Children's cortisol patterns and the quality of the early learning environment

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ABSTRACT: The aim of this study was to evaluate the influence of early educational quality on children’s cortisol levels. It was hypothesised that the environmental stressors might load children’s immature stress regulative systems thus affecting their diurnal cortisol levels. The study sample consisted of 146 preschool-aged children. Cortisol was measured during one day across five time points. The quality of learning environment was evaluated with the Learning Environment Assessment, focusing on indicators of psychological, physiological and social safety. The results revealed a typical daily rhythm in cortisol production characterised by higher levels in the morning on waking up followed by a decrease towards the afternoon and evening. In addition, the single early morning cortisol peak and the evening nadir indicated an average established function of the HPA-system. However, some children had cortisol pattern indicating clearly atypical HPA-activity. These children were sensitised to the effects of the learning environment. Low quality classroom arrangement and low quality team planning were associated with atypical cortisol patterns and with elevated cortisol levels.


ZUSAMMENFASSUNG: Ziel dieser Untersuchung war eine Evaluierung des Einflusses der Qualität frühkindlicher Erziehung auf die täglichen Schwankungen des Stresshormonniveaus (Cortisol) von Kindern. Ausgangshypothese war, dass umfeldbedingte Stressfaktoren das unausgereifte Stressregulationssystem der Kinder belasten und somit ihr tägliches Cortisolniveau beinflussen. Das Sample


Keywords: early childhood; stress; saliva cortisol; quality of learning environment; play

Introduction

One of the main focuses in early education today is on organising the learning environment so that it offers optimal opportunities for development (Hendrick 1992). However, less attention has been paid to the immediate role of educators in supporting and channelling children’s behaviour during different activities (Suhonen 2009).

In some early education studies, the children have been considered as active, competent and resilient learners who construct their own understanding of the world (Kjørholt 2005; Dahlberg and Moss 2005). Hendrick (1992) has pointed out that children are empowered if they are allowed to make choices and decisions about their daily activities. According to Hendrick (1992), this is the only way to enhance children’s self-confidence and active participation in a democratic society. Furthermore, early education is democratic and empowering when children have the opportunity to decide what, where, when and with whom they are acting (Erwin and Kipness 1997). In line with the above-mentioned values, the curriculum for early childhood education in Finland explicitly states that the child is a competent learner who expresses herself in play, through exercise and by means of various arts (The National Curriculum Guidelines on Early Childhood Education and care in Finland 2005). In past years, however, the extraordinary vulnerability of young children at risk for developmental, social and emotional problems due to environmental and biological factors has been recognised (Meaney 2001; Feldman 2008). In parallel with these findings, there has been an emergence of developmental and neurobiological data suggesting the unusual potential of intervening during the first years of life (Sajaniemi et al. 2001; Gunnar and Fisher, 2006).
The competent and vulnerable child

Children are born with enormous potential. The evolution of the human brain has multiplied the possibilities for learning, to creating and participating. However, it is known that the brain is immature and especially vulnerable during childhood (Bradley 2002; Knudsen 2004; Susman 2006; Knickmeyer et al. 2008). A growing number of studies have also revealed that brain development depends heavily on interaction with protective others (Swain et al. 2007; Schore and Schore 2008). This interaction is asymmetrical, as the children’s need for an adult’s protection is absolute. All the power to shape the child’s development, either to increase or decrease competence and resilience, lies in the hands of adults (Hautamäki 2001).

However, it is challenging for a child to be an active and competent participant in early childhood educational settings (Brennan 2007; Corsaro 2000). Through participation, children primarily express themselves in various forms of play. Play certainly has a significant role in children's lives. It is an essential way of learning social, cognitive and regulative abilities (Bodrova and Leong 2005a). During play activities, children have to get along with others. Play also offers opportunities to incorporate the rules and routines of the existing culture (Bodrova and Leong 2005b; Harrison 2008). Expectations to adapt behaviour for common purposes and to act according to fixed rules can cause some children to become frustrated or irritated. The ability to tolerate these emotional fluctuations is not innate; it must be learned (Wenner 2009). Early educational settings promoting play might be an optimal place to practice emotional tolerance and learn social and behavioural skills. However, very few studies have considered the mediating role of the learning environment on emotional regulation and play.

