

Measuring young children's stress response to social adversity using hair cortisol.

10th Annual Workshop of the International Network for Research on Inequalities in Child health
Hannah Bryson, Sharon Goldfeld, Anna Price, Fiona Mensah.

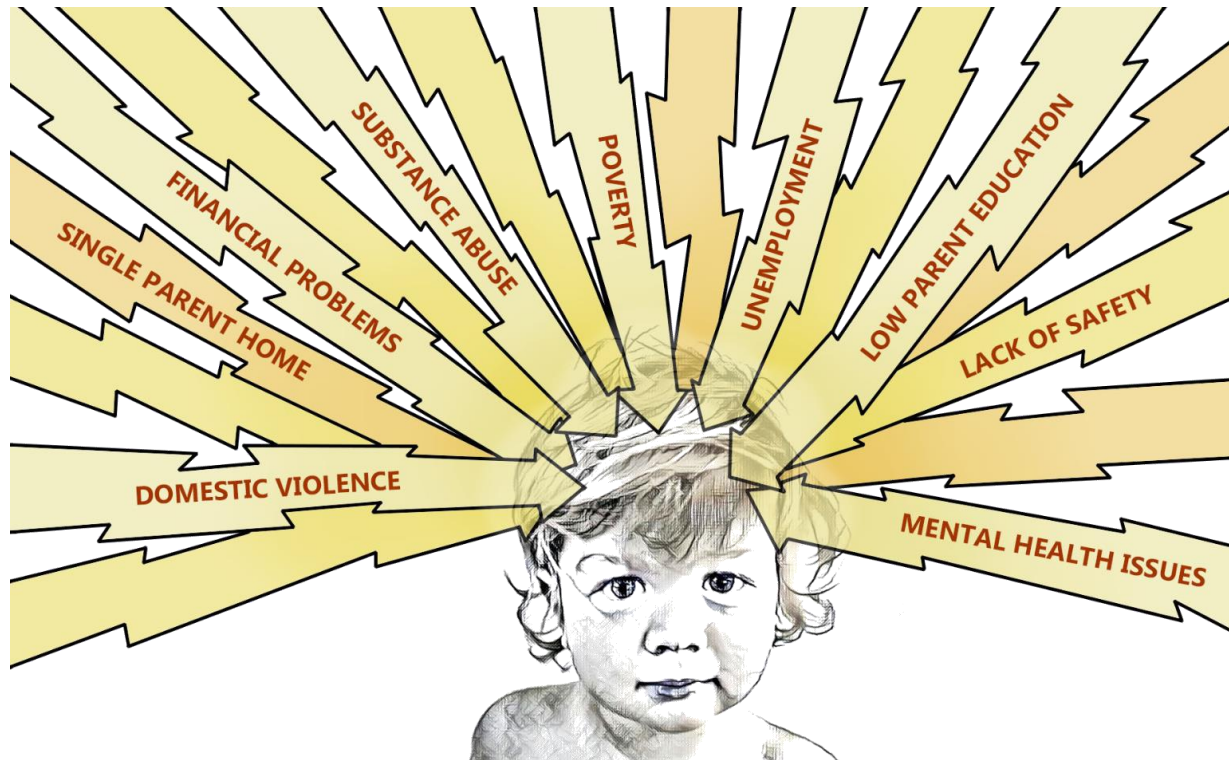
Thursday 7 June 2018



Social adversity

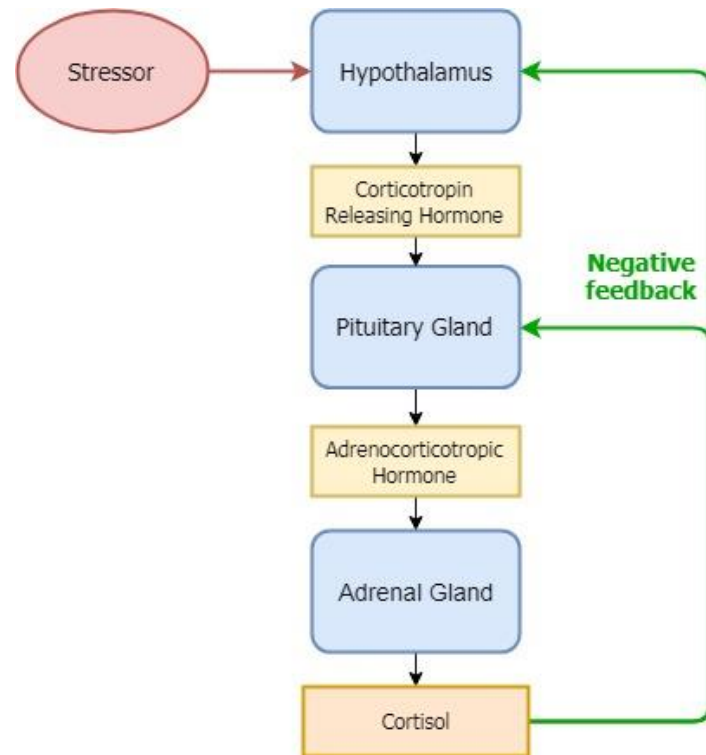
Adverse psychosocial, economic and environmental factors which affect the health, wellbeing and prosperity of individuals and societies.

