Early childhood stress, adversity, growth & development: findings from the SPRING home visits cluster randomised controlled trial in rural India

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“I (Sunil Singh Bhopal), confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis”

Sunil Singh Bhopal, 17 January 2019

Abstract

Background

Successes in improving child survival in low- and middle-income countries mean that the time is right to expand the child health agenda to encompass the ambition that all children are able to thrive. This expansion will have profound and positive implications for families, communities and societies because supporting children to thrive in the earliest years allows them to reach their potential through later child- and adulthood. Unfortunately, current estimates are that at least 43% of under 5 year olds in low and middle-income countries are at high-risk of suboptimal development because of the many obstacles they face, including poverty, family stress, malnutrition, exposure to violence amongst others. This PhD examined the associations between number and types of these adversities and stress through pregnancy and the first year of life, and growth and development at 18 months of age in SPRING-ELS (Early Life Stress). This was a sub-study of the community-based SPRING trial which developed a home visits intervention programme, delivered at-scale across a total population of 200,000 in rural India where the burden of adversity is great, and indicators of child wellbeing including early childhood stunting (low height-for-age) are shocking.

Methods

SPRING-ELS was initiated with formative work to understand mother's perceptions of childhood stress and adversity. These findings were combined with literature reviews and expert consultation to select 22 childhood adversities covering pregnancy and the first year of life in four domains (socioeconomic, carer-child relationship, maternal stress and child-related). Data on these adversities were collected at 12-months of age, except for socioeconomic status and parental education which had already been collected when children were identified by the trial surveillance system. Hair was sampled at 12-months to analyse chronic stress using cortisol, and six saliva samples were taken over two days to assess children's diurnal

cortisol rhythm. Growth and development outcomes were assessed when children were 18 months old; these were height-for-age, weight-for-age and the motor, cognitive and language domains of Bayley Scales of Infant Development 3rd edition. The relationships between these measures of adversity, cortisol stress measures, and early childhood growth and development were assessed using multi-level mixed-effects linear regression modelling.

Results

Adversity, growth and development data were collected on 1273 children; saliva cortisol results were available for 752 of these children and hair cortisol for 712. Most children (90.6%) faced at least 1 adversity and nearly 50% faced four or more of these potential impediments to wellbeing. Each additional adversity was associated with worsening weight-for-age (-0.09 (95%CI -0.11, -0.06)) and height-for-age (-0.12 (95% CI -0.14, -0.09)) z-scores. There were similar negative associations for child development as follows: -1.1 points (95% CI -1.3, -0.9) for motor, -0.8 points (95% CI -1.0, -0.6) for cognitive; and -1.4 points (95% CI -1.9, -1.1) for the language scale. Comparable results were found for each of the four adversity domains. Number of adversities was also strongly linked to concentration of cortisol in the hair (increase of 6.1% (95% CI 2.8, 9.4) for each additional adversity) but not with diurnal cortisol rhythm in saliva. Finally, hair cortisol itself strongly associated with poorer growth and development in all domains; this was predominantly independent of a child's exposure to adversity.

Conclusions

This PhD presents amongst the first evidence from a low/middle-income country showing the relationship between numbers of childhood adversities in multiple domains and growth and development at only 18 months of age, a crucial time for optimal brain development and a key predictor of future health and wellbeing. It is a reminder that children are never too young to absorb what is happening around them, and that the damaging effects of adversity on developing biological systems begins from the start. The findings reinforce the need for a multidimensional approach to tackling the burden of suboptimal growth and development, and that this approach should include a focus on early life adversity and stress because of the profound implications of these for child wellbeing. The World Health Organization and UNICEF have pioneered such a multidimensional approach at the global level through the Nurturing Care Framework and urgent translation of this into country-level action is now needed to support all children – no matter where they live – to thrive.

Acknowledgements and Dedication

This PhD was only possible because of the love, work and dedication of many friends, colleagues, co-authors and family members. I sincerely thank them all for everything.

My children were not yet born when I first began developing the ideas which led to this work. Leo was less than a year old when I started the PhD, and managed the relocation from Newcastle to India to London and back again with style. I hope he enjoys having a dad who doesn't have a thesis to 'finish off'. Ethan missed out on the India adventure but I hope I can make it up to him. I thank my dad, Prof Raj Bhopal for asking difficult questions and the reminder to 'question everything and everyone' from the early years onwards. My brilliant mum - Roma Bhopal - reminds me that actions triumph over words, is a wonderful mother and is also a great example to me as a clinical leader.

My supervisor, Prof Betty Kirkwood, believed in me from the first moment we discussed my ideas. Her willingness to communicate this confidence at times of difficulty and distress will stick with me forever. I am deeply grateful. I now aspire to be as wonderful a supervisor, mentor and friend to my own students.

This PhD is dedicated to my wife Dr Hannah Bhopal who has loved, supported, encouraged and cajoled me over the years, and shared (probably more than is strictly necessary) in the elation, hard work, and anxiety that comes with tackling a large project like this. I sincerely thank her for everything.

Table of Contents

Figures and Tables

SECTION A: BACKGROUND

Chapter 1: Introduction

1.1 Motivation for PhD

At the heart of my training as a Paediatrician - and key to the way I think about bringing up my own young children - is the idea that what happens in the earliest years matters for children's lifelong health and wellbeing, and that it is therefore crucial to intervene early to ensure that children grow up in nurturing environments that support them to meet their potential.

In October 2013 I attended an evening lecture given by Prof Sir Harry Burns at Northumbria University. I was enthralled by his descriptions of 'biological embedding' - where early adverse experiences alter children's brain architecture, hormonal axes and immune status with negative consequences not only whilst young but throughout the rest of life. Around the same time, I became aware of the SPRING cluster randomised trial that was developing a community-based intervention to improve these crucial years for young children in South Asia. I approached the SPRING principal investigator – Prof Betty Kirkwood – to explore whether it would be possible to integrate some of the measures I'd been hearing about from Prof Burns to the SPRING trial and whether she would support my application to the Wellcome Trust for a Research Training Fellowship. To my delight, Betty (as I discovered she preferred) encouraged me wholeheartedly and the Wellcome Trust agreed to fund my work. This thesis therefore describes the results of what became known as SPRING-ELS - the Early Life Stress sub-study of the SPRING cluster randomised controlled trial.

1.2 Early Childhood Development: Burden and Programmes

The global child health landscape is shifting as the successes of the Millennium Development Goal era lead to the expansion of the child survival agenda to encompass the ambition that all children are able to thrive in the early years[1,2]. This was reflected in the post-2015 Sustainable Development Goals – particularly aspects of goals 1 (poverty reduction), 2 (nutrition), 3 (good health and wellbeing), 4 (school readiness), and 16 (violence reduction).

The 2016 Lancet series "Advancing Early Childhood Development: from Science to Scale" estimated that 43% of under 5 year old children in low and middle-income countries are at high risk of not achieving their developmental potential. This is an indirect estimate based on the numbers of children who are stunted or exposed to poverty [3,4]. Figure 1 shows the prevalence of children at risk in 141 low/middle-income countries; in many of these, this includes more than a fifth of under 5 year olds. In some countries more than 60% of young children are at-risk.

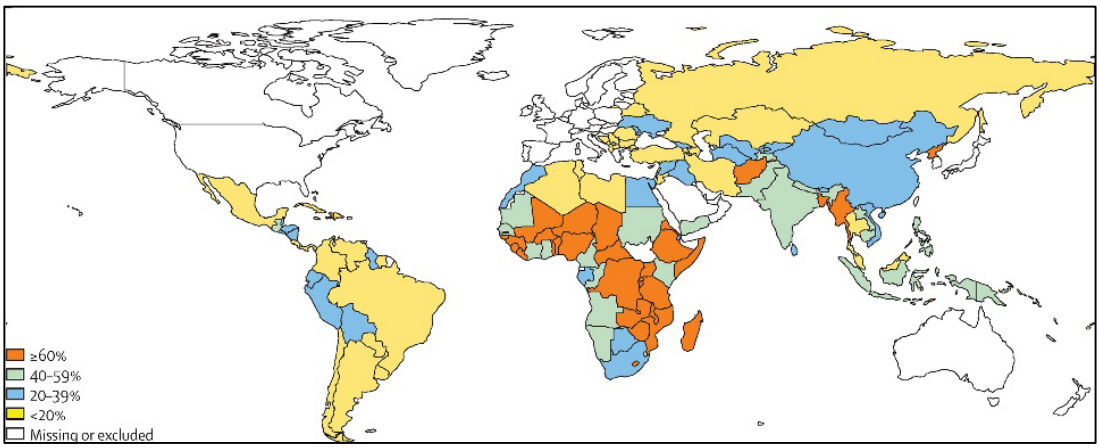

Figure 1: Country-level percentage of children under 5 years of age at risk of poor development in 141 low/middle-income countries (Figure from 2016 Lancet Series: Advancing Early Childhood Development: from Science to Scale [3])

The aim of this focus on early childhood development (ECD) is that all children are able to live healthy, productive lives and that families and communities are empowered to support children to achieve their maximum academic, behavioural, social, emotional and economic potential[4,5]. Not only will this will have benefits for the health and wellbeing of individuals throughout their lives but societies will in turn benefit from a population that is healthier, more educated, and less violent. There will also be benefits in future generations[4,6,7].

The reason ECD focusses on the early years is because of neuroscientific and epidemiological evidence suggesting that this is the period in which the brain is most amenable to change, specifically that the neuronal synapses are forming at the fastest rate during this time[8], and that the period from pregnancy through the first few years of life is highly sensitive period for multiple aspects of development[9].

The World Health Organization, UNICEF, the World Bank and others recently launched the "Nurturing Care Framework for Early Childhood Development: a framework for helping children survive and thrive to transform health and human potential" [10]. The guiding principles behind the framework are that all children have a right to survive and thrive; that no child should be left behind; that care should be family-centred; that a whole-of-society approach will yield optimal results, and that whole-of-government action is needed to see change. An ideal environment for child wellbeing is described in five domains. This is one which 1) protects a child from external threats and stressors, 2) offers opportunities for play and learning, 3) supports positive, responsive and stimulating interactions with adults 4) provides for adequate nutrition and 5) supports the health needs of the child[5]. These are illustrated in Figure 2.

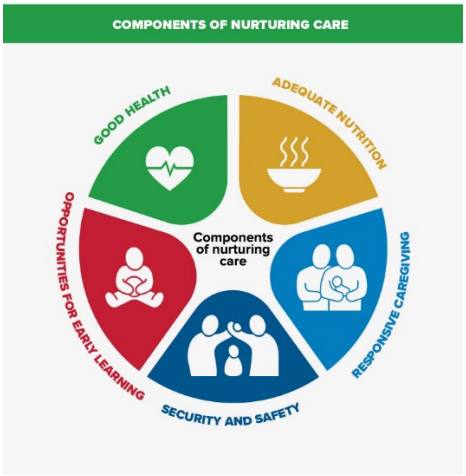

Figure 2: WHO/UNICEF Nurturing Care Framework Components of Nurturing Care

This approach has a high level of political and institutional support including Jim Yong Kim, who as President of the World Bank Group said in a recent speech:

> *"There can be no equality of opportunity without…appropriate stimulation, nurturing, and nutrition for infants and young children. Conditions of poverty, toxic stress and conflict will have produced such damage that they may never be able to make the best of any future opportunities. If your brain won't let you learn and adapt in a fast changing world, you won't prosper and, neither will society."* [11]

1.3 Importance of Adversity in Early Childhood

Adversities are wide-ranging and context specific, and include neglect and abuse, inadequate nutrition, maternal wellbeing, housing quality, pollution, war, famine and violence[12–14]. These adversities can be thought of in multiple layers around a child as illustrated in Figure 3 from the Nurturing Care Framework showing the influence of proximal and more distal factors on a child, including at the child, caregiver, community, service and policy level.

Figure 3: Enabling Environments for Nurturing Care from Nurturing Care Framework[10]

Eco-biodevelopmental frameworks[15] and models of the importance of social and environmental influences on early childhood development have been proposed. Figure 4 shows one of these linking policies and programmatic intervention to community and caregiver capacity through this nurturing care to improved health and development through the lifecourse[6]. Crucially, the figure lays out clearly the necessity of considering the biology of early childhood whereby early experiences (both positive and negative) become embedded, and become linked with health and disease.

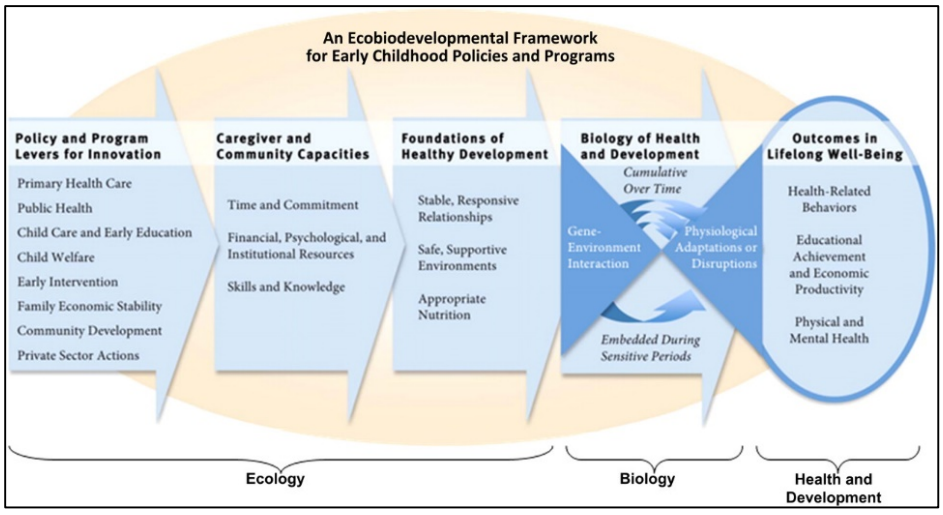

Figure 4: Eco-biodevelopmental framework linking early childhood development to improved health and development through the lifecourse.
Figure from American Academy of Paediatrics Technical Report 6

Whilst each individual adversity has the potential to cause problems for a child growing up, exposure to multiple adversities simultaneously poses a cumulative burden for children in high-income countries and has been seen to be detrimental to a lifelong wellbeing. It has been suggested that this may be different for children in low- and middle-income countries who are likely to be exposed to multiple simultaneous low-level risks[16,17], with attendant negative consequences, although this has been minimally studied in babies and young children.

1.4 Measurement of Stress

The body's stress response including the hypothalamic-pituitary-adrenal axis, the sympathetic-adreno-medullary system, and immune systems[18–20] is activated in response to adversity. In the absence of adequate caregiver support, abnormal over-activation of the stress response can result in a state described as toxic stress[9]. In this state, a wide range of inflammatory molecules including hormones (particularly cortisol, adrenaline, noradrenaline and CRH), inflammatory cytokines and c-reactive protein are released. This state is associated with a wide range of negative health outcomes in children and adults[21], including cardiovascular disease[22], depression[23] and cancer[24 20,25,26]. One of the most studied of the inflammatory molecules is cortisol which is the end product of the hypothalamic-pituitary-adrenal (HPA) axis and is a key part of this PhD.

The HPA axis connects the brain to the tissues and is a key part of the stress-response system. The axis begins in the brain at the hypothalamus where in response to a range of stimuli it releases CRH (corticotropin releasing hormone). This in turn stimulates the pituitary to release ACTH (adrenocorticotropic hormone) which in turn stimulates the adrenal cortex to release cortisol, the main end product of this axis. Cortisol is an essential and normal part of human physiology and has a multifaceted role. For example, cortisol is released in response to fasting to stimulate

gluconeogenesis and to infection to inhibit production of interleukins and other inflammatory factors. Figure 5 visually represents this description.

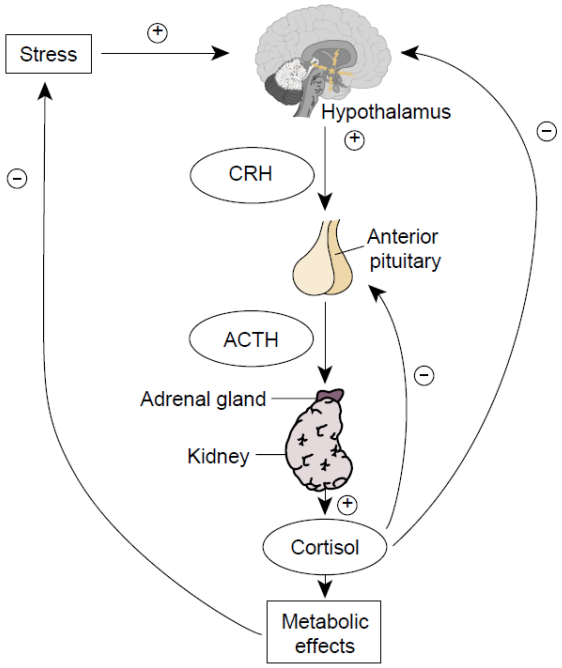

Figure 5: Schematic of Hypothalamic Pituitary Adrenal Axis.
Figure from [27]. The hypothalamus secretes CRH that acts on the pituitary gland which releases ACTH. This acts on the adrenal glands to release cortisol which has a range of metabolic effects

Cortisol has been assessed in relation to a wide range of adversity, including in the seminal work by Gunnar et al showing that children raised in Romanian orphanages in early life still had higher levels of salivary cortisol more than six years after adoption into a family if they had spent more than 8 of their first 12 months in the orphanage[28]. In a healthy state, cortisol rises rapidly on waking in the morning, reaching a peak at 20-30 minutes post-waking. It then gradually falls during the day to a nadir at night. This diurnal rhythm is seen from three months of age[29].

Research studies examining cortisol have standardly used blood, urine and saliva samples. There are measurement and practical difficulties with each. With blood sampling, a rise in the hormone is seen quickly after the beginning of the potentially stressful sampling procedure therefore limiting the validity of the result. With urine, all urine output must be collected over an extended period of usually 12-24 hours which

can be particularly difficult in children and gives only a total amount of cortisol rather than a measure of diurnal rhythm. Saliva has the advantage of measuring the diurnal rhythm but multiple samples are required to capture this. Calculated measures include diurnal cortisol slope (degree of decline in concentration from morning to late evening) and area under the curve (multiple measures are taken and an estimate made of average cortisol exposure - this provides no indication of diurnal change).

None of these methods measure chronic exposure to cortisol over weeks to months. This would be advantageous in understanding ways in which chronic stress affects health and wellbeing. Measuring cortisol concentration in hair provides a relatively novel way to overcome this because hair acts as a store for cortisol and gives an indication of the amount of cortisol a person has been exposed to over a prolonged period (1cm of hair is equivalent to approximately 1 month exposure). Other advantages of measuring this way are that only one sample is required, hair samples require no specific storage or transportation methods, and laboratory analysis is relatively straightforward. Sauve et al published one of the first reports of measuring cortisol in hair in 2007[30] and the number of studies reporting using this measure has increased rapidly since then. A recent systematic review described 36 studies specifically assessing the determinants of hair cortisol concentration in children aged under 18 years[31]. All studies were done in high income countries and were done predominantly with school age or older children. Eighteen of the studies assessed associations with child trauma, stressors and family socioeconomic status, however findings were mixed and effect sizes small or equivocal. The authors suggest that this may be because of inconsistent definitions of trauma and stressors, and because of studies being done in high-income, mostly relatively equal societies.

Some of the advantages and disadvantages of measuring cortisol in different specimens are compared in Table 1. This table also includes the recently described measurement of cortisol in fingernails[32].

Table 1: Relative benefits and drawbacks of using blood, urine, saliva, hair and fingernails for cortisol analysis in children (based on [33])

Sample	Use in clinical & research settings	Use in young children	Common protocols	Time period represented	Invasiveness of sample collection	Child-specific notes	Could sampling procedure affect result?	Storage requirements
Blood	Widely used	Used	One early morning sample	Point measure	High	Painful	Yes	Spinning then cooling - freezing required if analysing later
Urine	Widely used	Used	Usually collect all urine over 12 - 24 hours	Usually 12-24hr dependent on protocol	Moderate	Difficult & time-consuming to collect all urine	Possibly if stress response provoked	Cooling - freezing required if analysing later
Saliva	Widely used	Used	Multiple samples over multiple days	Point measure – multiple samples used to study diurnal rhythm	Low	Sample timing crucial	Unlikely if appropriate protocol used	Cooling - freezing required if analysing later
Fingernail	Very novel	Very novel	One sample taken at any time	Months	Low	Quick & pain free	No	Room temperature - may be possible to analyse years later
Hair	Relatively novel	Used but relatively novel	One sample taken at any time	Months	Low	Quick & pain free	No	Room temperature - can be analysed years later

In this PhD I measured cortisol in the saliva to assess diurnal rhythm and in the hair to assess chronic exposure.

Saliva has been the most widely used sampling method, providing a non-invasive method of collection which can be completed by non-experts (including family members). 0.1mL - 0.5mL is required and the process causes minimal distress in children. Samples are usually taken using absorbent palatable swabs and these may be stored at room temperature for 5 days[34,35] , and at 5°C for up to 3 months[36] without affecting results.

Hair grows at 1cm per month, and provides a method of measuring levels of chronic month-by-month systemic exposure to cortisol[33]. Hair cortisol levels are correlated with 24 hour urine levels[30] yet provide a much more feasible method of measurement, particularly in children[37].

1.5 Setting for the PhD

This PhD was embedded in the community-based SPRING cluster randomised controlled trial in India. Strong randomised controlled trial evidence suggests that home-visiting interventions can improve child development and allow children to compensate for delays in their development due to risks including malnutrition and poverty. The challenge is to deliver such interventions at scale. SPRING aimed to address this challenge by improving early childhood growth and development in India through a home-visiting intervention by community-based agents (CBAs), using a cognitive therapy (CBT) based counselling approach to promote optimal nutrition and psychosocial stimulation. SPRING began in 2011 in anticipation of the upcoming prioritisation of early childhood development at the global level.

The SPRING intervention was branded as *Kilkaari* which means the happy gurgling of a young child. It was delivered by project-appointed community-based agents

called *Kilkaari* workers who visited all mothers and their children monthly at home through pregnancy and the first two years of life. The aim was to target child feeding, interaction and play, using a counselling approach including live demonstrations of the skills being promoted. CBAs used a *Kilkaari* booklet 'job-aid' with visit-specific cards; one-side of the card contains pictures to be discussed and the core messages being promoted were on the reverse (example of a card shown in Figure 6).

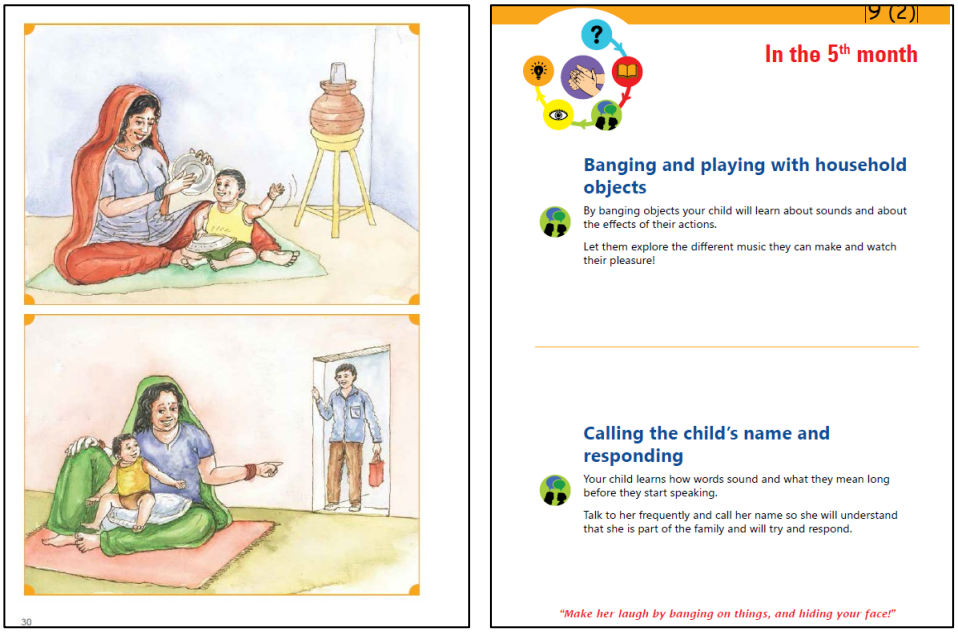

Figure 6: Kilkaari booklet job-aid – 5th month of life card. This shows two pictures to be discussed with key messages on the reverse (a Hindi version was used in the program)

The SPRING approach was guided by the conceptual framework illustrated in Figure 7. This was used during development of the intervention and to guide all data collection. The content of the SPRING intervention was based on formative research into current behaviours, barriers and facilitators for adoption of the promoted behaviours. These promoted behaviours for play were adopted from the WHO Care for Child Development curriculum and for feeding from WHO breast- and complementary feeding guidelines. The counselling approach used the following six principles: 1) family support 2) guided discovery using pictures 3) behavioural activation 4) empathic listening 5) problem solving and 6) praise. The play component included coaching on stimulation activities, where CBAs demonstrated and then

coached families on key elements including praise and scaffolding of new activities. The aim was to develop caregiver skills, self-efficacy and recall.

My SPRING-ELS sub-study built on the SPRING conceptual framework and change pathway outlined in Figure 7 in the blue boxes. This figure outlines SPRING inputs and processes focussing on home visits. These were expected to have their impact through intermediate outcomes relating to maternal mental and social wellbeing, knowledge and skills, efficacy, and family support. In turn, these were hypothesised to lead to improved feeding practices, mother-child interaction and improved child play/stimulation.

SPRING-ELS added the two elements which are highlighted in red boxes: the first is the addition of cortisol measures of early life stress and the second is broadening of SPRING contextual measures of family and childhood adversity.

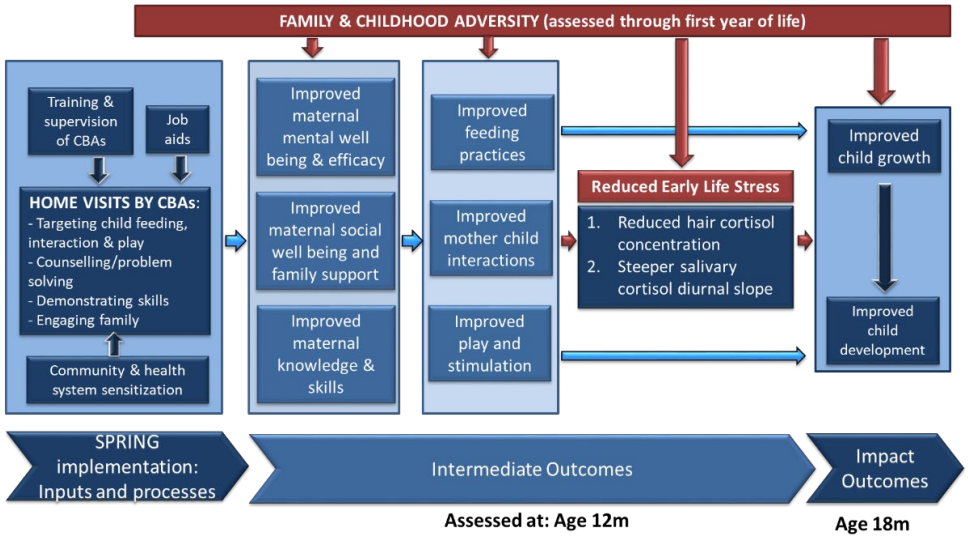

Figure 7: SPRING conceptual framework and change pathway with additions from the Early Life Stress sub-study (SPRING-ELS) highlighted in red boxes.
These are twofold: 1) An increased focus on number and types of family and childhood adversity through the first year of life and 2) Addition of cortisol measures of early life stress

SPRING-ELS had two aims: 1) to explore the relationship between adversity, early life stress, growth and development and 2) to evaluate the impact of the SPRING intervention on early life stress. This PhD focusses on the first of these.

1.6 Aims and objectives of PhD

The overall aim was to generate new knowledge regarding the relationships between childhood adversity, early life stress and growth and development of children in the first 18 months of life.

The underlying hypotheses were that childhood adversity is associated with measurable changes in cortisol measures of early life stress and that both adversity and cortisol measures are associated with impaired child growth and development. There were five specific objectives as follows:

1. To understand mothers' perspectives on early childhood adversity and stress and how this relates to health and development of young children
2. To develop a framework for assessing early life adversity in rural India, using both existing tools and developing new tools where required
3. To determine the impact of number and types of adversity on childhood growth and development in rural Indian infants. The hypothesis was that increasing numbers of adversities, and different types of adversities would be negatively associated with childhood growth and development
4. To develop understanding of the influence of number and types of adversity on cortisol measures of early life stress in rural Indian infants. The hypothesis was that adversity would be associated with chronically elevated cortisol, and with dysregulated daily rhythm
5. To examine the role of early life stress as measured by cortisol in early child growth and development. The hypothesis was that cortisol would be negatively associated with growth and development.

1.7 Structure of Thesis

This thesis is framed around five research papers as illustrated in the conceptual framework in Figure 8 and described in more detail below. These paper are presented in Section C.

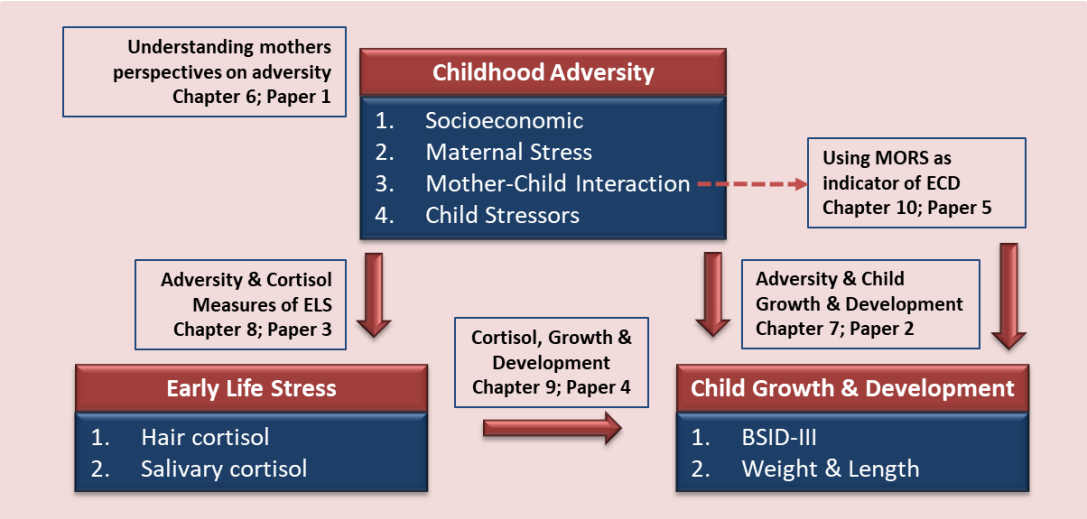

Figure 8: Conceptual framework for PhD including papers presented.
Note: ELS stands for Early Life Stress; MORS is the Mother's Object Relations Scale; BSID-III is the Bayley Scales of Infant Development Third Edition

- Paper 1 (Chapter 6): In this first paper I present qualitative work describing mothers' views of childhood adversity – this is an important part of considering how subsequent findings might be used to influence programmes and policies that could have an effect at the household level. All methods for this work are presented in the paper. This has been published online by Wellcome Open Research and awaits peer review.
- Paper 2 (Chapter 7): here I examine the relationship between cumulative adversity and growth and development. This is the first time this has been studied in this depth in a low/middle-income country setting and sets the scene for the subsequent papers. This paper has been peer-reviewed and was recently published in the journal PLOS ONE.