A safe learning environment can promote children’s play and boost their development (Cole 1996). A safe environment involves physical, social and psychological entities. Physical security means that adults ensure the regulation of physiological needs (Mäntymaa and Tamminen 1999; Siegel and Hartzell 2004). To promote the feeling of safety in demanding social situations, adults must take care that children can practice social skills without hurting anyone in any way (Luoma et al. 2008). Psychological safety is more complicated because it is intertwined in person-specific experiences that the child always carries within.

During activities in early educational settings children run into problems they cannot solve. These situations are extremely important for learning new skills and competencies, because children have to learn to adapt. To find new ways to rise to these challenges, the children need advice from more experienced children or from adults. According to Vygotsky (1978), children function in a zone of proximal development (ZPD).

When children are functioning in a ZPD, they are orientated towards novelty (Vygotsky 1978; Del Río and Álvarez 2007). Human beings are built with a neurobiological system that is hard-wired for threats and fear-signalling stimuli, including novelty (Gunnar and Quevedo 2007). These stimuli increase the alertness and they prepare the body for action. Increased alertness is a physiological change and it is experienced as a shift towards negative emotions (Gunnar and Quevedo 2007). In other words, the organism is in a condition of increased stress. Children have to learn to tolerate increased negative emotions and regulate their emotional balance. Timed and adequate responses to children’s expressions indicating physiological change enhance the capacity to approach, tolerate and incorporate novelty. The regulation of resilient emotions is a prerequisite not only for optimal social development, but also
for development of motor functions, perception, language, attention and memory (Schore 2002; Fuster 2003).

Early educational settings might increase stress in various ways (Bradley and Vandell 2007). The children have to regulate their behaviour in all kinds of relationships, both with other children and with adults. In addition, the children presumably choose their activities among a variety of possibilities. Further, they are forced to adjust their needs to daily routines. While these challenges may accelerate the development of social and cognitive skills, they may also tax emotional resources and adaptive competencies, thus activating the stress-sensitive physiological system (Watamura et al. 2003).

A physiological stress system includes the hypothalamic-pituitary-adrenocortical (HPA) system, which releases the steroid hormone cortisol. Basal levels of cortisol follow a daily rhythm, peaking about 30 minutes after waking, rapidly declining in the morning with a slower decrease in the afternoon and showing the lowest levels in the evening (Figure 1). Superimposed upon this daily pattern is the involvement of cortisol in intensifying stress response. High levels of cortisol prepare the body for action by mobilising energy stores and orchestrating behavioural responses to situations or events that are perceived as being stressful. To be effective, the cortisol response should be rapid in onset and terminate quickly as soon as the threat has passed (Fisher et al. 2006; Gunnar and Quevedo 2007).

Cortisol is known to have widespread developmental effects on body and brain functions (Gunnar and Cheatham 2003; Teicher et al. 2003). The ability to regulate HPA activity and to maintain optimal cortisol level is a critical prerequisite for optimal development (Tarullo and Gunnar 2006). Studies of early life stress have proposed that differences in HPA functioning may involve varying levels of activity and different patterns of change in cortisol levels. Both high and low levels and flattening of the expected daily rhythm have been linked to adverse living circumstances and poor developmental outcomes (Kertes et al. 2008; Gunnar et al. 2009).

The ability to regulate HPA activity matures along with brain development and is highly dependent on interactive processes in the social and physical environment (Schore 2002; Gunnar and Quevedo 2007). Consequently, the quality of early care plays an important role in children’s development and welfare. Some studies have shown that children’s cortisol levels are higher during day care than in home settings, indicating an increased load on stress-regulative systems (Vermeer and van Ijzendoorn 2006). In addition, low quality day care has been associated with the dysregulation of HPA activity in some studies (Geoffroy et al. 2006; Sims, Guilfoyle, and Parry 2006).