(Bauer & Boyce, 2004)



New approaches to thinking about adversity

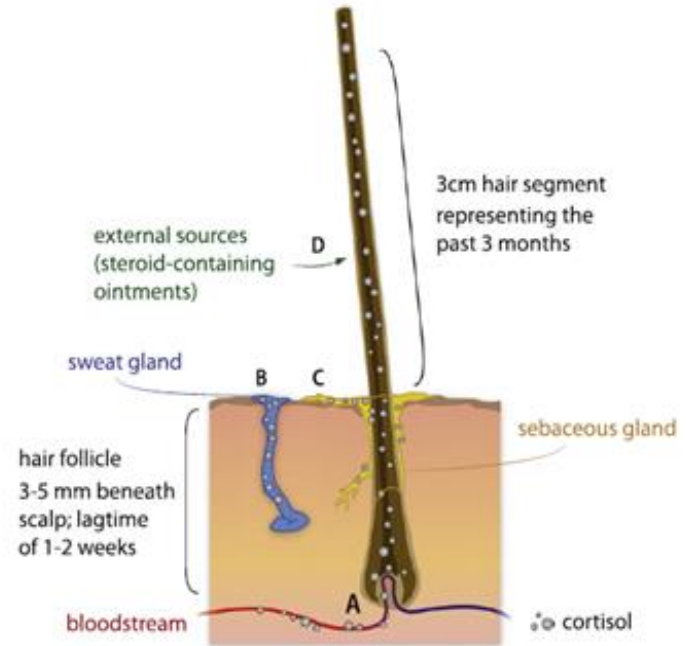
- Despite research and policy efforts, health inequalities remain.
- New approaches needed to understand biological mechanisms underlying health inequalities.
- “Biological embedding of experience” - Early experiences have long term consequences for the development of multiple organ systems, impacting health outcomes through life (*Hertzman, 1999*).



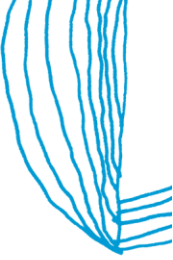
The hypothalamic-pituitary-adrenal axis.

Measuring cortisol in hair

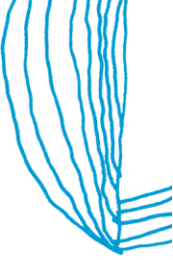
- Represents average systemic cortisol over time.
- Time period equivalent to 1 month per 1cm hair growth.
- Single sample collection.
- Easy collection and storage.
- High intra-individual stability.
- Possibly influenced by age and gender.
- Not influenced by hair colour or hair washing.



(Stalder & Kirschbaum, 2012)



Can we use hair cortisol to measure the stress response to early adversity, and how does it predict health and developmental outcomes in young children?



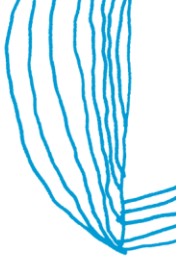
Current evidence: social adversity and hair cortisol

- Some evidence that indicators of adversity are associated with higher child hair cortisol.
- Contained to a small number of sociodemographic characteristics:
 - Low parent education (*Vaghri et al 2013, Ursache et al 2017*).
 - Low family income (*Rippe et al 2016, Windhorst et al 2017*).
 - Maternal unemployment (*Karlen et al 2015*).
- Few studies examining psychosocial aspects of adversity.

Current evidence: social adversity and hair cortisol

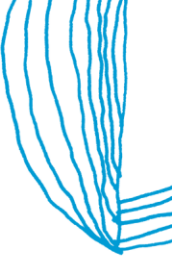


| Adversity indicators (number of studies) | Number of associations identified | | |
|--|-----------------------------------|--------------------------------|-------------------------------|
| | No association | High adversity – High cortisol | High adversity – Low cortisol |
| Low parental education (14) | 12 | 2 | - |
| Low household income (5) | 3 | 2 | - |
| Maternal unemployment (1) | - | 1 | - |
| Marital status - single parent (6) | 6 | - | - |
| Parents of ethnic minority (7) | 4 | 3 | - |
| Area of residence – low area level SES (3) | 2 | 1 | - |
| Poor maternal mental health (3) | 2 | 1 | 1 |
| High maternal stress: self-report (5) | 4 | 1 | - |
| Maternal life events (3) | 3 | - | 1 |
| Child life events (4) | 3 | 1 | - |
| Domestic violence / maltreatment (2) | 1 | - | 1 |



Current evidence: social adversity and hair cortisol

- Two studies examined the cumulative effect of adversity
- Karlen et al. (2015):
 - Multiple risk factor tally of maternal adversity during pregnancy.
 - Higher risk count associated with higher hair cortisol in children aged 1 year.
- Simmons et al. (2016):
 - Children's total lifetime exposure to adverse life events.
 - Higher total adverse events associated with higher hair cortisol in children aged 9 years.



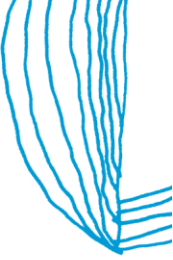
Current evidence: hair cortisol and child health

- Mainly focussed on weight/adiposity and mental health outcomes.
- Some evidence higher hair cortisol is associated with:
 - Higher BMI or being overweight/obese (*Veldhorst et al 2014, Noppe et al 2016, Rippe et al 2016, Gerber 2017, Windhorst 2017*).
 - Poorer mental health (*Rietschel 2016*).
- Contrasting evidence that lower hair cortisol is associated with poorer mental health, particularly externalising behaviour (*White et al 2017*).

Current evidence: hair cortisol and child health



| Child health indicators (number of studies) | Number of associations identified | | |
|--|-----------------------------------|-----------------------------|----------------------------|
| | No association | High cortisol – poor health | Low cortisol – poor health |
| Body mass index (13) | 6 | 7 | - |
| Waist circumference / waist to hip ratio (4) | 3 | 1 | - |
| Fat mass index / fat distribution (3) | 2 | 1 | - |
| Internalising symptoms / anxiety / depression (11) | 9 | 2 | 1 |
| Socioemotional development (1) | 1 | - | |
| Externalising symptoms / ADHD (5) | 4 | 1 | 2 |
| Combined mental health (1) | 1 | 1 | |
| Self-harm (1) | 1 | - | - |
| Cognition (2) | 2 | 1 | - |
| Allergy / asthma (3) | 2 | - | 1 |
| General health / illness / wellbeing (5) | 4 | 1 | 1 |

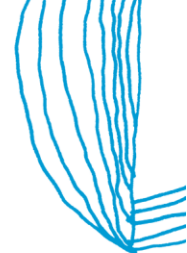


Gaps in the hair cortisol field

- Current field of research still very small.
- Few studies with children younger than 3 years, and none in this age group that are Australian.
- Generally population representative cohorts, with low variability in adversity indicators.
- Studies have each focussed on a narrow range of indicators of social adversity, with inconsistent findings across studies.
- Few have examined the cumulative effect of multiple co-occurring factors or longitudinal exposure over time.
- Limited evidence as to whether stress, measured using hair cortisol, mediates associations between adversity and health.

