

## RESEARCH SUMMARY

### **Attachment security buffers the HPA axis of toddlers growing up in poverty or near poverty: Assessment during pediatric well-child exams with inoculations.**

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Growing up poor in a disadvantaged neighbourhood increases an individual's risk of a range of adverse physical and mental health outcomes (Yoshikawa et al, 2012, amongst others) including early death (Meijer et al, 2012). However, not all children growing up in poverty experience adverse outcomes. Both stress and parenting have been invoked as potential mediators of the effects of poverty on behaviour, health and the brain (Farah, 2017; Kim et al., 2013; Mayer, 1997).

Stress activates the hypothalamic-pituitary-adrenocortical (HPA) system (more information in footnote). Cortisol is one of the products of this activation. A small sponge, put into the mouth, is a convenient way of taking a sample of saliva. The sample is squeezed out into a tube, frozen and taken to a commercial lab to be tested.

Giving an inoculation to a child (at their routine check-ups timed at age 12, 15 or 18 months) has been shown to stress the HPA system and cause a rise in cortisol in saliva.

This study examined whether a stronger emotional security/attachment of a child to their parent(s) reduces (i.e. buffers) the expected increase in cortisol in saliva following such an inoculation. The group of 177 families were asked to fill in a questionnaire about depression, family income and negative life events. The attachment behaviour of the child was assessed by a trained observer using a numerical scoring system (Q-Sort) (Waters & Dean, 1985).

The purpose of this study was to examine the association between family income and cortisol detected in the saliva of toddlers aged 12-22 months. Saliva was sampled at three time-points for each child:

1. Approx. 7 minutes after time zero (arrival at the clinic), after permission had been given by the parent
2. After a well-child examination by the nurse/pediatric provider (approx. 38 minutes after time zero)
3. 20 minutes after an inoculation given by the nurse/pediatric provider (approx. 67 mins after time zero).

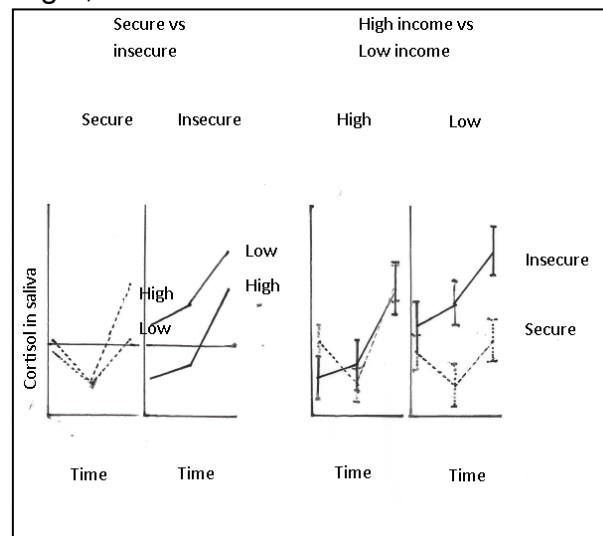
Three aspects were compared for each child, a) the cortisol reading at the start of the experiment b) the degree of reduction of cortisol between 1 and 2, as a measure of the child being at ease after a short time and c) the increase in cortisol (3. Minus 2.) which is the response of the child to the stressor.

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(This Summary may be photocopied)

Significant correlations were found comparing income vs security, income vs depression, negative life events vs depression, attachment/security vs initial cortisol sample.

The information given by the 177 families on income and family size was converted to give the family's income as a percent of the federal poverty limit for each child participant. The cut off, of 150% of Federal poverty limit (FPL), was used to give approx. equal groups of 84 and 83 participants (total 167 with cortisol samples for all three time-points). Within each income group, participants were ranked as insecure or secure using the scores on attachment. The graphs show the mean cortisol for each sub-group at each time point. Bars correspond to 1 standard deviation each way. The two figures, left and right, show the same data but with a different comparison.



## Results

- The cortisol measured in the first samples from secure children was similar in the low- and high-income groups. The insecure high-income participants had an average of a lower starting cortisol and the low-income insecure group had higher cortisol.
- Both income groups of secure children had a decrease in cortisol after the examination by a paediatrician (at + 30 mins). Both groups of insecure children had a rise in cortisol for the same period, a slightly steeper rise in the children of the lower income group than the higher income group.
- All groups had an increase in cortisol following the inoculation. The smallest increase was in the secure, low-income group (around 33 ng/dl), a larger increase was seen in the insecure, low-income group (around 57 ng/dl) and the highest increase was in the two high-income groups (around 76 ng/dl) (no difference between insecure and secure).