- Paper 3 (Chapter 8): this paper examines the relationship between adversity and cortisol measures of early life stress. This is the first paper describing hair cortisol assessment in children in any low/middle-income country, and the results make an important contribution to the literature examining determinants of cortisol dysregulation which is a growing field of study. I responded to reviewer comments at the Elsevier journal Psychoneuroendocrinology in January 2019 and await a final editor's decision.
- Paper 4 (Chapter 9): this describes the specific relationship between hair cortisol and growth and development, finding an important predictive role for hair cortisol which may be of interest to future research and programmatic work. This paper is prepared for submission.
- Paper 5 (Chapter 10): this final paper examines whether the Mothers Object Relations Scale - a relatively simple questionnaire administered with mothers examining the mother-child relationship - could be an efficient proxy measure for early childhood development and will be of interest to those designing future studies. This paper also describes the SPRING adaptation process in detail. This paper is under review at the journal Child: Care, Health and Development.

Section B which precedes the papers contains additional detail on PhD methods for papers 2 to 5. The thesis ends with Section D which summarises conclusions and recommendations for future research.

1.8 Literature Searches

As well as background information presented in this section, each of the PhD papers contains relevant literature. The detailed search strategies used for all papers are presented in Appendix 1.

1.9 Ethical and Regulatory Approvals

SPRING-ELS was approved by the LSHTM intervention research ethics committee (19 May 2015, approval number 9886) and the Sangath Institutional Review board (27 May 2015). All work conducted by SPRING was also approved by these bodies (LSHTM: 23 June 2011, approval number 5983; Sangath: 19 February 2014). Letters from these bodies are presented in Appendix 2.

I also obtained specific approval from the Indian Council of Medical Research's Health Ministry Screening Committee (HMSC) (6 October 2015) which is responsible for approving foreign funded research being carried out in India. SPRING had previously received this approval (24 November 2014).

1.10 Funding

SPRING-ELS was funded by my Wellcome Trust Research Training Fellowship of £445,440, held at the London School of Hygiene & Tropical Medicine (LSHTM) where I was employed as a Clinical Research Fellow from 4 March 2015 until 5 March 2018. Betty Kirkwood was the sponsor in London and Vikram Patel was the sponsor in India.

1.11 Role of the candidate

I conceived SPRING-ELS as a sub-study of the SPRING trial in India and developed the proposal with input and advice from Betty Kirkwood, Reetabrata Roy, Bilal Avan, Jane Barlow, Matt Bristow, Gauri Divan, David Osrin, Barak Morgan, Sophie Hambleton, Helen Weiss, David Mabey, members of the SPRING team and Technical Steering Committee, and members of The Wellcome Trust Bloomsbury Centre for Global Health Research Policy Group.

I was based full-time at the study site in India between March 2015 and July 2016. During this period, I set up the SPRING-ELS sub-study including: attaining ethical and regulatory clearance, creating administration and financial systems, designing data-collection tools and standard operating procedures for these, leading cultural adaption, designing fieldwork strategy, training fieldworkers, writing laboratory protocols, and contracting and supervising the laboratory.

As well as these activities in SPRING-ELS, I was an integral member of the SPRING India trial management team. In the SPRING 12-month child assessment I was responsible for writing and finalising all assessment tools and standard operating procedures, and cultural adaptation of these for use in Haryana. I was also integrally involved in training for all tools, recruitment of research associates and fieldwork staff, and setting up the data management and data entry systems. On my return to London in July 2016, I managed weekly outcome assessor fieldwork schedules for both SPRING-ELS and SPRING using an electronic system which I designed; managed field supervisors through regular phone and internet communication; and managed the laboratory sample storage and analysis. For the SPRING 18 month child assessment I played a major role in revising the Bayley Scales of Infant Development for use by non-specialists and managed weekly outcome assessor fieldwork

schedules. I made two week-long trips to Haryana during this period to troubleshoot and supervise fieldwork.

I was actively involved in all SPRING data management and analysis as well as that of SPRING-ELS. I received all SPRING and SPRING-ELS data from India in Microsoft Excel sheets. I cleaned this data, and merged it into the final database. I created all trial flowcharts. I did all of the SPRING-ELS analysis presented in this PhD. I took statistical guidance predominantly from Seyi Soremekun, with specific advice from Kathleen O'Reilly on multilevel modelling, and Christian Bottomley on multilevel modelling and multiple imputation.

I wrote the five papers presented in this PhD.

I resumed my NHS specialty training post in Paediatrics on 6 March 2018.

SECTION B: Methods

Chapter 2: Study Design

2.1 Setting

SPRING took place across three administrative blocks of Rewari district, Haryana state, India. The total population was around 200,000. Rewari district is predominantly rural and has health and demographic indicators around average for the state. The overall literacy rate in Haryana is 76%, with female literacy of 67%[38]. The sex ratio is 879 females per 1000 males[38] – amongst the lowest ratio in India. Infant mortality is 41/1000 live births[39] – around the national average. More than one third of under-five year old children are stunted[40].

2.2 SPRING Evaluation Overview

SPRING was evaluated by a cluster randomised controlled trial with the aim to provide high-quality policy-relevant evidence.

There were 24 clusters which were defined as the catchment area of a sub-centre (the lowest level of the Indian public healthcare system) with a functional Auxiliary Nurse Midwife, and covering a population of at least 8000. The map in Figure 9 shows the clusters spread across the study site. The clusters were also the supervisory zones of the “ASHAs”, a governmental community health worker comparable to the project appointed Kilkaari workers.

The trial was supported by a trial surveillance system set up specifically for SPRING. This was managed separate to the SPRING intervention and involved trained surveillance fieldworkers visiting all households throughout the study site (intervention and control clusters) every 8 weeks to identify pregnant women and newborns, and to follow-up all women of reproductive age, aged less than 50 at enrolment into the system, married and not sterilised.

A restricted randomisation procedure was used to allocate clusters to intervention or control arms of the trial, with the following parameters specifying allowed differences between trial arms: no more than 0.5% difference in stunting, no more than 2.5% difference in mothers with no education, and no more than 2.5% difference in healthcare facility delivery.

The target population of the SPRING home visiting intervention (briefly described in Section 1.5; more details at clinicaltrials.gov, identifier NCT02059863) was all pregnant women and mothers with babies under two years of age. Trial participants were mothers of all live born babies identified by the surveillance system in trial clusters in the period following the date of full implementation of SPRING (18 June 2015). Exclusion criteria were babies with major congenital malformations and babies whose mothers died or who were incapable of answering questions.

All clusters (intervention and control) received advice as currently provided by government health workers (ASHAs and Anganwadi Workers), and access to routine maternal and child health services.

SPRING impact outcomes were height-for-age, the best early childhood predictor of human capital[41], and Bayley Scales of Infant Development III (Bayley-III), the gold standard assessment of a child's development in the early years[42]. Outcomes were measured on the first children born per cluster following the date of full implementation of SPRING (18 June 2015) until sample size requirements were met in each cluster. This was done so that all children in the trial evaluation had the potential to benefit from the full intervention content prior to assessment.

It was not possible to blind surveillance fieldworkers to cluster allocation because they lived in the study site, however all efforts were made to blind those who did outcome assessments when children were 12 and 18 months of age.

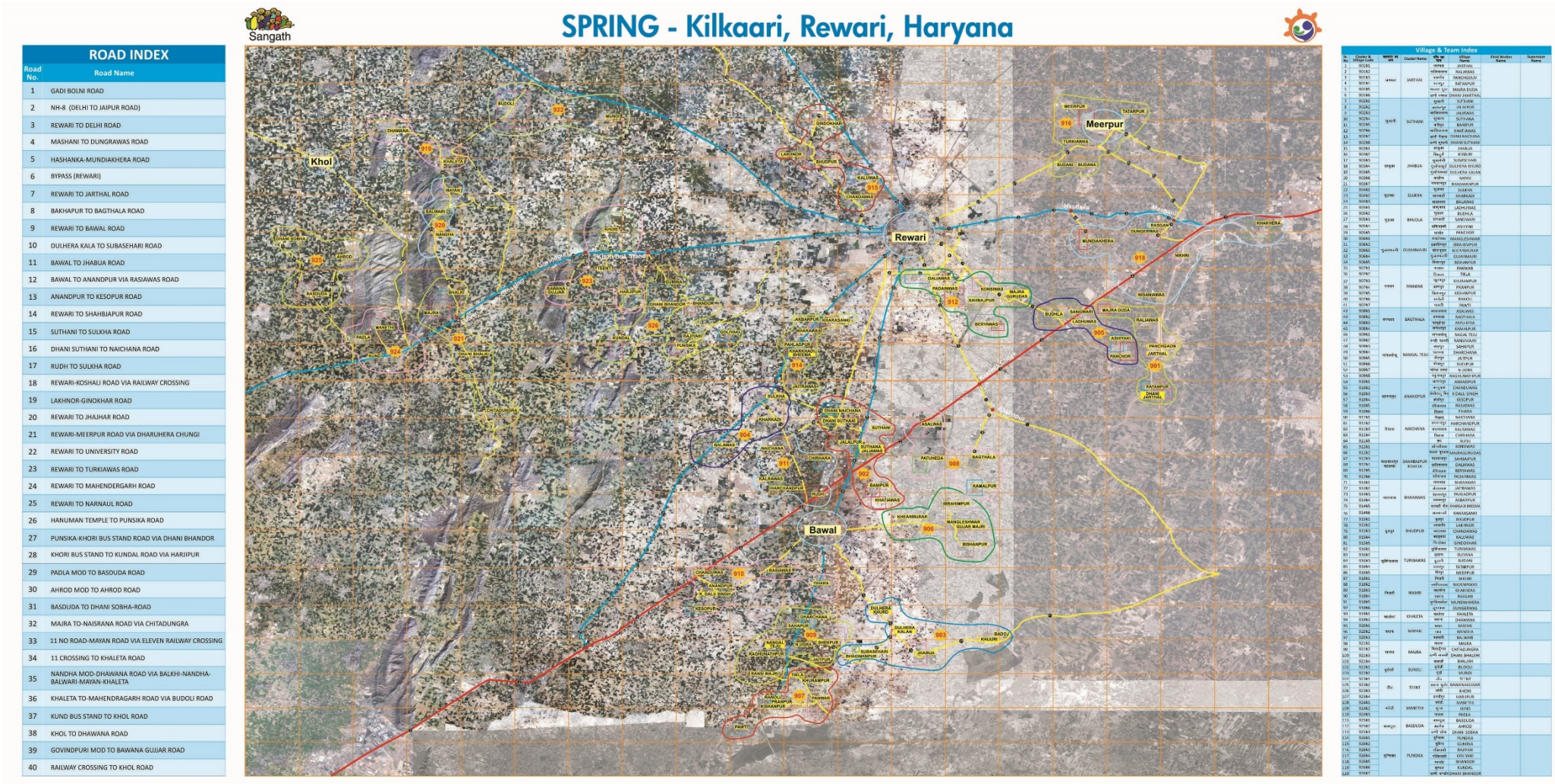

Figure 9: Map of SPRING study area

2.3 SPRING-ELS Participants

SPRING-ELS participants were all children enrolled in SPRING, who were born in each cluster following the data of full implementation (18 June 2015) until the sample size was met in each cluster. This included children who lived in both intervention and control clusters in order to maximise sample size and therefore statistical power. A minimum sample size of 25 children per cluster was needed to give 90% power at the 5% level of significance to explore a range of adversities with prevalence of 20% to 80% and to detect effect sizes between 0.4SD and 0.5SD (assuming an intra-cluster correlation of 0.05) using an established formula[43]. Despite the lack of impact of SPRING on primary outcomes, allocation to control or intervention cluster was included in all statistical models to account for any potential interference of this allocation in conclusions drawn regarding the associations between adversity, cortisol and growth and development.

Chapter 3: Data Collection

3.1 Assessor recruitment, training and supervision

All assessors were non-specialists. Recruitment was conducted in a multi-stage process starting with 200 candidates. Following interview, 41 individuals were trained for a month in theoretical and practical aspects of study tools before being allocated to one of three roles based on their ability to understand tools, observational skills, organisational and communication skills and level of initiative and discipline shown during training. These were Outcome Assessor (OA), Junior Outcome Assessor 1 (JOA1) and Junior Outcome Assessor 2 (JOA2).

Each assessor received at least one supervision visit per fortnight by one of two research associates who had backgrounds in public health, physical anthropology and mental health. Supervisors evaluated adherence to standard operating procedures and communication skills with families. Immediate feedback was provided and key lessons for all assessors compiled for a weekly meeting. During this meeting assessors also raised questions from the field, practiced role-plays of difficult scenarios and were updated on organisational changes.

Assessors worked from a separate office to that of the intervention team. They were blinded to cluster allocation and were not introduced to the trial objectives but told broadly that this was a study about child growth and development.

3.2 Measurement of childhood adversity

Adversity is context-specific so in SPRING-ELS we needed to generate relevant measures of childhood adversity for our study setting. To develop our set of adversities, we did formative research with local mothers (reported in Paper 1 (Chapter 6)), took advice from child development experts and reviewed the literature on existing tools.

We applied these three sources of information to a new conceptual framework for adversity in young infants in this setting. This put the child at the centre of the model, with connected to caregivers, with a child-carer relationship, all within a socioeconomic context. We did not include environmental or wider community-based factors in this model. We placed adversities that had emerged from the formative research into the four categories, and supplemented each of the categories with factors identified from the literature which appeared to be of importance in the context. Finally, we discussed the selected measures with child development experts to include their perspectives on both the proposed adversities and measurement tools. Where possible, we included established and validated measurement tools over developing new tools/measures. Finally there were 22 adversities as detailed below. Each was scored as a binary measurement; an adversity was scored either 1 if it was present or 0 if absent. Data on the majority were collected at the 12-month child assessment, except for socioeconomic status and parental education which had already been collected when children were identified by the trial surveillance system. Adversities 5 to 9, 12 to 15, and 17 to 22 were added by SPRING-ELS. The remainder were already planned in SPRING. All SPRING-ELS additions were assessed using the tools “ELS Questionnaire” and “Observed Feeding Index” which are presented in Appendix 7.

1) Asset index: this was calculated with principal components analysis using data on mother, household demographics and animal and other asset ownership. This adversity was considered to be present if a family was in the lowest quintile for the population at enrolment.

2) Low mother education: this was defined as the child’s mother having no formal education or having only attended primary school

3) Low father education: this was defined as the child’s father having no formal education or having only attended primary school

4) Father occupation: this was defined as the father not working, being seasonably employed or being a casual labourer

5) Age of mother's marriage: this was present if the mother reported having been married under the legal age of 18 years

6) Family debt: this adversity was present if the mother reported family debt or being unable to afford to buy food for herself or her child at any point since becoming pregnant

7) Death of mother's close family members: this was present if the mother reported one or more deaths in a first degree relative or close friend since becoming pregnant

8) Mother seriously injured or ill: present if the mother answered 'yes' to the question "Whilst you were pregnant, did you have any serious illness or have you been seriously injured?" or to the follow-up question "and what about since your child was born? Have you had a serious illness or have you been seriously injured?"

9) Violence against mother: This was assessed using 1) the WHO multi-country study on women's health and domestic violence against women[44] to assess violence from the husband and 2) mother reported violence of any type from any other person. It was considered present if the mother reported any violence since becoming pregnant

10) Maternal depression: this was assessed using the PHQ9, one of the most commonly used screening tools for depression which has been used widely in India[45]. It related to the past two weeks. The adversity was present if the mother screened positive for mild, moderate or severe depression (score greater than 5) or answered 'yes' to PHQ9 question on suicidal ideation

11) High maternal stress or low support: this was assessed using the Duke social support and stress scale[45] which asks a mother to report the amount of a)

support and b) stress she receives from people she knows as ‘none’ (0 points), ‘some’ (1 point) or ‘a lot’ (2 points). These points are summed to make a score for support and one for stress. The adversity was present if the support score was 40 or less, or stress was 28 or more

12) Father alcohol use: This was present if the mother reported problematic alcohol use by her husband when asked the question “does your husband’s alcohol use cause any problems for you?”

13) Preference for boy child: this was defined as mother report of any family member being unhappy when they found out that the child was a girl

14) Mother-infant relationship: this was assessed using the Mother Object Relations Scale – short form (MORS-SF) which consists of 14 short statements placed within two subscales (warmth and invasion) which a mother is asked to rate on a Likert-type scale from 0-5 to identify potential problems in early mother-infant relationship[46]. Each scale therefore has a minimum score of 0 and maximum of 35. This adversity was defined as moderate or high concern level (moderate: warmth 0-22 & invasion 0-11, or warmth 23-25 & invasion 12-35; high: warmth 0-22 & invasion 12-35). There is more detail on scoring of this scale in Paper 5.

15) Feeding Style: this was defined as a very low number of interactions between carer and child observed during a feeding episode. It was assessed using the observed feeding index, a tool developed in this PhD where feeding is scored using tick-boxes (See Observed Feeding Tool, Appendix 7. This adversity was present if there were: <=1 positive talk by mother towards child, and <=1 episodes of playful feeding and <=1 responsive feeding actions, plus one or more negative actions such as force feeding, holds child’s head still to give food, shaking, threatening, shouting or berating observed by the mother towards child during feeding session

16) Quality of the home environment: measured using the HOME inventory through observations of the home and questions to the mother over the course of one hour[47]. This adversity was present if the score was in the lowest quintile; the cut-off for the quintile fell between 27 & 28 points and the lowest of these (27 points) was chosen to create a conservative estimate

17) Mother reported premature birth: this was assessed by asking mothers "Was your child born early?"

18) Child hospitalised in first year of life: reported by mother

19) Separation of mother and child: this was present if the mother reported being separated for more than a week in the first year of life

20) Inadequate care: defined based on UNICEF Multiple Indicator Cluster Survey methodology[48] as the child being left alone or with a child under 10 years for more than one hour in the past week

21) Verbal sibling abuse: Older children in the house say anything to make child cry or unhappy in the last week [48]

22) Physical sibling abuse: Older children who live in house hit, punched, kicked or bit child on purpose to make them unhappy in the last week

3.3 Cultural adaptation of adversity tools

All tools followed the same rigorous cultural adaptation process to make them ready for use in SPRING and SPRING-ELS. The aim was to produce tools in Hindi which were culturally relevant. The emphasis in the methods use was on testing multiple versions of suggested tool translations and changes in an iterative manner, whereby possible improvements are tested with multiple audiences before finalisation.

This was done in a systematic process using six steps as described below:

Step a) Translation into locally-relevant Hindi: Translation from English to Hindi was done independently by the two research associates and written out in full (both

Hindi and English language scripts). Hindi has different dialects and vocabulary changes between regions; because the two research associates had been based in the field-site for a considerable period of time, and were interacting in the local language on a daily basis, they were able to suggest locally appropriate language. They discussed original tool-items that were ambiguous or difficult with me at this stage to attempt to develop as strong a translation as possible.

Step b) Assessing technical equivalence of translation: The translators were joined by a clinical psychologist with specialist knowledge of the underlying tool constructs and experience of cultural adaptation to form a translation team. The clinical psychologist compared and reviewed the translations to ensure that they were technically equivalent. Some translations were removed at this stage, and where multiple translations were considered equivalent, all were field tested along with any new suggested translations emerging from team discussion. Queries remaining following this step were discussed with the trial director and principal investigator, with me and with original tool authors where appropriate.

Step c) Field research: cognitive interviews with mothers of young children and project staff: The two research associates were trained by the clinical psychologist to do the field research through focus group discussions. The first discussion group for each tool comprised non-specialist SPRING trial surveillance workers who were residents of the study area and were themselves mothers. Findings from this group informed further sessions held with mothers in the study site with children aged 2 to 5 years old. These children were born before the trial started and were therefore not part of outcome assessments. All discussions were held in the SPRING site office.

Participants were recruited purposively to encourage detailed discussion and were paid travel expenses.

The facilitators explained to participants that we were developing a questionnaire and needed them to help us in selecting the correct words that mothers of young children in Rewari district would find it easy to understand. They emphasised that they were not asking participants to answer questions, rather were asking for help in choosing appropriate wording.

For each statement, the facilitator read out the translation and asked a participant to repeat it back using their own words. Where the participant's description differed from the original tool meaning, the facilitator asked why those words were used and discussed this with the group. The facilitators then asked the group for input on the statement and the individual words used within it. They asked for suggestions of improved ways of asking the same question and for the group to point out words they felt mothers would not understand.

The translation team revised the statements in the light of these two focus groups discussions and then held individual cognitive interviews with mothers of children aged 2-5 years in the SPRING study area. Interviews were done in the mother and child's home at a convenient time for the mother and a similar discussion method to the focus groups was used.

Decisions from each interview were incorporated into the provisional translation. Translations continued to be modified in this way until no further useful information was being gathered.

Focus groups and interviews were documented using a grid filled out after each session against each original English statement as follows: up to three translations per item; notes on technical equivalence; notes and comments from each focus group along with revised translation; notes and comments from each cognitive interview

along with revised translation. This grid made clear the progression of each item through the translation, technical equivalence, focus group and cognitive interview adaptation steps and allowed us to refer back to earlier discussions whilst conducting field research.

Step d) Finalisation of tool for pre-testing: The whole team reviewed final tools. Back translation was performed by a bilingual public health expert who did not know the tools and only knew broadly that they addressed elements of child health.

Step e) Pre-testing by research associates: Pre-testing was carried out by the RAs with mothers of young children. The RA was accompanied by an assistant who took notes and recorded their own perceptions of the interview. The purpose was to test the administration of the whole tool, including instructions and standard operating procedures. During pretesting the wording of the tool was also assessed, and the extent to which the wording allowed the tool to flow in a natural manner.

Step f) Assessor training and pilot-testing: establishing inter-rater reliability and testing standard operating procedures: Training was done in the classroom and in the field, with specific training depending on the tool; for example, the HOME-inventory was a more complex tool that required more in-depth supervision compared with PHQ9, a nine-item tool that had been previously used extensively in India. Assessors pilot-tested tools by working in pairs. Each assessor conducted assessments whilst their partner scored simultaneously. Inter-rater reliability was measured based on performance of each assessor-pair. All assessors were observed by a supervisor performing several assessments. More detail on cultural adaptation of the MORS-SF is presented in paper 5 (Chapter 10).

3.4 Measurement of Cortisol

Hair: A sample of 1-3cm was cut with scissors from the posterior vertex (back of the head – the area with least intra-individual variability[30]) as close to the scalp as possible. The aim was to obtain at least 10mg of hair (approximately 1cm diameter, 2-3cm length)[37]. This volume of hair was acceptable to families and caused minimal impact to hair appearance. Samples were wrapped in aluminium foil, labelled and the scalp end marked. This is illustrated in Figure 10.

Figure 10: Hair sampling in SPRING-ELS study
Selection of hair strands from posterior vertex (left) and laying out on aluminium foil prior to packaging (right)

On arrival at the site office samples were cut to select the most proximal 3cm and repackaged in aluminium foil then a paper envelope ready for weekly courier collection and shipping to the laboratory along with the saliva samples but outside the cooled container. On arrival at the laboratory, samples were stored at room temperature. Hair was analysed using established methods whereby the hair is washed and dried, cut finely, extracted into ethanol and analysed using a Salimetrics ELISA kit[49,50] in four stages as outlined in the protocol in Appendix 3 which was developed from reports from Davenport[49] and Kirschbaum[50], and on the advice of Dr Matt Bristow, a collaborator with expertise in cortisol analysis.

There were considerable cultural barriers to doing hair sampling in Haryana, and so we carried out formative research which is summarised in Appendix 4. The findings were:

1) It was unlikely to be possible to get 100% compliance because cutting children's hair prior to a ceremonial haircut may be difficult, and because young children often have very short hair in summer
2) Hair cutting would not be acceptable in public places
3) Families may be suspicious of the study team's motives for wanting to cut hair because of associations with black magic
4) Haircutting may not be acceptable on Tuesdays for religious reasons. It may also be unacceptable on Thursdays and Saturdays as well as during religious festival periods

Further details are discussed in Appendix 4.

It was possible to take hair samples in 712 children. Reasons for no sample were consent refusal (283 children), hair being too short (257 children). This is outlined in more detail in the flowchart in Figure 1, Paper 3 (Chapter 7).

Saliva: I chose to use Salimetrics SalivaBio Children's Swabs (Salimetrics, USA; part no 5001.06) for child saliva sampling because they were designed for young infants to avoid choking risk and to be palatable. These swabs have been used in many settings worldwide and are the gold-standard for collection of saliva for cortisol analysis. The swab is pictured in Figure 11.

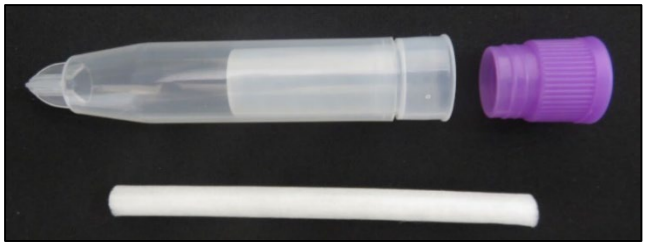

Figure 11: Absorbable saliva swab and storage tube

Saliva sample piloting was done in 10 households in order to learn about young child routines, including sleep and feeding times, to assess difficulty of saliva sampling and to develop SOPs for the whole saliva assessment. The final protocol was based on this piloting and early field experience. There were no cultural barriers to saliva sampling.

Each sample was taken at least 30 minutes after the child last ate, drank and last woke from sleep to avoid interference with cortisol levels. The first sample of each day was taken as soon as possible on entering the household in order to minimise the opportunity for there to be a transient rise in concentration due to a stranger in the household. Samples were not taken if children had been unwell in the past 24 hours because illness affects cortisol production. Samples were not taken if a child had taken a steroid-containing medication in the past 7 days because this is likely to mimic cortisol and give spurious results. Because families and fieldworkers were not able to identify steroid-containing medications by name, we developed a card with commonly seen medications which fieldworkers carried with them for reference.

Sampling was done as follows. The child was positioned on their mother or grandmother's lap and the fieldworker gently introduced the swab into the child's mouth for 30-60 seconds. When it was at least 1/3 saturated (a minimum of 150µL saliva is required for laboratory analysis) it was removed, placed into a storage tube (Salimetrics USA; part no 5001.05) and labelled with a pre-printed freezer-proof label containing only a sample identifier and anonymised child identifier. Time of sampling, time of last food, drink and last waking was then recorded.

Fieldworkers kept samples cool in insulated cooled flasks through the day and we refrigerated them at the site office overnight (samples remain stable at room temperature for several weeks [36,51] but cooling is normal practice). Samples were packed in a cooled container (2-5°C) for daily courier collection and shipping to SRL

Laboratories Ltd, Mumbai, India. Shipping followed the laboratory's established freight route by road to Delhi airport (1.5-2 hours), and air to Mumbai (approximately 2-hour flight) from where they were delivered to the laboratory's Research and Development division. Samples were frozen on arrival and stored at -20°C.

At the laboratory, samples were thawed in batches, centrifuged at 1500g for 15 minutes and refrozen at -20°C. Samples were analysed later in batches using a Salimetrics USA high-sensitivity salivary cortisol enzyme-linked immunosorbent assay (ELISA) according to the manufacturer's instructions. A randomly selected 10% of samples per batch were analysed in duplicate. The intra-assay coefficient of variation of 5.6% and inter-assay coefficient of variation of 9.2% was within acceptable limits [52].

It possible to do saliva assessments in 752 children. The main reason for not being able to take saliva samples in children who had other assessments was illness (192 children) and there were very few consent refusals. This is displayed in the flowchart in Figure 1, Paper 3 (Chapter 7).

3.5 Measurement of growth and development

Weight was measured to the nearest 0.01Kg using SECA-384 electronic scales which were calibrated weekly at the site office. Weighing was ideally done with the child's clothes removed. If this was not possible, the child was weighed fully-clothed, then the clothes were removed and weighed. The difference between the weight of the fully-clothed child and the weight of the clothes was calculated to give the child's weight. Assessors were trained to wait until the scales had finalised measurement, which took up to 30 seconds of the child staying still. The first assessor read out the value which was recorded by a second assessor.

Length was measured to the nearest 0.1cm using a SECA-417 infantometer by two assessors as follows. The child was laid down on the infantometer board. The first assessor cupped their hands over the child's ears and held the head against the end of the measurement board. The second assessor then ensured that the child's body was straight on the board, placed one hand on the child's legs to stabilise them and brought the footpiece upwards towards the child's feet which were held perpendicular to the board. This assessor then read aloud the length board reading and this was recorded by the first assessor.

Bayley Scales of Infant Development (Bayley-III) assessments were done as follows. One assessor performed the assessment whilst the other recorded the results and managed the home environment to ensure that children were not distracted by other family members. Assessments which in a clinic environment would be done using a table and chairs, were done on a specially designed low-level table which allowed assessments, parents and children to sit cross-legged on the floor. Assessors brought this with them on each visit. They also brought stairs which had been specially designed according to the Bayley-III manual, because many houses in the geography did not have stairs and this is a core part of the assessment of motor skills. Each assessment took 2-3 hours to complete.

Each Bayley-III scale consists of a series of progressively more difficult activities which children are asked to do whilst interacting with an assessor. Each item was scored 1 if the activity was demonstrated, otherwise it was scored 0. Assessment on each scale started at the item marked 'K' (start point for 16.5 – 19.5 month old children). Children not able to achieve three activities at that level were assessed as far as two levels back (the item marked 'I', which is the start point for 11 – 13.5 month old children) before the assessment was stopped. The assessment on each scale ended when the child scored 0 on five consecutive activities. Comprehensive cultural

adaptation and inter-rater reliability (IRR) checks found a mean agreement between assessors of greater than 97%.

3.6 Organisation of 12-month child assessment

Adversity and cortisol assessments were done over two days within a window of 7 days prior and 21 days after a child was 12 months of age.

One OA and two JOAs worked as a team of three across a pair of clusters (total of 36 people working in 12 pairs of clusters). On day 1 one the OA and JOA1 worked in a pair. On day 2 the JOA2 worked alone. Each team of three travelled in one vehicle for fieldwork. Day 1 assessments were done from Monday to Friday, and there was a team meeting for Day 1 assessors on Saturdays at the site office. Day 2 assessments were done on Tuesday to Saturday, and these assessors had team meetings on Mondays.

Assessors also made consenting-visits during the spare time between assessments on the two days. These were done in households 2-4 weeks before a child's 1st birthday. They did a second visit to make an appointment a week prior to assessment. These two visits brought the benefit that by the time of the assessment, assessors and families had already met and this was particularly important for biological sampling.