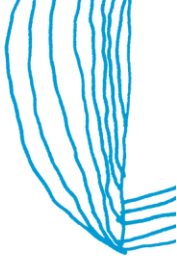
Research program overview

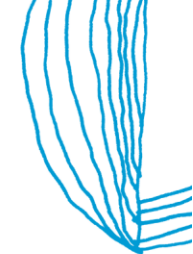
- Using the largest Australian population cohort of children with hair cortisol, collected within the right@home randomised controlled trial, my research examines:
 1. Whether indicators of adversity in the family environment are associated with children's stress response, measured using hair cortisol at 2 years.
 2. The role that maternal stress response and maternal parenting behaviours play in explaining children's stress response to adversity at 2 years.
 3. Whether stress mediates the associations between adversity and children's health outcomes at 3 years.



Research program overview

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Aims

In a large population cohort of women recruited for their experience of adversity, and their 2 year old children, this study aimed to determine whether:

- 1) Exposure to a broad range of maternal reported indicators of adversity were associated with child hair cortisol at age 2.
- 2) A cumulative count of multiple adversity indicators was associated with child hair cortisol at age 2.

Research design



- Cross-sectional analysis of the right@home randomised controlled trial (RCT) cohort.
- 722 women recruited from antenatal clinics at maternity hospitals in Victoria and Tasmania.
- Recruited for their experience of adversity during pregnancy
- ≥ 2 antenatal risk factors on a 10-item screening survey.
- Women and their 2 year old children who completed a 2-year assessment, with child hair sample collected for cortisol analysis.

Measures

Child hair cortisol concentrations

- Single continuous measure of average cortisol concentration (pg/mg).
- Collected at 2 year face-to-face visit.
- 3cm hair sample cut from the posterior vertex region of the scalp.
- 30-50mg total sample size taken in 2-3 discrete portions.
- Analysis by enzyme linked immunosorbent assay (ELISA).



**Maternal reported indicators of adversity at 2 years**

| Item | Description |
|--------------------------------------|---|
| Young age at pregnancy | <=23 years vs >24 years. |
| Education | Did not complete high school vs completed high school, vocational or higher education. |
| Marital status | Single, not living with partner, separated or divorced vs married or living with partner. |
| Employment | Not employed vs employed. |
| Ethnicity | Main language other than English vs English as main language. |
| Aboriginal or Torres Strait Islander | Yes vs no. |
| Ever had a drug problem | Yes vs no. |
| Had a drinking problem in past year | Yes vs no. |
| Current smoker | Yes vs no. |