The aim of the present study is to evaluate the influence of quality differences in early educational settings on children’s HPA activity and on play behaviour. One hypothesis tested here is that the environmental stressors are loading immature stress regulative systems that compromise children’s ability to deal with emotional ups and downs and to function to full capacity in the zone of proximal development. Play behaviour is thought to reflect a child’s potential to be an active participant. A further hypothesis is that the quality of early education can either scaffold or hinder children’s maturing ability to regulate stress responses.

Methods

Participants

The children were recruited from 15 childcare centres in three middle-class communities in metropolitan Helsinki. The children were drawn from full-day groups for
preschoolers in each centre. The parents were approached for permission with 58% responding.

A total of 146 children participated in this study. The mean age of the children at the time of saliva sampling for cortisol measurements was 5 years and 1 month (range 4 to 6, 2). Eighty of the children were females and 69 were males. All the children were without major disabilities or physical illnesses but 7% were considered to have special needs based on attention problems or language impairments.

Home data were available from 60% of these children. The average annual income of children’s families was categorised as low (< 20,000 ) in 14, 7% of the families; medium (20,000 –50,000 ) in 44, 2% of the families; and high (> 50,000 ) in 41, 1% of the families. The proportion of one-parent families in this sample was 29%.

**Procedure**

**Saliva cortisol samples**

Cortisol levels are easily and non-invasively assessed in saliva. The saliva samples in this study were collected during a single day in November 2007. Due to the diurnal fluctuation of cortisol levels in humans, a total of five samples were collected from each subject. The samples were collected at the following times: (1) On waking up; (2) 30 minutes later; (3) immediately after arriving at the day-care centre, approximately one hour after waking; (4) in the afternoon between 2pm and 3pm; and (5) before sleeping. Samples 1, 2 and 5 were taken at home and samples 3 and 4 at day-care centres. Parents collected samples at home and educators collected samples at the day-care centres. Both parents and educators were trained in the sampling procedure. There were no other extra activities or deviations from the daily routines during the sampling day.

The sampling procedure was simple and easy for most of the children. The children mouthed 2-inch cotton wads until they were wet. The cotton wads were placed in Salivette tubes according to written instructions and stored in a refrigerator until they could be sent to the laboratory responsible for salivary cortisol level measurements. In the laboratory the saliva was separated from the wad of cotton by centrifugation (1000 G, 5 min.) and stored at −20°C until the measurements.

**Quality assessments and individual assessments**

The time interval in quality assessments was November 2007–March 2008. The quality data were collected by trained professionals who were not staff members but who were acting as supervisors in the research groups. The preschool teachers observed and assessed children’s play behaviour during several free-play sessions throughout the saliva sample day.

**Measurements**

**Cortisol level measurements**

The saliva cortisol samples were transported to the laboratory in the Finnish Institute of Occupational Health, where the salivary cortisol levels were measured using a commercially available technique.
Play behaviour

The teachers assessed the children’s play behaviour by using the Preschool Play Behaviour Scale (PPBS) (Coplan and Rubin 1998). The PPBS has 18 items on a five-degree Likert scale, with low scores indicating rarely observed behaviours. The PPBS is designed to evaluate the multiple forms of young children’s behaviours during free-play sessions.

Solitary-passive behaviour includes the quiescent exploration of objects and constructive activity while playing alone. Reticent behaviour consists of prolonged looking at the playmate without accompanying play, the child being essentially unoccupied. Solitary-active behaviour is characterised by repeated sensory motor actions with or without objects and by solitary dramatising in the presence of the social group. In addition, the PPBS has items for social play (group play, sociodramatic play and peer conversation) and rough play (rough-and-tumble play).