On the day of assessment, assessors arrived in the assessment household at 8am. They used a questionnaire to establish whether the visit could go ahead (See Appendix 7: One Year Visit Form). This established if the mother and child were both present and willing to take part. Next it established whether the child had fever, diarrhoea, vomiting or cough in the preceding 24 hours, and whether they had used steroid medication in the last 7 days. In these cases, saliva samples were not taken but the remainder of the visit went ahead. The order of assessments and timing of

them across the two days is illustrated in Figure 12 showing that the following assessments were done on day 1:

- Three saliva samples at 8am, 12 noon, 4pm
- HOME-IT
- Observed Feeding Index
- Hair cortisol
- Weight and length
- ELS Questionnaire

And that on Day 2 the following assessments were done:

- Three saliva samples at 8am, 12 noon, 4pm
- PHQ9
- Duke Social Support and Stress Scale
- Complementary Feeding questionnaire
- Maternal Knowledge questionnaire

Tools are presented in Appendix 7.

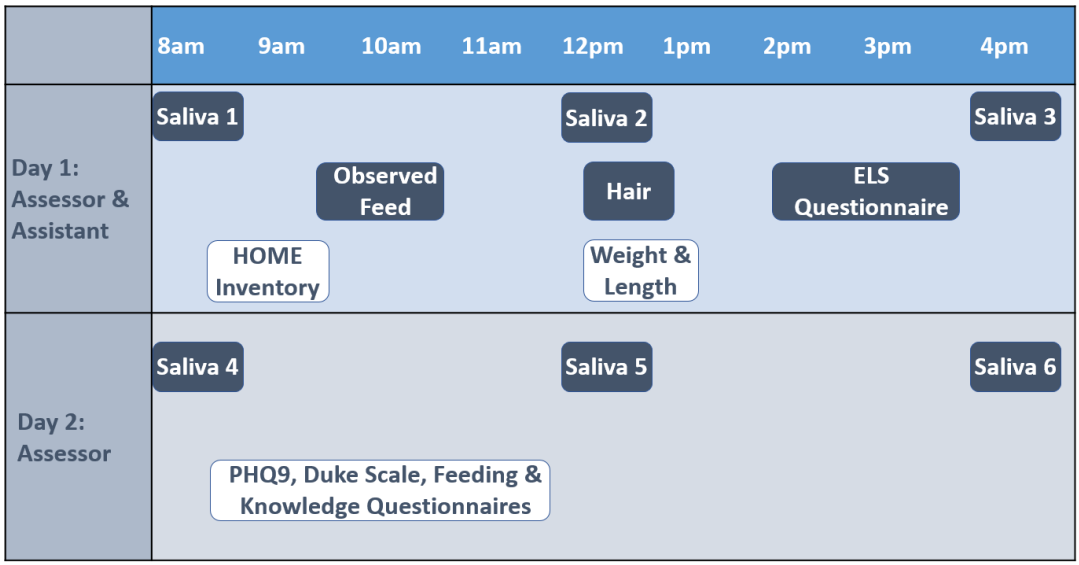

Figure 12: SPRING 12-month outcome assessment visit plan.
Blue boxes with white text indicate contribution of this PhD, white boxes with blue text indicate SPRING data collection

All assessments were recorded on paper-forms and handed in at the site office at the end of each day's fieldwork.

3.7 Child assessment at 18 months

The best performing assessors from the 12-month assessment were selected to do assessments at 18 months of age. They worked in pairs, and each pair assessed two children per day. First ensuring that near they nor their mother was unwell or away from the home, and that the planned assessment day was convenient to the family.

Chapter 4: Data Management and Analysis

4.1 Data Management

All assessment forms were checked for completion daily by a research associate and queries raised with assessors or sent back for checking in the community. Common difficulties or problems encountered were collated and fed back to all assessors at a weekly meeting.

Forms were 'batched' by type, and stored alongside all of those forms done in that week. They were entered into a computer programme by two independent data entry operators. The two entries were compared and anomalies compared with the original form by a senior data entry operator, and rectified.

The next level of checking was to check that entered values were within a pre-specified range, and that results were consistent between questions within a form. This was performed by the Data Manager. Finally, the data manager did inter-database checks to ensure consistency between the different forms and between the existing database.

I received the final SPRING and SPRING-ELS data in individual Microsoft Excel format files for each form, and did all merging of these files, and cleaning of data in Stata 15.

4.2 Adversity Analysis

There was a small amount of missing data as follows: mother married under legal age – 41 missing (3.2%) because this question was edited after the initial week of fieldwork; PHQ9 & DUKE Scale (23 missing (1.8%) because these were done on day 2 of assessment and it was not possible to contact this family again after day 1 assessments were complete); HOME inventory (1 missing (0.07%)) because the mother chose not to answer the questions. There were more missing data for the

feeding quality adversity (418 (32.8%)). Most of these were not done because no mealtime took place during the time in which assessors were in the home. We assumed that these was missing at random and used multiple imputation by chain equations (MICE), including all explanatory and outcome variables in each analysis. We used 30 imputations. Descriptive analyses are presented using a combination of all imputations.

A cumulative adversity measure was created by summing the total of the scores for each adversity. This gave each child a total score with a minimum possible value of 0 and a maximum possible of 22.

Principal components analysis was used to capture the linear combination of adversities which created the maximum variance in the data. The raw PCA output was converted into quintiles to split children into five groups of adversity levels. This is the same technique as that used for generating socioeconomic status quintiles.

Adversities were also summed within four categories to give four adversity domain scores. These were as follows: socioeconomic (adversities 1 to 6), maternal stress (adversities 7 to 12), relationship (adversities 13 to 16) and child (adversities 17 to 22) (This is displayed in Table 1 of Chapter 7 (Paper 2)).

4.3 Cortisol Analysis

Hair Cortisol: hair cortisol concentration was log transformed for each child because of left-skew and then four remaining outliers were winsorized to 3SD above the mean for analysis.

Saliva Cortisol: two measures were calculated from saliva cortisol results for each child. The first was saliva cortisol slope which is a measure of the change in saliva cortisol concentration per hour across the day's sampling. The second was saliva cortisol area under the curve which is a measure of the total hourly exposure of a

child to cortisol over the sampling period. For each saliva cortisol result we first winsorized outlying high values to 3SD above the mean. We then used the rise-over-run formula (change in two cortisol values divided by hours between these) for children with results at 8am and 4pm to calculate the saliva slope for each child. Similarly, we used the trapezoid formula to estimate the total cortisol a child was exposed to which was represented by the total area bounded by two parallel lines at each of two time points on the x-axis, the base on the y axis (where cortisol is zero) and the line connecting the two cortisol values on the y-axis. This was done for children with all three samples on at least one day to calculate saliva cortisol area under the curve with respect to the ground.

A modelling approach was used in regression analyses to make maximum use of saliva cortisol data despite missing values. This is described in Chapter 8 (Paper 3).

4.4 Bayley Scales of Infant Development Analysis

There were five raw Bayley-III scores as follows: gross motor, fine motor, cognitive, expressive language, and receptive language. These were converted to composite scores for each child following the Bayley-III manual, to give the three composite outcome scores motor, cognitive and language.

4.5 Statistical Methods

These are described in detail in Papers 2 to 5 in Section C. In brief, multi-level mixed-effects linear regression was used, taking account of the clustered design by including cluster as a random intercept. There was an extension of this multilevel modelling for Paper 3 which allowed for calculation of two saliva cortisol measures within the model using a varying number of saliva cortisol results per child.

In all analyses I adjusted for SPRING trial arm allocation. However SPRING had no impact on early childhood development, growth, maternal stress, or child cortisol levels (publications in preparation by SPRING evaluation team) and this adjustment did not materially influence the results presented.

Chapter 5: Fellowship Timeline

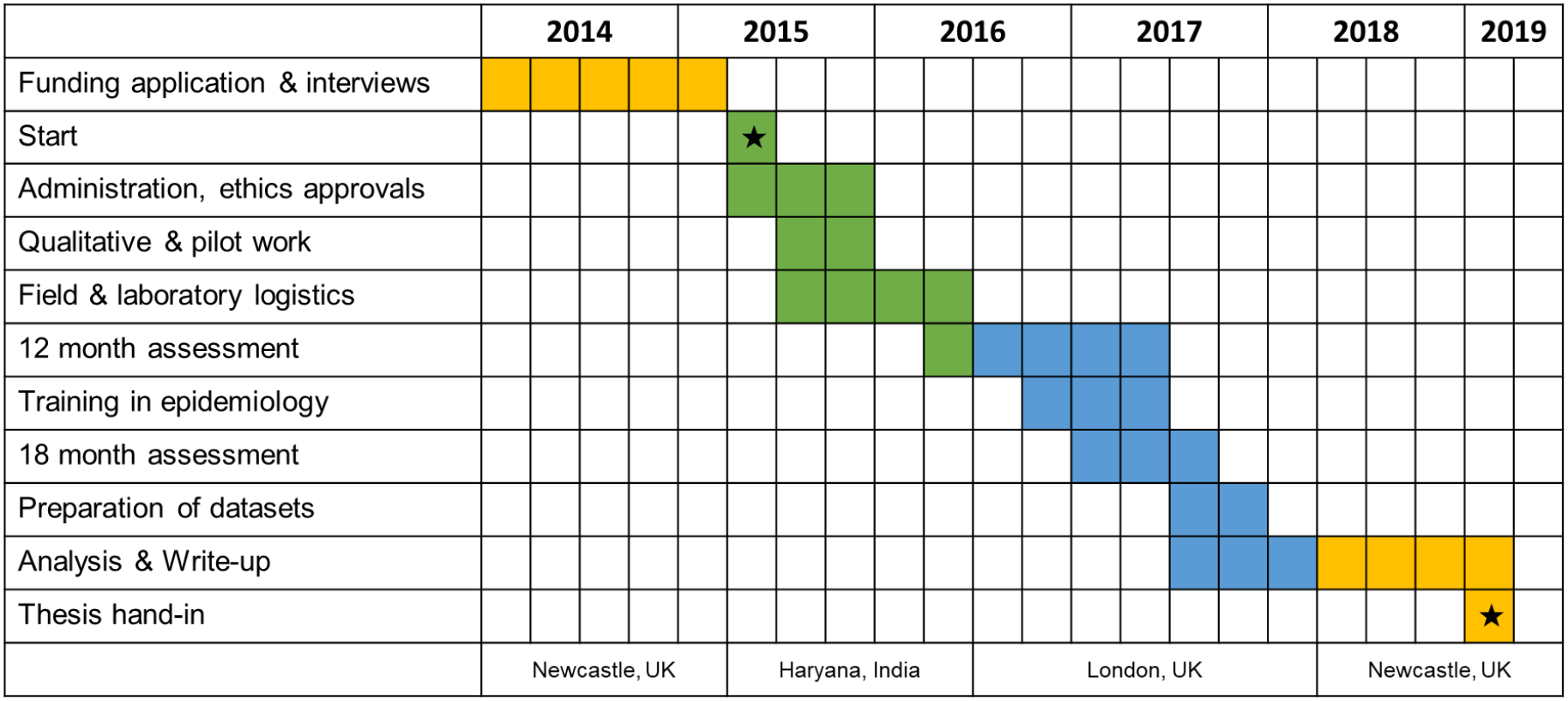

Figure 13: Fellowship timeline showing dates of major activities.
I was based in Newcastle upon Tyne in the time-periods coloured in gold, in India in those coloured green, and in London in those coloured blue. *indicates beginning and end of PhD registration

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SECTION C: Results

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Chapter 6 (Paper 1)

Mothers explanatory models of infant stress & adversity in rural Haryana, India: qualitative findings from the Early Life Stress sub-study of the SPRING cluster randomised controlled trial (SPRING-ELS)

Bhopal S, Verma D, Roy R, Divan G, Hill Z, Kirkwood BR

Wellcome Open Research 2018, 3:153
https://doi.org/10.12688/wellcomeopenres.14943.1

This paper describes the perceptions of mothers of 0-2 year olds with regards to infant stress and adversity. Data were obtained through a series of eight focus group discussions held in the community.

Note regarding this multi-author work:

I led the SPRING-ELS study, of which this paper is a part. I wrote the discussion guide, led recruitment of mothers, analysed data and wrote the paper. The SPRING-ELS research associate moderated the focus groups.

RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

Student	Dr Sunil Bhopal
Principal Supervisor	Prof Betty Kirkwood
Thesis Title	Early childhood stress, adversity, growth & development: findings from the SPRING home visits cluster randomised controlled trial in rural India

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	Wellcome Open Research (online prior to peer-review)		
When was the work published?	03 December 2018		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	N/A		
Have you retained the copyright for the work?*	**Yes**	Was the work subject to academic peer review?	**No**

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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	N/A
Please list the paper's authors in the intended authorship order:	N/A
Stage of publication	Choose an item.

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper	See previous page

Student Signature: [redacted] **Date:** 17 January 2019

Supervisor Signature: [redacted] **Date:** 17 January 2019

RESEARCH ARTICLE

Mothers explanatory models of infant stress & adversity in rural Haryana, India: qualitative findings from the Early Life Stress sub-study of the SPRING cluster-randomised controlled trial (SPRING-ELS) [version 1; referees: awaiting peer review]

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Abstract

Background Exposure to a range of biological and psychosocial adversities in early childhood is of negative consequence through the lifecourse. This is particularly important for children in low- and middle-income countries where at least 250 million children are at high-risk of not meeting their developmental potential. Minimal evidence describes mothers' views of this. We therefore elicited an explanatory model exploring mothers' perceptions of infant stress and adversity in rural Haryana, India.

Methods We did eight focus-group discussions to explore the perspectives of mothers in the general population of this rural area of India using a discussion guide based on Kleinman's explanatory model. Data were coded by two analysts and arranged in themes for presentation. Illustrative quotations were used for presentation of findings.

Results All mothers identified several causes of adversity and stress for children, including poverty, neglect and violence. They described the consequences of this for emotions, behaviour and school readiness of children, and that some of the consequences were reversible with appropriate management. Mothers described younger children as being unable to be affected by adversity, because they were "too young to understand".

Conclusions Mothers agreed with much of the current biomedical model for early childhood development, however the predominant view was that young infants were "too young to understand" is an important deviation. These findings are of importance in designing behaviour change strategies for this crucial period of early childhood which is rising up the global policy agenda with the aim of giving every child the opportunity to thrive.

Keywords

toxic stress, adversity, child development, explanatory model, qualitative, health inequalities

Open Peer Review

Referee Status: *AWAITING PEER REVIEW*

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Comments (0)

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Background

Being exposed to a wide-range of biological and psychosocial adversities including violence, neglect, and maternal depression in early childhood is of negative consequence across the lifecourse[1]. In the absence of high-quality protective caregiving, exposure to these adversities is associated with a condition of toxic stress leading to biological changes throughout the body including overactivation of the sympathethic nervous system, excess of stress hormones, and systemic inflammation[2]. This toxic stress is associated with both structural and functional changes in the brain, with implications for development, health, and disease throughout child- and adulthood[3]. This is a concern worldwide, but particularly for those children growing up in the most disadvantaged settings; at least 250 million children in low- and middle-income countries are at high-risk of not meeting their developmental potential because of early childhood adversity[4]. The president of the World Bank recently commented on the problems this poses for individuals and society:

> *"There can be no equality of opportunity without…appropriate stimulation, nurturing, and nutrition for infants and young children. Conditions of poverty, toxic stress and conflict will have produced such damage that [children] may never be able to [take up] future opportunities. If your brain won't let you learn and adapt in a fast changing world, you won't prosper and, neither will society."*[5]

There is mounting momentum to improve this situation. The World Health Organization recently published a roadmap to improvement in its 'Nurturing Care Framework' for early childhood development[6]. The 'Nurturing care' concept is made up of five interrelated components: adequate nutrition, good health, opportunities for early learning, security and safety, and responsive caregiving[7]. Promoting this at an individual child level requires a meaningful engagement with families, particularly with mothers who are responsible for much of young-child caregiving. This study is based on the premise that mothers have their own explanations for the ways in which infants are growing and developing, and for the positive and negative influences of the environment, including adversity. These explanations influence a mother's behaviour and therefore their capacity to consider new ideas from interventions aiming to improve early childhood development. There is minimal evidence describing ways in which mothers consider adversity and its association with child health and development and so the aim of this study was to elicit an explanatory model, exploring mothers' perceptions of infant stress and adversity in rural Haryana, India.

Methods

Setting

This study was conducted in Rewari district, Haryana state, India in September and October 2015. The district is predominantly rural, and has health and demographic indicators around average for the state. The literacy rate in Haryana at the last census was 76%, with female literacy of 67%[8]. Infant mortality was 36/1000 live births – around the national average[9]. More than one third of under-five year old children were stunted (extremely low height-for-age)[10]. The district capital is Rewari town, which houses the district government administration, government program offices, and key healthcare facilities including the district hospital. Rewari town is around 90km from the Indian capital New Delhi, to which it is connected by rail and road highway. There are considerable family, cultural, and social connections between the villages of Rewari district, the town and surrounding area including New Delhi. Most villages have members who work and travel between the village and the surrounding urban areas. The study setting is diverse and families live in a variety of configurations, however the traditional 'joint-family' where multiple siblings (usually brothers) live with their wives, children, and parents is common. Children are therefore often raised by several adult caregivers, including parents, aunts/uncles, and grandparents.

The site is part of the SPRING (Sustainable Program Incorporating Nutrition and Games) programme, a home visits intervention delivered at scale and aiming to improve early child growth and development. SPRING is evaluated by cluster randomised controlled trial and this is described in detail elsewhere (clinicaltrials.gov registration NCT02059863; see SPRING website).

Choice of data collection method and sampling

We selected focus-group discussions as the most appropriate method by which to explore the combined perspectives of mothers. Collecting data in this way in groups allowed for interaction between participants, and for new thoughts to emerge from discussion. This was important because we were not exploring a named disease but a concept which was not clearly familiar to all participants at the start of discussions. The groups allowed us to gain a broad understanding of models of child development by which we could gather explanations, reasons behind these, and tensions between them. We also wanted to develop insight into which elements were widely shared, and which were more open to individual interpretation.

We used purposive sampling to identify mothers of any age and background, with at least one child aged under 2 years, who lived in the control clusters of the SPRING study area across three blocks of Rewari District, Haryana, India (i.e they were not receiving SPRING home visits). Participants were excluded if they were unable to speak Hindi, or if they were not able to travel to the focus group location. They were included based on their ability to contribute their knowledge on early childhood, and fieldworkers selected participants who they felt were willing and able to share their experiences and views in a group setting. We ensured that they had lived in the area for the majority of their young child's life. This is because some mothers move between their parental- and family- homes when children are young, and we wanted to understand the perspectives of those most settled in the study area as this comprises the majority of the population. A SPRING resident fieldworker with knowledge of the local area and families identified participants who met these criteria and were willing to take part. The mothers selected were from a range of ages and were broadly representative of the communities in which they live. Fieldworkers did not

report difficulties recruiting mothers and none dropped out after agreeing to participate.

Focus group methods

We prepared a discussion guide based on Kleinman's explanatory model[11], conceptualising illness within a framework comprising aetiology, onset, consequences, prognosis, and treatment. Kleinman notes the difference in illness explanation between lay-people and professionals, and builds on Engel's position that the biomedical model focusses on anatomy and biochemistry over information, beliefs and concepts[12]. In this study we specifically wanted to identify areas of conflict between mothers and biomedical explanations.

We wrote the guide in English, translated it to Hindi and then did a back-translation to assess accuracy (see Extended data[13]). We pre-tested the guide with six SPRING staff members who are local residents.

The guide started with two warm-up exercises. These aimed to: introduce the general area of discussion, establish participants as experts compared to the moderator, and introduce planned methods of probing. Mothers were asked to group 20 pictures of child facial expressions into 4 piles: "happy", "sad", "neutral" and "cannot tell" - they were then asked to comment on their own and peers decisions, and were challenged to explain and expand on this thought process. In the second exercise mothers were asked to sort a pile of pictures of objects into piles of items that make a child happy, sad or has no effect (images available as Extended data[13]).

The next step was outlining two scenarios. The first was of a family living in poverty with low-income, poor-quality housing, and overcrowding. Mothers were asked to comment on possible consequences for a child living in this family. Following discussion, the second scenario was introduced illustrating a family with a mother with alcoholic-use problems and a mother with depression. The guide then outlines topics relating to ways in which these scenarios affect children, timing of this effect, other potential causes, and other longer-term consequences for children. Finally, the guide outlines a discussion around prevention and treatment. The moderator was encourage to modify questions and question-order as appropriate to the sessions.

Sessions were conducted at Anganwadi centres or in a health sub-centre (lower level health system facilities), in order that participants were able to easily access the venue and were attending a socially acceptable meeting point. Participants usually lived in the village in which the session was held, and occasionally in a nearby village. In the vast majority of cases, they did not know each other prior to the session, and had not met the moderator previously. We estimated that 5-10 sessions would be required in order to reach a theoretical point of data 'saturation' based on our prior experiences. We expected this to depend on the degree to which the discussion guide and moderation made the topic accessible to participants.

Following piloting with a group of mothers who worked in the SPRING programme, seven focus groups were held, each with 4-6 participants. We felt that given the context and topic, these relatively small groups would encourage active contributions, and that they would facilitate high quality interactions between participants. Each group lasted 50-65 minutes. A total of 34 mothers aged 20 to 35 years took part. Data were collected between September and October 2015 by a female, local research associate (DV) with a PhD in physical anthropology, who was familiar with the local culture and language. DV was trained in qualitative methods, and was well acquainted with the subject, study objectives and discussion guide. DV moderated the focus groups using the guide for structure, and was encouraged to modify questions and order of these as appropriate to moderate high-quality discussion.

Data analysis

Field notes were taken by the moderator who later listened to audio recordings and expanded these, recording her own understanding of the session through reflexive writing and also recording participant's direct quotations in Hindi alongside a translation into English. These 'expanded notes' give a strong reflection of the details of a session in the context of the moderator's comments, and observations of participants and group dynamics[14]. Each draft was discussed in detail with SB and finalised whilst listening to the recording of the session. These expanded notes were the data with which analysis was performed.

We aimed to discover and build an explanatory model by using several components of the grounded theory. There was no *a priori* hypothesis. Data were collected, analysed, provisionally coded, and understood during the process of data collection. Each element of analysis altered subsequent FGDs and the moderator included current understanding in probes and discussions to tested emerging theories with new participants.

Data were continuously analysed by reading the expanded notes, and creating initial word-processed tables capturing data from the expanded notes within provisionally labelled themes. After three sessions we carried out a fuller analysis to identify gaps in understanding, to check if saturation had been reached, and to evaluate the themes and sub-themes that were emerging. After three further sessions (session six) data saturation was approaching as few new concepts were emerging. The data was rich, varied and grounded in what the participants had discussed. In the seventh session, the moderator found that she was able to use fewer prompts, and that the data was in accordance with the synthesised findings of sessions 1-6.

Following the final session, DV and SB read through all data several times on one laptop computer for familiarisation and used NVIVO 11 (QSR international), to code data into domains. Data could be coded in zero, one or more than one domain. Next a document containing all data separated into domains was printed. Each line was analysed in an attempt to 'fracture' the data to open up multiple lines of enquiry, compare with existing

theories, and understand the deeper meaning of the data, and coded zero, one or more codes. Many codes were generated at this stage - the aim was to consider the data as fully as possible, and many of these were later amalgamated or discarded.

Following this fracturing of the data, the codes were arranged within themes to generate themes and subthemes, which is the way in which the data are presented in this report. At this stage there were many quotations per sub-theme. The most descriptive quotations were chosen to represent sub-themes and are presented to illustrate the findings of data analysis.

Ethics
The Institutional Review Board of Sangath (27 May 2015) and the Research Ethics Committee at The London School of Hygiene & Tropical Medicine (19 May 2015, approval number 9886) reviewed and approved the study. Participants were approached in their home by the SPRING fieldworker and DV in the days preceding a planned session. At the beginning of each focus group, an information sheet was read out by DV and participants were invited to discuss this. Participants were asked to keep the session confidential and were assured that the recordings and fieldnotes would be stored securely and not shared with anyone. Written informed consent was then obtained from all participants for both participation and audio-recording of the session. Participants were informed that the study was being conducted for the purposes of understanding how people in the geography think about infant wellbeing. All data were kept on password protected disk drives, data were anonymised for analysis and audio recordings will be deleted one year after publication.

Results
All mothers in all groups recognised both initial scenarios, and were able to describe similar individuals and situations they had come across previously. All participants agreed that the outlined scenarios could cause harm of some type to children. All participants contributed actively, being keen to contribute their thoughts on this topic which related strongly to their own experiences of raising young children. The word '*tanau'* was used to describe 'stress' in Hindi. This term captures a condition which participants described both adults and children as having the potential to suffer from. There was no regularly used word to describe 'adversity'.

Participants explanatory models of childhood stress and adversity are presented in Table 1, organised into four major themes: causes, mechanisms and consequences, prevention and treatment. Three of these have sub-themes.

Causes
Each mother identified several causes of adversity and stress. Most were discussed in several FGDs and are listed with illustrative quotations in Table 2. The table is listed in order of frequency in which the cause was discussed.

Mothers were clear that the effect of each adversity varies from child to child.

> *"We never know which child will take what to heart.... maybe there has been an incident which has occupied their mind.....resulting in [unusual] behaviour. We often do not know what might have hurt a child. If it had been considered during childhood, maybe behaviour would have been different" FGD 1*

Contrary to this negative view, occasionally in several groups individual mothers argued that adversity can lead to positive consequences.

> *"A poor child would be very well behaved, as he has more understanding about valuing the things and opportunities he has, compared with a child born into a rich family" FGD 3*

Mechanisms and consequences
Age of "understanding". The age at which children are seen to be able to "understand" is the crucial factor rather than a specific age in years. Children were described as being shielded from the impact of adversity and stress until they are able to process and comprehend what is happening in their environment. When asked directly by the moderator to give an age, most participants agreed that this was around 3 or 4 years of age.

Table 1. Explanatory model for childhood stress and adversity - themes and subthemes.

Theme	Sub-theme
Causes	Child, Family and Community Causes
Mechanisms and Consequences	Age of "understanding" Mechanisms connecting adversity to consequences Early emotional and behavioural consequences Longer term consequences Reversibility
Prevention	Avoiding stressors Adult support
Treatment	Supportive adult care Medical professionals

Table 2. Causes of childhood adversity and stress identified by participants in focus group discussions.

Cause	Illustrative quotes
Poverty	*"when a child gets hungry....or only gets food half of the time....that child wishes for everything they see, thinking that if they can get it, they can eat" FGD 5* *"In a poor family proper attention is not given to a child, there is no food, there is a lack of money, there is angriness…a child is often beaten" FGD 6*
Neglect	*"If proper attention is not given to young children, such as inadequate feeding, playing or talking with the mother, then the child will not be healthy....they'll lie down silently, and not pay attention to things happening around them" FGD 4*
Violence	*"[when there is alcoholism and fighting in the household] the amount of attention a mother can pay towards looking after her child is reduced" FGD 2*
Pregnancy maternal mental health including stress	*"When a mother thinks about negative things whilst pregnant, it has a negative impact on the unborn child.... on their mental wellbeing....they might be born weak" FGD 2* *"In local language it is said that when child is in the womb, mother should not take stress....as we say that it affects the child in the womb" FGD 5* *"when the mother is fine she will be able to take care of child, when she is sad how will she take care?" FGD 6*
Alcoholic father	Commonly discussed in responses to initial scenarios, with universal agreement that this can cause problems for children.
Household environment	*"Being unable to play because of living in a crowded space will have physical and mental effects" FGD 4*
Birth order	*"Sometimes what happens is a mother has a workload of two children.... When it was only one she [was able to] give complete care....but now when she has to give attention to both children, she takes time to adjust...." FGD2*

> *"if he is too young he will not have stress, only if he understands things then he can become stressed....a 4 year old child is able to understand" FGD 7*

> *"young children do not know what is happening… only when they understand do they know what is happening [regarding violence or maternal distress] and then it can affect them" FGD 6*

> *"two year old children do not understand anything, they are happy and play…there won't be any effect [of adversity] at this age - at 4–5 years old, that's when they start to understand" FGD 3*

During one discussion, a mother pointed to her own baby situated in her lap and said:

> *"he does not know anything – these things [adversity] don't make him cry, don't make him sleep…it makes no difference" FGD 2*

Even if household difficulties are noticed, children were described as being quick to forget, giving another reason why they cannot be impacted by adversity.

> *"a younger child will forget as quickly as he learns…" FGD 4*

> *"Younger children do not get bothered, a 3–4 year old child is able to understand the things and for a moment things will be in their mind....later when they play, they will forget about them and move on. Even if a younger child is beaten, after sometime he again gets involved in games" FGD 1*

Contrary to this, a few mothers described young children being affected whilst young – but this was not a predominant view.

> *"[mothers] need to give proper care until 2 years of age… because at this stage physical and mental development occurs" FGD 4*

> *"…young children learn quickly and remember....whereas elder children understand [and are able to think], so may or may not be affected by adversity" FGD 3*

Mechanisms connecting adversity to consequences. Two key mechanisms were discussed. First, adversity was described as leading to changes in the household environment and caregiver capacity, both of which are related to negative consequences for children. Second, the brain was described as a key way in which adversity more directly translates into physical and mental health problems over the lifecourse. This was understood in several ways but most commonly, ruminating on hardship (or adversity 'staying in the mind') was described as being bad for the brain.

> *"[The impact of adversity] is felt directly on the brain" (all participants in unison)… "[adversity] then remains in the child's mind" FGD 2*

> *"for instance if there is a fight the child trembles, starts crying and there is major effect on the child's heart....these*

negative instances remain in a child's mind and go on to affect their brain…[this is] because these instances will keep wandering in their mind, even when the child is playing" FGD 5

The transmission of adversity was additionally described as beginning from conception, with significant importance placed on the *in-utero* period. Mothers described 'blood-mixing' between mother and child and the umbilical cord and its role in connecting the mother and foetus.

"it is said that [mother and child connect] through the umbilical cords. When the cords touch each other, mother and child blood mixes" FGD 2

"If a mother is tense then that will have a direct impact on her child's brain during pregnancy" FGD 3

There was a suggestion in several discussions that children who have constant adversity may appear to be coping better than those with unpredictable environments.

"when fighting in the household is rare, children cry and are unhappy. But when these things become a daily habit, children get used to them. If the child continues to pay attention to the negativity, they might be sad – maybe crying, staying quiet, or not playing, but usually they do normal things" FGD 5

Early emotional and behavioural consequences.
Physical and mental development
Adversity was widely described as leading to *Kamjori.* This phrase describes a physical and mental 'weakness' including growth stunting, lethargy, intellectual impairment, cognitive deficiencies and development delays.

"[children living with adversity have] hampered mental and physical growth....the brain will not grow and neither will the body. When the child plays with other children he will be kamjor and get tired easily" FGD 5

Low activity level
These children were described as being less active than others and being less willing to play. This was described as causing further physical and mental problems.