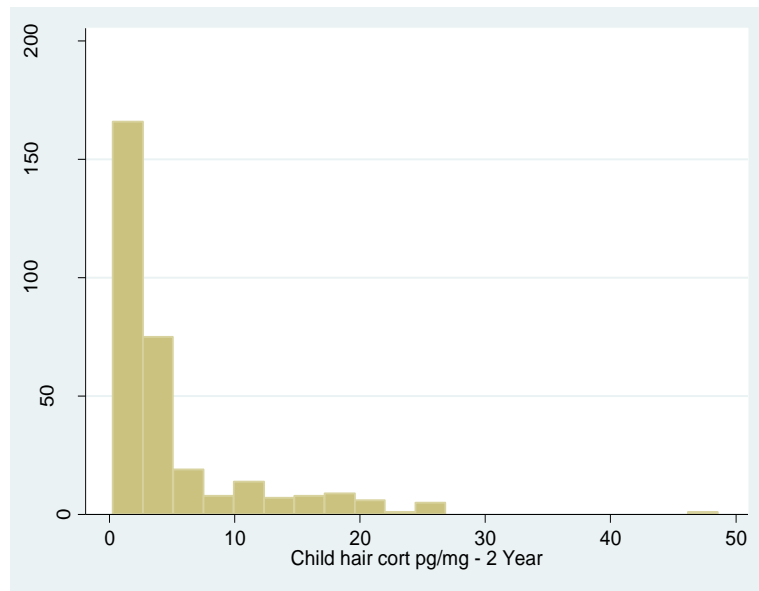


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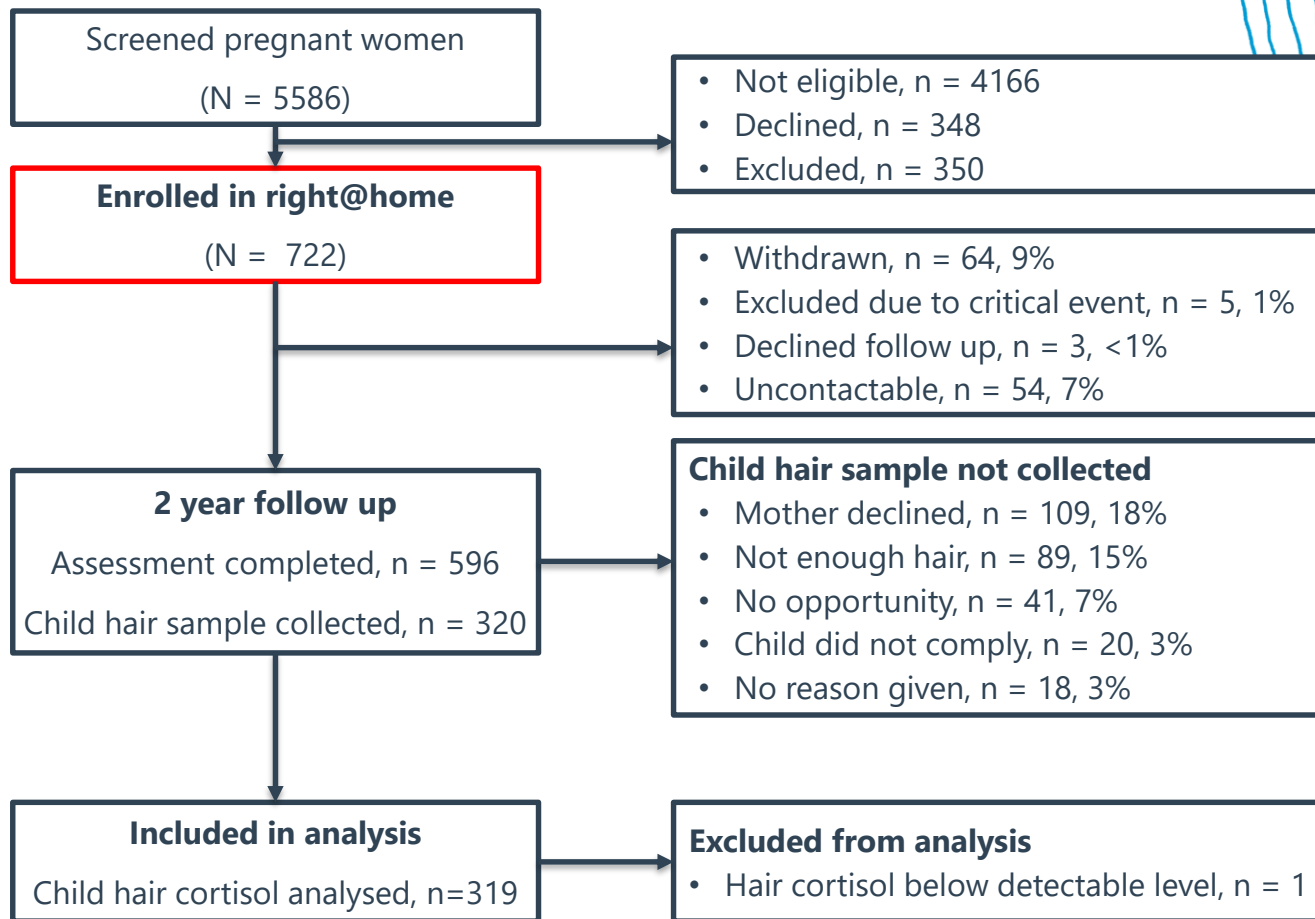
| Item | Description |
|--|---|
| Experienced family violence in past year | Two items reflecting family violence or being threatened; Yes vs no to either. |
| Mental health | Symptom ratings on three subscales: Depression, Anxiety and Stress. Dichotomised into top 15% of scores vs bottom 75% based on population representative data (<i>Henry & Crawford, 2005</i>). |
| Main source of household income | Benefit, pension or no income vs paid employment. |
| Type of household accommodation | Public rental, paying board or living rent free vs private rental, fully owned or being purchased. |
