar, M.R., Brodersen, L., Krueger, K. and Rigatuso, J., (1996b). Dampening of adrenocortical responses during infancy: normative changes and individual differences. *Child Development*, 67, 877-889.

Gunnar, M. R., Brodersen, L., Nachimas, M., Buss, K. & Rigatuso, J. (1996a). Stress reactivity and attachment security. *Developmental Psychobiology* 29(3), 191-204.

Gunnar, M.R & Cheatham, C.L. (2003). Brain and behavior interface: Stress and the developing brain. *Infant Mental Health Journal*, 24, 185-211.

Gunnar, M. R. & Donzella, B. (2002). Social regulation of the cortisol levels in early human development. *Psychoneuroendocrinology* 27(1-2), 199-220.

Gunnar, M.R., Larsson, M.C., Hertzgaard,L., Harris, M.L. & Brodersen, L. (1992). The Stressfulness of Separation among Nine-Month-Old Infants: Effects of Social Context Variables and Infant Temperament. *Child Development*, 63(2), 290-303.

Gunnar, M. & Quevedo, K. (2007). The neurobiology of stress and development. *Annual Review of Psychology* 58, 145-173.

\*Gunnar, M. R., Sebanc, A.M., Tout, K., Donzella, B. & van Dulmen, M.M.H. (2003). Peer rejection, temperament, and cortisol activity in preschoolers. *Developmental Psychobiology* 43(4), 346-368.

Gunnar, M. R., Tout, K., deHaan, M., Pierce, S. & Stansbury, K. (1997). Temperament, social competence, and adrenocortical activity in preschoolers. *Developmental Psychobiology* 31(1), 65-85.

Harmon, A., Hibel, L.C., Rumyantseva, O. & Granger, D.A. (2007). Measuring salivary cortisol in studies of child development: Watch out-what goes in may not come out of saliva collection devices. *Developmental Psychobiology*, 49(5), 495-500.

Kirschbaum, C. and D. H. Hellhammer (1994). Salivary cortisol in psychoneuroendocrine research: Recent developments and applications. *Psychoneuroendocrinology* 19(4), 313-333.

- \*Legendre, A. (2003). Environmental features influencing toddlers' bioemotional reactions in day care centers. *Environment and Behavior* 35(4), 523-549.
- Lewis, C. C. (1995). Educating hearts and minds: Reflections on preschool and elementary education in Japan. New York: Cambridge University Press. In Maccoby, E. E. & Lewis, C.C (2003). Less Day Care of Different Day Care? *Child Development*, 74 (4), 1069-1075.
- Li, I. & , Shen, P-S. (2008). Internalizing disposition and preschool children's cortisol fluctuations. *Child: Care, Health and Development* 34(5), 626-630.
- \*Lisonbee, J. A., Mize, J., Payne, A.L. & Granger, D.A. (2008). Children's Cortisol and the Quality of Teacher-Child Relationships in Child Care. *Child Development* 79(6), 1818-1832.
- Lowe Vandell, D. (2004). Early Child Care: The Known and the Unknown. *Merrill-Palmer Quarterly*, 50, 387-414.
- Maccoby,E. & Lewis,C. (2003). Less Day Care of Different Day Care? *Child Development*, 74(4), 1069-1075.
- McCarthy, A.M., Hanrahan, K., Kleiber, C., Zimmerman, M.B, Lutgendorf, S. & Tsalikian, E. (2009). Normative salivary cortisol values and responsivity in children. *Applied Nursing Research*, 22(1), 54-62.

Ot.prop. 52. 2007-2008. Om lov om endringer i barnehageloven (rett til plass i barnehage). *Kunnskapsdepartementet*.

Quas, J. A., M. Hong, Alkon, A. & Boyce, T.W. (2000). Dissociations between psychobiologic reactivity and emotional expression in children. *Developmental Psychobiology* 37(3), 153-175.

Risbrough, V.B. & Murray, B.S. (2006). Role of corticotropin releasing factor in anxiety disorders: A translational research perspective. *Hormones and behavior*, 50, 550-561.

\*Roisman, G.I., Susanman, E., Barnett-Walker, K., Boot-LaForce, C., Tresch Owen, M., Belksky, J., Bradley, R.H., Houts, R. & Steingberg, L. (2009). Early family and child-care antecedents of awakening cortisol levels in adolescence. *Child Development*, 80 (3), 907-920.

Schulkin, J., Gold, P.W. & McEwen, B.S. (1998). Induction of corticotropin-releasing factor gene expression by glucocorticoids: Implications for understanding the states of fear and anxiety and allostatic load. *Psychoneuroendocrinology*, 23, 219-243.