Emotions and behaviours
In the short term, adversity was linked to moodiness, crying, sadness, anger, violence and jealousy.

"[The child] stays sad, even when playing with other children in neighbourhood and develops low self esteem" FGD 3

"[a child in adverse circumstances] will get angry....sad.... be worried for the whole day....they will get upset easily". FGD 3

Discussion showed adversity being connected with children being nervous and fearful. This was linked most often to those children living in homes with violence or where the father was seen as being unpredictable (often linked to alcohol consumption).

"[my child] gets frightened.... he fears that he would be scolded as his mother is being scolded and this makes him unhappy…" FGD 2

Mothers were clear, however, that these behaviours are not only caused by adversity and that it is not possible for a mother to know exactly what has caused their child's problem.

Longer term consequences. Mothers recognised that earlier consequences may continue into later childhood and adulthood causing further consequences for physical and mental health.

"earlier effects will remain - if the child's situation does not improve with time then these will continue" FGD 4

Poor school readiness and inferior academic performance during education is a long term consequence of early life adversity.

"When the child grows, he will face problem in his studies as in the beginning of school he can't learn ABCD properly - without this how can he proceed further?" FGD 3

Participants described a cycle of adversity – for example, those children brought up by an alcoholic father are more likely to misuse alcohol themselves in later.

"When (the child) sees father drinking, he will learn the same habit and this will cause him [problems as an adult]" FGD4

Reversibility. Mothers described improvements in adverse circumstances leading to reduced consequences for children, with the caveat that there may be an enduring impact, particularly for some of the more severe adversities -

"when a child receives love, it may reduce the negativity by some percentage but something will be left in the child's mind that these things previously happened in the house, and something will remain" FGD 4

"if there is a proper improvement [in circumstances], the child may change but otherwise, childhood weakness can't be recovered rapidly" FGD 5

and that the earlier a stressor is removed the better because managing consequences becomes more more difficult over time.

"Initially it's a small thing, but later it could grow bigger....if it is found and dealt with when the child is small it is fine otherwise it would keep on amplifying and become a big problem" FGD 3

Prevention

Avoiding stressors. Mothers detailed ways in which they try to protect their own children from stress and adversity. This mainly involved keeping them away from sources of stress.

"Mothers avoid fighting in front of their children in order to stop household conflict affecting children" FGD 1

"Suppose a child's father drinks [alcohol] - he should be kept away and the mother should play with the child. Even if there is a fight then after some moment, the mother should talk happily so that the child forgets what has just happened" FGD 5

Mothers also described their own role in avoiding stress whilst pregnant.

"Pregnant women should have food on time, walk around, avoid tension....the child in the womb should not suffer so that they can remain healthy" FGD 1

Adult support. The importance of care for supporting children in adversity was emphasised. This includes spending time and playing with children, and clearly showing them love and affection.

"Mother should take out time from household work to give attention to the child, she should spare time to feed the child, this would enable a child to understand that their mother is there and to help them to feel safe" FGD 4

"Take out time for child, try to understand what the child has to say and is feeling...." FGD 3

The question of who is most suitable for offering this care was repeatedly raised with mothers promoting the joint-family system and its benefits for caring. Family members including the grandmother and neighbours often extend their help.

"Until 6 months of age a child is breastfed and so spends most of the time with his/her mother. As they grow older, other family members can take care – grandmother, grandfather....anyone in family can do this" FGD 1

Treatment

Supportive adult care. Children suffering from the negative consequences of adversity are seen as being predominantly a family problem that should be treated by offering extra love and care.

"Talk to the child with love, call them near, give them things....so that the child's mind is distracted...." FGD 1

"The mother has to take care, by giving love....then they would be happy" FGD 2

"Give the child what they need - if they need food, give food – if they need to have a bath, give bathe ...." FGD 2

However, mothers were clear about the difficulties faced in this regard if the adversity is continuing. Impacts last until the adversity stops or the family support improves.

"Unless their parents stop fighting [the adverse consequences] will remain until adulthood" FGD4

"Only if circumstances become favourable, then a child's tension can be reduced so that they have the capability to go ahead in life" FGD3

Medical professionals. Doctors were mentioned by several mothers as having a role, but they did not know what sorts of treatments or cures might be offered. One participant described a doctor asking for a test, but that in her experience this comes back normal for these sorts of children.

Discussion

This study describes a qualitative exploration of mothers views regarding childhood adversity in rural Haryana, India. It is, to the best of our knowledge, the first such study in a low/middle-income country setting.

Mothers' explanations of the effects of adversity and stress were broadly in alignment with biomedical understanding on the wide range of adversities faced by children, their potential consequences and adult care as the key to prevention and treatment. This is in accordance with the literature on adverse childhood experiences from high-income settings, where increased number of adversities are associated with impaired development and emotional regulation[15,16], later-life depression[17], and causes of death in adulthood including cardiovascular disease, cancer and diabetes to name a few[18]. It is also in accordance with the focus on promotion of high-quality parent-child interaction, maternal health and the mother-child relationship, through early childhood development policy and programmes. Mothers described adversity reflecting in emotional and behavioural consequences for children in the relatively short term and there was broad agreement that these consequences can persist into later child- and adulthood with reversal becoming increasingly difficult.

The brain was described as being a link between adversity and consequences. This is in accordance with currently biomedical understanding on the impacts of 'toxic stress' on the developing brain, and messaging being used in some high income countries to build communities of practice aiming to improve childhood development (for example, in the USA, the National Scientific Council on the Developing Child[19]).

There were important exceptions to this concordance. Of particular note, the widely held view view of young children being "too young to understand" is at odds with neuroscientific and epidemiological evidence suggesting that adversity in this early-life period has negative consequences. This evidence underpins much of the currently early childhood development agenda, and so those developing early childhood development programmes may wish to test and address this potential barrier to implementation in their own context. This finding is not well-described in the literature, but has also been noted by programmers including in an Early Childhood Development programme funded by the Department for International Development in Zambia (R Hughes, LSHTM, personal communication. May 2018)

Interestingly, mothers did not mention preference for boy-children, highly prevalent in this setting which has a sex-ratio at birth of 879 females per 1000 males[8], and which leads to discrimination in allocation of healthcare and other resources throughout childhood[20,21].

Mothers often used the word '*kamjori'* to describe 'weakness'. It is an aspiration of all mothers to avoid this weakness with regards to their children. Previous descriptions in the literature focus on its relation to undernutrition[22,23] and the term, which describes a broad range of negative physical and mental health features of young children, may be of use in framing future interventions in this geography and similar terms are likely to be used elsewhere.

The study provides useful data on a relatively unexplored area. Strengths of our methodology include our structured approach to focus group methods, including that emerging descriptions were tested in focus groups throughout data collection, giving a sense of the degree to which participants agreed with our analysis. Using two analysts meant that disagreements in coding and interpretation were noted and dealt with early in the analysis process. A limitation of our use of focus-groups was that mothers mainly discussed children abstractly, rather than discussing personal experiences. Future work could compare these findings with those conducted through in-depth interviews, and also collect data from other key carers and family members. We attempted to overcome other limitations through high-quality moderation, including the potential for conformity bias where participants state opinions that go along with previous participants, rather than their own views.

Conclusion

Improving the capacity of parents and other caregivers to provide optimal nurturing care is seen as being one of the major solutions to supporting all children to reach their developmental potential. Designing interventions that work depends on thoroughly understanding the ways in which caregivers understand child development and the impact of environmental factors including adversity on young children. Results from this study suggest that in this area of rural India, mothers are in agreement with much of the current biomedical model of early childhood, and that they may therefore be receptive to behaviour change messages that make use of these concepts. There were, however, crucial areas of divergence including that mothers believed that young infants were 'too young to understand'. This is of great importance for those designing interventions aiming to improve development in this crucial period of early childhood where learning potential is at its peak and the impact of suboptimal care can be lifelong.

Declarations

Ethics approval

London School of Hygiene and Tropical Medicine (9886) and Sangath (27 May 2015)

Data availability

The raw data are not provided because the audio and focus group transcripts contain identifiable and sensitive information regarding individual participants (including names and locations). These participants were assured that discussions would be kept confidentiality and we do not believe that providing open access to the raw data would uphold this assurance.

Researchers who wish to access the data for re-analysis or for integrity purposes can do so by contacting the corresponding author and this will be done on agreement of the Sangath Institutional Review Board (H No 45 Bhatkar Waddo, Porvorim, Goa 403501 India; contactus@sangath.in; +91 7887872345), LSHTM Research Ethics Committee (Keppel Street, London WC1E 7HT; ethics@lshtm.ac.uk) and the researcher's research ethics committee/institutional review board or equivalent. The key considerations will be the aim to minimise potential harms and to protect the interests of participants. Sangath will remain the custodian of all data which will be provided under the following conditions. Firstly, researchers must be able to guarantee confidentiality of participants. Second, the authors of the article must be informed about any publication (paper, theses, dissertations, presentations, among others) in which the data will be used, prior to their dissemination. Finally, if the data is used in any other publication, it should be acknowledged that it is of secondary source, providing the appropriate citation.

Extended data

The study guide and images used in the warm-up exercise are available from the LSHTM Data Compass

LSHTM Data Compass: Extended data. SPRING Early Life Stress Sub-study: Additional Resources https://doi.org/10.17037/DATA.00000947[13]

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Chapter 7 (Paper 2): Impact of adversity on early childhood growth & development in rural India: findings from the early life stress sub-study of the SPRING cluster randomised controlled trial (SPRING-ELS)

Bhopal S, Roy R, Verma R, Kumar D, Avan D, Khan B, Gram L, Sharma K, Amenga-Etego S, Panchal SN, Soremekun S, Divan G, Kirkwood BR

PLoS ONE 14(1): e0209122
https://doi.org/10.1371/journal.pone.0209122

This paper describes the relationship between cumulative adversity through pregnancy and the first year of life, and its relation to growth (length and weight) and the motor, cognitive and language scales of the Bayley Scales of Infant Development measured at 18 months of age in a large sample in rural India. Results suggest that cumulative adversity in multiple domains has a strong and negative effect on these important early life outcomes, with lifelong implications for wellbeing.

Note regarding this multi-author work:

The Early Life Stress sub-study of SPRING (SPRING-ELS) was funded by the Wellcome Trust as a fellowship to me, with Betty Kirkwood as my supervisor. I spent 18 months at the study site in Haryana, India as an integrated member of the SPRING trial team and was heavily involved in all aspects of design and conduct of the trial.

The idea of introducing measures of adversity and stress to SPRING through SPRING-ELS were mine. I obtained funding, ethical & regulatory approvals, and led the fieldwork, administration and finance for this sub-study.

This paper also draws on data from SPRING which was led by Betty Kirkwood as principal investigator, Gauri Divan (India Principal Investigator) and Reetabrata Roy (India Trial Director). I contributed to all aspects of this data collection including cultural adaptation, preparation of tools, fieldwork planning and fieldworker organisation.

I performed all data analysis and wrote this paper.

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SECTION A – Student Details

Student	Dr Sunil Bhopal
Principal Supervisor	Prof Betty Kirkwood
Thesis Title	Early childhood stress, adversity, growth & development: findings from the SPRING home visits cluster randomised controlled trial in rural India

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	PLoS ONE		
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For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper	See previous page

Student Signature: [redacted] **Date:** 17 January 2019

Supervisor Signature: [redacted] **Date:** 17 January 2019

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RESEARCH ARTICLE

Impact of adversity on early childhood growth & development in rural India: Findings from the early life stress sub-study of the SPRING cluster randomised controlled trial (SPRING-ELS)

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Abstract

Introduction

Early childhood development is key to achieving the Sustainable Development Goals and can be negatively influenced by many different adversities including violence in the home, neglect, abuse and parental ill-health. We set out to quantify the extent to which multiple adversities are associated with impaired early childhood growth & development.

Methods

This was a substudy of the SPRING cluster randomised controlled trial covering the whole population of 120 villages of rural India. We assessed all children born from 18 June 2015 for adversities in the first year of life and summed these to make a total cumulative adversity score, and four subscale scores. We assessed the association of each of these with weight-for-age z-score, length-for-age z-score, and the motor, cognitive and language developmental scales of the Bayley Scales of Infant Development III assessed at 18 months.

Results

We enrolled 1726 children soon after birth and assessed 1273 of these at both 12 and 18 months of age. There were consistent and strongly negative relationships between all measures of childhood adversity and all five child growth & development outcome measures at 18 months of age. For the Bayley motor scale, each additional adversity was associated with a 1.1 point decrease (95%CI -1.3, -0.9); for the cognitive scales this was 0.8 points (95%CI -1.0, -0.6); and for language this was 1.4 points (95%CI -1.9, -1.1). Similarly for

(0936115/Z/10/Z) for which BRK is the principal investigator. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

growth, each additional adversity was associated with a -0.09 change in weight-for-age z-score (-0.11, -0.06) and -0.12 change in height-for-age z-score (-0.14, -0.09).

Discussion

Our results are the first from a large population-based study in a low/middle-income country to show that each increase in adversity in multiple domains increases risk to child growth and development at a very early age. There is an urgent need to act to improve these outcomes for young children in LMICs and these findings suggest that Early Childhood programmes should prioritise early childhood adversity because of its impact on developmental inequities from the very start.

Introduction

Childhood development is key to achieving the ambitious global Sustainable Development Goals[1,2], particularly aspects of goals 1 (poverty reduction), 2 (nutrition), 3 (good health & wellbeing), 4 (school readiness), and 16 (violence reduction). Improving the development of young children will lead to improved health and wellbeing across the lifecourse, indeed children who were part of the early childhood home-visiting trials in Jamaica have now been followed into adulthood where the effects of this early years intervention are sustained in terms of increased employment & earnings[3]. The global child health community has placed early childhood development (ECD) high on the health agenda, and the Lancet Series *Advancing Early Childhood Development*: *from Science to Scale* served as a call to action, arguing that getting children off to a good start in life will reap benefits in health and wellbeing for "today's children, tomorrow's adults, and for future generations"[1].

Optimal child development starts before conception and is dependent on adequate nutrition for mother & child, protection from threats, provision of learning opportunities, and caregiver-interactions that are stimulating, responsive, & emotionally supportive. This whole environment around a child is conceptualised in the World Health Organization's Nurturing Care Framework for Early Childhood Development[4] which was presented at the World Health Assembly in May 2018. The focus is on the 'first thousand days'—the period from conception through the first two years of a child's life—because of the adaptability of children's brains during this period and because reversing early deficits becomes more difficult as children grow older[5].

Optimal development in early childhood can be knocked off course by a whole range of factors concerning a child's environments and relationships with caregivers. These 'adversities' vary in intensity and include for example, violence in the home, neglect, abuse, lack of opportunity for play & cognitive stimulation, and parental ill-health[6,7]. Whilst each of these has the potential to cause problems for a child growing up, exposure to multiple adversities simultaneously poses a cumulative burden and is even more detrimental to a child's wellbeing. This is all the more important in low- and middle-income countries where children are exposed to multiple low-level risks [8,9] with attended negative consequences. Empirical evidence has been presented from LMICs including in Guatemala where Gorman & Pollitt describe a linear relationship between cumulative psychosocial risk and cognition [10], Sri Lanka where increasing number of traumatic events was associated with impaired development [11] as well as the described associations between cumulative risk and adjustment disorder and PTSD [12,13]. However, there is minimal evidence from the crucial period when children are 0–2

years old from LMICs. Given the broad range of adversities faced by children in LMICs and impacts of these on health and wellbeing, we set out to quantify the extent to which these negatively affect child growth & development in the very early years, and aimed to assess the relative contribution of different groups of adversities In this paper we analyse the role of childhood adversity through pregnancy & the early years on early childhood development amongst children enrolled in the Early Life Stress sub-study of the SPRING randomised controlled trial (SPRING-ELS) in Haryana state, India–the country with the largest number of young children at extreme risk of impaired cognitive and social-emotional development[14].

Methods

Overview of study design

SPRING-ELS was a sub-study of the Wellcome Trust funded SPRING cluster randomised controlled trial in India analysing stress and adversity in young children. Details on SPRING are presented elsewhere[15] but in brief SPRING in India developed an innovative, feasible, affordable & sustainable community-based approach to delivering a home visiting programme through a new cadre of community-based worker with the aim to improve early childhood growth and development. SPRING was designed from the outset to be feasible and scalable through the governmental health system. A parallel trial was done in Pakistan with the same aim but working through existing health system structures with an existing cadre of worker. SPRING was evaluated by parallel cluster randomised controlled trials with clusters in India defined as the catchment area of functioning health sub-centres, the lowest level of the Indian primary healthcare system. There were 24 clusters. Primary outcomes were height-for-age, the best early childhood predictor of human capital[16], and Bayley Scales of Infant Development III (BSID-III), the gold standard assessment of a child's development in the early years[15]. These impact outcomes were complemented by in-depth economic analysis, process-evaluation and a broad range of intermediate outcomes selected based on a conceptual-framework. This additional work will inform unpacking of the SPRING causal pathway, provide deeper understanding of mechanisms of trial impact, and inform lessons for scale-up and incorporation into health systems. SPRING took place in 120 villages across three administrative blocks of Rewari district, Haryana state, India. The total population was around 200,000. Rewari district is predominantly rural and has health and demographic indicators around average for the state. The overall literacy rate in Haryana is 76%, with female literacy of 67% [17]. The sex ratio is 879 females per 1000 males[17]–amongst the lowest ratio in India. Infant mortality is 41/1000 live births[18]–around the national average. More than one third of under-five year old children are stunted[19]. The SPRING trial is registered with Clinical-Trials.gov, number NCT02059863.

Data collection

Participating SPRING mothers and their children were identified by an ongoing trial surveillance system whereby trained resident fieldworkers visited every household in the study area every 8 weeks to identify pregnancies and births, and follow-up pregnant women & children already identified. Surveillance system fieldworkers collected the demographic & socioeconomic data used in this study on custom-programmed mobile phones at enrolment. A separate group of fieldworkers did detailed SPRING assessments with children and their mothers when children turned 12 & 18 months of age. Adversity assessments were done at 12 months with mothers and children where the child was planned to have outcome assessments at 18 months of age. This was at least the first 50 children born in each of the 24 clusters after the trial start date (18 June 2015). These detailed assessments were spread out over two days in

order to reduce the burden to participants and took a total of around 2.5 hours. All questionnaires were asked of the mother, and observations were done with both the mother and child. Other assessments during this two day visit that are not described in this paper include anthropometry, a feeding questionnaire, a maternal knowledge questionnaire and saliva and hair sampling for stress biomarker analysis.

Childhood adversity measures. To develop the set of adversities, we carried out formative research with local mothers and grandmothers, took advice from child development experts and reviewed the literature on existing evidence and tools. We selected 22 adversities with a focus on those adversities operating at the household level and did not consider those operating more widely because young children in this setting spend most of their time and interact most closely with family members inside the home and these adversities are therefore of most importance to these young children. Three of the adversities were assessed at enrolment, and the other 19 were assessed at 12 month assessment (Table 1).

To explore further we examined the relative importance of particular groups of adversities based on a conceptual framework starting with direct adversities for a child with links to more distal adversities including maternal stress and difficulties in the carer-child relationships and the more overarching socio-economic factors (Fig 1).

For the second part of this analysis, the 22 adversities were therefore grouped as follows: 1) household-level socio-economic factors, 2) maternal stressors, 3) child-carer relationships and 4) child-related factors and are described within these groups below.

Group 1—Socioeconomic—Consists of five factors: 1) Asset index—being in the lowest quintile for the population at enrolment (calculated with principle components analysis using data on mother, household demographics and animal & other asset ownership) 2) Low parental education–no education or primary-schooling only (asked at enrolment) 3) Father occupation—father did not work, was seasonably employed or was a casual labourer at 12-month assessment 4) Mother married under the legal age of 18 years (reported at 12 month assessment) 5) Family debt—mother reported family debt or being unable to afford to buy food for herself or her child at any point between becoming pregnant and the 12 month assessment.

Group 2—Maternal stress—Consists of six factors: 1) Death of one or more of mother's close family members since becoming pregnant reported at 12-month assessment 2) Mother seriously injured or ill 3) Any violence towards mother from husband (assessed using WHO multi-country study on women's health and domestic violence against women[20]) or any other person since becoming pregnant reported at 12-month assessment 4) mother screens positive for mild, moderate or severe depression on PHQ9 or answers 'yes' to PHQ9 question on suicidal ideation (at 12-month assessment). PHQ9 is one of the most commonly used screening tools for depression and has been used widely in India[21] 5) Low level of support or high stress from others around the mother using the Duke social support & stress scale[22] reported at 12-month assessment 6) Problematic husband alcohol use reported by mother at 12-month assessment

Group 3—Relationship—Consists of four factors: 1) Any family member was unhappy when they found out that the child was a girl 2) Moderate or high concern level on Mother Object Relations Scale–short form (MORS-SF) at 12-month assessment. MORS-SF is a screening tool consisting of 14 short statements which a mother is asked to rate on a Likert-type scale to identify potential problems in early mother-infant relationship[23] 3) Very low quality interactions observed during a feeding episode at the 12-month assessment (assessed by non-specialist fieldworkers using the observed feeding index, a tool developed in this project where feeding is scored using tick-boxes. This tool will be published in due course). Very low quality means that the following was observed during the feeding episode: < = 1 positive talk by

Table 1. Childhood adversities in SPRING-ELS sub-study. prevalence and proportion of imputated values.

Domain	Items	Prevalence	Imputation
Socioeconomic	1. Socioeconomic status: lowest quintile of asset index (*E) [a]	20.0%	
	2. Father education level: primary or none(*E)	5.0%	
	3. Mother education: none or 1–5 grades (*E)	11.9%	
	4. Father occupation: at home, seasonably employed or casual labourer	24.7%	
	5. Mother married under legal age (18 years)	20.0%	41 (3.2%)
	6. Family debt [b] or mother reports being unable to afford food for self or child at any point [c]	18.0%	
Maternal Stress	1. Mother reports death of husband, parent, sibling, child or friend since pregnancy	5.4%	
	2. Mother seriously injured or ill since pregnancy	4.0%	
	3. Any violence from husband or mistreated by any other person since pregnancy [d]	13.4%	
	4. PHQ9 score > = 5 or problems described make it very/extremely difficult to do daily activities	19.5%	23 (1.8%)
	5. Duke social support & stress scale: support < = 40 or stress >27	6.3%	23 (1.8%)
	6. Husband's alcohol use causes problems for mother [e]	8.3%	
Relationship	1. Any of mother, father, mother or mother-in-law were "unhappy" when found out child was a girl [f]	15.2%	
	2. Mother's Object Relations Scale concern level: moderate or high	50.4%	
	3. Observed feeding style: very low quality [g]	13.3%	418 (32.8%)
	4. HOME inventory[h] score: lowest quintile	15.6%[i]	1 (0.07%)
Child	1. Mother-reported child born prematurely	10.2%	
	2. Child admitted to hospital any time during first year of life	14.9%	
	3. Mother & child separated for one week or more during first year of life	1.7%	
	4. Child left alone or with child under 10 years for more than one hour in the past week	4.6%	
	5. Older children who live in house: say anything to make child cry or unhappy (in last week)	30.5%	
	6.Older children who live in house: hit/punched/kicked/bit child on purpose to make them unhappy (in last week)	17.9%	

[a] SES score calculated with principle components analysis using data on mother, household demographics and animal & asset ownership

[b] Answered yes to question: "Since you became pregnant, have you or your immediate family who live with you been in debt?"

[c] Answered yes to question: "Since you became pregnant, have you ever been hungry because you could not afford to buy food?" or similar related to child

[d] Using WHO multi-country study on women's health and domestic violence against women

[e] If woman reported husband drinking alcohol, answered yes to question: "does this cause any problems for you"

[f] Question: "When [person] found out your baby was a girl were you/they happy, unhappy or didn't mind whether you had a girl or a boy?"

[g] Assessed using observed feeding index. Very low quality means < = 1 positive verbalisations, and < = 1 games played and < = 1 responsive actions, plus > = 1 negative actions by mother towards child during feeding session

[h] The Home Observation for the Measurement of the Environment Inventory

[i] Not exactly 20% because cut-off made at HOME score of 27

*E All items were assessed at 12 months of age except those marked *E which were collected at enrolment into the surveillance system

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mother towards child, and < = 1 episodes of playful feeding and < = 1 responsive feeding actions, plus one or more negative actions such as force feeding, holds child's head still to give food, shaking, threatening, shouting or berating observed by the mother towards child during feeding session 4) Lowest quintile score on HOME inventory measuring quality of the home environment through observations of the home and questions to the mother (total of 45 items, each scored 0 or 1) over the course of one hour [24] at 12 month assessment–the cut-off for the quintile fell between 27 & 28 points and the lowest of these (27 points) was chosen to create a conservative estimate of this factor.

Group 4—Child—Consists of six factors: 1) Child born prematurely (asked at 12-month assessment) 2) Child hospitalised in first year of life 3) Separation of mother & child for more than a week in the first year of life 4) Inadequate care–child left alone or with a child under 10 years for more than one hour in the past week (assessed at 12-month assessment) (From [25]) 5) Older children in the house say anything to make child cry or unhappy (in last week) (at

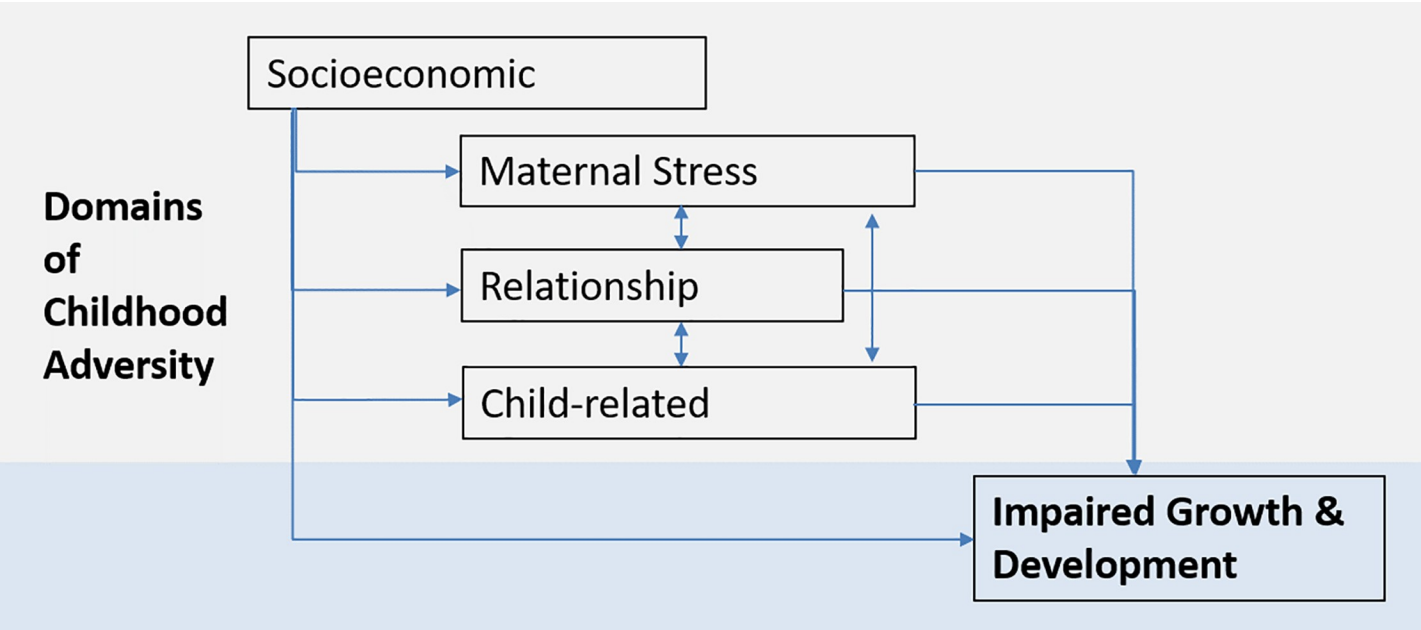

Fig 1. Conceptual framework linking domains of childhood adversity to suboptimal growth and development.

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12-month assessment) (From [25]) 6) Older children who live in house: hit/punched/kicked/bit child on purpose to make them unhappy (in last week) (assessed at 12 month assessment)

A systematic cultural adaptation process based on Khan & Avan[26] was used. This comprised of six steps and aimed to ensure that each item was assessing the construct it was attempting to understand. Each item was first written in English, and the process of adaptation was: 1) Translation into Hindi independently by two trained research associates 2) Comparing these translations & assessing technical equivalence of these, then producing final translations by consensus for testing 3) Field research with project staff and mothers of young children to test understanding of translations and to improve them 4) Finalisation of tool for pretesting 5) Pretesting in the community to assess usability, 6) Assessor training, establishing inter-rater reliability and Pilot-testing.

For the 10 mothers with twins, questions relating to the child (e.g child hospitalisation) were asked for each child, and those relating to the mother herself (e.g maternal depression) were asked only once and answers applied to each child.

Growth & development measures. We trained assessors to do child development assessments at 18 months of age using the motor, cognitive & language scales of the Bayley Scales of Infant Development 3rd Edition (BSID-III) in the home[27]. Assessors did two BSID-III assessments per day in pairs. Each assessment took 2–3 hours to complete. Each BSID-III scale consists of a series of progressively more difficult activities which children are asked to do whilst interacting with an assessor. Each item was scored 1 if the activity was demonstrated, otherwise it was scored 0. Assessment on each scale started at the item marked 'K' (start point for 16.5–19.5 month old children). Children not able to achieve three activities at that level were assessed as far as two levels back (the item marked 'I', which is the start point for 11–13.5 month old children) before the assessment was stopped. The assessment on each scale ended when the child scored 0 on five consecutive activities. We did comprehensive cultural adaptation and inter-rater reliability (IRR) checks, finding mean agreement between assessors of greater than 97%.

The same fieldworkers did anthropometrical measurements of children. Weight was measured to the nearest 0.01Kg using SECA-384 electronic scales which were calibrated weekly. Weighing was ideally done with the child's clothes removed. If this was not possible, the child was weighed fully-clothed, then the clothes were removed and weighed. The difference between the weight of the fully-clothed child and the weight of the clothes was calculated to give the child's weight. Length was measured to the nearest 0.1cm using the SECA-417 infantometer by two assessors as follows. The child was laid down on the infantometer board. The first assessor cupped their hands over the child's ears and held the head against the end of the measurement board. The second assessor then ensured that the child's body was straight on the board, placed one hand on the child's legs to stabilise them and brought the footpiece upwards towards the child's feet which were held perpendicular to the board. This assessor then read aloud the length board reading and this was recorded by the first assessor.

There were therefore three development outcomes & two growth outcomes assessed at 18 months of age.

Sample size

One sample size calculation was done for the whole SPRING-ELS substudy, and the minimal sample size was exceeded in the work presented in this paper. A minimum sample size of 25 children per cluster was chosen for the overall SPRING-ELS substudy to give 90% power at the 5% level of significance to explore a range of adversities with prevalence of 20% to 80% and to detect effect sizes between 0.4SD & 0.5SD (assuming an intra-cluster correlation of 0.05) using an established formula[28].