| Housing problems | Overcrowding, threatened with eviction, lead or mould; yes vs no. |
| Financial hardship | 6-items reflecting issues relating to shortage of money; 2 or more hardships vs one or none. |
| Live in a safe place | No vs yes. |

Analyses

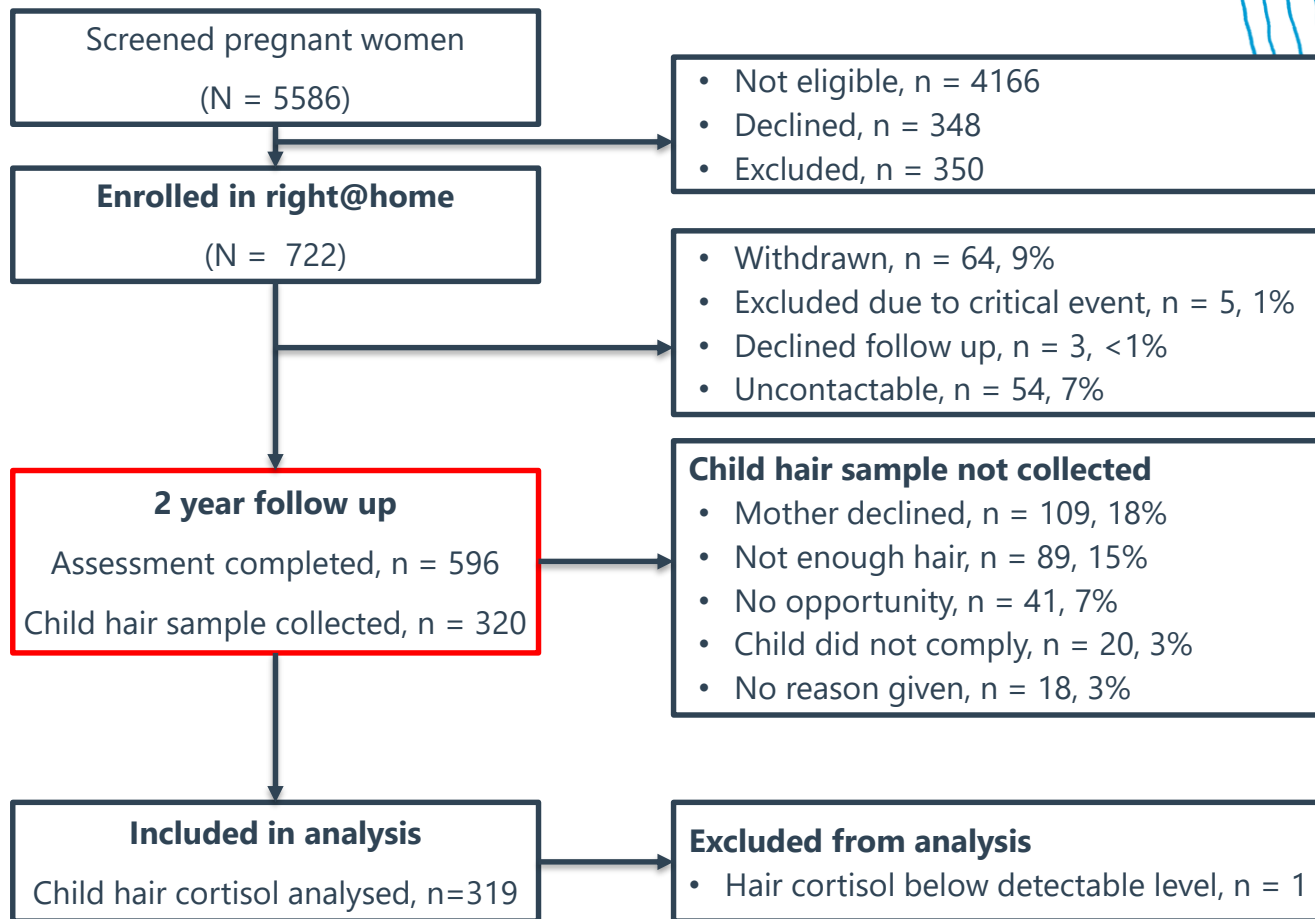
- Child hair cortisol analysed as a continuous outcome, log transformed.
- Linear regression used to examine:
 - Univariable analysis for each adversity indicator.
 - Multivariable analysis for all adversity indicators in a single model.
 - Analysis for effects of total adversity indicator count.
- Adjusted for potential confounders of child age, gender, RCT allocation status, hair sample characteristics.