Silva, M.L., Mallozi, M. & Ferrari, G.F. (2007). Salivary cortisol to assess the hypothalamic-pituitary-adrenal axis in healthy children under 3 years old. *Journal de Pediatria*, 83(2), 121-126.

\*Sims, M., Guilfoyle, A. & Parry, T.S. (2006). Children's cortisol levels and quality of child care provision. *Child: Care, Health and Development* 32(4), 453-466.

St.meld.nr. 27. Barnehage til beste for barn og foreldre. (1999/2000). *Barne-og familiedepartementet*. Retrieved October 26, 2009 from <http://www.regjeringen.no/nb/dep/kd/dok/regpubl/stmeld/19992000/stmeld-nr-27-1999-2000-.html?id=133808>.

St.meld.nr.41. Kvalitet i barnehagen. (2008/2009). *Kunnskapsdepartementet*. Retrieved October 26, 2009 from <http://www.regjeringen.no/nb/dep/kd/dok/regpubl/stmeld/2008-2009/stmeld-nr-41-2008-2009-.html?id=563868>.

Statistisk Sentralbyrå (SSB). *Barn i barnehager, etter oppholdstid per uke og ulike aldersgrupper per desember 2008*. Retrieved October 23, 2009 from <http://www.ssb.no/barnehager/tab-2009-06-15-04.html>.

Tarullo, A. R. & Gunnar, M.R. (2006). Child maltreatment and the developing HPA axis. *Hormones and Behavior* 50(4), 632-639.

Tetzchner von, S. (2002). Relasjoner mellom barn. *Utviklingspsykologi: Barne-og ungdomsalderen*. Oslo: Gyldendal Akademisk.

Tollefsrud, M. (2007). Små barn-store barnehager. Newspaper article. Retrieved from <http://www.aftenposten.no/meninger/debatt/article1802124.ece>.

\*Tout, K., M. de Haan, Campell, E.K. & Gunnar, M.R. (1998). Social behavior correlates of cortisol activity in child care: Gender differences and time-of-day effects. *Child Development* 69(5), 1247-1262.

UNICEF (2008). The child care transition: A league table of early childhood education and care in economically advanced countries. *Unicef Report Card 8, 2008*. Innocenti Research Center.

Ursin, H. & Eriksen, H.R. (2004). The cognitive activation theory of stress. *Psychoneuroendocrinology 29(5)*, 567-592.

Ursin, H. & Zahl-Begnum, O.H.(1993). Kapittel 12. Stress. In *Biologisk psykologi*. Oslo: Tano Forlag

Vandell, D.L. (2004). Early Child Care: The known and the unknown. *Merrill-Palmer Quarterly, Journal of Developmental Psychology, 50(3)*, 387-414.

\*Vermeer, H. J. & IJzendoorn van, M.H. (2006). Children's elevated cortisol levels at daycare: A review and meta-analysis. *Early Childhood Research Quarterly, 21*, 390-401.

\*Ward, T. M., Gay, C., Alkon, A., Anders, T.F. & Lee, K.A. (2008). Nocturnal Sleep and Daytime Nap Behaviors in Relation to Salivary Cortisol Levels and Temperament in Preschool-Age Children Attending Child Care. *Biological Research for Nursing 9(3)*, 244-253.

\*Watamura, S. E., Donzella, B., Alwin, J. & Gunnar, M.R. (2003). Morning-to-Afternoon Increases in Cortisol Concentrations for Infants and Toddlers at Child Care: Age Differences and Behavioral Correlates. *Child Development 74(4)*, 1006-1020.



Watanabe, S. E., Kryzer, E.M. & Robertson, S.S.(2009). Cortisol patterns at home and child care: Afternoon differences and evening recovery in children attending very high quality full-day center-based child care. *Journal of Applied Developmental Psychology* 30(4), 475-485.

\*Watanabe, S. E., Sebanc, A.M. & Gunnar, M.R. (2002). Rising cortisol at childcare: Relations with nap, rest, and temperament. *Developmental Psychobiology* 40(1), 33-42.

Weinfield, N.C, Sroufe, L.A., Egeland, B. & Carlson, E. (2008). Cassidy, J. & Shaver, P.R. (Eds.). Individual Differences in Infant-Caregiver Attachment. *Handbook of Attachment. Theory, Research and Clinical Applications*. New York: The Guilford Press.

Yehuda, R, Halligan, S.L., Yang, R.K., Guo, L.S., Makotkine, I., Singh, B. & Pickholtz, D. (2003). Relationship between 24-hour urinary-free cortisol excretion and salivary cortisol levels sampled from awakening to bedtime in healthy subjects. *Life Sciences* 73(3), 349-358.