Data analysis

Adversities. Table 1 shows that five adversities had missing data. Four were missing less than 4%, and the fifth was missing 32.8%. We assumed these were missing-at-random and used multiple imputation by chained equations (MICE)[29], including all explanatory and outcome variables in each analysis. We used 30 imputations. We calculated descriptive data using a combination of all imputations.

We summed the 22 adversities described to create a total adversity score following a cumulative-adversity model [30–32] which recognises that children can be resilient to single adversities, but that combinations of these may be more harmful and overwhelm protective factors in a child's life. In addition to this overall measure, we summed adversities within each of the four categories. This gave a total of five primary explanatory variables.

To ensure that summing adversities in this manner was not 'double counting' adversities (because children who had one adversity may be more likely to have several other related adversities) we used principle-components-analysis (PCA) to capture the linear combination of adversities which creates the maximum variance in the data, a similar manner to calculation of wealth indices[33]. We converted the raw PCA score into adversity quintiles giving five groups of children for analysis, giving a sixth explanatory variable.

Development measures. Raw scores for the BSID-III scales were converted to composite scores for each child following the BSID-III manual, based on the child's age at assessment. This is done because BSID-III scores change quickly with age at this stage of development.

Growth measures. We converted child length and weight to height-for-age and weight-for-age z-scores using the zscore06 package for Stata15[34] which is based on the 2006 WHO child growth standards[35]. Using z-scores for these growth measures allowed child length & weight to be compared with international standards based on healthy breastfed children who on a population-level grow with the same distribution and trajectories wherever in the world they live.

Association of cumulative adversity and growth & development outcomes

We used Stata 15 for all statistical analyses (StataCorp LLC: College Station, TX, USA). We used mixed-effects linear regression, accounting for trial cluster as a random effect and trial arm allocation as a fixed effect to calculate the adjusted mean growth and development values at each level of cumulative adversity and adversity quintile. This allowed us to examine the change in these outcomes as children were exposed to incrementally greater adversity. Because only 4% of children had a total adversity score of nine or more, we combined these with the children with a score of 8 to create an 8+ group for this analysis. Scatter diagrams suggested a linear relationship and we next we created models treating each of adversity score and adversity quintile as continuous variables to calculate the change in each of the five outcomes for a one-unit change in cumulative adversity.

Association of adversity domains and growth & development outcomes

We used a similar model to explore the relationship between each of the four individual adversity domains and outcomes adjusted only for clustering and trial arm allocation. We then analysed the four domains together in a mutually adjusted multivariate model to examine the interrelationships between them with respect to outcomes.

Ethics

Ethics approval was obtained from the London School of Hygiene & Tropical Medicine research ethics committee (SPRING: 23 June 2011, approval number 5983; SPRING-ELS substudy 19 May 2015, approval number 9886) and the Sangath Institutional Review board (IRB) (SPRING: 19 February 2014; SPRING-ELS substudy 27 May 2015). Approval was also granted by the Indian Council of Medical Research's Health Ministry Screening Committee (HMSC) (SPRING: 24 November 2014; SPRING-ELS substudy: 6 October 2015). The SPRING trial is registered with clinicaltrials.gov, number NCT02059863. Informed written consent was obtained from mothers at enrolment into the trial surveillance system and again before a child's first birthday for detailed developmental assessments.

Role of funding source

The work was funded by the Wellcome Trust through two awards: a Wellcome Trust Research Training Fellowship to Sunil Bhopal (107818/Z/15/Z) & a Wellcome Trust Strategic Award for the SPRING Programme (0936115/Z/10/Z) for which Betty Kirkwood is the principle investigator. The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript. SB & BK have complete access to the study data and are responsible for the reported study findings, and made the decision to submit for publication.

Results

SPRING-ELS sample description

SPRING enrolled 1726 eligible children soon after birth and aimed to assess all of those available at 12 and 18 months of age. 18 additional children were not eligible for enrolment because they were not living with their mother, had a congenital anomaly or because their mother was not capable of doing assessments. The flowchart in Fig 2 shows that we assessed 1273 (73.8%) children at both 12 and 18 months of age (between 6 July 2016 and 16 October 2017) in SPRING-ELS. This was a mean of 53 children per cluster (range 50–61).The majority of loss to follow-up was between enrolment & 12 months of age because families were not available for

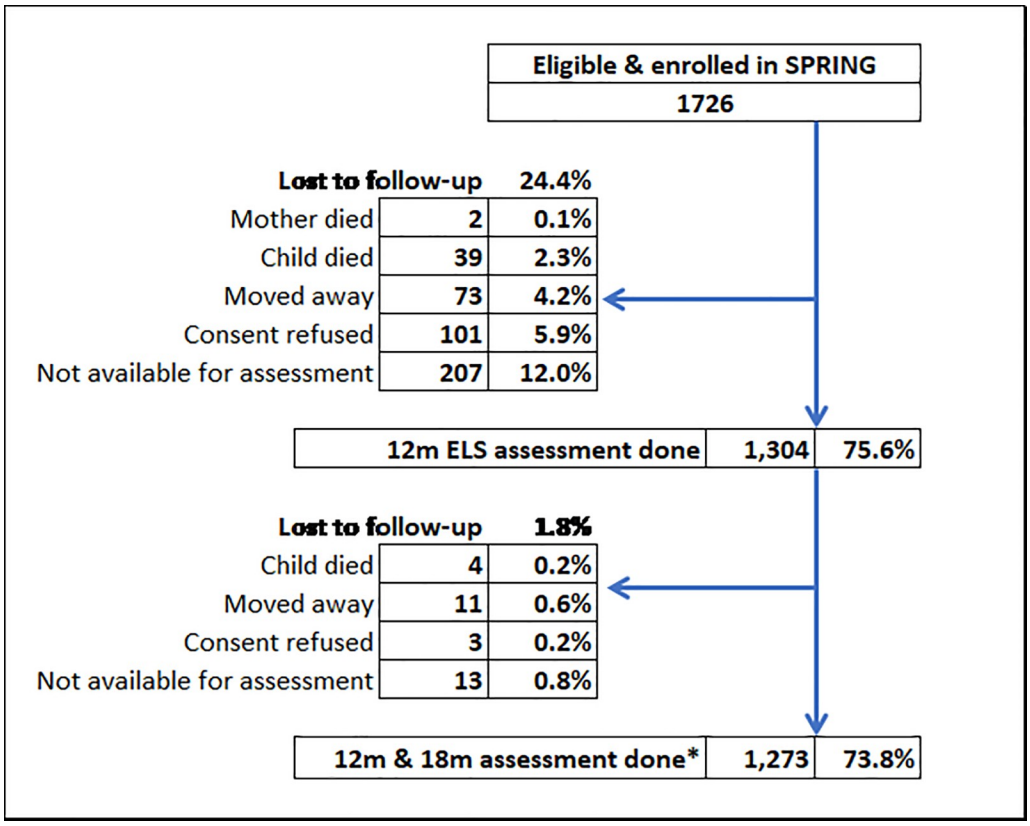

Fig 2. SPRING-ELS sub-study–flowchart of final assessment sub-sample *inclusion in this paper's analysis sample requires both a 12 and 18 month assessment to be done.

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assessment (12.8%), refused consent (5.9%), had moved away (4.2%) or because of the death of the mother or child (2.6%).

Table 2 provides an overview of the demographic characteristics of the sample, and shows that there was no evidence of selection bias with regards to maternal education, caste, socio-economic scores, sex, being a twin/triplet, and mother's age at delivery in children lost to follow up compared to those in the assessment sample. There was a small difference in proportion of deliveries in a health facility, with a small p-value, however prevalence of facility-delivery was extremely high in both groups.

The histogram in Fig 3 shows that 9.3% of children had no adversities, the proportion with one, two and three adversities was 16–17% for each, and that 42% of children had four or more adversities. The mean total adversity score was 3.3 (SD 2.4; range 0–12).

The four histograms in Fig 4 illustrate the distribution of adversity scale scores. More than half of children had a socioeconomic scale score of 1 or more, and the maximum observed score was 6. For maternal-stress, around a third of children had a score of 1 or more with a maximum observed score of 4 out of a possible 6. For the relationship scale, most children had a score of 0 or 1 with a maximum observed score of 3 out of a possible 4. For the child scale, half of children had a score of 0 and the maximum score observed was 5 out of a possible 6.

Associations between cumulative adversity and growth & development

There were consistent and strongly negative relationships between all measures of childhood adversity and all five child growth & development outcome measures at 18 months of age. The

Table 2. Comparison of children completing ELS sub-study with those lost to follow up (* adjusted for clustering).

Indicator	Completed ELS assessment (C)	Lost to Follow Up (L)	C-L Difference * (95% CI)	p
Children in sample	1,273	453		
% No maternal education (n)	6.2% (79)	7.5% (34)	-1.25% (-3.96, 1.45)	0.364
% scheduled/backward caste/tribe (n)	60% (764)	60% (272)	-0.06% (-5.85, 5.73)	0.985
% poorest (lowest 2 quintiles) (n)	43% (548)	37.7% (171)	4.35% (-1.09, 9.80)	0.117
% Male (n)	53.4% (680)	55.4% (251)	-2.03% (-7.38, 3.32)	0.456
% Twins/Triplets (n)	1.6% (20)	1.1% (5)	0.26% (-0.56, 1.08)	0.538
% Delivered in facility (n)	98.2% (1250)	96% (435)	2.15% (0.22, 4.08)	0.029
Mean age of mother at delivery (sd)	22.3 (3.8)	22.3 (3.6)	0.031 (-0.374, 0.437)	0.879
Mean SES score (sd)	-0.15 (2.69)	0.02 (3.08)	-0.114 (-0.408, 0.180)	0.445

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upper half of Table 3 shows the predicted mean development (left side) and growth (right side) outcomes at each total adversity score. Children with an adversity score of 0 had the highest scores in all of the motor, cognitive and language developmental domains, and were the least undernourished. These outcomes all worsened for each additional adversity as illustrated in Fig 5, Panels A & B with no evidence of a threshold effect. This figure also shows that the of the three developmental domains, language had the greatest slope of decrease for adversity.

Results treating total adversity score as continuous in the regression model are presented in the grey bar at the bottom of the upper half of the Table 3. For motor this was a 1.1 point decrease per adversity (95%CI -1.3, -0.9); for cognitive 0.8 points (95%CI -1.0, -0.6); for language 1.4 points (95%CI -1.9, -1.1). For growth this was -0.09 change in weight-for-age z-score (-0.11, -0.06) and -0.12 for height-for-age (-0.14, -0.09).

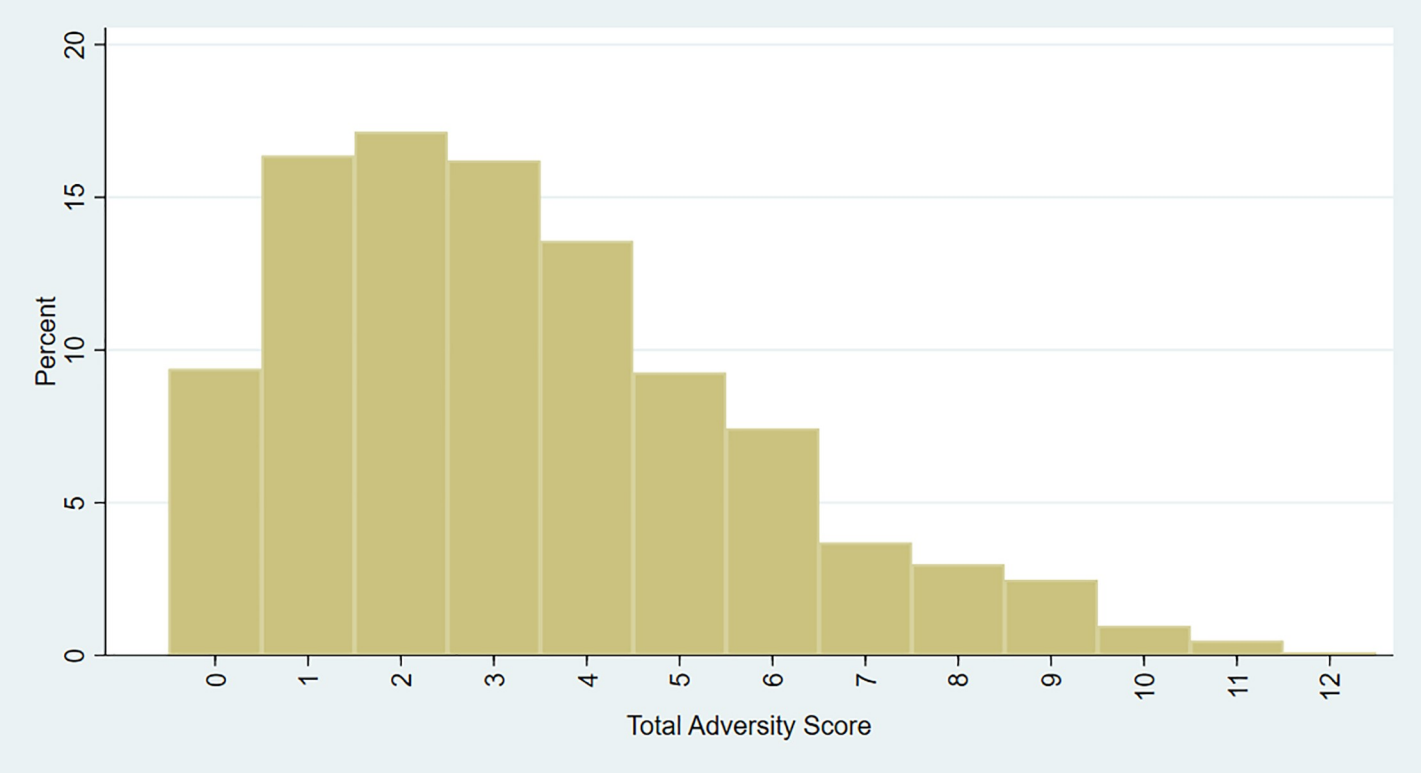

Fig 3. Proportion of children in the SPRING-ELS sub-study with each total adversity score.

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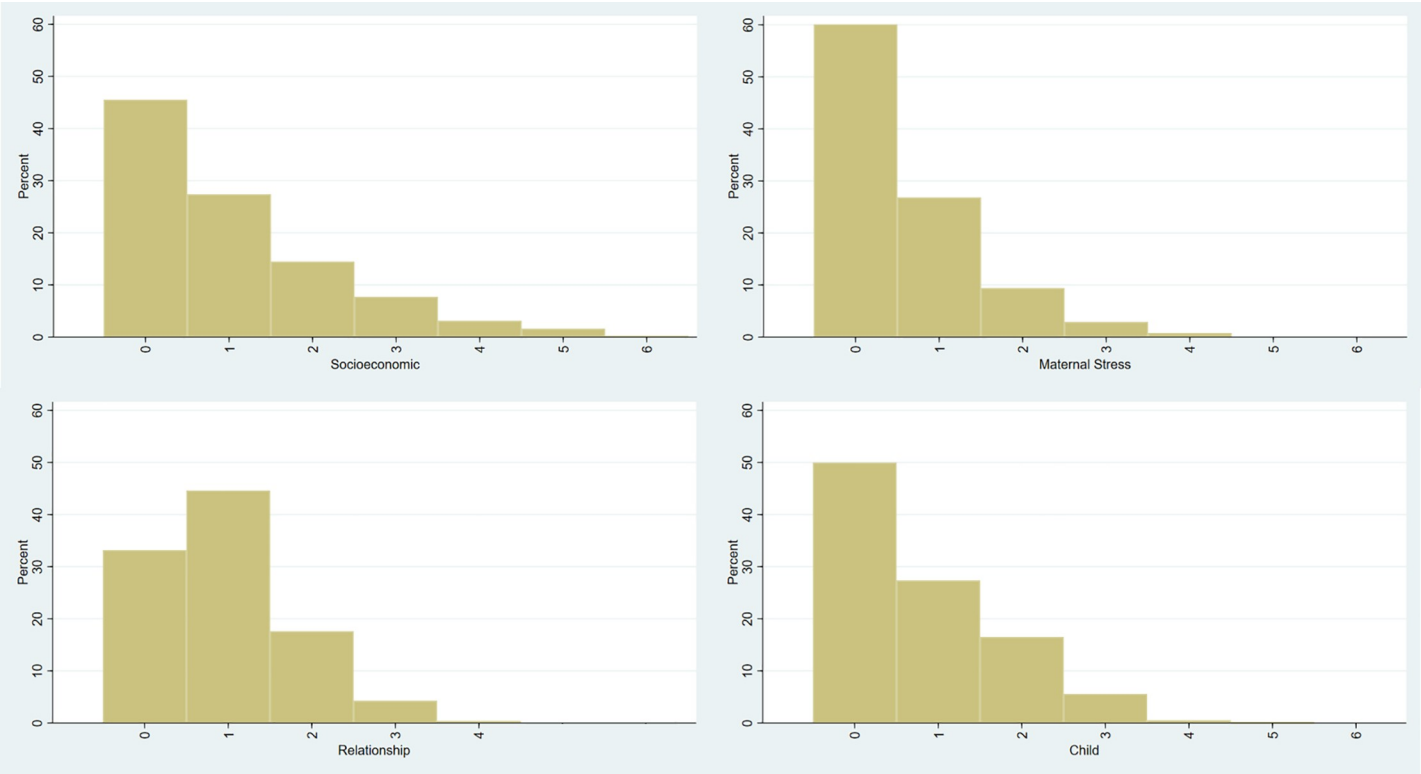

Fig 4. Histograms showing adversity scale scores for children in SPRING-ELS study for each of A) Socioeconomic B) Maternal Stress C) Relationship D) Child.

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The bottom half of Table 3 shows similar strong and negative relationships using adversity quintiles, albeit with narrower differences between most and least adversity. The decrease from the 4th to 5th (most disadvantaged) quintiles is greater than for other quintile changes.

Associations between domains of adversity and growth & development

Table 4 shows the strong and consistent negative relationships between adversity domains and outcomes. For each regression model the mean growth or development outcome at an adversity scale score of 0 is presented, along with a change with each increase in adversity using a linear model. These relationships are illustrated in Fig 6 showing the adversity score (x-axis) scaled between 0 adversities and the maximum score observed.

Table 5 displays the results of five mutually adjusted analyses examining the interrelationship between adversity scales and each outcome. Here all of the relationships in Table 4 are somewhat attenuated, but the majority still show strong negative associations. The exception is the mother-stress scale, which has smaller point estimates and confidence intervals that cross zero indicating that this scale is less associated with outcomes. In addition, the association between adversity and weight-for-age appears to be mostly accounted for by the socioeconomic scale as the point estimates for the remaining three scales reduce considerably.

Discussion

We did a population-based study in rural India and followed up mothers and their infants through pregnancy and the first 18 months of life. We found that most children faced one or more adversity and nearly 50% faced four or more of these potential impediments to

Table 3. Association between childhood adversity and growth & development outcomes at 18 months of age.

Total Adversity Score	Number of children[1]	% [1]	Mean Bayley Scales of Infant Development III scores[2]						Mean Anthopometric Measures[2]			
			Motor	95% CI	Cognitive	95% CI	Language	95% CI	Weight-for-age	95% CI	Height-for-age	95% CI
0	119	9.4%	98.9	(97.1, 100.7)	95.2	(93.0, 97.3)	96.5	(93.6, 99.4)	-1.04	(-1.22, -0.86)	-1.34	(-1.53, -1.14)
1	208	16.4%	96.5	(95.0, 97.9)	94.2	(92.5, 95.9)	93.9	(91.6, 96.3)	-1.21	(-1.35, -1.07)	-1.59	(-1.75, -1.44)
2	218	17.1%	95.7	(94.3, 97.1)	94.0	(92.3, 95.6)	93.3	(91.0, 95.5)	-1.32	(-1.46, -1.18)	-1.71	(-1.86, -1.56)
3	206	16.2%	95.1	(93.6, 96.6)	92.5	(90.8, 94.3)	90.6	(88.2, 92.9)	-1.31	(-1.45, -1.16)	-1.70	(-1.86, -1.55)
4	173	13.6%	94.3	(92.7, 95.9)	92.6	(90.8, 94.4)	89.0	(86.5, 91.5)	-1.46	(-1.62, -1.30)	-1.86	(-2.04, -1.69)
5	118	9.3%	91.9	(89.9, 93.8)	91.3	(89.1, 93.5)	87.4	(84.5, 90.3)	-1.54	(-1.74, -1.35)	-2.09	(-2.29, -1.88)
6	95	7.4%	92.3	(90.2, 94.4)	91.3	(89.0, 93.6)	86.8	(83.7, 89.9)	-1.54	(-1.75, -1.32)	-2.13	(-2.35, -1.91)
7	47	3.7%	88.4	(85.5, 91.3)	88.3	(85.1, 91.4)	82.4	(78.1, 86.6)	-1.56	(-1.86, -1.25)	-2.12	(-2.43, -1.81)
8+	89	7.0%	88.6	(86.6, 90.7)	87.4	(85.1, 89.7)	85.0	(81.9, 88.1)	-1.95	(-2.16, -1.74)	-2.46	(-2.68, -2.24)
Decrease per adversity (linear model)			-1.1	(-1.3, -0.9)	-0.8	(-1.0, -0.6)	-1.4	(-1.8, -1.1)	-0.09	(-0.11, -0.06)	-0.12	(-0.14, -0.09)
p-trend			<0.001		<0.001		<0.001		<0.001		<0.001	
Adversity quintile	1		97.1	(95.8, 98.4)	94.3	(92.7, 95.8)	95.1	(92.9, 97.2)	-1.14	(-1.27, -1.01)	-1.52	(-1.66, -1.38)
	2		95.6	(94.3, 97.0)	93.6	(92.1, 95.2)	92.6	(90.5, 94.8)	-1.29	(-1.42, -1.15)	-1.64	(-1.78, -1.50)
	3		94.7	(93.4, 96.0)	92.9	(91.4, 94.4)	91.7	(89.6, 93.9)	-1.30	(-1.43, -1.18)	-1.73	(-1.87, -1.59)
	4		94.8	(93.5, 96.1)	93.4	(91.9, 94.9)	88.6	(86.5, 90.8)	-1.47	(-1.60, -1.34)	-1.91	(-2.05, -1.77)
	5		90.1	(88.8, 91.4)	88.7	(87.2, 90.2)	85.2	(83.0, 87.3)	-1.71	(-1.84, -1.58)	-2.24	(-2.38, -2.10)
Decrease per quintile (linear model)			-1.5	(-1.9, -1.1)	-1.1	(-1.5, -0.7)	-2.4	(-2.9, -1.8)	-0.13	(-0.17, -0.09)	-0.17	(-0.21, -0.13)
p-trend			<0.001		<0.001		<0.001		<0.001		<0.001	

Note: Total adversity score represents the summed score of 22 possible adversities. Adversity quintiles are based on principle components analysis (1 represents the least adverse group, 5 the most).

[1] because of multiple imputation, numbers & percentage of children in each total adversity score group is an estimate based on combinations of the imputed datasets

[2]estimated mean value at each adversity level, using multiple-imputation

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wellbeing. The key finding was that each extra increase in childhood adversity was associated with both poorer growth and also poorer development measured at 18 months, a crucial time for optimal brain development and a key predictor of future health and wellbeing. This finding was described both using the overall cumulative adversity measure of 22 adversities, and four subscale measures each made up of 4–6 items. There was no evidence of a threshold effect in either the growth or development models, with each additional adversity being associated with progressively poorer outcomes. This adds to the case for a cumulative-risk approach to adversity, supporting the notion that it is the accumulation of multiple factors that is detrimental to child wellbeing in this context rather than specific adversities. Finding similar results using the

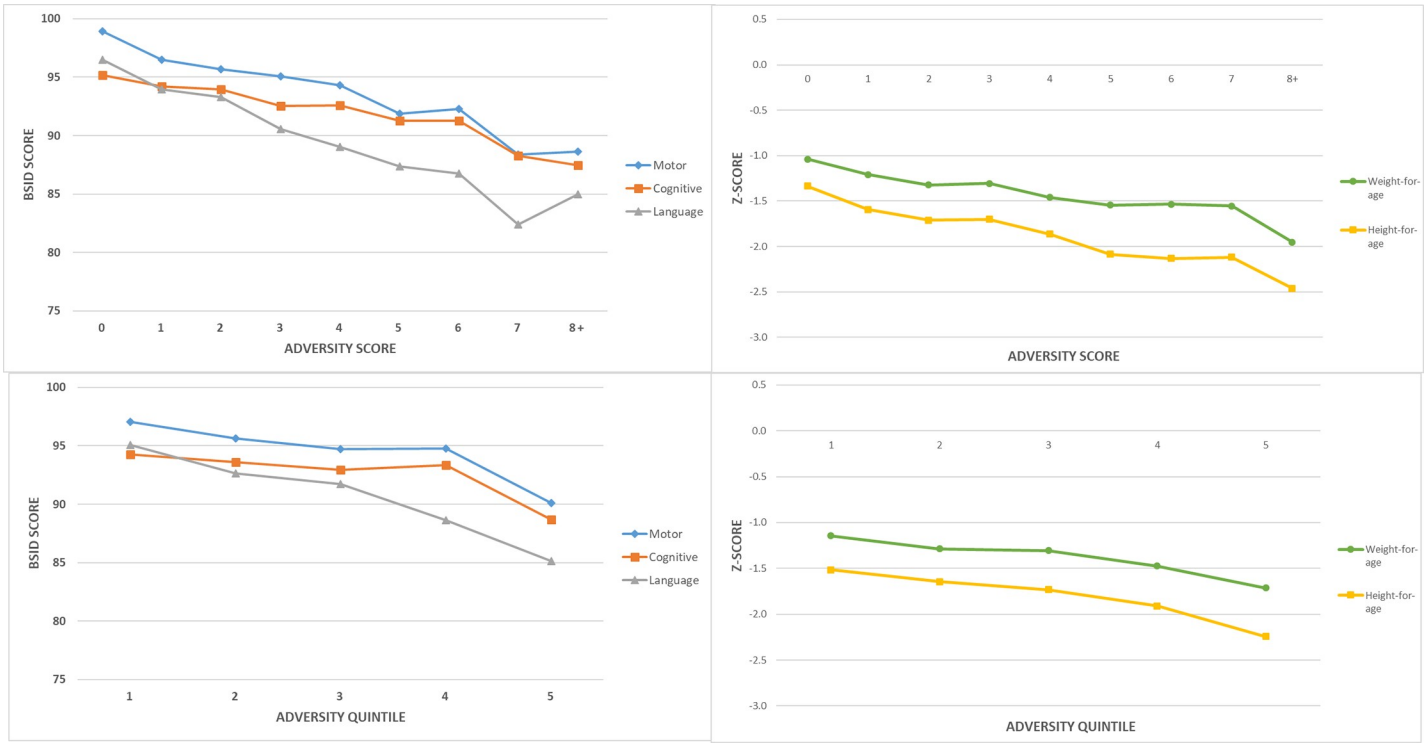

Fig 5. Regression model associations between adversity and growth & development at 18 months of age in children enrolled in SPRING-ELS as follows. A) Cumulative adversity & Development B) Cumulative adversity & Growth C) Adversity Quintile & Development D) Adversity Quintile & Growth.

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Table 4. Association between four adversity scales and growth & development outcomes at 18 months of age.

Adversity scale	Items	Max observed		Bayley Scales of Infant Development			Anthropometry	
				Motor	Cognitive	Language	Weight-for-age	Height-for-age
Socioeconomic	6	6	Mean at 0 (95% CI)	96.2 (95.3, 97.1)	93.9 (92.8, 95.0)	93.0 (91.3, 94.7)	-1.20 (-1.28, -1.13)	-1.58 (-1.67, -1.49)
			Change with increase (95% CI)	-1.7 (-2.1, -1.2)	-1.3 (-1.8, -0.8)	-2.3 (-3.0, -1.7)	-0.18 (-0.22, -0.13)	-0.22 (-0.27, -0.18)
			p for slope	<0.001	<0.001	<0.001	<0.001	<0.001
Maternal stress	6	4	Mean at 0 (95% CI)	95.3 (94.4, 96.2)	93.3 (92.2, 94.3)	91.7 (90.0, 93.4)	-1.33 (-1.41, -1.24)	-1.76 (-1.86, -1.66)
			Change with increase (95% CI)	-1.4 (-2.1, -0.8)	-1.2 (-1.9, -0.5)	-1.9 (-2.8, -1.0)	-0.10 (-0.16, -0.03)	-0.09 (-0.16, -0.02)
			p for slope	<0.001	0.001	<0.001	0.004	0.017
Relationship	4	3	Mean at 0 (95% CI)	96.5 (95.4, 97.5)	94.2 (93.0, 95.4)	93.0 (91.1, 94.9)	-1.25 (-1.35, -1.16)	-1.64 (-1.75, -1.53)
			Change with increase (95% CI)	-2.1 (-2.8, -1.5)	-1.7 (-2.4, -1.0)	-2.5 (-3.4, -1.6)	-0.14 (-0.20, -0.07)	-0.18 (-0.25, -0.10)
			p for slope	<0.001	<0.001	<0.001	<0.001	<0.001
Child	6	5	Mean at 0 (95% CI)	95.6 (94.6, 96.5)	93.1 (92.0, 94.2)	92.1 (90.3, 93.9)	-1.32 (-1.40, -1.23)	-1.69 (-1.79, -1.58)
			Change with increase (95% CI)	-1.4 (-1.9, -0.8)	-0.7 (-1.3, -0.1)	-1.9 (-2.6, -1.1)	-0.08 (-0.14, -0.03)	-0.16 (-0.22, -0.10)
			p for slope	<0.001	0.026	<0.001	<0.001	<0.001

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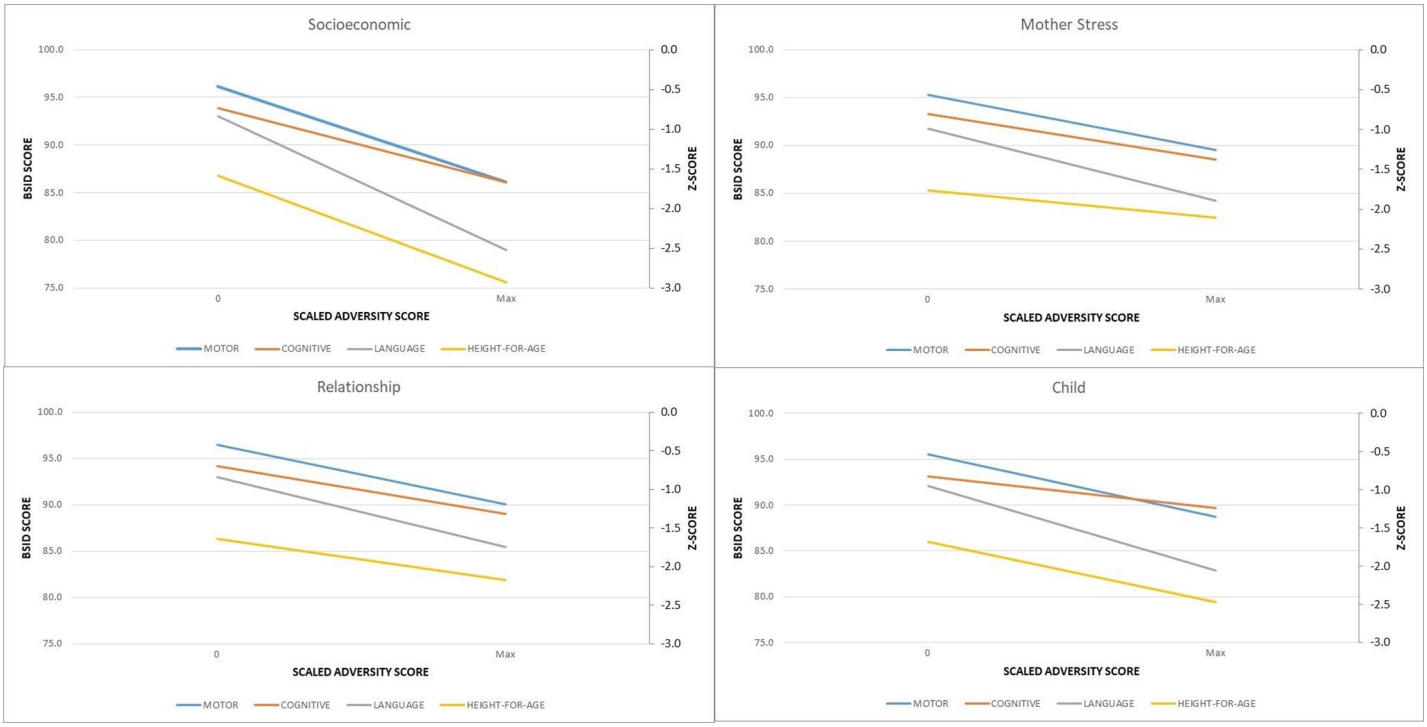

Fig 6. Regression model associations between adversity scales and growth & development at 18 months of age in children enrolled in SPRING-ELS as follows. A) Socioeconomic Score B) Maternal Stress C) Relationship D) Child. Note: weight-for-age described in text but not shown to aid clarity of figure.

