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Downregulation of the immune system in low-quality child care: The case of Secretory Immunoglobulin A (SIgA) in toddlers

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ABSTRACT

Does the experience of stress during child care lead to downregulation of the immune system, in particular in low-quality care? Saliva was collected from 68 toddlers attending center or family child care at home and at child care, and assayed for secretory IgA (SIgA). Caregiver sensitivity was used as an index of quality of care and was observed during three videotaped episodes of 10 min. Diurnal patterns of SIgA showed a steep fall in the morning followed by a flattening out. SIgA was not associated with type of care, but lower caregiver sensitivity was associated with lower SIgA levels in both types of care. Quality of child care is associated with a non-specific secretory component of children's mucosal immunity with well established protective effects against upper respiratory infections.

1. Introduction

In adults the experience of persistent stress has the potential to lower or even compromise immune activity [1,2], in particular when chronic stressors are associated with changes in identity or social roles [3]. Virtually no research on social determinants of children's immune system is available. We suggest that during infancy and early childhood, the formative years of the immune system, the experience of stress through regular attendance of group child care may lead to downregulation of the immune system, in particular when quality of care is low (chronic stress). This downregulating effect of low-quality group care might partly explain why children attending child care more often fall ill than children who stay at home [4]. That is, stress as experienced through caregiving of lower quality may alter the immune response by making the organism more vulnerable to infection. Indeed, higher levels of stress in adults and children have been associated with increased susceptibility to acute infection, for instance upper respiratory infections (URIs) [5,6]. It should be noted that the distinction between chronic and acute stress is relevant because both suppressive and enhancing effects of stress on the immune response have been documented [7]. Acute or short-term stress experienced at the time of immune activation can enhance the immune response, whereas chronic or long-term stress can suppress immunity. In the current study, we consider the experience of stress through regular attendance of group child care as chronic or long-term stress.

One of the major classes of immunoglobulins (antibodies) that protect humans against antigens such as toxins or viruses is Immunoglobulin A (IgA). Secretory IgA (SIgA) is present in abundance in mucosal secretions and its levels in oral fluids serve as a key component of the first line of defense against antigens that cause upper respiratory infection, periodontal disease, and caries [1]. Unlike cortisol as a marker of stress, the study of SIgA as a marker of stress is a relatively under-explored area, especially in children. In a study on eight healthy adults [8], it was confirmed that salivary SIgA showed a similar diurnal cycle to cortisol: An early morning peak was followed by a decline to a stable base 6 h after awakening. Furthermore, as in cortisol, chronic stress in adults has been associated with a reduction in SIgA, whereas rises in SIgA have been reported when acute stress is involved [8].

The effects of relatively long-term stress on immune parameters, such as SIgA, have been well documented in studies on adults and studies employing animal models [9,10]. Across studies the negative direction of the effect is reliably observed, and the magnitude, on average, of the effect of stress is estimated to be 10% [1]. Deinzer et al. [11], for example, tested the influence of a tough academic examination on SIgA in medical students, immediately before and after the examination, as well as 14 days afterwards. They found significantly lower SIgA levels in students who took the exam compared to a control group, even 14 days after the end of the examination period. Shirtcliff, Coe and Pollak [12] reported that a stressful early childhood history (early deprivation through institutionalization and physical abuse) affects the long-term functioning of the immune system (SIgA) in adolescents. Antibody profiles were still altered years after adoption into a more benevolent environment with supportive families.

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It is however still unclear how findings from studies on stress in adults apply to very young children. In particular the effect of psychosocial stress on children's immune functioning is under-explored. In the study reported here, we examined potential links between out-of-home child care and children's immune functioning. Out-of-home child care has become a substantial part of life for an increasing number of young children and their families. Child care in a group setting may elicit not only positive challenges for children (e.g., the development of cognitive and social skills) [13] but may also create persistent strains and stresses because of group life separate from the parents and/or or novelty [14]. Dettling, Gunnar, and Donzella [15] examined salivary cortisol, the primary product of the hypothalamic–pituitary–adrenal (HPA) axis, of 51 children both at home and at child care. Dettling and colleagues reported the normative decrease in cortisol levels from morning to afternoon at home, but not while the children were at child care. Watamura, Sebanc, and Gunnar [16] collected saliva samples of 35 children from four child care classrooms. Consistent with an interpretation that child care is associated with increased HPA activation, for 90% of the children cortisol production rose rather than fell across the day at child care. In a meta-analysis on seven studies comparing cortisol levels at home and at center child care, Vermeer and Van IJzendoorn [17] found that at child care children display higher cortisol levels compared to the home setting, and that diurnal patterns revealed significant increases from morning to afternoon, but at child care only. The authors speculated that children in center child care show elevated cortisol levels because of the stressful interactions in a group setting, and that lower quality of care may exacerbate the influence of child care on cortisol levels [18,19].