The PPBS is a widely used evaluation method in early educational settings to identify social immaturity, impulsivity and risk for externalising behaviour (Coplan and Rubin 1998; Coplan and Rubin 1994).

Quality of the learning environment

Trained professionals assessed the quality of the learning environment by using The Learning Environment Assessment (Strain and Joseph 2004). The focus of this evaluation is manifold and includes classroom arrangement, schedules and transitions, classroom activities, team planning and behaviour plans. The quality of the learning environment is rated on a three-degree Likert scale, with low scores indicating low quality.

Classroom arrangements mean, for example, the quality of specific learning centres, the organisation of materials, the variety of materials available to all skill levels, and the accessibility of toys that promote social play. Schedules and transitions indicate stability and predictability of activity schedules, the alternation of active and less active experiences and the utilisation of a zone approach in supervising the children. Classroom activities include modifications in group sizes, timing, directions, feedback, and so on. Team planning means, for example, the teacher’s co-operation, the integration of individualised goals into daily activities, and educator’s shared philosophy about classrooms. Further, behaviour plans point to specific behaviour plans, observation and documentation.

Statistical analyses

Analyses were conducted with SPSS for Windows 16.0. Measures were highly peaked and positively skewed because of many outliers and extremes in the data (see Table 1). The cortisol analysis laboratory has verified the flawlessness for all the measurements, and for this reason, the outliers were also included in the analysis. In order to avoid the violation of test assumptions caused by the skew, all the values were converted to the ordinal scale measure by using 10 percentile categories.

In order to identify homogeneous subsets of daytime cortisol patterns, individual cortisol percentile levels at each measurement point were subjected to hierarchical cluster analysis. Clustering method was between group’s linkage and measure was the
Squared Euclidean distance. Different groups were formed manually by using the dendrogram graph. The description of the dendrogram graph is presented in Table 3. There were no statistical gender differences in the clusters. The grouping variables were tested with the Kruskal-Wallis test against both the absolute (nmol/l) and the percentile cortisol values.

The morning cortisol level and increase as well as the daytime level and decrease were also calculated for each child. The morning level is the mean of measurements 1 and 2; morning increase is the difference in these measurements. The daytime level is the mean of the measurements 2–5, and the decrease is the slope from the regression equation estimated separately for each child.

Analysis of variance, Pearson’s correlation and repeated measures were used in analysing the connections between play behaviour, quality of the learning environment, cortisol measurements and clusters.

Results

Average cortisol levels and daytime cortisol patterns

The children in this study showed a typical diurnal cortisol pattern during an ordinary day in childcare. Descriptive data (means and standard deviations) for the cortisol measurements across different time points are presented in Table 1. The cortisol levels were unrelated to family background data, and there were no significant gender or age differences at any measurement point.

As expected, there was a significant increase in salivary cortisol levels during the first 30 minutes after waking. Corresponding to earlier findings, the pattern of cortisol production over the day decreased, with the lowest values being in the evening samples (Figure 1).

The children with special needs had slightly but significantly different cortisol patterns than the other children. The morning peak for children with special needs tended to diminish (r = 0.337; p < 0.01). The more special educational needs the children had, the less was the morning peak.

Play behaviour

The evaluation of play behaviour revealed that the study children were, on average, social players with a low degree of reticent or solitary play. However, the children with special needs were rated to have significantly less social play than the other children [F (1,53) = 5.8; p < .01].

Table 1. Descriptive statistics for cortisol measures.