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adversity quintiles derived from the PCA analysis corroborates this finding, suggesting that individual factors contribute independently to the associations with impaired outcomes. When the adversity scales were added into individual regression models assessing the combined effects of the scales on each outcome, the point estimates for each were somewhat attenuated, suggesting that there was some overlap between the scales. Notably, in these models, the

Table 5. Results from five regression models assessing the combined effect of all four adversity subscales on each growth & development outcome at 18 months of age.

Adversity scale	Items	Max observed		Bayley Scales of Infant Development			Anthropometry	
				Motor	Cognitive	Language	Weight-for-age	Height-for-age
Socioeconomic	6	6	Change with increase (95% CI)	-1.3 (-1.8, -0.9)	-1.0 (-1.5, -0.5)	-1.9 (-2.6, -1.3)	-0.16 (-0.21, -0.11)	-0.21 (-0.26, -0.16)
			p for slope	<0.001	<0.001	<0.001	<0.001	<0.001
Maternal stress	6	4	Change with increase (95% CI)	-0.4 (-1.1, 0.2)	-0.4 (-1.2, 0.3)	-0.6 (-1.5, 0.4)	-0.01 (-0.08, 0.06)	0.04 (-0.03, 0.11)
			p for slope	0.178	0.232	0.241	0.840	0.264
Relationship	4	3	Change with increase (95% CI)	-1.5 (-2.2, -0.9)	-1.3 (-2.1, -0.6)	0.5 (-2.6, -0.7)	-0.08 (-0.14, -0.01)	-0.11 (-0.18, -0.04)
			p for slope	<0.001	0.001	<0.001	0.031	0.003
Child	6	5	Change with increase (95% CI)	-0.9 (-1.5, -0.4)	-0.3 (-0.9, 0.3)	0.4 (-2.1, -0.5)	-0.05 (-0.11, 0.01)	-0.12 (-0.18, -0.06)
			p for slope	0.001	0.321	0.001	0.087	<0.001
Mean when all adversity scales = 0				98.3 (97.2, 99.3)	95.4 (94.0, 96.7)	95.5 (93.6, 97.4)	-1.11 (-1.21, -1.00)	-1.42 (-1.53, -1.31)
p for overall model fit				<0.001	<0.001	<0.001	<0.001	<0.001

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maternal stress scale point estimates were considerably attenuated with 95% CI crossing zero suggesting that the other scales accounted for much of the association seen in the initial analysis. This is an unexpected finding as these sorts of adversities–including maternal stress and depression—are some of the first to be considered when considering infant wellbeing.

Socioeconomic adversities were strongly associated with impaired growth & development, and are not addressed directly through SPRING. There is, however, evidence to support prioritisation of socioeconomic improvement for families because of benefits to the youngest members of society–for example, the cash-transfer schemes in Mexico's Opportunidates[36] and Nigaragua's Atención a Crisis[37] and our results suggest that other programmes may wish to explore this further, particularly given that early childhood programs may exacerbate existing developmental inequalities (e.g described by Victora et al in Brazil[38]) if uptake of promoted activities is greater in higher socio-economic groups with already comparatively better growth & development.

Some of the other adversities, including carer-child relationship are more clearly modifiable through SPRING's home-visiting approach, and it is therefore crucial that programs examine the extent to which interventions address a broad range of adversities, including those that are culturally specific and important–for example, in this study context, family desire for a boy-child was prevalent.

Growth data give a clear reminder of the appalling anthropometric status of children in this area. The mean height-for-age z-score and 42.2% prevalence of stunting are amongst some of the worst reported worldwide. Of note, even those children living with the least adversity have growth far below the expected norms for age (weight for age -1.04SD (95% CI -1.22, -0.86) below the mean; height for age -1.34SD (95% CI -1.53, -1.14) below the mean—this was much worse for those children with higher adversity scores. Addressing adversity is likely to go some way towards improving growth status of children, but we do not provide evidence here that suggests that this alone would bring this up to global norms. The differences seen in development between those with the least (zero adversity) and the most (8+ adversities) was considerable at more than 10 points on the BSID-III motor scale, nearly 8 points on the cognitive scale, and more than 11 points in the language scale. These differences are notable at the individual level and mean that these individual children are at risk of continuing suboptimal development through childhood.

Our findings are in accordance with the limited literature on young child growth & development. The study which comes closest to addressing the questions we set out to answer in similarly young infants is from Bangladesh[39] where Hamadani et al focussed on socioeconomic status and home stimulation as measures of adversity and examined the association with the mental developmental index of an earlier version of BSID. Other work tends to focus on individual adversities, particularly socioeconomic status, maternal depression & the home-environment (measured using the HOME inventory) and one or two domains of child development. For example, in the early 1980s, Agarwal et al reported associations between socioeconomic status, family size & the HOME-inventory with developmental scores in 1–3 year olds in India[40]. Paxton & Schady reported poorer cognitive development in children in Ecuador by socioeconomic status[41]. Patel et al report poorer mental and motor development in 43 children of depressed mothers compared with controls in India[42]. Similarly, Galler reported poorer maternal mood was associated with poorer motor development in a sample of 92 infants in Barbados[43] and there is a report of poorer living conditions being associated with poorer Peabody scores[44]. In contrast to our approach, several studies treat adversities as possible confounders in the relationship between a particular adversity of interest and outcomes to delineate the contribution of a specific adversity. An example is a study that examined the relationship between common mental disorder scores (using the SRQ-20) & child

growth/development in four LMICs. This is based on a conceptual framework that treats child, maternal & household characteristics as potential confounders and then statistically adjusts for these to examine adjusted risk ratios for the association[45]. We prefer the approach of considering many adversities around a child to understand their cumulative impact as described by Evans et al [46] in their review of different models of risk for child development, and by Wachs & Rahman[9] based on the understanding that children are likely to be able to manage individual adversities, but that the combination of these simultaneously is more highly detrimental to coping mechanisms. One limitation of this approach is that it is not possible to examine possible interactions between adversities–this is important because the impact of any one adversity is likely to be influenced by the presence or absence of other adversity and protective factors.

Ours is the first large population-based study in a LMIC to examine growth & developmental disadvantage in multiple domains faced by young infants living with a wide range of adversities relating to their own experiences, stressful experiences for their mothers, difficulties with carer-child interaction, and broader socioeconomic position of their household. Unlike previous studies, we assessed adversity prospectively from birth by identifying all pregnancies & births in our large study area through a trial surveillance system. We found good representativeness of those in our cohort compared with those identified by the trial surveillance system but not assessed. Other strengths include the robust approach we took to deal with a small amount of missing data, the use of a secondary principle components analysis to confirm the primary analysis based on total number of adversity factors, and the broad range of adversity factors analysed. We also used BSID-III–the gold-standard measurement tool which has been used worldwide including in India—to measure child development. We comment on between-group developmental differences in our study and not on absolute values because of complexities in cross-setting interpretation.

Given the nature of the analyses presented there is a possibility that unmeasured confounding, bias or common cause of both adversity and outcome—for example genetic differences and other characteristics at birth–account for some or all of the relationship described. Other study designs would be required to examine this further.

Our results are the first from a large population-based study in an LMIC to show that increasing adversity in multiple domains increases risks to child growth & development at a very early age. There is an urgent need to act to improve these outcomes for young children in LMICs and these findings suggest that Early Childhood programmes should prioritise early childhood adversity because of its impact on developmental inequities from the very start.

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Chapter 8 (Paper 3): The contribution of childhood adversity to cortisol measures of early life stress amongst infants in rural India: findings from the early life stress sub-study of the SPRING cluster randomised controlled trial (SPRING-ELS)

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Awaiting decision following resubmission to Psychoneuroendocrinology on 31 December 2018

This paper describes the relationship between cumulative childhood adversity through pregnancy and the first year of life, and diurnal cortisol rhythm (measured in saliva) and chronic exposure to cortisol (measured in hair). Cortisol is one of the hypothesised mediators between early life adversity and negative health impacts, and this is the first study to examine the influence of adversity on these cortisol measures in such young children in a low/middle-income country.

Note regarding this multi-author work:

The Early Life Stress sub-study of SPRING (SPRING-ELS) was funded by the Wellcome Trust as a fellowship to me, with Betty Kirkwood as my supervisor. I spent 18 months at the study site in Haryana, India as an integrated member of the SPRING trial team and was heavily involved in all aspects of design and conduct of the trial.

The idea of introducing measures of adversity and stress to SPRING through SPRING-ELS were mine. I obtained funding, ethical & regulatory approvals, and led the fieldwork, administration and finance for this sub-study.

This paper also draws on data from SPRING which was led by Betty Kirkwood as principal investigator, Gauri Divan (India Principal Investigator) and Reetabrata Roy (India Trial Director). I contributed to all aspects of this data collection including cultural adaptation, preparation of tools, fieldwork planning and fieldworker organisation. I performed all data analysis and wrote this paper.

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SECTION A – Student Details

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Principal Supervisor	Prof Betty Kirkwood
Thesis Title	Early childhood stress, adversity, growth & development: findings from the SPRING home visits cluster randomised controlled trial in rural India

If the Research Paper has previously been published please complete Section B, if not please move to Section C

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The contribution of childhood adversity to cortisol measures of early life stress amongst infants in rural India: findings from the early life stress sub-study of the SPRING cluster randomised controlled trial (SPRING-ELS)

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Abstract

Background: The majority of the world's children live in low- and middle-income countries and face multiple obstacles to optimal wellbeing. The mechanisms by which adversities – social, cultural, psychological, environmental, economic – get 'under the skin' in the early days of life and become biologically embedded remain an important line of enquiry. We therefore examined the contribution of childhood adversity through pregnancy and the first year of life to hair and salivary cortisol measures of early life stress in the India SPRING home visits cluster RCT which aims to improve early childhood development.

Methods: We assessed 22 adversities across four domains: socioeconomic, maternal stress, family-child relationship, and child and summed them to make a cumulative adversity score & quintiles, and four subscale scores. We cut 3cm of hair from the posterior vertex and took three saliva samples from morning till late afternoon on each of two days (total six samples). We analysed both for cortisol concentration using ELISA techniques. We used multiple linear regression techniques to assess the relationship between cumulative adversity and log hair cortisol concentration and saliva diurnal slope and area under the curve.

Results: We assessed 712 children for hair, and 752 children for saliva cortisol at 12 months of age. We found a strong positive relationship between adversity and hair cortisol; each additional adversity factor was associated with hair cortisol increases of 6.1% (95% CI 2.8, 9.4, $p<0.001$) and the increase from adversity quintile one to five was 59.4%. Socioeconomic, relationship and child scales were independent predictors of hair cortisol (socioeconomic 6.4% (95% CI -0.4, 13.6); relationship 11.8% (95% CI 1.4, 23.2); child 7.9% (95% CI -0.5, 16.9). We did not find any association between any measures of adversity and either of the saliva cortisol outcomes.

Discussion: This is the largest study of hair cortisol in young children, and the first in a low- and middle-income country setting. Whilst the short-term diurnal measures of cortisol did

not appear to be linked with adversity, chronic exposure over several months appears to be strongly associated with cumulative adversity. These findings should spur further work to understand the specific ways in which adversity becomes biologically embedded, and how this can be tackled. They also lend support to ongoing action to tackle childhood adversity in communities around the world.

1. Introduction

Health and development in the crucial early life period is now firmly on the global agenda and interventions are being designed to address the myriad obstacles to optimal wellbeing faced by the majority of the world's children who live in low- and middle-income countries. Childhood adversity is associated with negative effects across the lifecourse including on growth, development, behaviour and academic ability in childhood and conditions including depression, cardiovascular disease and healthy ageing later in life (Shonkoff et al., 2012). The question, then, is by which mechanisms do these disparate adversities – social, cultural, psychological, environmental, economic – get 'under the skin' and become biologically embedded (Berens et al., 2017; Nelson, 2013)? Several mechanisms have been proposed and studied including genetics and epigenetics, inflammation, hormonal changes, and structural and functional brain changes.

Cortisol is one of the most studied of these mechanisms, and we examined the relationship between this hormone and childhood adversity in young infants aged 12 months in India. Cortisol is the end product of the hypothalamic-pituitary-adrenal (HPA) axis and has been widely used as a stress biomarker, but rarely in such young infants. It can be measured in multiple ways. The concentration of cortisol in hair gives a measure of chronic exposure to stress over a period of months (Russell et al., 2012). Measuring cortisol in multiple saliva samples at different times of day allows for measures of diurnal change to be calculated – cortisol is expected to be highest upon waking and falls through the day (Adam and Kumari, 2009). These measure two complementary features of a healthy cortisol rhythm – that it should fall from a peak soon after waking to a nadir in the evening (slope), and that increased exposure throughout the day will lead to elevated cortisol area under the curve (Area under the curve). This rhythm starts in the first six months of life and is expected to be fully established by age one year (Gunnar and Adam, 2012; Mantagos et al., 1998). Other developmental consideration include daytime naps (Watamura et al., 2004) which

must be accounted for in this age group. Few studies examine associations between hair cortisol and cortisol in other samples in the first year of life.

Changes in cortisol are well documented in older children exposed to adversities including those exposed to deprived care in Romanian orphanages (Gunnar et al., 2001) where flattened diurnal rhythm is described in saliva cortisol at age 6-12 years following adoption in the first year of life, maternal depression and participation in home visiting programmes (Fernald and Gunnar, 2009) where participation in a home-visiting programme was associated with lower salivary cortisol at age 2-6 years, and childhood trauma is associated with increased mean cortisol in a range of studies reviewed by Nemeroff (Nemeroff, 2004). A recent systematic review included 36 studies of hair cortisol in children from birth-18 years of age describing higher hair cortisol in boys, and with greater body mass index. A possible association with socioeconomic status was described whereby higher socioeconomic status was associated with lower hair cortisol and the authors called for more research into associations with stressful experiences (Gray et al., 2018). Another recent review examined diurnal salivary cortisol measures in all age groups and described associations of flattened diurnal slopes with impaired health outcomes; this relationship was clearer in adults than in children (Adam et al., 2017). A systematic review focussing on young children aged 12-60 months included nine studies and found chronic stress was associated with raised hair cortisol but that there was no difference between boys and girls at this age (Bates et al., 2017).

In the work described in this paper we therefore set out to assess the relationship between early life adversity and these chronic and diurnal measures of cortisol in hair and saliva in children enrolled in the Early Life Stress sub-study of the SPRING cluster randomised controlled trial in rural Haryana, India. Our hypothesis was that adversity would be associated with increased hair cortisol, and in saliva with increased daily exposure to cortisol and flattened diurnal slope. This is the first time hair cortisol has been reported in

children from a low/middle-income country (LMIC), and few studies examine both saliva and hair simultaneously.

2. Methods

2.1 Overview of Study Design

SPRING-ELS was a sub-study of the Wellcome Trust funded SPRING cluster randomised controlled trial in India. It focussed on cortisol measures of early life stress, and on early childhood adversity in children enrolled in SPRING. Details on SPRING are available elsewhere (Clinicaltrials.gov registration NCT02059863) but in brief SPRING developed an innovative, feasible, affordable and sustainable community-based approach to delivering a home visiting programme aiming to improve child growth and development at-scale in India and Pakistan, two countries with high burden of disadvantage. Implementation was evaluated by parallel cluster randomised controlled trials where clusters represent geographical areas served by a health sub-centre with a functioning auxiliary nurse midwife, covering a population of at least 8000. The primary outcomes were height-for-age, the best early childhood predictor of human capital (Victora et al., 2008), and Bayley Scales of Infant Development III, the gold standard assessment of a child's development in the early years("ClinicalTrials.gov: SPRING Cluster Randomised Controlled Trial," 2018). These impact outcomes were complemented by in-depth economic analysis, process-evaluation and a broad range of intermediate outcomes selected based on a predefined conceptual-framework. The aim was to help to unpack the SPRING causal pathway, provide deeper understanding of mechanisms of trial impact, and inform lessons for scale-up and incorporation into health systems. SPRING took place in 120 villages of Rewari district, Haryana state across a population of around 200,000. The district is predominantly rural and has health and demographic indicators around average for Haryana state. The literacy rate in Haryana is 76%, with female literacy of 67%. The sex ratio is 879 females per 1000 males – amongst the lowest ratio in India (Office of the Registrar General & Census

Commissioner, India Ministry of Home Affairs, Government of India, 2015). Infant mortality is 41/1000 live births (National Institution for Transforming India, Government of India, 2016) – around the national average. More than one third of under-five year old children are stunted (National Family Health Survey - 4: 2015-16, 2017).

2.2 Data Collection

Children were identified by a surveillance system whereby trained resident fieldworkers visited each household in the study area every 8 weeks to identify pregnancies and births, and follow-up pregnant women and children already identified. Socioeconomic data was collected at enrolment and assessors were trained to take saliva and hair samples from children, and to do adversity assessments with their mothers when infants turned 12 months of age. Full implementation of the SPRING intervention was achieved in May 2015 and these children were born from 18 June 2015. Assessments were therefore done when SPRING had been running for at least one year in intervention clusters.

Adversities: These were selected to be contextually important based on formative research with local mothers and grandmothers, advice from child development experts and reviews of the literature on existing tools. The adversities covered four domains as follows: 1) household-level socio-economic factors, 2) maternal stressors, 3) child-carer relationships and 4) child-related factors. The focus was on these groups because young children in this setting spend most of their time and interact most closely with family members inside the home. The aim was to focus on a broad range of potential impediments to wellbeing because children can be resilient to single adversities, but combinations of these may be more harmful and overwhelm protective factors in a child's life (Wachs and Rahman, 2013).

Data on 22 adversities were chosen. These are summarised in Table 1 which shows the four domains in which they were placed, and the prevalence of each adversity. Nineteen of the adversities were assessed at one year of age and only the first three (marked *E in the

table) were assessed at enrolment. Further details on each adversity are provided below. These descriptions were published previously (Bhopal et al., 2019).

Socioeconomic: 1) Asset index - being in the lowest quintile for the population at enrolment (calculated with principle components analysis using data on mother, household demographics and animal and other asset ownership) 2) Low parental education – no education or primary-schooling only (asked at enrolment) 3) Father occupation - father did not work, was seasonably employed or was a casual labourer at 12-month assessment 4) Mother married under the legal age of 18 years 5) Family debt - mother reported family debt or being unable to afford to buy food for herself or her child at any point between becoming pregnant and the 12 month assessment.

Maternal stress: 1) Death of one or more of mother's close family members since becoming pregnant 2) Mother seriously injured or ill since pregnancy 3) Any violence towards mother from husband (assessed using WHO multi-country study on women's health and domestic violence against women(World Health Organization, 2005)) or any other person since becoming pregnant 4) mother screens positive for mild, moderate or severe depression on PHQ9 or answers 'yes' to PHQ9 question on suicidal ideation (at 12-month assessment). PHQ9 is one of the most commonly used screening tools for depression and has been used widely in India(Patel et al., 2010) 5) Low level of support or high stress from others around the mother using the Duke social support and stress scale(Parkerson et al., 1991) reported at 12-month assessment 6) Problematic husband alcohol use reported by mother at 12-month assessment

Relationship: 1) Any family member was unhappy when they found out that the child was a girl 2) Moderate or high concern level on Mother Object Relations Scale – short form (MORS-SF) at 12-month assessment. MORS-SF is a screening tool consisting of 14 short statements which a mother is asked to rate on a Likert-type scale to identify potential problems in early mother-infant relationship(Oates et al., 2005) 3) Very low quality interactions observed during a feeding episode at the 12-month assessment (assessed by

non-specialist fieldworkers using the observed feeding index, a tool developed in this project where feeding is scored using tick-boxes. This tool will be published in due course). Very low quality means that the following was observed during the feeding episode: <=1 positive talk by mother towards child, and <=1 episodes of playful feeding and <=1 responsive feeding actions, plus one or more negative actions such as force feeding, holds child's head still to give food, shaking, threatening, shouting or berating observed by the mother towards child during feeding session 4) Lowest quintile score on HOME inventory measuring quality of the home environment through observations of the home and questions to the mother (total of 45 items, each scored 0 or 1) over the course of one hour (Cox and Walker, 2002) at 12 month assessment – the cut-off for the quintile fell between 27 and 28 points and the lowest of these (27 points) was chosen to create a conservative estimate of this factor.

Child: 1) Child born prematurely (asked at 12-month assessment) 2) Child hospitalised in first year of life 3) Separation of mother and child for more than a week in the first year of life 4) Inadequate care – child left alone or with a child under 10 years for more than one hour in the past week (assessed at 12-month assessment) (From ("UNICEF: Multiple Indicator Cluster Surveys," 2018)) 5) Older children in the house say anything to make child cry or unhappy (in last week) (at 12-month assessment) (From ("UNICEF: Multiple Indicator Cluster Surveys," 2018)) 6) Older children who live in house: hit/punched/kicked/bit child on purpose to make them unhappy (in last week) (assessed at 12 month assessment)

Adversity questionnaires were double-entered and verified using a computer program written in C Sharp with an SQL Server 2008 database.

Hair Sampling: Trained assessors cut hair samples from the posterior vertex (the area of least intra-individual variability (Sauvé et al., 2007)) as close to the scalp as possible using scissors. The aim was to obtain at least 10mg of hair (approximately 1cm diameter, 2-3cm length) (Stalder and Kirschbaum, 2012). This amount of hair was acceptable to families and caused minimal impact to hair appearance. Samples were wrapped in aluminium foil, labelled and the scalp end marked. On arrival at the site office samples were cut to select the most proximal 3cm of hair and repackaged in aluminium foil then a paper envelope ready for weekly courier collection and shipping to the laboratory at room temperature. On arrival at the laboratory, samples were stored at room temperature and analysed using established methods (Davenport et al., 2006; Kirschbaum et al., 2009) whereby the hair is washed in isopropanol, dried thoroughly for 24 hours, cut finely with scissors, extracted into methanol and analysed using a Salimetrics ELISA kit to give a final result for each hair sample in picograms of cortisol per milligram of hair. The laboratory protocol is presented as an additional file.

Saliva Sampling: The same fieldworkers took saliva samples three times (at 8am, 12pm and 4pm) on each of two consecutive days (total six samples). They used Salimetrics SalivaBio Children's Swabs (Salimetrics, USA; part no 5001.06) which are designed for young infants to avoid choking risk and to be palatable. These swabs have been used in many settings worldwide and are the gold-standard for collection of saliva for cortisol analysis (Tryphonopoulos et al., 2014) . The first sample of each day was taken as soon as possible on entering the household in order to minimise the opportunity for there to be a transient rise in concentration due to a stranger in the household. Samples were not taken if children had been unwell in the past 24 hours because illness can lead to raised cortisol. Samples were never taken within 30 minutes of eating drinking or waking from sleep to avoid interference with cortisol levels (Schwartz et al., 1998).

Sampling was done as follows. The child was positioned on their mother or grandmother's lap and the fieldworker gently introduced the swab into the child's mouth for 30-60 seconds. When it was observed to be at least 1/3 saturated (a minimum of 150µL saliva is required for laboratory analysis) it was removed, placed into a storage tube (Salimetrics USA; part no 5001.05) and labelled with a pre-printed freezer-proof label containing only a sample identifier and anonymised child identifier. Time of sampling, time of last food, drink and last waking were then recorded.

Samples were kept cool in insulated flasks through the day and refrigerated them at the site office overnight (samples remain stable at room temperature for several weeks (Nalla et al., 2015; Tryphonopoulos et al., 2014) but cooling is normal practice) before being packed in a cooled container (2-5°C) for daily courier collection and shipping to SRL Laboratories Ltd, Mumbai, India. Shipping followed the laboratory's established freight route by road to Delhi airport (1.5-2 hours), and air to Mumbai (approximately 2-hour flight) from where they were delivered to the laboratory's Research & Development division. Samples were frozen on arrival and stored at -20°C. Samples were thawed in batches, centrifuged at 1500g for 15 minutes and refrozen at -20°C. Samples were analysed later in batches using a Salimetrics USA high-sensitivity salivary cortisol enzyme-linked immunosorbent assay (ELISA) according to the manufacturer's instructions. A randomly selected 10% of samples per batch were analysed in duplicate. The intra-assay coefficient of variation of 5.6% and inter-assay coefficient of variation of 9.2% was within acceptable limits (Salimetrics, 2018).

2.3 Sample Size

With 24 geographical clusters, a sample size of 25 children per cluster was chosen to give 90% power at the 5% level of significance to explore a range of adversities with prevalence of 20% to 80% and to detect effect sizes between 0.4SD & 0.5SD (assuming an intra-cluster correlation of 0.05). The aim was to assess more children than this - at least 30 children per cluster for saliva and 35 per cluster for hair - to ensure that the minimum sample size was met even if samples were of insufficient volume (saliva) or weight (hair) for analysis.

2.4 Data Analysis

Stata 15 was used for all analyses (StataCorp LLC: College Station, TX, USA).

Adversities: we used multiple imputation by chained equations (MICE) to account for the missing values in adversity data described in Table 2. We used 30 imputations and included all explanatory and outcome variables in each model as is standard practice. We also carried out a repeat analysis using only complete cases. We calculated descriptive data using a combination of all imputations.

We categorised adversities in three ways as follows: 1) we summed the adversities to create a total adversity score of 0-22 following a cumulative-adversity model (Björkenstam et al., 2017; Slopen et al., 2014; Turner and Lloyd, 1995) 2) we summed adversities within each of the four domains in a similar manner 3) we used principle-components-analysis (PCA) to capture the linear combination of adversities which creates the maximum variance in the adversity data to avoid any 'double counting' in the cumulative adversity analysis. We converted the raw PCA score into adversity quintiles for analysis.

Hair Cortisol: We log-transformed hair cortisol concentrations for each child because of left-skew and then winsorized four remaining outliers to 3SD above the mean. This was the first outcome variable.

Saliva Cortisol: We calculated two outcomes from saliva cortisol measures for each child. The first was saliva cortisol slope which is a measure of the change in saliva cortisol concentration per hour across the day's sampling. The second was saliva cortisol area under the curve which is a measure of the total hourly exposure of a child to cortisol over the sampling period. For each saliva cortisol result we first winsorized outlying high values to 3SD above the mean. We then used the rise-over-run formula (change in two cortisol values divided by hours between these) for children with results at 8am and 4pm to calculate the saliva slope for each child. Similarly, we used the trapezoid formula to estimate the total cortisol a child was exposed to which was represented by the total area bounded by two parallel lines at each of two time points on the x-axis, the base on the y axis (where cortisol is zero) and the line connecting the two cortisol values on the y-axis. This was done for children with all three samples on at least one day to calculate saliva cortisol area under the curve with respect to the ground.

2.5 Association of cumulative adversity and hair cortisol

We assessed the relationship between cumulative adversity and hair cortisol using multi-level modelling, accounting for clustering as a random-effect and allocation to the SPRING intervention or control arm allocation as a binary fixed-effect in the model. We first treated adversity as categorical to examine mean hair cortisol for each of the observed cumulative adversity scores, and then as continuous to assess the linear trend in this relationship. We ran the same model with the adversity quintiles replacing cumulative adversity. We ran all of these models including Sex and Body Mass Index (BMI) to assess for possible confounding.

2.6 Association of cumulative adversity and saliva cortisol outcomes

We also used multi-level modelling to assess the association of adversity and saliva cortisol slope in the whole sample using a three-level model which accounted for saliva results nested hierarchically within the random effects day, child and cluster, accounting for time of sample collection as a fixed-effect interaction term. Child wake-up time was a fixed-effect to control for any effect of waking time on saliva cortisol values. The difference in saliva cortisol slope between cumulative adversity scores was represented by the interaction term between adversity and time of sample with cortisol result at that time as the outcome.

We used a similar approach to model AUC. The difference in AUC between cumulative adversity scores for the whole sample was modelled using predicted margins for cortisol concentration at 8am, noon and 4pm. The model first used the trapezoid formula described earlier to calculate the AUC at each adversity level, and then subtracted one from the other to calculate the difference. We ran these models including Sex and Body Mass Index (BMI) to assess for possible confounding.

2.7 Association of adversity domains and cortisol

We examined the association between the four adversity domains and the three cortisol outcomes using similar models to the analyses with total cumulative adversity. We used a three-step process as follows:

We first ran models to explore the association between each domain and cortisol, adjusted only for clustering and trial arm allocation. We then added socioeconomic score to the models for Maternal Stress, Relationship and Child domains to adjust for potential confounding in these associations by socioeconomic status. We finally ran a model including all scales showing either a strong relationship or p-value less than 0.1 to create a mutually adjusted model.

2.8 Ethics

Ethics approval was obtained from the London School of Hygiene & Tropical Medicine research ethics committee (23 June 2011, approval number 5983; 19 May 2015, approval number 9886) and the Sangath Institutional Review board (IRB) (19 February 2014; 27 May 2015). Approval was also granted by the Indian Council of Medical Research's Health Ministry Screening Committee (HMSC) (24 November 2014; 6 October 2015). The SPRING trial is registered with clinicaltrials.gov, number NCT02059863. Informed written consent was obtained from mothers at identification by the surveillance system and again before a child's first birthday.