Winsvold, A. & Gulbrandsen, L. (2009). *Kvantitet og kvalitet: Kvalitet i en barnehagesektor i sterk vekst*. NOVA rapport 2/2009.

*References marked with an asterisk represents the studies included in this review.*

Table 1							
<i>Study</i>	<i>Country</i>	<i>Sample size (n)</i>	<i>Age range (years)</i>	<i>Measure</i>	<i>Type of care</i>	<i>Duration (hours/week)</i>	<i>Significant effects</i>
Bradley et al. (2007)	World (Review)	N/A	0+	Effect sizes in correlational and experimental research on child care effects	Parental and non-parental care	N/A	Cortisol rise from midmorning to midafternoon at child care, but not on days spent at home. Increase prominent for toddlers and children with regulating difficulties, fearful temperament, less involved in peer play and less socially competent. More positive child care environments associated with lower rise and decrease in cortisol.
Vermeer et al. (2006)	World (Review)	N/A	0+	Effect sizes of cortisol levels at child care and at home	Parental and non-parental care	N/A	Cortisol rise from morning to afternoon at child care, particularly prominent for children younger than 36 months.
Geoffroy et al. (2006)	World (Review)	N/A	0+	Effect sizes for daycare and cortisol in relation to individual and environmental conditions	Parental and non-parental care	N/A	Cortisol rise during child care, related to quality of caregivers, child age (explained as social competence) and child temperament
Roisman et al. (2009)	USA	1364	0-15	Salivary cortisol, maternal sensitivity	Parental and non-parental care	24.1	insensitivity Higher levels of maternal insensitivity and more hours in center based care uniquely during first 3 years of life was related to lower awakening cortisol
Watanabe et al. (2009)	USA	65	3-6	Salivary cortisol, caregiving environment (M-ORCE)	Child care center	40 +	Cortisol rise from morning to afternoon in a small sample of children, with return to baseline in the afternoon both on child care days and weekends. Negative relation with child cortisol level and good climate. Very high quality child care facilities.

Li, et al. (2008)	Taiwan	37	2.5-5.5	Salivary cortisol, temperament	Child care center (university)	N/A (full time)	Cortisol rise from morning to afternoon in children with moderate to high internalizing dispositions, but decreased for the least internalizing children
Lisonbee et al. (2008)	USA	191	3.5-5.6	Salivary cortisol, teacher-child relationship (STRS), relationship quality (FAMST), temperament (CBQ), teacher insensitivity (CIS)	Child care centers (community)	N/A	Cortisol rise from morning to afternoon for half the children, children rated by teachers as overdependent (mainly the youngest) showed most increase as well as children from larger groups with less sensitive teachers
Ward et al. (2008)	USA	38	3-5	Salivary cortisol, temperament, sleep	Child care center (university based)	N/A (full time)	Cortisol rise from morning to afternoon and more difficult temperament in problem nappers
Sims et al. (2006)	Australia	117	3-5	Salivary cortisol, quality (QIAS)	Child care center	Min. 3 full days/week	Cortisol rise from morning to afternoon in child care settings characterized by lower quality. High quality is related to a smaller increase or decrease in cortisol.
Ahnert et al. (2004)	Germany	70	0.9-1.8	Salivary cortisol, temperament (TTS), attachment, mothers sensitivity,	Child care center	40	Elevated levels of cortisol in child care with mother present compared to home levels measured before entry and more pronounced for insecurely attached toddlers, elevated levels in child care without mother's presence attached toddlers as opposed to avoidant insecurely attached
Gunnar et al. (2003)	USA	82	3-5	Salivary cortisol, temperament (CBQ), aggression, sociometric interviews	Child care center (university based)	N/A (part time)	Peer rejection associated with elevated levels of cortisol in peer group settings.