<table>
<thead>
<tr>
<th>Sample time</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Skew.</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. On waking-up</td>
<td>138</td>
<td>15,24</td>
<td>12,12</td>
<td>17</td>
<td>6.71</td>
<td>57,6</td>
</tr>
<tr>
<td>2. 30 minutes later</td>
<td>138</td>
<td>19,58</td>
<td>16,29</td>
<td>18,2</td>
<td>5.9</td>
<td>42,2</td>
</tr>
<tr>
<td>3. One hour later</td>
<td>139</td>
<td>12,53</td>
<td>9,21</td>
<td>16,6</td>
<td>6,11</td>
<td>42,5</td>
</tr>
<tr>
<td>4. Afternoon between 2–3 pm</td>
<td>138</td>
<td>5,45</td>
<td>3,56</td>
<td>11,6</td>
<td>7,71</td>
<td>61,8</td>
</tr>
<tr>
<td>5. Before sleeping</td>
<td>139</td>
<td>2,35</td>
<td>1,3</td>
<td>3,3</td>
<td>4,46</td>
<td>26,4</td>
</tr>
</tbody>
</table>
There were also significant gender differences in play behaviour. The scores indicating social play were significantly higher in girls \[F (1,90) = 6.5; p < .01]\), and the scores in rough play were significantly higher in boys \[F (1,90) = 20.22; p < .0001]\).

**Quality of the learning environment**

The results representing the quality of the learning environment showed a good average quality (Table 2). The mean value over all the categories in learning environment assessment was 2.42, with the highest values in team planning (mean = 2.49) and the lowest value in behavioural plans (mean = 2.36). However, significant learning environment differences were found \((p < .0001)\) (Anova). Team plans and classroom activities seemed to be categories with the most widely varying quality in day care centres showing the highest and lowest values (Table 2).

Play behaviour was significantly connected to the quality of the learning environment. The higher the rank in the quality of classroom arrangement, the higher were

<table>
<thead>
<tr>
<th>ASSESSMENT FORM</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning environment</td>
<td>2.42***</td>
<td>0.19</td>
</tr>
<tr>
<td>classroom arrangement</td>
<td>2.4</td>
<td>0.2</td>
</tr>
<tr>
<td>schedules and transitions</td>
<td>2.39</td>
<td>0.27</td>
</tr>
<tr>
<td>classroom activities</td>
<td>2.46</td>
<td>0.28</td>
</tr>
<tr>
<td>team planning</td>
<td>2.49</td>
<td>0.31</td>
</tr>
<tr>
<td>behavior plans</td>
<td>2.36</td>
<td>0.28</td>
</tr>
</tbody>
</table>

*** \(p<.000\)
the scores indicating both solitary-passive (r = 0.36; p < 0.01) and solitary-active play (r = 0.24; p < 0.05).

**Subgroups of diurnal cortisol patterns**

Hierarchical cluster analysis revealed eight different subgroups of daytime cortisol patterns. The means for each cluster are presented in Table 3; the median for the whole data in each measurement is 5.5. The grouping variable was tested with the Kruskal-Wallis test against both the absolute (nmol/l) and the percentile cortisol values, and it was found that the differences between the groups were statistically significant in all measurements (p < 0.001). There was no significant gender or age difference in any cluster.

As illustrated in Figure 2, some clusters had both atypical cortisol patterns and atypical values.

Table 3. Number of cases and percentile cortisol values in each cluster.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>N</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>9.63</td>
<td>9.25</td>
<td>9</td>
<td>9.13</td>
<td>9.38</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
<td>5.42</td>
<td>8.79</td>
<td>8.32</td>
<td>7.47</td>
<td>3.68</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>7.62</td>
<td>7</td>
<td>5.69</td>
<td>2.62</td>
<td>2.38</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>2.33</td>
<td>7.11</td>
<td>6.67</td>
<td>2.56</td>
<td>1.78</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>8.87</td>
<td>5.47</td>
<td>3.67</td>
<td>8.27</td>
<td>5.13</td>
</tr>
<tr>
<td>6</td>
<td>26</td>
<td>3.65</td>
<td>5.04</td>
<td>6.92</td>
<td>6.15</td>
<td>7.23</td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>2.31</td>
<td>2.75</td>
<td>1.94</td>
<td>4.5</td>
<td>8.5</td>
</tr>
<tr>
<td>8</td>
<td>23</td>
<td>6.43</td>
<td>2.61</td>
<td>2.96</td>
<td>3.48</td>
<td>4.96</td>
</tr>
</tbody>
</table>

Figure 2. The mean curve and atypical cortisol patterns in clusters 1, 5, 8 and 7.
The children in cluster 1 had extremely high values at each measurement point. The pattern of morning change atypically decreased in cluster 5 and cluster 8. Cortisol levels in cluster 7 showed flat daytime pattern and an unusual increase in the evening.