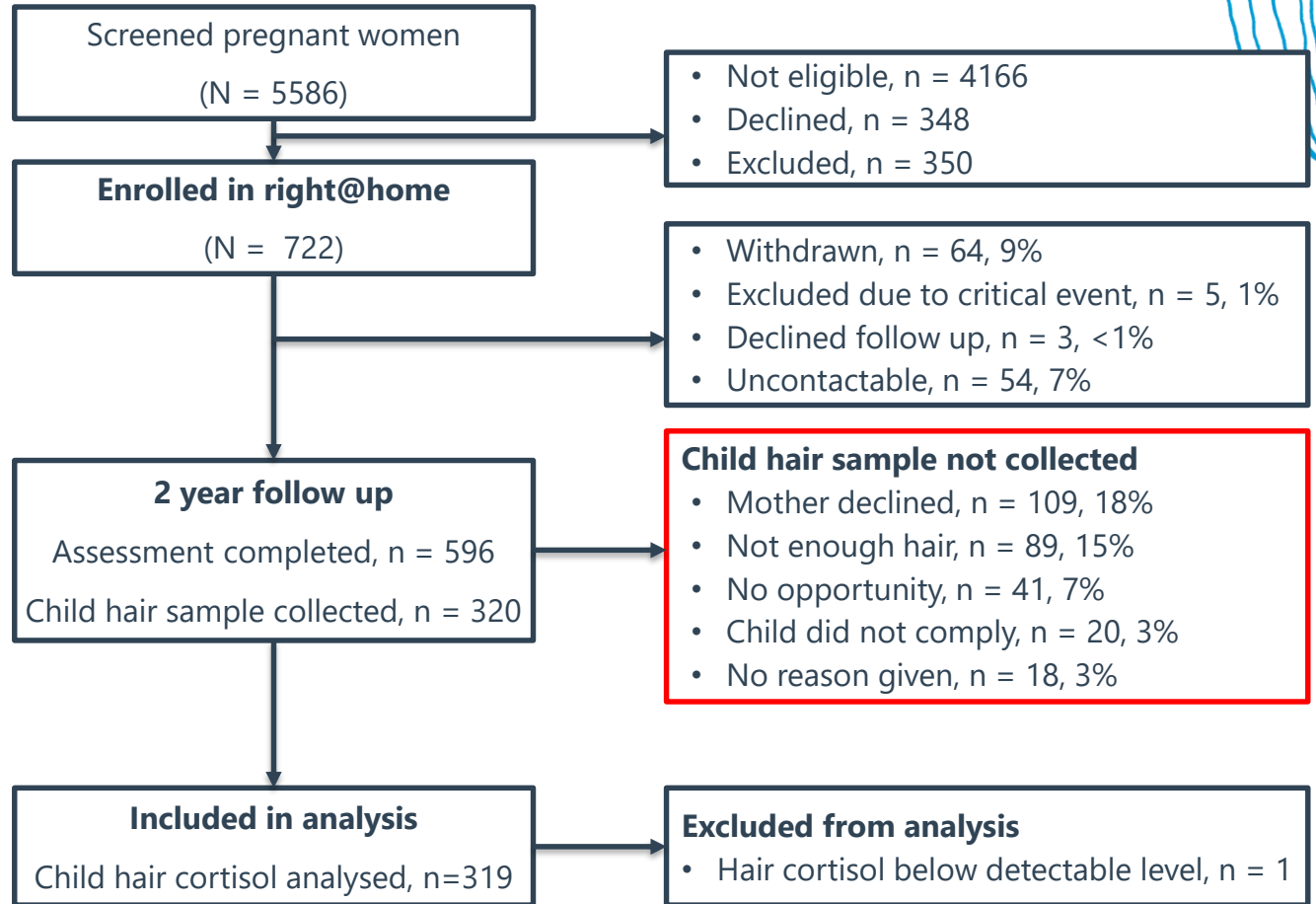
Participant flow



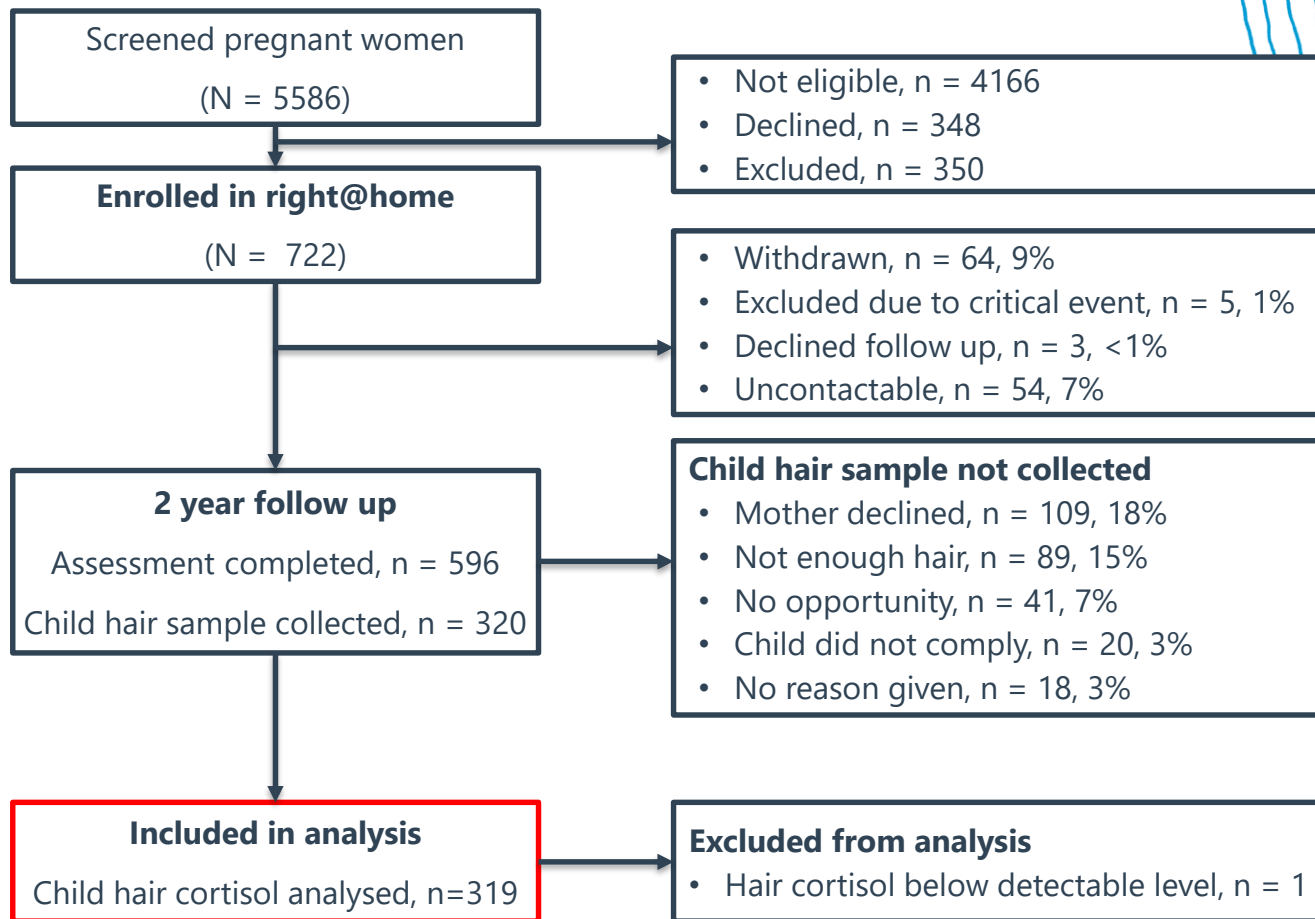
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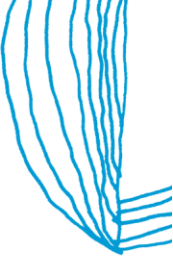


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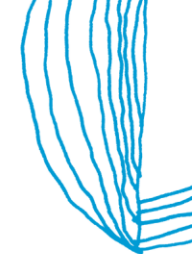
Results

- Univariable adjusted analyses:
 - No evidence of association between hair cortisol and 17 of the 18 indicators of adversity
 - Maternal report of not living in a safe place was associated with higher child hair cortisol
($\beta = 0.57$, 95% CI= 0.08 to 1.07, $p = 0.02$)