2.9 Role of Funding Source

The funder (Wellcome Trust) had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript. SB and BK have complete access to the study data and are responsible for the reported study findings, and made the decision to submit for publication.

3. Results

3.1 Hair and Saliva Cortisol sub-samples

1693 children were enrolled for hair assessment, and 1350 children were similarly enrolled for saliva assessment. The flowcharts for both of these sub-samples are shown in Figure 1 showing that 712 children had hair assessments and 752 had saliva assessments. Loss to follow-up was because of consent refusal, having moved away, being unable to make an appointment and (for hair only) because the hair length was too short for sampling. 436 children had both hair and saliva assessments. The median age at assessment was 12.4 months (IQR 12.2-12.6). All of these children had adversity assessments. Prevalence of each adversity factor ranged from 4.0% to 50.4% (Table 1).

Table 3 shows that there was no evidence of selection bias with regards to maternal education, caste, socioeconomic scores, being a twin/triplet, and mother's age at delivery. However, girls were more likely to be assessed than boys in the hair sub-sample.

Table 4 shows the mean values for all cortisol measures including for boys and girls separately. The mean of log hair cortisol concentration was 1.85 log pg/mg (SD 1.05) This is equivalent to a geometric mean of 6.26 pg/mg (SD 3.01). Hair cortisol did not vary by length of hair sampled or weight of hair used in analysis. Saliva cortisol slopes were relatively flat; 60.0% of children had a slope between -0.01µg/dL/hr and +0.01µg/dL/hr as illustrated in Figure 2A. In addition, contrary to our expectation of negative slopes, 15.3% had slopes that increased by more than 0.01µg/dL/hr through the day. The overall mean saliva AUC was 1.29 ug/dL (SD 0.47). The distribution for saliva cortisol is illustrated in Figure 2, and this figure also shows little difference in saliva cortisol between the two days of sampling.

3.2 Hair Cortisol & Adversity

Cumulative adversity: most children had a cumulative adversity score of at least one. The maximum score was 12. Cumulative adversity was strongly positively associated with hair cortisol on the log scale as illustrated in Figure 3A. The adversity quintile analysis displayed in Figure 3B shows a similar association; the increase between the least and most adverse quintiles was 59.5% (4.77 to 7.61 log pg/mg hair). Each additional adversity was associated with an increase of 6.1% (95% CI 2.8, 9.4, p<0.001) in hair cortisol (bottom shaded row of Table 5). BMI and Sex were not independently associated with hair cortisol, and adding these to the model did not materially change the associations seen.

Adversity domains: the strongest association was with the Relationship scale where each increase in score was associated with an increase of hair cortisol of 15.8% on the log scale. This scale was observed across a range of 0 to 3 adversities and so is not directly comparable to other scales which were observed over greater ranges as illustrated in Table 5. We therefore present Figure 4 where each scale has been rescaled to between 0 and maximum, allowing for direct comparison. Here, socioeconomic, child and relationship scales have the greatest change in cortisol between those with the least and most adversity, whilst that for maternal stress is lower. Table 5 also shows that including socioeconomic status in the model ameliorated the relationship between the relationship and child scales and hair cortisol somewhat. The final mutually adjusted model which aims to assess the relative contribution of each domain is presented in this table and suggests that socioeconomic, relationship and child scales were independent predictors of hair cortisol despite 95% CI that cross 0 – the increase in hair cortisol per adversity factor was 6.4% (95% CI -0.4, 13.6, p=0.065) for socioeconomic, 11.8% (95% CI 1.4, 23.2, p=0.026) for relationship, and 7.9% (95% CI -0.5, 16.9, p=0.065) for Child. The p for the model was <0.001. The initial and final models for each adversity domain and hair cortisol are illustrated in Figure 4.

3.3 Saliva Cortisol & Adversity

Analyses presented in Table 6 show that whilst the direction of the effect size for the relationship between saliva cortisol slope and AUC and measures of adversity were all in the hypothesised direction (less steep slopes, and higher AUC), the effect sizes were small with wide confidence intervals meaning that no association was seen between saliva cortisol and measures of adversity.

4. Discussion

We found that childhood adversity was clearly positively associated with the concentration of cortisol in hair samples taken at one year of age. This assessed cortisol exposure over several months. This relationship was not confounded by BMI or sex. We did not find the same relationship with saliva measures which focus on the cortisol rhythm over two days. This increased chronic exposure to cortisol is likely to be detrimental to child wellbeing and our findings should serve as a wake-up call that children are never “too-young” to be affected by adverse circumstances, that children need protection and support to avoid adversity and that programmers and policy-makers should reiterate efforts to ameliorate these effects.

Most studies of hair cortisol in young children are relatively small. We identified 11 studies done in under 5 year olds, a similar number to those identified in a recent systematic review (Gray et al., 2018). Most of these had a sample size of less than 100 and none were done in low/middle income countries. Our study is therefore to the best of our knowledge not only one of the largest studies of hair cortisol in young children ever done, but the first in the low/middle-income country setting where the burden of adversity is greatest and where most children live. This limited literature of 0-5 year olds has mixed findings. In concordance with our findings, no association is seen between hair cortisol by gender in these 0-5 year olds ((Gerber et al., 2017; Grunau et al., 2013; Maurer et al., 2016; Rippe et al., 2016)

although this has been reported in older children). Two small studies reported no association with socioeconomic status, parental education or income (Groeneveld et al., 2013; Hoffman et al., 2017) whilst a larger study from Canada reported negative associations with parental education and no association with parental income (Vaghri et al., 2013). Findings in older children are equally mixed with some showing associations with these variables (Rippe et al., 2016; Ursache et al., 2017) but others finding no association between individual adversity factors and hair cortisol (Gerber et al., 2017; Groeneveld et al., 2013; Karlén et al., 2015; White et al., 2017). Reasons for these differing findings are not clear, however two studies using composite scores of socioeconomic status in Sweden (Karlén et al., 2015) and the Netherlands (Vliegenthart et al., 2016) similar to our methods find similar results, suggesting that these composite scores may more clearly identify the cumulative nature of risk to children with attendant cortisol rise compared with examining individual risk factors separately. We think this is crucial to understanding our results.

The finding that maternal-stress factors were less critical to cortisol than other factors in our analysis should give pause for thought, as these are often some of key issues considered when attempting to address problems in early childhood. Similar to our findings, Liu et al examined children at 9 months and 1 year and found no difference in hair cortisol by maternal stress, affect or mood (albeit in a small sample of 41 children) (Liu et al., 2016). However, Palmer et al found that maternal depression and parenting stress were associated with hair cortisol in 1 year old infants in the USA, with some differences in subgroup analyses between racial groups (Palmer et al., 2013).

That saliva cortisol was not associated with childhood adversity is noteworthy, and contrary to our hypothesis. We found very flat slopes in the majority of the sample and it is possible that this contributes to this finding. For example, St John et al describe slopes which are 10 times greater than the decline we describe in under one year olds (Flom et al., 2017; St. John et al., 2017). Having said that, authors do not always report descriptive data, saliva cortisol values are known to vary depending on assay used (Miller et al., 2013) and slopes

are generally shallow overall in young children (for example (Watamura et al., 2003)). Another consideration is that whilst the diurnal rhythm is likely to be in place at this age, the HPA axis continues to mature through the first few years of life (Davis and Granger, 2009; Gunnar and Donzella, 2002; Hill-Soderlund et al., 2015). A recent meta-analysis did not find a relationship between adverse events in childhood and saliva cortisol in adulthood (Fogelman and Canli, 2018). Finally, that the findings are discordant between hair and saliva is in line with previous work (Flom et al., 2017) and theoretical understanding that they are assessing different components of the stress response system described earlier (Russell et al., 2012).

Strengths of our study include the measurement of adversities at the time they are occurring, in contrast with the common approach to Adverse Childhood Experiences focussing on adult recall of childhood events (Felitti et al., 1998). We were also able to include a wider range of adversities, some of which are more easily measured when children are young. Our use of modelling tools allowing for analysis of unbalanced numbers of saliva samples per child (Hruschka et al., 2005).

Limitations are that biological measures were restricted to cortisol whilst biological embedding of adversity is likely to occur through multiple factors acting simultaneously. Assessing multiple biological markers simultaneously (for example, “epigenetic clocks”) can provide more detailed estimation of the biological toll of adversity (Belsky et al., 2018; Jylhävä et al., 2017). A specific limitation related to the saliva cortisol is that the first sample of the day was taken at 8am rather than the closer to waking-time, similarly our final sample was taken at 4pm rather than immediately before bedtime. Similar schedules have, however, yielded expected results in other studies (Adam and Kumari, 2009), so it is far from clear that this is the reason for our null findings.

That hair cortisol was seen to rise with each increase in a wide-range of adversities suggests that efforts to improve this will require a multisectoral approach to both reduce

adversities and to design interventions that can protect children who face these – the care for child development curriculum being promoted by WHO/UNICEF is one such example of an intervention promoting stimulation and nurturing care within the household.

In attempting to understand the effects of adversity in early childhood on a broad range of outcomes, a key question relates to ways in which these become biologically embedded, causing suboptimal lifelong health and wellbeing. Simultaneously, programmers implementing early-life interventions require tools that can provide insight into the biological impact of these. Hair cortisol has the potential to be of use in both regards.

In summary, we present for the first time the finding that early life adversity is related to chronic childhood exposure to cortisol in a low/middle-income country. Most children live in LMICs and these countries are where the burden of adversity and suboptimal health and wellbeing is greatest. Action is ongoing worldwide to tackle childhood adversity at societal, community and household levels and our work reiterates its importance in very early childhood, in a low/middle-income country. Further work is needed to develop deeper understanding into ways in which adversity becomes biologically embedded to help refine this action.

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Table 1: 22 Childhood adversities within four categories: socioeconomic, maternal stress, relationship & child-related

Domain	Item	Prevalence[h]
Socioeconomic	1. Socioeconomic status: lowest quintile (*E) [a]	20.0%
	2. Father education: none or 1-5 grades (*E)	5.0%
	3. Mother education: none or 1-5 grades (*E)	11.9%
	4. Father occupation: at home, seasonably employed or casual labourer	24.7%
	5. Mother married under legal age (18 years)	20.0%
	6. Family debt [b] or mother reports being unable to afford food for self or child at any point [c]	18.0%
Maternal Stress	1. Mother reports death of husband, parent, sibling, child or friend since pregnancy	5.4%
	2. Mother seriously injured or ill since pregnancy	4.0%
	3. Any violence from husband or mistreated by any other person since pregnancy [d]	13.4%
	4. PHQ9 score >=5 or problems described make it very/extremely difficult to do daily activities	19.5%
	5. Duke scale: support <=40 or stress >27	6.3%
	6. Husband's alcohol use causes problems for mother [e]	8.3%
Relationship	1. Any of mother, father, mother or mother-in-law were "unhappy" when found out child was a girl [f]	15.2%
	2. MORS concern: moderate or high	50.4%
	3. Observed feeding style: very low quality	13.3%
	4. HOME score: lowest quintile	15.6%[g]
Child	1. Mother-reported child born early	10.2%
	2. Child admitted to hospital any time after birth	14.9%
	3. Mother & child separated for one week or more	1.7%
	4. Child left alone or with child under 10 years for more than one hour in the past week	4.6%
	5. Older children who live in house: say anything to make child cry or unhappy (in last week)	30.5%
	6. Older children who live in house hit/punched/kicked/bit child on purpose to make them unhappy (in last week)	17.9%

[a] SES score calculated with principle components analysis using data on mother & household demographics and animal & asset ownership
[b] Answered yes to question: "Since you became pregnant, have you or your immediate family who live with you been in debt?"
[c] Answered yes to question: "Since you became pregnant, have you ever been hungry because you could not afford to buy food?" or similar related to child
[d] Using WHO multi-country study on women's health and domestic violence against women(World Health Organization, 2005)
[e] If woman reported husband drinking alcohol, answered yes to question: "does this cause any problems for you"
[f] Question: "When [person] found out your baby was a girl were you/they happy, unhappy or didn't mind whether you had a girl or a boy?"
[g] Not exactly 20% because cut-off made at change between integers (HOME score of 27 & 28)
[h] Includes all children with adversity assessments regardless of hair or saliva assessment status. No imputation for missing values.
*E data collected at enrolment; all others collected at 12m

Table 2: Adversity scores - proportion with missing values in each of hair & saliva sub-samples

Adversity	Number (%) children in each sub-sample with missing values	
	Hair	Saliva
Mother marriage age	16 (2.2%)	14 (1.9%)
PHQ9 score	13 (1.8%)	18 (2.4%)
Duke scale	13 (1.8%)	18 (2.4%)
Observed feeding index	201 (28.2%)	176 (23.4%)
HOME-IT score	0 (0%)	1 (0.1%)

Table 3: Comparison of children completing hair assessments with those lost to follow-up, and comparison of children with 0, 1 and 2 days of saliva sampling (*adjusted for clustering)

Indicator	HAIR				SALIVA			
	Completed Assessment (C)	Lost to Follow up (L)	C-L Difference (95% CI)*	p*	0 days	1 day	2 days	p*
Numbers meeting inclusion criteria in hair & saliva subsamples	**712**	**981**			**598**	**125**	**627**	
% No education (n)	5.3% (38)	7.2% (71)	-1.8% (-4.0, 0.5)	0.147	7% (42)	6.2% (39)	4.8% (6)	0.594
% scheduled/backward caste/tribe (n)	59.1% (421)	60.4% (593)	-3.0% (-8.3, 2.3)	0.504	58.7% (351)	61.2% (384)	60% (75)	0.750
% poorest (lowest 2 quintiles) (n)	39.7% (283)	42.7% (419)	-2.5% (-7.5, 2.4)	0.179	42.1% (252)	44.5% (279)	47.2% (59)	0.560
% Male (n)	47.9% (341)	58.4% (573)	-10.5% (-15.4, -5.7)	<0.001	55% (329)	53.7% (337)	49.6% (62)	0.541
% Twins/Triplets (n)	1.3% (9)	1.6% (16)	-0.2% (-1.0, 0.6)	0.219	0.8% (5)	2.4% (15)	0.8% (1)	0.093
% Delivered in facility (n)	97.9% (697)	97.5% (956)	0.4% (-1.0, 1.9)	0.852	97.5% (583)	97.6% (612)	97.6% (122)	0.991
Mean age at delivery (sd)	22.3 (3.7)	22.3 (3.8)	0.02 (-0.34, 0.38)	0.842	22.2 (3.5)	22.5 (3.9)	22.2 (3.7)	0.362
Mean SES score (sd)	0.05 (2.6)	-0.4 (2.9)	-0.02 (-0.28, 0.25)	0.931	-0.14 (2.93)	-0.36 (2.56)	-0.24 (2.77)	0.550

Table 4: Hair cortisol concentration, saliva cortisol slope & AUC – descriptive data

	BOYS		GIRLS		OVERALL	
	N	Mean (SD)	n	Mean (SD)	n	Mean (SD)
Hair cortisol concentration* (log pg/mg hair)	341	6.26 (3.01)	371	6.29 (2.71)	712	6.28 (2.85)
Saliva Slope (ug/dL/hr)	399	0.00015 (0.022)	353	-0.0023 (0.016)	752	-.0010 (0.019)
Saliva area under curve (ug/dL)	399	1.29 (0.50)	353	1.28 (0.42)	752	1.29 (0.47)

*Geometric mean

Table 5: Adversity domains and cumulative adversity – association with log hair cortisol concentration

HAIR CORTISOL CONCENTRATION	n	No of factors	Range observed	Model adjusted for clustering			Model adding socioeconomic			Mutually adjusted model			
				% cortisol increase per adversity	95% CI	p	% cortisol increase per adversity	95% CI	p	% cortisol increase per adversity	95% CI	p	p for model
Socio-economic factors	712	6	0-6	8.8%	(2.0, 16.0)	0.011	-	-	-	6.4%	(-0.4, 13.6)	0.065	
Maternal stress factors	712	6	0-4	6.0%	(-3.2, 16.0)	0.207	-	-	-	-	-	-	<0.001
Relationship factors	712	4	0-3	15.8%	(5.4, 27.2)	0.002	13.3%	(2.8, 24.8)	0.011	11.8%	(1.4, 23.2)	0.026	
Child factors	712	6	0-5	10.0%	(1.6, 19.2)	0.019	9.4%	(1.0, 18.5)	0.027	7.9%	(-0.5, 16.9)	0.065	
Cumulative adversity	712	22	0-12	6.1%	(2.8, 9.4)	<0.001							

Table 5: Adversity domains and cumulative adversity – association with saliva cortisol slope and area-under-curve

	n	Number of factors	Range observed	Saliva Cortisol Slope			Saliva Cortisol Area-Under-Curve		
				Increase per adversity	95% CI	p	Increase per adversity	95% CI	p
Socio-economic factors	752	6	0-6	0.00009	(-0.00063, 0.00081)	0.805	-0.028	(-0.102, 0.046)	0.456
Maternal stress factors	752	6	0-4	0.00021	(-0.00082, 0.00125)	0.683	-0.026	(-0.132, 0.079)	0.626
Relationship factors	752	4	0-3	0.00010	(-0.00097, 0.00118)	0.852	-0.030	(-0.140, 0.080)	0.594
Child factors	752	6	0-5	0.00063	(-0.00025, 0.00151)	0.162	-0.018	(-0.108, 0.073)	0.703
Total adversities	752	22	0-12	0.00017	(-0.00019, 0.00054)	0.352	-0.018	(-0.123, 0.090)	0.362

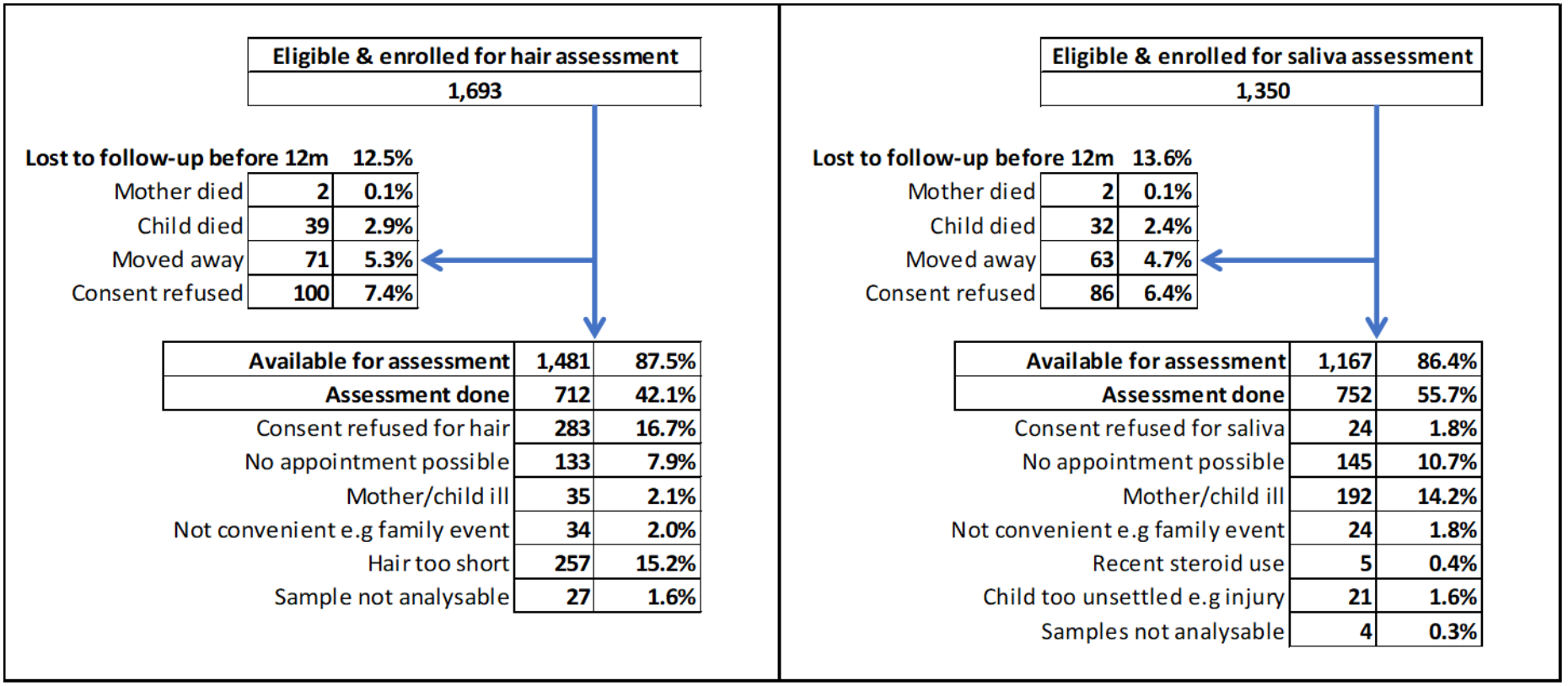

Figure 1: Hair & Saliva Subsample flowchart

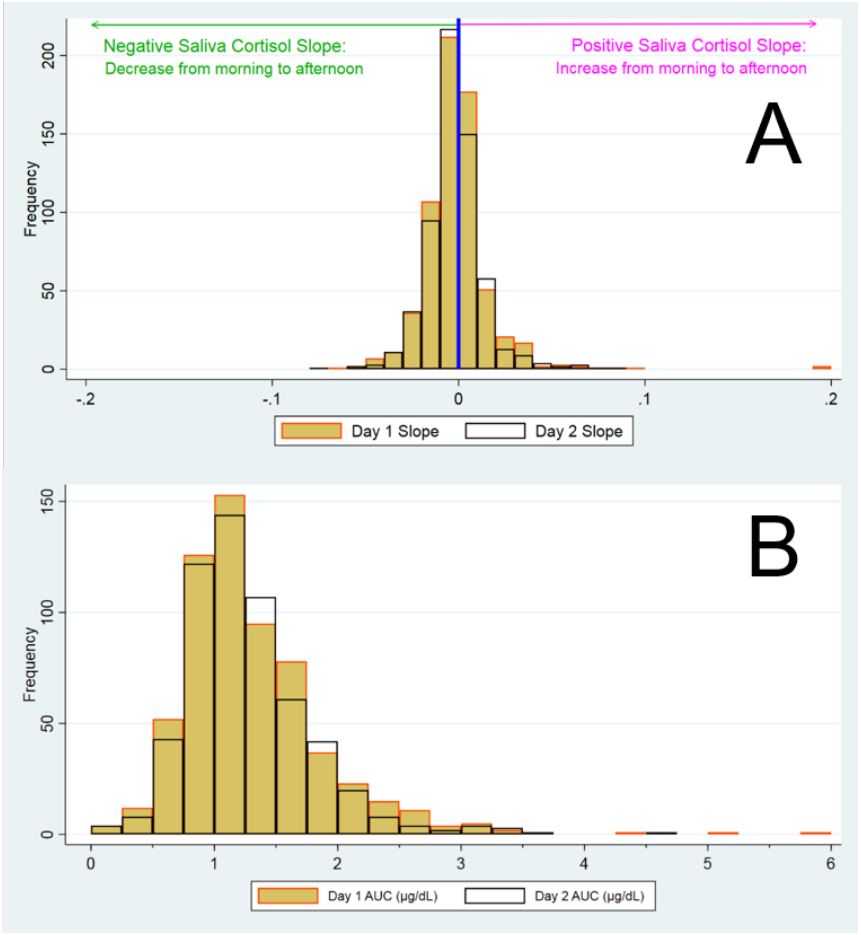

Figure 2: Saliva cortisol descriptive analysis: slopes (A) & area-under curve (B) for days 1 and 2

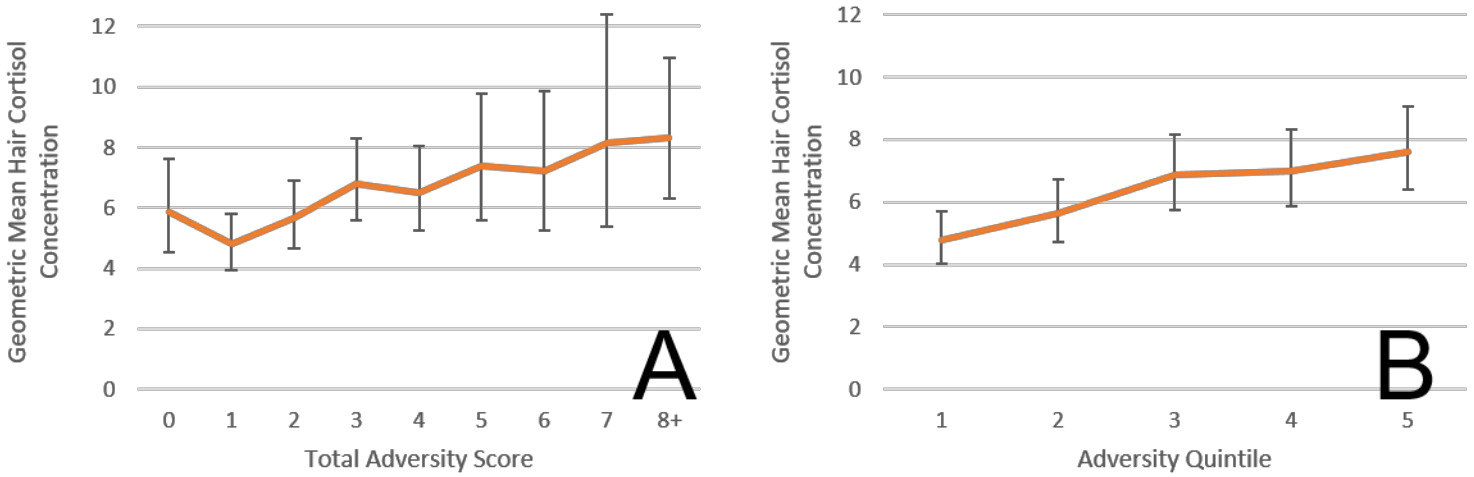

Figure 3: Association of log Hair Cortisol Concentration and Adversity using total adversity score (A) and adversity quintile (B)

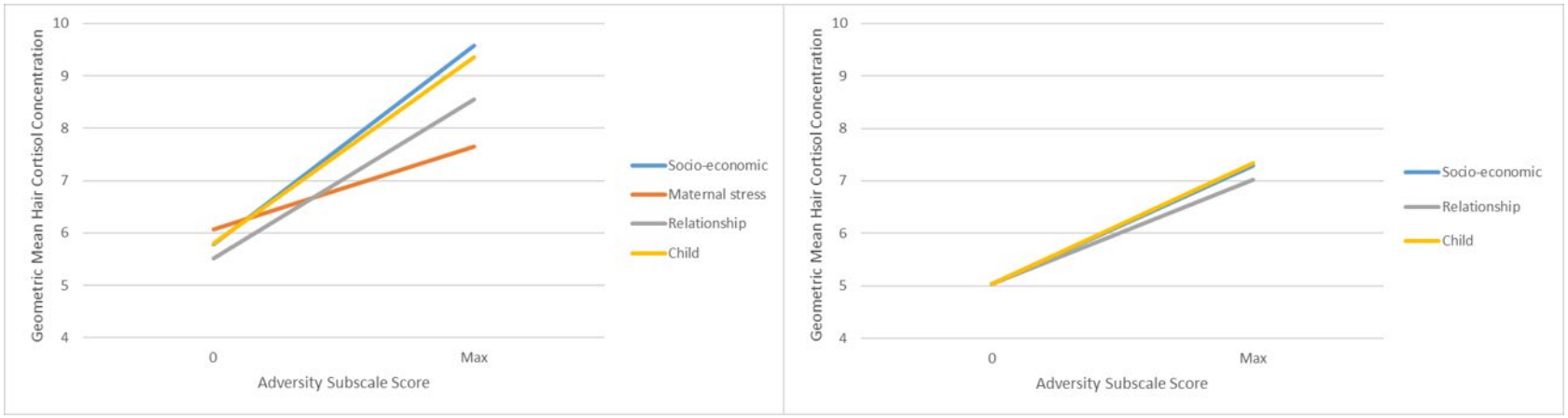

Figure 4: Relationship between adversity subscales and mean hair cortisol concentration – presenting unadjusted (A) and fully-adjusted (B) models

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Chapter 9 (Paper 4): Early Life Stress (ELS) and Adversity: associations with growth and development at 18 months of age (Findings from the ELS sub-study of the SPRING cluster randomised controlled trial in rural India)

Bhopal S, Verma R, Roy R, Soremekun S, Kumar D, Bristow M, Bhanushali A, Divan G, Kirkwood BR

Prepared for Submission

This paper describes the relationship between chronic exposure to cortisol, measured in children's hair at 12 months of age, and child growth and development measured when these infants were 18 months old.

Note regarding this multi-author work:

The Early Life Stress sub-study of SPRING (SPRING-ELS) was funded by the Wellcome Trust as a fellowship to me, with Betty Kirkwood as my supervisor. I spent 18 months at the study site in Haryana, India as an integrated member of the SPRING trial team and was heavily involved in all aspects of design and conduct of the trial.

The idea of introducing measures of adversity and stress to SPRING through SPRING-ELS were mine. I obtained funding, ethical & regulatory approvals, and led the fieldwork, administration and finance for this sub-study.

This paper also draws on data from SPRING which was led by Betty Kirkwood as principal investigator, Gauri Divan (India Principal Investigator) and Reetabrata Roy (India Trial Director). I contributed to all aspects of this data collection including cultural adaptation, preparation of tools, fieldwork planning and fieldworker organisation.

I performed all data analysis and wrote this paper.

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RESEARCH PAPER COVER SHEET

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SECTION A – Student Details

Student	Dr Sunil Bhopal
Principal Supervisor	Prof Betty Kirkwood
Thesis Title	Early childhood stress, adversity, growth & development: findings from the SPRING home visits cluster randomised controlled trial in rural India

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	N/A		
When was the work published?	N/A		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	N/A		
Have you retained the copyright for the work?*	Choose an item.	Was the work subject to academic peer review?	Choose an item.

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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Lancet Global Health
Please list the paper's authors in the intended authorship order:	Bhopal S, Verma D, Roy R, Soremekun S, Kumar D, Bristow M, Bhanushali A, Divan G, Kirkwood B
Stage of publication	**Not yet submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	See previous page

Student Signature: [redacted] **Date:** 17 January 2019

Supervisor Signature: [redacted] **Date:** 17 January 2019

Early Life Stress (ELS) and Adversity: associations with growth and development at 18 months of age (Findings from the ELS sub-study of the SPRING cluster randomised controlled trial in rural India)

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Abstract

Background: The 2016 Lancet Early Childhood Development Series calculated that 250 million children in low- and middle-income countries are at high risk of not meeting their developmental potential**.** A large and growing body of literature connects adversity in early childhood to impaired health outcomes throughout the lifecourse**.** One suggested pathway is through hormonal systems including cortisol regulation which changes in response to stress. We therefore present findings from the Early Life Stress sub-study of the SPRING cluster randomised controlled trial (SPRING-ELS) in rural India evaluating the relationship between adversity through pregnancy and the first year of life, and growth and development measured at 18 months.