**Associations of cortisol clusters, cortisol values and play behaviour**

There were no significant differences between cortisol cluster in play behaviour (PPBS). However, when the relationship between children’s cortisol levels, daytime changes in cortisol and play behaviour were analysed across the entire spectrum, significant correlations (Pearson) were found. A high degree of solitary-active play was associated with unusually low and sharply decreasing daytime cortisol values (r = −0.28; p < 0.001). Solitary-passive behaviour correlated as well with low and sharply decreasing daytime cortisol values (r = −0.28; p < 0.01).

**Associations of cortisol clusters, levels and the quality of the learning environment**

Exploration of possible connections between cortisol clusters and the learning environment assessment revealed that the children in cluster 2 were significantly more often in day-care groups with low quality classroom arrangements [F (1, 7) = 2.74; p < .01]. Figure 3 shows that the cortisol values in cluster 2 children increased sharply above the median values immediately after waking, staying unusually high during the day, falling below median values in the evening sample.

Other interesting connections were found as well. Children in clusters 7 and 8 tended to be significantly more often in day-care groups with high quality team planning [F (1, 7) = 2.28; p < .03]. As shown in Figure 4, the cortisol values were unusually low in all measurements except the morning value in cluster 7 and the evening value in cluster 8.

Unexpectedly, the cortisol levels increased during the hours in day care (measurements 3 and 4), although they remained below median values.

![Figure 3](image-url)  
**Figure 3.** The mean curve and percentile cortisol values in cluster 2.
Daytime cortisol changes and quality characteristics of the learning environment were further analysed across all the data. Low daytime cortisol values were found to correlate weakly but still significantly with high quality team planning ($r = -0.20; p < 0.01$) and with high quality classroom arrangement ($r = -0.22; p < 0.01$). Sharp decline patterns from the morning peak towards evening values correlated significantly with high quality team planning ($r = -0.34; p < 0.001$) and with the quality of behaviour plans ($r = -0.19; p < 0.001$). In addition, high quality classroom arrangements were significantly associated with low morning cortisol values ($r = -0.26; p < 0.01$).

**Discussion**

In essence, it was demonstrated that the children in our study showed a typical daily rhythm in cortisol production characterised by higher levels in the morning on waking up followed by a decrease towards the afternoon and evening. In addition, the single early morning cortisol peak and the evening nadir indicated an average established function of the HPA-system in the study children.

However, notable individual variability in diurnal cortisol patterns was also found in our study. Children’s cortisol patterns could be divided into eight groups with significant inter-group differences in cortisol production. Four groups of children showed cortisol pattern indicating clearly atypical HPA-activity. Significantly, children in cluster 1 had unusually high cortisol levels at each time point. This finding indicates that these children might be emotionally overloaded, since high cortisol levels are frequently linked to increased stress and anxiety both in children and in adults (Gunnar et al. 2009; Van der Bergh et al. 2008; Van West et al. 2008; Quirin, Pruessner, and Kuhl 2008). Early identification of the vulnerable children and modification of environment with increased sensitivity to their needs might be crucial in preventing cumulative stress-related developmental disadvantages.
The number of physical and psychological stressors in lives of children has multiplied in recent years as number of children with various kinds of behavioural and developmental difficulties has increased. Besides other stressful childhood events such as family turmoil, disruptions or adverse social circumstances, day care may also be challenging for some children. The length of the day, the interaction with numerous children and the pressure to organise security-seeking behaviour around many adults are some of the challenges children in day care settings face (Dettling et al. 2000). The link between elevated cortisol levels and day care has been shown in several studies including ours, which showed that the cortisol levels in some children increased towards the end of the day (Legendre 2003; Geoffroy et al. 2006; Sims et al. 2006; Watamura et al. 2003). These findings should be considered alarming since developmental difficulties may be, at least partly, the consequence of chronically-induced stress which is known to have detrimental effects on brain activity, emotional well-being and development (Dettling et al. 2000; Teicher et al. 2003; Geoffry et al. 2006). Quality day care might be one protective factor in brain development during the sensitive and vulnerable early years. Paying attention to the quality of day care thus might have long lasting and beneficial consequences with notable individual and societal significance.