Results

- Multivariable adjusted analysis

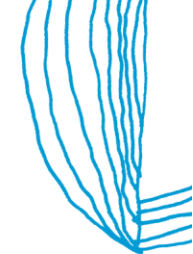
| | Summary statistic (N=319) | Multivariable regression R-squared = 0.19 (N=294) | | |
|---|---------------------------|---|--------------|---------|
| | | β^a | 95% CI | p-value |
| <i>Maternal indicators of adversity</i> | | | | |
| Young age at pregnancy (<23 years) | 25.1 | -0.08 | -0.34; 0.19 | 0.57 |
| Did not complete high school | 26.3 | 0.12 | -0.14; 0.39 | 0.35 |
| Single / not living with partner / separated / divorced | 32.0 | 0.02 | -0.28; 0.32 | 0.92 |
| Income from benefit / pension / no income | 44.3 | -0.12 | -0.44; 0.21 | 0.48 |
| Not currently employed | 65.3 | -0.06 | -0.33; 0.20 | 0.64 |
| Public rental / boarding / living rent free | 19.1 | 0.36 | 0.05; 0.67 | 0.023 |
| Main language other than English | 5.7 | 0.20 | -0.28; 0.68 | 0.41 |
| Aboriginal or Torres Strait Islander | 6.3 | -0.15 | -0.63; 0.33 | 0.53 |
| Ever had a drug problem | 13.8 | -0.03 | -0.38; 0.32 | 0.87 |
| Alcohol problem in the past year | 2.6 | 0.16 | -0.53; 0.86 | 0.64 |
| Current smoker | 34.6 | 0.03 | -0.23; 0.30 | 0.80 |
| Family violence in the past year | 20.7 | -0.10 | -0.41; 0.21 | 0.53 |
| Not living in a safe place | 4.8 | 0.66 | 0.12; 1.19 | 0.017 |
| Housing problems | 18.8 | -0.33 | -0.63; -0.02 | 0.035 |
| 2 or more financial hardships | 18.7 | -0.02 | -0.31; 0.28 | 0.91 |
| Anxiety symptoms ^b | 1.9 (2.7) | -0.03 | -0.10; 0.03 | 0.33 |
| Depression symptoms ^b | 2.2 (2.9) | -0.05 | -0.11; 0.01 | 0.11 |
| Stress symptoms ^b | 4.5 (3.6) | 0.06 | 0.01; 0.11 | 0.013 |
| <i>Covariates</i> | | | | |
| Site of collection (ref posterior vertex) | | | | |
| Side | 6.6 | 0.04 | -0.42; 0.50 | 0.85 |
| Top | 9.4 | -0.81 | -1.20; -0.42 | <0.001 |
| Both side and top | 0.6 | 0.37 | -0.98; 1.72 | 0.59 |
| Season of collection (ref Summer) | | | | |
| Autumn | 31.7 | 0.03 | -0.30; 0.35 | 0.86 |
| Winter | 27.6 | -0.53 | -0.87; -0.20 | 0.002 |
| Spring | 21.6 | -0.32 | -0.67; 0.04 | 0.083 |
| Child gender, female | 58.1 | -0.22 | -0.46; 0.02 | 0.069 |
| Randomization status, usual care group | 45.8 | 0.04 | -0.19; 0.27 | 0.71 |
| Child age (months) ^b | 24.2 (0.9) | 0.01 | -0.12; 0.14 | 0.84 |



Results

- Multivariable adjusted analysis

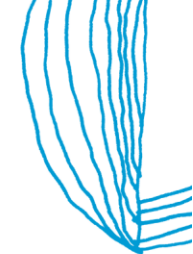
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| Spring | 21.6 | -0.32 | -0.67; 0.04 | 0.083 |
| Child gender, female | 58.1 | -0.22 | -0.46; 0.02 | 0.069 |
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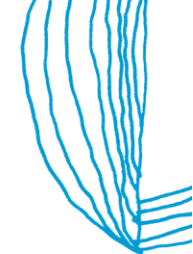
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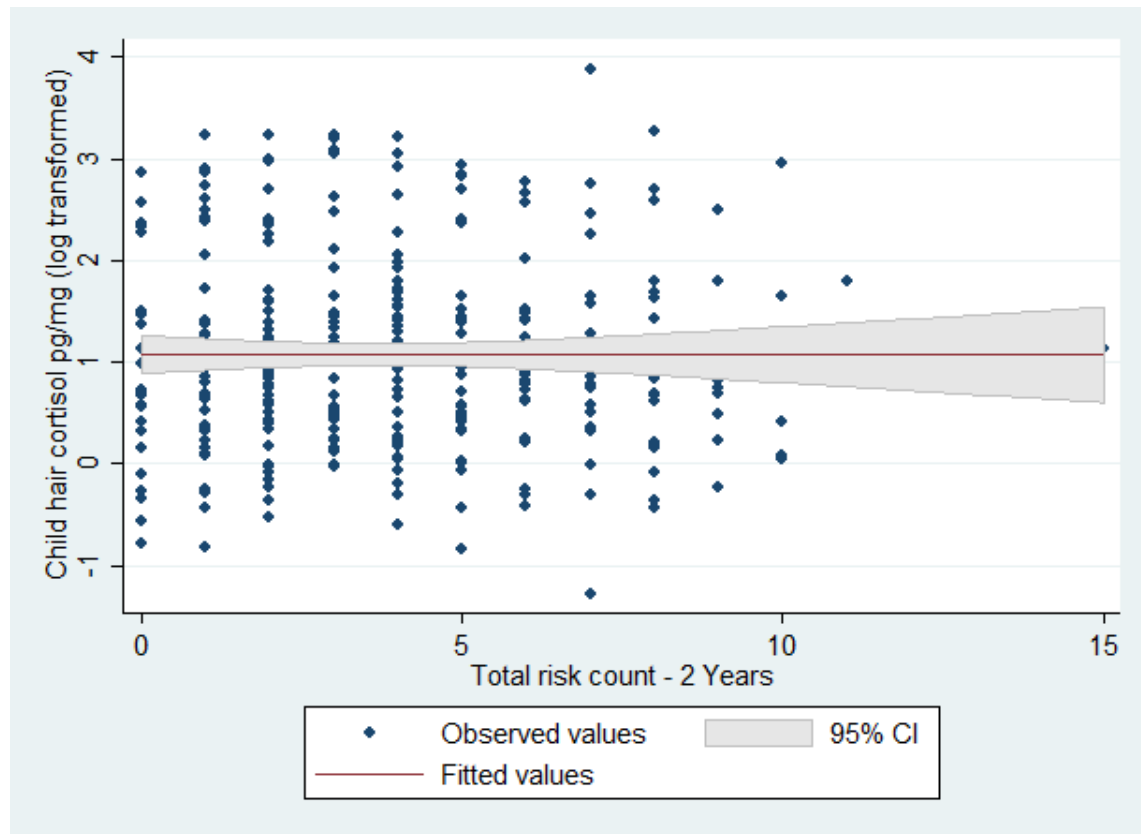
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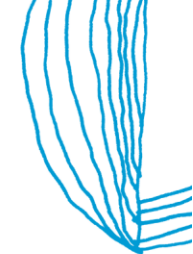
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| Spring | 21.6 | -0.32 | -0.67; 0.04 | 0.083 |
| Child gender, female | 58.1 | -0.22 | -0.46; 0.02 | 0.069 |
| Randomization status, usual care group | 45.8 | 0.04 | -0.19; 0.27 | 0.71 |
| Child age (months) ^b | 24.2 (0.9) | 0.01 | -0.12; 0.14 | 0.84 |



Results

- Total adversity risk count in the cohort ranged from 0 to 15 (M = 3.8, SD = 2.7)
- Total count was not associated with differences in child hair cortisol.