Inadequate early caregiving has been associated with risks of stress-related psychological and physical illness over the life span [20]. In the current study, the emotional support provided by the caregiver (hereafter: caregiver sensitivity) is used as a proxy of quality of child care. Caregiver sensitivity is usually considered as one of the most crucial aspects of child care quality, and refers to the sensitivity with which a caregiver responds to signals indicating that the child does not feel well or needs emotional support [21,22]. Sensitivity requires that the caregiver perceives the moods and the signals of the child, that he or she is able to interpret these signals correctly, and that he or she responds to them promptly and appropriately, so that the child feels understood, accepted and secure [21,22]. Several studies have shown that insensitive care-giving, both by parents and substitute caregivers, may elicit stress in children, as indexed by their cortisol levels [23,24]. In the same vein, the availability of substitute caregivers who are sensitive and responsive may function as a buffer against stress responses, for instance when parental separations are involved [25].

Whether quality of child care also is associated with individual differences in SIgA levels has not yet been studied. In fact, only a few studies of links between stress and immune activity in early childhood have been conducted. In a recent study, Keller et al. [26] showed that higher levels of SIgA in 8- to 10-year-old children were associated with internalizing and externalizing symptoms for girls, while some marginal negative associations were found for boys. Sanchez-Martin et al. [27] examined associations between social behavior in preschool children (4- to 5 year-old), cortisol levels and their immune activity (SIgA), but could not confirm any. Watamura, Coe, Laudenslager and Robertson [28], using 3- to 6-year-old children, found that a rising cortisol pattern at child care predicted lower antibody levels on the subsequent weekend. Furthermore, a declining daily pattern in SIgA was evident on weekend and child care days for older preschoolers, but only on weekend days for younger preschoolers. Here, we suggest to focus on the quality of the children's out-of-home care environment, in particular caregiver sensitivity, rather than focusing on their social behavior or mental health. One possibility is that the dearth of studies examining associations between quality of care and SIgA levels in children is due to parents' and children's hesitation to consent to giving the blood samples needed to obtain estimates of most immunologic parameters. Thus, the minimally invasive nature of saliva sampling and the assessment of SIgA in oral fluids may afford an opportunity to begin to address this knowledge gap. Here we suggest that child care may be stressful for children, in particular when quality of care is not optimal. Changes in the psychobiology of the stress response, i.e. elevated levels of cortisol, may induce changes in the immune system, as the HPA axis and the immune system have been shown to be interrelated [1]. Beyond the inclusion of quality of care, an innovative element in our study is that we will focus on children that are younger than the children in previous studies on SIgA and child care [27,28].

The literature provides evidence of both suppressive [5] and enhancing effects [29] on the child's immune system when the frequency of exposure to antigens is persistently high, such as in large child care groups with a higher risk of contagion. Downregulation of children's immune system may be due to differential exposure to antigens that a group of children is carrying and sharing. In family child care, fewer children and caregivers are present than in center child care. Aggregation of individuals in large groups in center child care creates higher exposure to antigens than in family child care with smaller groups of children. Therefore, we additionally examine whether the child's immune system differs dependent on the type of child care.

In sum, it is suggested that lower caregiver sensitivity (chronic stress) will change the psychobiology of children's stress response, which may induce suppression of the immune system. Since stress responses to parental separations in children can be decreased by providing sensitive alternative care [25], we test whether lower quality of care is associated with lower levels of SIgA. Second, we explore whether SIgA levels differ dependent on type of care (center child care versus family child care).

2. Material and methods

2.1. Participants

Sixty-eight children and their professional caregivers ($N = 77$) participated. Similar recruitment strategies were used in family child care and center child care. All children in family child care ($N = 45$) were cared for by one caregiver, whereas most children in the child care centers ($N = 23$) were cared for by two caregivers. Furthermore, group sizes were larger in center-based care (on average almost 11 children) than in family-based care (on average almost 3 children). The sample consisted of 39 boys and 29 girls with a mean age of 30 months ($SD = 5.8$). Children spent on average 19.7 ($SD = 6.8$) hours per week at child care which is the modus in the Netherlands, and had a mean history in child care of 22.8 months ($SD = 9.6$). Children in both types of care did not differ in age, hours in child care, or child care history. All children were raised in two-parent families; almost all (95%) had the Dutch nationality. Parents' educational level was used as a proxy for socioeconomic status (SES), and was coded as the number of years of education after primary school entry (at age 6). Five parent couples did not provide this information. Parents' mean educational level across mothers and fathers was 13.8 years ($SD = 2.01$), and did not differ across the two types of child care settings.

All caregivers were female and had a mean age of 39.0 years ($SD = 10.59$). Caregiver educational level was coded as the number of years of education after primary school entry (from age 6). Caregivers' mean educational level was 12.2 years ($SD = 1.89$), and did not differ across the two types of child care settings.

2.2. Procedure

The review board of the institute of Education and Child Studies at Leiden University approved this study, and all procedures were carried