Current research on stress reactivity has shown that not only cortisol levels, but also diurnal fluctuations are essential indicators of HPA activity (Gunnar and Quevedo 2007). It has been suggested that long-lasting hyperactivity of the HPA axis produces a down-regulation of the stress system resulting in a suppressed pattern of cortisol production and seen, for example, in chronically stressed adults (Yehuda 2001). In addition, a flattening of the expected daily cortisol rhythm has been reported in children living in adverse conditions (Burke et al. 2005; Dozier et al. 2006). Further, high levels of maternal depression have been associated with low baseline cortisol levels with less of an increase in environmental stressors (Fernald, Burke, and Gunnar 2008). In our study, atypically low cortisol patterns were also found. Children in clusters 5 and 8 showed decreasing morning levels, and children in cluster 7 tended to have low cortisol levels in all but the evening measurements. The findings might have clinical relevance, since hypo-activity of the HPA-axis is thought to affect brain activity in areas essential for learning and memory, thus possibly causing accumulated risk for optimal development (Charmandari et al. 2003; Gunnar and Cheatham 2003; Hart 2006; Chéh 2008; Robinson, Fernald, and Clayton 2008). Interestingly, children with special educational need in our study tended to have diminished morning values. However, much more research is needed before any firm conclusions can be drawn about the role of HPA-activity in neurocognitive development.

As mentioned, quality day care might be a protective factor in children’s development. However, it is well known that the quality among day care providers varies widely as was the case in our study, too. Definitions of quality have usually included child–caregiver interaction, educational plan, safety, caregiver-to-child ratio, group size and caregiver education (Howes 1990; Geoffroy et al. 2006; Belsky et al. 2007). Among the different quality assessments, responsible adult’s support, sensitivity and level of education have been the most essential indicators of quality (Kalliala 2008).

In our study, the quality of learning environments deviated most significantly from each other in team planning, meaning educators’ co-operation, integration of individualised goals into daily activities and a shared philosophy about the classroom. Quality team planning might imply that adults are committed to consistency in dealing with children. It is possible that consistent practices and adult understanding of children are building blocks for a psychologically safe environment, which is believed to boost a
stress-regulative system and promote the development of resilience in varying stress-evoking events (Siegel 2001; Boyce and Ellis 2005; Gunnar and Fisher 2006). In our study, quality team planning was weakly but significantly correlated with sharply decreasing and low daytime cortisol values. We hypothesise that good team planning creates a calm and relaxed environment in which children can cope safely with their emotional ups and downs.

In addition, there were considerable between-group variations in the functionality of learning sites, in the organisation and variability of materials and in the lay-out of play-promoting toys (classroom arrangement). Our results showed a slight but significant correlation between quality classroom arrangements and low daytime cortisol values. A thoughtfully, well-organised and comfortable environment appears to accommodate with children’s needs and abilities. Such environments can influence children’s experiences of physiological safety and have positive effects on children’s ability to tolerate stress.

When children feel safe, they can demonstrate a capacity for active participation and play (Crittenden 1990; Bodrova and Leong 2005b). Unexpected, low cortisol values in our study correlated slightly but significantly with solitary play. It was previously noted that the quality of classroom arrangements was also related to solitary play. One explanation for this somewhat surprising finding could be that the children who were playing alone in our study were fragile with little ability to tolerate stress and, therefore, social play was overwhelming for them. It is possible that they experienced a structured and well-organised learning environment as protective, which might, in turn, have had the effect of decreasing cortisol values. The quality of the environment may well enable children to practice their skills and find ways to adapt to stress factors in peace. By allowing the children to accommodate stress factors with respect to their regulative abilities, stress tolerance can probably be strengthened.