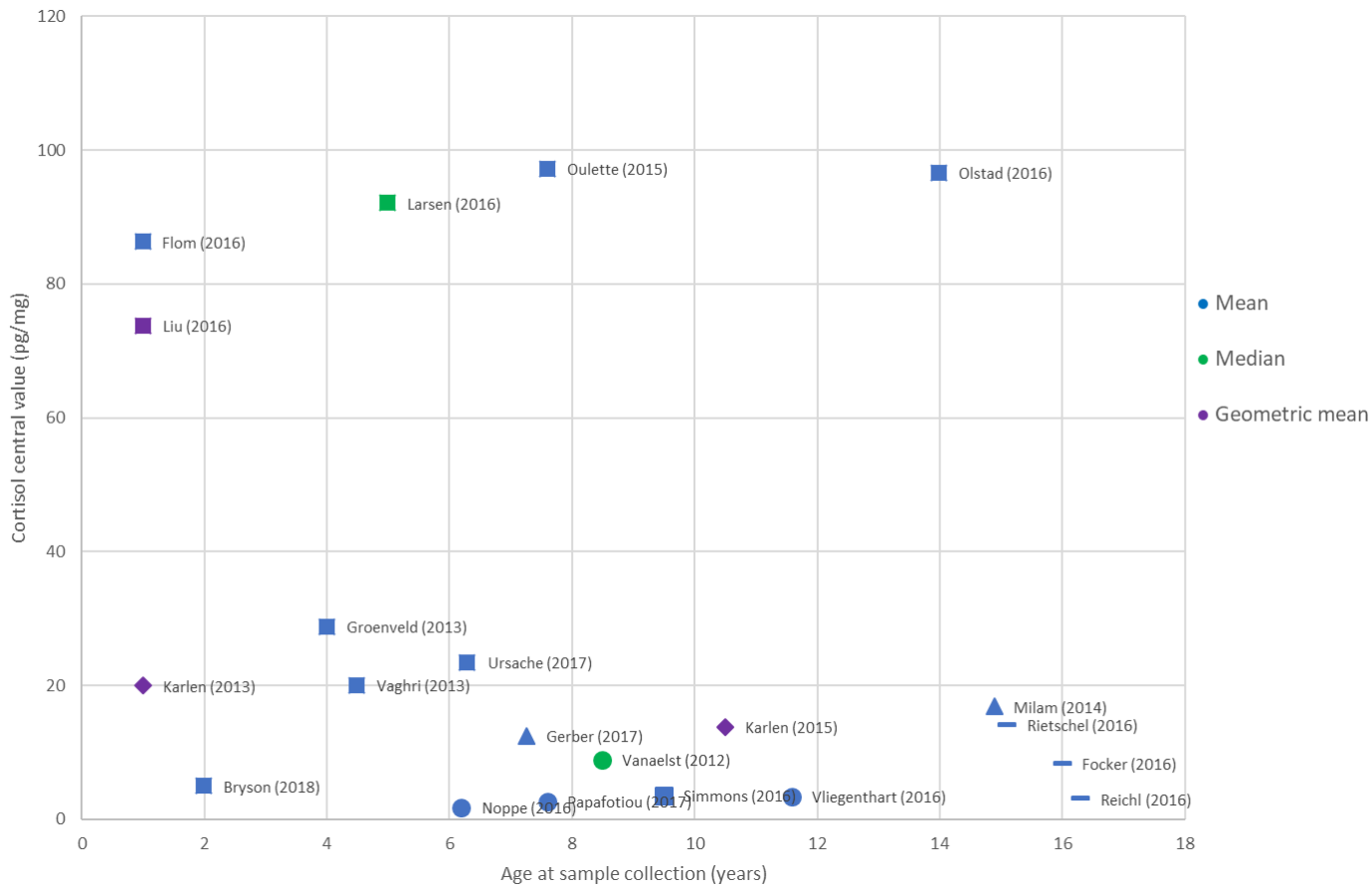
Strengths

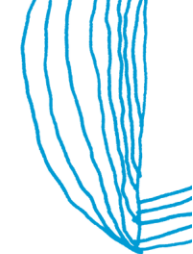
- Large prospective cohort design
- Wide range in the types and degrees of adversity experienced
- Youngest practical age for population level collection of child hair cortisol

Limitations

- International variability in hair cortisol analysis methodology
- Lack of population level reference ranges or comparable data

Hair cortisol values reported across the literature





Conclusions and discussion

- Some evidence of adversity associated with higher child hair cortisol.
- Findings inconsistent and not present for many potentially stressful experiences.
- Important to understand what these findings mean for population health and the growing interest in biomarkers like hair cortisol.

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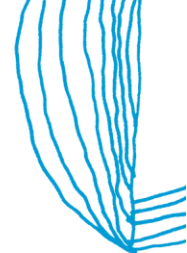
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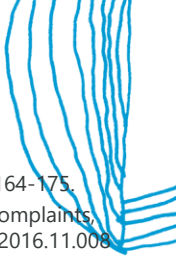
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