## Discussion

In the low-income group, there was a significant difference between the cortisol levels in the secure and insecure young children. In the low-income, insecure group, there were also correlations with depression and negative life events. The low-income, insecure children (compared to secure) had higher starting cortisol, a rise from time point 1 to 2 and steeper rise after inoculations. The pattern for the low-income, secure

children (compared to insecure) was significantly lower cortisol levels at each measurement, and a lower response to inoculation, in fact the lowest response in any of the four sub-groups.

The research clearly indicates that in low-income families, a secure attachment protects children from stress.

In the high-income group there were some surprises. The insecure group had, on average, a lower starting cortisol than any of the secure children (from either income group). Within the high-income children there was no difference in response to inoculation. All high-income children had a steep rise in cortisol, a larger reaction than any of the children from poorer families.

The authors conclude that these data are inconsistent with earlier findings from the 1990's by their group (Gunnar et al., 1996). More than 20 years ago, at their check-ups, middle- to high-income 15 month olds were buffered (protected) from elevations in cortisol. Only those children who were both fearful and insecurely attached to the parent who was with them were not buffered (their rate of increase in cortisol was higher). The authors put forward some suggestions but, in general, could not adequately explain the data. There were differences in the way the children were held for the inoculations (more pacifying by parents in 2017) but this would not explain the children being more sensitive to stress in 2017. There were differences in the number of inoculations, one in 1996 and three in a year for those in 2017 (authors explained more sensitive response as either habituation or continual responding). There were changes in the procedure of the well-child check-up between 1996 and 2017. There could have been differences in the sample populations (all families from well-resourced families in 1996, whilst in 2017, they were from 2 pediatric clinics which were chosen as they served a diverse population).

The authors list several limitations to their study such as the tests were done throughout the day rather than at the same time each day. They had planned to do another swab, 40 minutes after inoculation, but the participants could not be persuaded to stay any longer for this test. The attachment behaviour test (Q-sort) could not differentiate between types of insecurity (between disorganised, avoidant or resistant) and the children were not followed up to see whether the cortisol levels observed had a negative effect on health or behaviour of the children.

*Dr E A Bland comments:*

*There was no information given in this study about the number of working parents in each family, whether 2, 1 or neither working parents. Families in which children were being looked after at home (with any siblings) by the mother, father or a close member of the family (when a family could not afford childcare) or where one parent was working only part-time, would be more likely to have lower income but would have enhanced opportunities for stronger attachments.*

*In contrast, families where the mothers and fathers were both working full-time and the toddlers being cared for in nurseries, by a nanny or a child minder would be more likely to be in the higher income group. Those who can afford higher cost childcare, where the mother has a higher paid job, would be more likely to have a child in non-parental care for long hours. This situation would have been much more common in 2017 than in 1996.*

**Footnote:** *The HPA axis is the hypothalamus and the pituitary (next to each other in the brain). The hypothalamus secretes corticotropin-releasing hormone (CRH) which triggers the pituitary gland to secrete adrenocorticotropic hormone (ACTH), which then acts on the adrenal glands (on the kidneys) to produce glucocorticoid hormones such as corticosterone and cortisol. Through a negative feedback, glucocorticoids act on receptors in the hypothalamus and pituitary to suppress secretion of CRH and ACTH. The feedback mechanism is important as it allows the levels of cortisol in the blood to decrease again after the threat has ceased. Glucocorticoids are steroids which help regulate the immune system, primarily by reducing inflammation.*

*The hippocampus is the region of the brain which normally keeps track of cortisol levels and sends a signal to the hypothalamus to hold back when levels of cortisol become toxically high. Continuously high levels of cortisol are damaging to these hippocampus cells, eventually destroying them, allowing the free-wheeling of the hormones and very poor regulation of cortisol.*

*The authors of this paper reported no buffering of response to inoculations in the secure children of the high-income group from 2017. One reason may be a less effective feedback regulation of cortisol caused by continued high levels of stress in a child's life, either in the womb or in the months post-birth. In the low income, insecure group, the causes of their continued stress are likely to be poverty, negative life events or parent's depression but for the high-income group they may be other factors such as separation stress.*

*The cortisol levels coming through the placenta to the neonatal child in the womb are critical (there are negative effects from alcohol abuse, intra-uterine violence and high maternal stress). The levels of cortisol will determine the set point of the HPA axis which will rule the behaviour of the individual in teenage and adult years. Under stress, HPA dysregulation can be either under or over-regulation, the first is associated with the susceptibility of males to externalising disorders such as high risk-taking, violence and autism spectrum and the second is related to internalising disorders in females such as depression, anxiety and self-harm. There are sex-specific differences in the maturation of the HPA axis in the foetus, maturing faster in females than males. There is a greater output of cortisol in male foetuses than in females. The maturation of the body's immune system in pre and peri-natal periods will determine an individual's trajectory toward health and disease susceptibility throughout their life.*

*Dr E.A. Bland*