The ability to tolerate stress is a prerequisite for optimal neurocognitive development (Gunnar 2007; Schore and Schore 2008). There is clear evidence that early childhood educational services of good quality improve developmental outcomes of children (Peisner-Feinberg et al. 2001; Love et al. 2003; De Shipper et al. 2003, 2004; Belsky et al. 2007). High quality care has been associated with enhanced cognitive and language skills (Cambell et al. 2001; NICDH 2000). Some studies have pointed out that quality day care buffers development especially in high-risk children (Papero 2005). Time spent in quality care has contributed to bolstered development of communicative skills, perseverance and self-management (Wylie et al. 2006).

On the other hand, day care is also known to have jeopardised children’s development. Many studies have suggested that day care is a stressful environment and that its low-quality care has a detrimental influence on children’s cortisol levels (Geoffry et al. 2006; Sims et al. 2006; Lisonbee et al. 2008). Shortages, especially in teacher–child interactions, have been connected to high levels of afternoon cortisol (Lisonbee et al. 2008; Sims et al. 2006). Inadequate planning and evaluation of services have also been related to high afternoon cortisol levels (Sims et al. 2006). In addition, structural features such as group size, the number of adults in the group, and the space available for each child have been suggested as affecting diurnal cortisol levels (Legendre 2003).

The association between day care quality and HPA activity was evident in our study. Some children seemed to be more sensitised to the quality of the learning environment than others. Children in cluster 2 were significantly more often in day care groups with low quality classroom arrangements. Cortisol values in these chil-
Children increased sharply above the median values immediately after waking. This might mean that the children already anticipated an overloaded day. Since the cortisol values indeed remained unusually high during the day in these children, the low-quality classroom environment was perhaps experienced as being overloaded. It might be that the stress-regulative system in cluster 2 children is more fragile than in other children, and environmental features are therefore more important to them.

Quality team planning seemed to activate the children in clusters 7 and 8. The cortisol values in these children were unusually low in all measurements except the morning value in cluster 7 and the evening value in cluster 8. The unusual low cortisol values are thought to indicate hypo-activation of the HPA system (Kertes et al. 2008; Gunnar and Quevedo 2006). Hypo-activation is related to a constantly overloaded environment, and it is known to be a significant risk for well-being, learning and memory (Hart 2006; Gunnar and Cheatham 2003). It was interesting that the cortisol levels in cluster 7 and 8 children increased during the hours in day care, yet remained below the median values. It might be, that the quality learning environment, including the educators’ cooperativeness and engagement in common goals, was safe and stimulating for children with possibly increased developmental risks.

In summary, the present study demonstrated that the higher the evaluated quality of the day care was, the lower were children’s daytime cortisol values. In addition, the results indicated that some children’s cortisol activity was more sensitive to the day care context than other children’s. Along with previous studies this study highlighted the importance of environmental factors in children’s lives although it is difficult to come to any definite conclusion about the implications of differences in cortisol production. It is not known what the optimal cortisol levels in children are, and it is not possible to identify a healthy HPA-axis functioning.

However, it can be argued that the quality of day care plays a critical role in children’s experiences. Significantly, the children with indications of dysfuctional cortisol production in our study seemed to be especially sensitised to context. It is essential to identify these children early on, because they may be at risk of long-term undesirable developmental outcomes. Quality improvement may have positive effects on stress regulation and future development.

Finally, longitudinal studies are needed to examine the impact of cortisol patterns on children’s emotional well-being. In addition, more attention should be given to the possible moderating effects of the individual characteristics on the HPA-functioning. Future research should also consider stress on educators, since this too may be closely linked to the quality of care.

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References