Legendre(2003)	France/Hungary	113	1,5-3,5	Salivary cortisol, environmental factors	Child care centers	N/A	Cortisol rise during morning and mid morning hours, related to number in caregiver team (>4), area available per child (<5m <sup>2</sup> ), group size (>15 children) and age difference (>6 months). Normal diurnal pattern at home on non child care days.
Watamura (2003)	USA	67	0,1-3,1	Salivary cortisol, observation of play and distress, temperament (IBQ/TBAQ)	Child care centers	N/A (full day > 30 hours)	Cortisol rise from morning to afternoon especially for toddlers and children who were less involved in play and children who displayed social fear.
Watamura et al. (2002)	USA	35	2.8-5.43	Salivary cortisol, sleep (napping), temperament (CBQ)	Child care center (university)	N/A	Cortisol rise from morning to afternoon in child care, diurnal pattern at home, decreased cortisol levels during rest/napping
Detting et al (2000)	USA	21+ 19+ 21	3-5.7	Salivary cortisol, temperament (CBQ/TBQ), caregiving environment (ORCE)	Home based child care, parental care, center based child care	40	Cortisol rise from morning to afternoon for children in center based care of high quality and home based child care of low quality, but declined in home based child care of high quality. Temperament had an additive effect with childcare quality in producing inverse patterns of cortisol production. Significantly lower morning values for children attending center based child care.
Detting et al. (1999)	USA	36	3.3-5,7	Salivary cortisol, temperament and social behavior	Child care center (university)	40	Cortisol rise from morning to afternoon, especially among the youngest children and also related to self regulatory skills and negative peer relations
Tout et al. (1998)	USA	75	2,6-5,8	Salivary cortisol, behavior, teacher ratings	Child care center (university and community based)	N/A	Cortisol rise from morning to afternoon, also related to temperament (anxious and withdrawn behavior) in the boys, especially the youngest

Figure 1

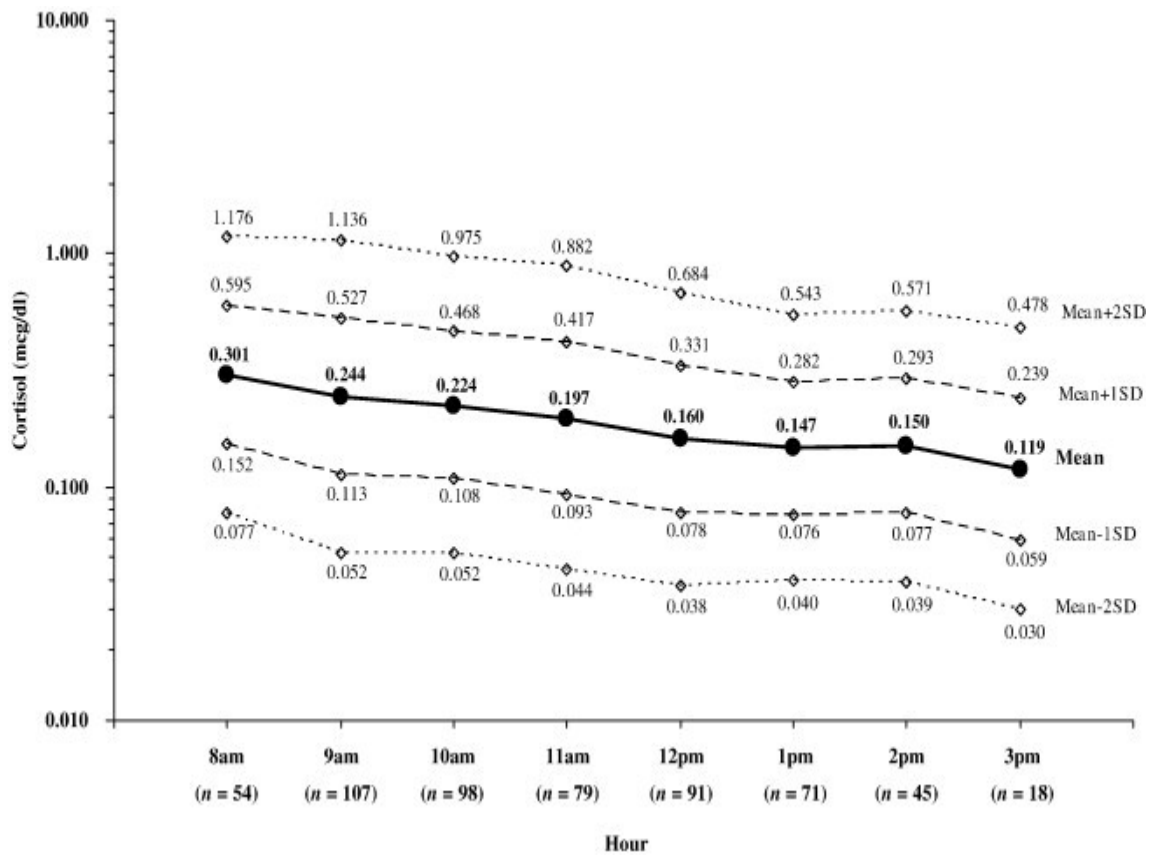


Fig. 1. Normative salivary cortisol levels in children aged 4-9 years, established by baseline group mean values. Retrieved from McCarthy, Hanrahan, Kleiber, Zimmerman, Lutgendorf & Tsalikian (2009).

Veiledet

Helge Holgersen