Methods: SPRING-ELS was a sub-study of the Wellcome Trust SPRING cluster randomised controlled trial in India**.** Three adversities were assessed at SPRING enrolment. At 12 months of age, 19 further adversities were assessed covering the period from pregnancy onwards. One hair sample was also taken for cortisol analysis at this time. At 18 months, children were assessed for height, weight and using the motor, cognitive and language scales of the Bayley Scales of Infant Development 3rd Edition. Multi-level mixed-effects linear regression modelling was used to assess the relationship between adversity and hair cortisol at 12 months, and growth and development at 18 months of age.

Results: 698 children had all of adversity, hair cortisol, growth and development assessments. There were consistent and strongly negative relationships between hair cortisol and development as follows: for the language scale this was a 2.3 point (95% CI 1.3, 3.3) decrease for each log pg/mg increase in hair cortisol; for motor it was 1.3 points (95% CI 0.6, 2.0) and for cognitive 1.1 points (95% CI 0.3, 1.8). Change in height-for-age was -0.12 z-scores (95% CI -0.19, -0.05) for each log pg/mg increase in hair cortisol and for weight-for-age this was -0.15 z-scores (95% CI -0.22, -0.07). These point estimates were only attenuated somewhat by the addition of adversity to the model.

Discussion: Hair cortisol concentration was strongly associated with poorer height-for-age, weight-for-age and development in the motor, cognitive and language domains. This relationship was only partly driven by exposure to adversity. Impaired growth and development at this age is of lifelong negative consequence, predominantly because this is the stage at which the brain is most amenable to change, neuronal connections are forming at their fastest rate and early experiences rapidly become biologically embedded. Intervening to improve early childhood adversity and stress is likely to reap benefits for children throughout their lives with additional intergenerational benefits, and should be prioritised as part of multisectoral interventions aiming to improve childhood growth and development in the earliest years.

Background

The 2016 Lancet Early Childhood Development Series calculated that 250 million children in low- and middle-income countries are at high risk of not meeting their developmental potential and emphasised the damaging impact of this for communities and societies[1]. The series emphasised that multi-sectoral nurturing care interventions for tackling this potential loss of potential from early childhood onwards are key[2], and that these interventions will be key to achieving many of the Sustainable Development Goals[3].

A large and growing body of literature connects adversity in early childhood to impaired health outcomes throughout the lifecourse[4,5] including in low- and middle-income countries where children are exposed to multiple, overlapping and cumulative risks which are worse than single risk factors alone[6]. We previously showed in rural India that each additional adversity risk factor in early life is associated with a decrease in language, cognitive and motor skills, and with impaired growth at only 18 months of age[7]. What is not fully understood is the mechanisms by which these disparate social, environmental and economic adversities change the biology of individual children and lead to this impairment[8–10]. One suggested pathway is through hormonal systems including cortisol regulation which changes in response to stress.

Cortisol is the end product of the hypothalamic-pituitary-adrenal (HPA) axis and is secreted by the adrenal glands in response to normal activation by the hypothalamus. Stressful experiences can lead to over-stimulation of the HPA axis, particularly those experiences that evoke fear or a feeling of threat to self-wellbeing, across the lifecourse[11]. This includes, for example, exposure to painful procedures as a newborn[12], social deprivation and maternal depression in early childhood[13,14], and loneliness, poverty and family conflict in adulthood[15]. Animal models support these findings; both rats and non-human primates exposed to experimenter-induced stressors, particularly in the absence of nurturing caregivers, are susceptible to over-activation of the HPA axis with resulting

increases in cortisol secretion with attendant physical negative physiological consequences[16,17].

In this paper we therefore present findings from the Early Life Stress sub-study of the SPRING cluster randomised controlled trial in rural India, evaluating the hypothesis that chronic exposure to high levels of cortisol is detrimental to optimal early childhood development in rural India.

Methods

Setting & Participants

SPRING-ELS was a sub-study of the Wellcome Trust SPRING cluster randomised controlled trial in India, investigating the role of stress and adversity in young children. Details on SPRING are presented elsewhere[18] but briefly, SPRING was a public health programme delivered at scale, aiming to improve child growth and development through a monthly home-visiting intervention by a new cadre of ECD community health worker who visited all pregnant women and children up to 2 years of age. Restricted randomisation was used to allocate 24 clusters to receive either the SPRING intervention or to control. These clusters were defined as geographical areas served by a health sub-centre (the lowest level of the Indian public healthcare system) with a functioning auxiliary nurse midwife, covering a population of at least 8000. The primary outcomes of the trial were height-for-age – the best early childhood predictor of human capital[19] – and the motor, cognitive and language sub-scales of the Bayley Scales of Infant Development-III – the gold standard measure of child development in early childhood[20]. The SPRING causal pathway is being examined with a range of economic analyses, process-evaluation and intermediate outcomes to understand mechanisms of trial impact and to inform lessons for incorporation into health systems.

SPRING-ELS was situated throughout the SPRING trial study area in Rewari district, Haryana covering a population of around 200,000. Rewari district is predominantly rural and has health and demographic indicators around average for the state. According to most recent census, the literacy rate in Haryana is 76%, with female literacy of 67%[21]. The sex ratio was 879 females per 1000 males[21] – amongst the lowest ratio in India. Infant mortality was 41/1000 live births in 2015-16[22] which was around the national average. More than one third of under-five year old children are stunted (extremely low height for age)[23].

Data Collection & Analysis

Resident fieldworkers identified pregnant women and their newborns through the SPRING trial surveillance system by visiting every household in the study site every eight weeks and asking the question “has anyone in the house become pregnant or had a baby since the last time we met?”. They took consent and enrolled participants if the answer was “yes” to this question, and then collected demographic and socioeconomic data.

Full implementation of the home visiting intervention was reached on 18 June 2015 so children enrolled in the trial were those born on or after this date. We aimed to take hair samples from a minimum of the first 25 children born from this date in each cluster to give a minimum sample size of 600 children, and to assess adversity concurrently. The aim was to assess all children for growth and development at 18 months of age. All assessments were done in the home.

Hair Cortisol Measures: Trained assessors cut hair from the posterior vertex (the area of least intra-individual variability[24]) as close to the scalp as possible using scissors. The aim was to obtain at least 10mg of hair (approximately 1cm diameter, 2-3cm length)[25]. Samples were stored at room temperature, washed in isopropanol, dried thoroughly for 24 hours, cut finely with scissors[26], extracted into methanol and analysed using a Salimetrics ELISA kit as per established methods[16,27]. Each hair sample contributed one hair cortisol concentration to analysis and this result was log transformed for analysis because of left-skew. We then winsorized four remaining outliers to 3SD above the mean, giving a final value measured in log picograms of cortisol per milligram of hair.

Cumulative Adversity: We did formative research with mothers, took advice from child development experts and did literature reviews on existing adversity tools. A set of 22 adversities were agreed including some related to the child themselves (e.g hospitalisation), to the mother (e.g maternal depression), to the care environment (e.g HOME-IT) and to socioeconomic status (e.g asset index). These are fully described

elsewhere[7] and are summarised in Table 1 which has been published previously. The 22 adversities were summed, creating a cumulative adversity score recognising the particular damaging effects of multiple adversities[7,28–30]. We used multiple imputation by chained equations to account for a small amount of missing adversity data described in Table 1. We used 30 imputations and included all explanatory and outcome variables in each model as is standard practice. We also carried out a repeat analysis using only complete cases. We calculated descriptive data using a combination of all imputations.

Anthropometry: Weight was measured to the nearest 0.01Kg using SECA-384 electronic scales which were calibrated weekly. Weighing was ideally done with the child's clothes removed but if this was not possible the child was first weighed whilst clothed, then the clothes were weighed separately and the weight recorded - the difference between these two weights (representing the unclothed weight) was finally calculated at the data analysis stage. Length was measured to the nearest 0.1cm using a SECA-417 infantometer by two assessors. Further details on measurement techniques were described previously[7]. Child length and weight were converted to height-for-age and weight-for-age z-scores using the zscore06 package for Stata15[31] which is based on the 2006 WHO child growth standards and takes into account the child's age and sex[32].

Developmental Assessment: Trained non-specialists used the motor, cognitive and language scales of the BSID-III[20] to assess children. We did comprehensive cultural adaptation and inter-rater reliability (IRR) checks, finding mean agreement between assessors of greater than 97%. Each BSID-III scale consists of a series of progressively more difficult activities which children are asked to do whilst interacting with an assessor. Each item was scored 1 if the activity was demonstrated, otherwise it was scored 0. Assessment on each scale started at the item marked 'K' (start point for 16.5 – 19.5 month old children). Children not able to achieve three activities at that level were assessed as far as two levels back (the item marked 'I', which is the start point for 11 – 13.5 month old children) before the assessment was stopped. The assessment on each scale ended

when the child scored 0 on five consecutive activities. Each assessment took 2-3 hours to complete. Assessors did two BSID-III assessments per day in pairs. Raw scores for BSID-III scales were converted to three composite-scores for each child following the BSID-III manual[20], based on the child's age at assessment.

Statistical Models: Children needed all of hair cortisol, adversity, growth and developmental assessments to be included in the analyses presented in this paper. Stata 15 was used for all analyses (StataCorp LLC: College Station, TX, USA). We assessed the association between hair cortisol and each of the five continuous growth and development outcomes using multi-level mixed-effects linear regression modelling, adjusting for the clustered study design as a random effect. We included a binary variable reflecting whether a child lived in an intervention or control cluster in all models. In the second step we added cumulative adversity into the model to assess the relative importance of each of hair cortisol and adversity to outcomes. We assessed this model for interaction.

Ethics

We gained ethics approval from the London School of Hygiene & Tropical Medicine research ethics committee (SPRING: Approval 5983 (23 June 2011); SPRING-ELS: 9886 (19 May 2015)) and the Sangath Institutional Review board (SPRING: 19 February 2014; SPRING-ELS 27 May 2015). We also gained the approval of the Indian Council of Medical Research's Health Ministry Screening Committee (SPRING: 24 November 2014; SPRING-ELS: 6 October 2015). Informed written consent was obtained from mothers at enrolment into the trial surveillance system and again for detailed developmental assessments when children were one year of age.

Results

SPRING-ELS subsample

The flowchart in Figure 1 shows that 698 children had all of hair cortisol, adversity, growth and developmental assessments. Of those children who had growth and development assessments at 18 months, it was not possible to make an appointment for assessment at 12 months in 167 children (11.6%), families specifically refused consent for hair sampling in 274 children (19.0%) and 248 children had hair that was too short to be cut (17.2%). A few children had hair which was not analysable in the laboratory (26 samples, 1.8%) and we did not assess 30 children because the sample size had been met in that cluster (2.1%).

Table 2 shows descriptive data. The mean of log hair cortisol concentration was 1.83 log pg/mg (SD 1.05). This did not vary by length of hair sampled (mean length 2.3cm), weight of hair used (mean weight 23.3mg), sex (365 girls) or by age at sampling (median 379 days old, IQR 372, 384). The minimum adversity score was zero and the maximum was 12; the median score was 3. Mean (SD) BSID-III scores were 93.3 (10.7) for cognitive, 91.7 (14.3) for language, and 95.3 (9.8) for motor. The mean (SD) height-for-age z-score was -1.75 (1.08) and mean weight-for-age was -1.31 (1.00).

Hair cortisol and growth & development

There were consistent and strongly negative relationships between hair cortisol and BSID-III developmental outcomes, with small confidence intervals. This is shown in Model A in Table 3 showing that hair cortisol showed the strongest relationship with the BSID-III language scale (2.3 point (95% CI 1.3, 3.3) decrease in BSID-III for each log pg/mg increase in hair cortisol) followed by motor then cognitive (1.3 (95% CI 0.6, 2.0) and 1.1 (95% CI 0.3, 1.8) points respectively). Change in height-for-age was -0.12 z-scores (95% CI -0.19, -0.05) for each log pg/mg increase in hair cortisol and for weight-for-age this was -0.15 z-scores (95% CI -0.22, -0.07). These same relationships are displayed visually in

Figure 2 showing the modelled decline in both development (Panel A) and growth (Panel B) as hair cortisol increases from minimum to maximum along the x-axis.

Adversity and Hair Cortisol

There was a positive association between cumulative adversity and hair cortisol. This was similar to findings presented in our earlier paper[33] which was based on the larger sample of participants as it was not restricted to those having a hair sample at 12 months. Figure 3 shows the geometric mean hair cortisol at each adversity score, and the proportion of children with this score is overlaid in the blue shaded bars. This was equivalent to an increase of 6.1% (95% CI 2.8, 9.6) in hair cortisol for each additional adversity in the linear model.

Adversity, Hair Cortisol and Growth & Development

Figure 2 shows the linear modelled relationship between adversity and growth & development in the sample. There is good evidence of a strongly negative association, with the greatest decline in BSID-III scores seen in the language scale, followed by the cognitive scale and then motor. We presented more details on this relationship in a larger sample previously[7].

Model B in Table 3 shows that the relationship between hair cortisol and growth & development were only attenuated somewhat by adding cumulative adversity into the model, suggesting that the relationship between hair cortisol and growth & development outcomes is predominantly independent of adversity. The adjusted r2 for these models are displayed in this table showing that the percentage of variation predicted by these linear models is relatively low (8% or less) for each of the models.

There was weak evidence for interaction between hair cortisol and adversity in the motor scale (p=0.099), with small effect estimates and large p-values for the cognitive (p=0.598) and language (p=0.945) scales. There were similar findings for height-for-age z-score (p=0.571) and weight-for-age z-score (p=0.596). Figure 4 displays the modelled

relationships for each of these scales and for the growth indicators including the interaction term as per the planned analysis. In Panels A, B and C the predicted BSID-III scores are represented by colours from red (higher score) to blue (lower score) showing that overall as either hair cortisol or adversity increases, the predicted outcome score decreases. The curved nature of the boundary lines demarcating predicted outcome scores mean that for lower levels of adversity the predicted BSID-III scores are high, at any given value of hair cortisol in both the BSID-III motor and cognitive scales. This is not the case for language, where the straight lines mean that for any adversity score, predicted BSID-III score varies independently of the hair cortisol value.

Panels D and E of this figure show that for any given level of adversity in the height-for-age model, a wide range of predicted outcome scores is possible based on hair cortisol. This is reversed for weight-for-age where boundary lines are curved in the opposite direction.

Discussion

We assessed chronic exposure to cortisol in young children enrolled in a population-based study in rural India by measuring this hormone in hair samples taken at one year of age and related these results to growth and developmental assessments on the same children at age 18 months. The key finding was that hair cortisol concentration is strongly associated with poorer height-for-age, weight-for-age and development in the motor, cognitive and language domains. Impaired growth and development at this age has lifelong negative consequence, predominantly because this is the stage at which the brain is most amenable to change, neuronal connections are forming at their fastest rate and early experiences rapidly become biologically embedded.

We addressed the question of whether all of the association seen was due to cumulative adversity by including a measure of adversity in models. Adversity was independently related to the growth and development outcomes, but did not account for the whole of the relationship seen between hair cortisol and outcomes. The percentage of variation explained by these models was relatively low (R^2 8% or less for each model) suggesting that there is considerable uncertainty around these estimates and as we would expect, that hair cortisol and adversity alone are not sufficient for predicting outcomes with complex aetiology such as development and growth. However, this figure is comparable to the R^2 figure for the HOME inventory[34] (data not published) which was design specifically as a predictor of child development and is much more complex to administer, requiring a trained assessor visiting the household for at around an hour.

Hypothesis testing for interaction requires large sample sizes[35] but gives an indication when there is strong evidence. Our visualisations of the final models include the possibility of interaction between adversity and hair cortisol. There was minimal evidence of this for the language BSID-III scale. For the cognitive scale and for the growth outcomes, the estimate of the size of the interaction term was small, with weak evidence provided by the hypothesis test (and hence large p-values).

Possible biological mechanisms for our findings include the allostatic load model which says that whilst a stress response is necessary for normal physiological response to stressful situations, prolonged and severe activation creates 'wear and tear' leading to dysregulation of multiple physiological systems with implications for physical and mental health[36], however that this might apply to such young children is a question that remains. Other explanations for our findings include the direct impact of cortisol on the brain – animal studies show that direct exposure can disrupt cellular metabolism and increase the vulnerability of neurons[37] – and the brain in early childhood is at its most plastic and may be particularly vulnerable to stress hormones[15]. Having said this, a recent study found no clear pattern of association between hair cortisol and brain changes after accounting for multiple testing[38]. With regards to growth, as well as the bidirectional association with development, there may be a direct impact of cortisol as we know that direct administration in clinical contexts impairs growth in children[39].

Empirical literature examining consequences of raised cortisol in children is limited. There are reports suggesting that chronic exposure to cortisol could be a determinant of mental health problems including externalising symptoms[40], however this work is in the early stages, results are not consistent (for example[41]) and may be found only in certain sub-groups[42]. The most similar study is by Saridjan et al which used cortisol measured in saliva finding that some of the variations in daily cortisol rhythms were associated with impaired cognition at a median age of 14.2 months[43], the more recent use of hair cortisol is a major advance over the use of total exposure to cortisol measured using multiple saliva samples over one day.

Most studies including ours use cross-sectional designs, limiting ability to draw conclusions about direction of association. A recent review article concluded that there are suggestions in the literature of an association between cortisol exposure and child development and psychopathology, but that "we are still far from understanding the

various pathways through which adversity ‘gets under the skin’ to influence stress and development”[44].

Strengths of our approach include the population-based sampling, follow-up from pregnancy onwards, the reasonably large sample size and the use of gold standard measurement tools for growth, development and hair cortisol. Height-for-age and weight-for-age are standard for use worldwide because at this age children in optimal circumstances grow equally[45] and our results are a reminder of the shocking state of child anthropometrics in this part of the world. We do not comment about absolute values of BSID-III scores because of cross-cultural variation that has not yet been addressed in a global measurement tool. Limitations include that around half of those we attempted to assess for cortisol and adversity were not included in the study. Consent refusals were high because hair cutting in young children is associated with cultural barriers including association with the evil-eye. We reduced refusal rates considerably through strong community-relations building. Many children had hair that was too short to cut because it was extremely hot in this location in the summer, and many children have shaved heads. Having said this, comparisons of those children with and without hair samples which we presented previously[33] suggest that there was no difference in terms of education levels of parents, caste, socioeconomic status, being delivered in a facility, mother’s age at delivery or being a twin. There was a difference in refusals by sex – more boys were missed for assessment than girls. Other limitations include that we studied only one hormone whilst growth and development are clearly multifactorial and influence by multiple biological measures. Future work could consider a battery of biological assessments in order to make use of newer ‘big data’ techniques. Such a technique could, for example, allow for building a developmental status risk assessment tool based on a single biological sample analysed for multiple compounds including DNA methylation, inflammation and stress hormones[46,47].

In summary, we present the first evidence that at a very young age, in a LMIC with great burden of disadvantage, cortisol sampled in the hair representing chronic exposure to the hormone is associated with impaired early childhood development. This appeared to be only partly due to its association with psychosocial adversity faced by children. Further work will be needed to understand other determinants of these cortisol levels, and to what extent hair cortisol can be used as a predictor of developmental status.

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Table 1: Details of childhood adversities used to calculate total adversity score, along with proportion of imputed values

Domain	Item	Imputed n, (%)
Socioeconomic	1. Socioeconomic status: lowest quintile (*E) [a]	
	2. Father education: none or 1-5 grades (*E)	
	3. Mother education: none or 1-5 grades (*E)	
	4. Father occupation: at home, seasonably employed or casual labourer	
	5. Mother married under legal age (18 years)	
	6. Family debt [b] or mother reports being unable to afford food for self or child at any point [c]	
Maternal Stress	1. Mother reports death of husband, parent, sibling, child or friend since pregnancy	
	2. Mother seriously injured or ill since pregnancy	
	3. Any violence from husband or mistreated by any other person since pregnancy [d]	
	4. PHQ9 score >=5 or problems described make it very/extremely difficult to do daily activities (last 2 weeks)[48]	12 (1.7%)
	5. Duke scale: support <=40 or stress >27[49]	12 (1.7%)
	6. Husband's alcohol use causes problems for mother[e]	
Relationship	1. Any of mother, father, mother or mother-in-law were "unhappy" when found out child was a girl [f]	
	2. Mothers Object Relations Scale concern level moderate or high[50]	
	3. Observed feeding style: very low quality	197 (28.2%)
	4. HOME-Infant/Toddler[34] score: lowest quintile	
Child	1. Mother-reported child born early	
	2. Child admitted to hospital any time after birth	
	3. Mother & child separated for one week or more	
	4. Child left alone or with child under 10 years for more than one hour in the past week	
	5. Older children who live in house: say anything to make child cry or unhappy (in last week)	
	6. Older children who live in house hit/punched/kicked/bit child on purpose to make them unhappy (in last week)	

[a] SES score calculated with principle components analysis using data on mother & household demographics and animal & asset ownership
[b] Answered yes to question: "Since you became pregnant, have you or your immediate family who live with you been in debt?"
[c] Answered yes to question: "Since you became pregnant, have you ever been hungry because you could not afford to buy food?" or similar related to child
[d] Using WHO multi-country study on women's health and domestic violence against women[51]
[e] If woman reported husband drinking alcohol, answered yes to question: "does this cause any problems for you"
[f] Question: "When [person] found out your baby was a girl were you/they happy, unhappy or didn't mind whether you had a girl or a boy?"
*E data collected at enrolment; all others collected at 12m

Table 2: Descriptive summary of the hair cortisol, adversity and growth and development outcome variables included in this analysis

	Min	Max	Mean (SD)	Median (IQR)
Log Hair Cortisol Concentration (log pg/mg)	-0.35	5.02	1.83 (1.05)	1.98 (1.34, 2.52)
Total Adversity score	0	12	3.28 (2.41)	3 (1, 4)
BSID-III Cognitive score	55	125	93.3 (10.7)	95 (85, 100)
BSID-III Language score	47	135	91.7 (14.3)	94 (83, 103)
BSID-III Motor score	49	133	95.3 (9.8)	97 (91, 100)
Height-for-age z-score	-5.07	1.75	-1.75 (1.08)	-1.77 (-2.43, -1.04)
Weight-for-age z-score	-5.03	1.95	-1.31 (1.00)	-1.24 (-2.03, -0.63)

Table 3: Relationship between hair cortisol concentration measured at 12 months of age and growth & development outcomes at 18 months [1] measured in BSID-III points [2] measured in z-scores

	Change for unit increase in log Hair Cortisol (95% CI)				
	A: Adjusted for clustering		**B: Adjusted for clustering & adversity**		
BSID		p		p	adj R^2
Motor	-1.3 (-2.0, -0.6)	<0.001	-1.0 (-1.7, -0.3)	0.003	0.07
Cognitive	-1.1 (-1.8, -0.3)	0.004	-0.9 (-1.6, -0.1)	0.023	0.05
Language	-2.3 (-3.3, -1.3)	<0.001	-1.9 (-2.9, -1.0)	<0.001	0.08
z-score					
Weight for Age	-0.12 (-0.19, -0.05)	0.001	-0.10 (-0.17, -0.03)	0.006	0.05
Height for Age	-0.15 (-0.22, -0.07)	<0.001	-0.12 (-0.20, -0.05)	0.001	0.07

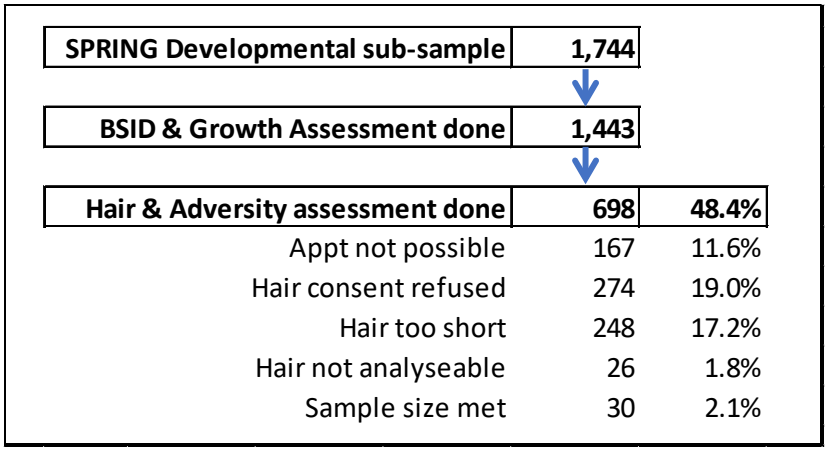

Figure 1: Flowchart showing children assessed for hair cortisol and adversity at 12 months of age as a proportion of those assessed for growth & development in SPRING trial 18 month assessments

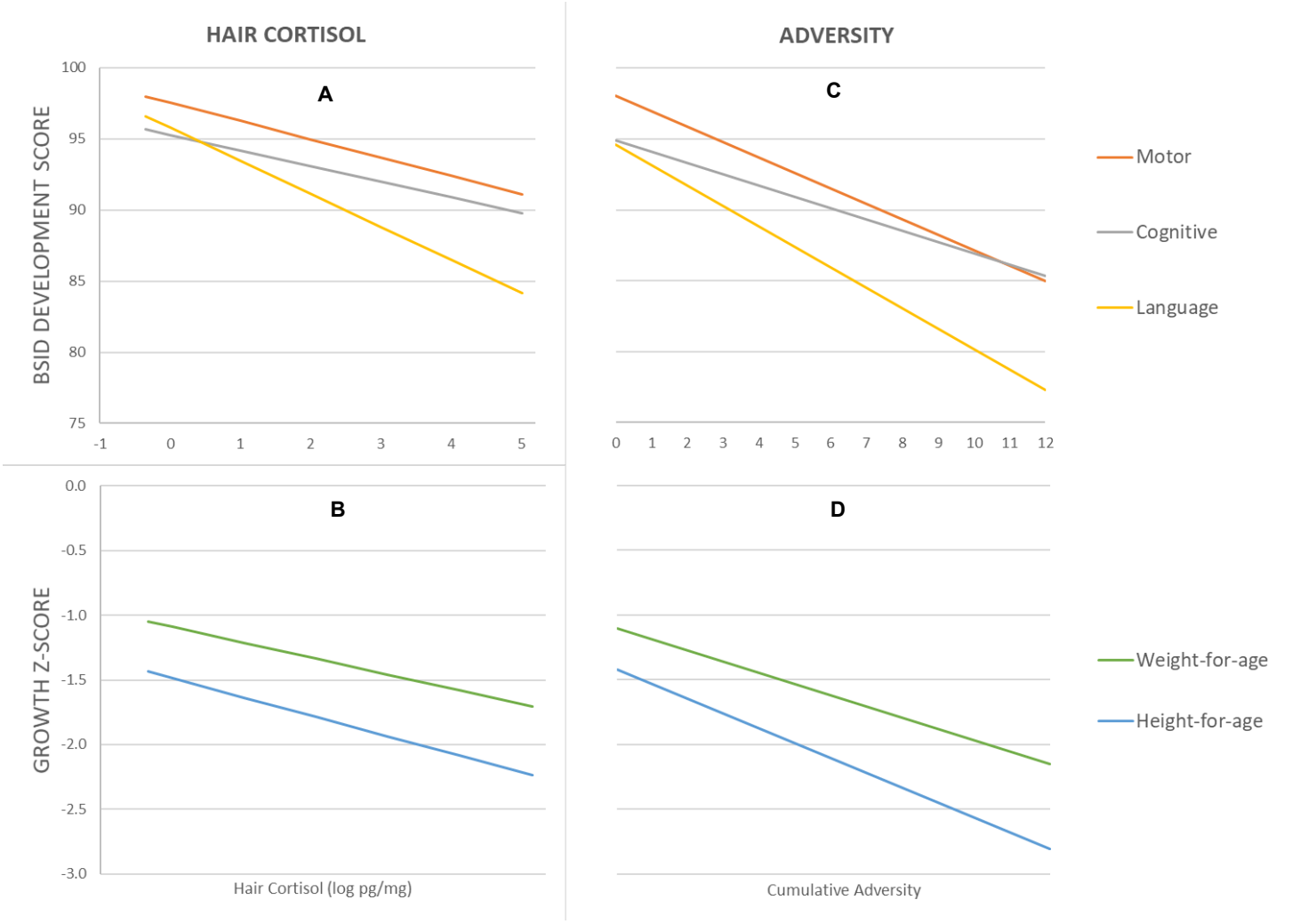

Figure 2: Association between hair cortisol and motor, cognitive and language domains of BSID-III (Panel A), and anthropometry (PANEL B). Association between childhood adversity and BSID-III scales (PANEL C), and anthropometry (PANEL D)

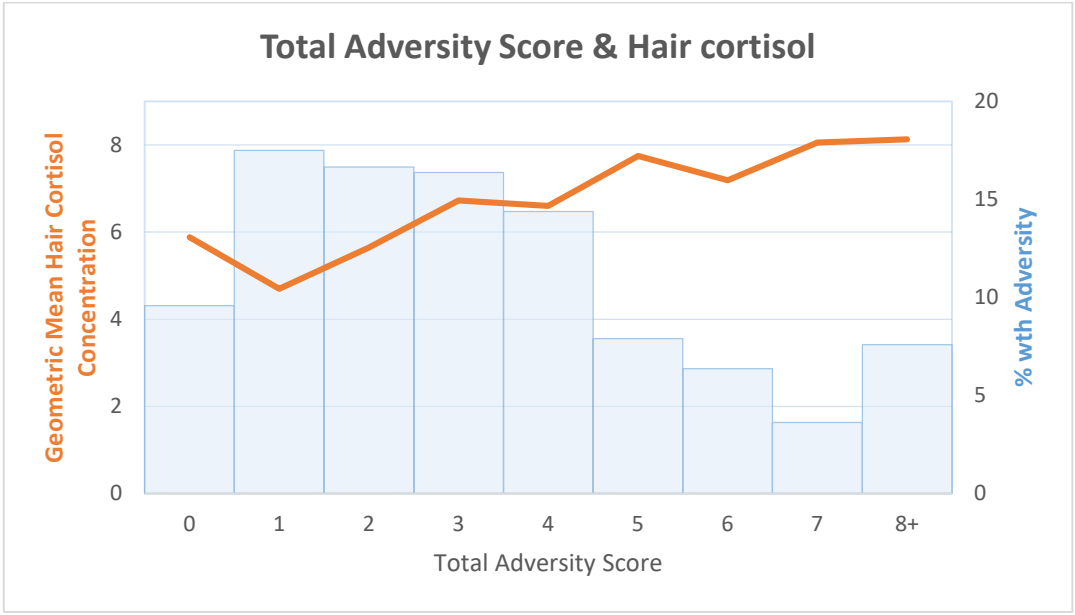

Figure 3: Overlapping visualisation of geometric mean of hair cortisol concentration (orange line) alongside proportion of children with each total adversity score (blue bars)

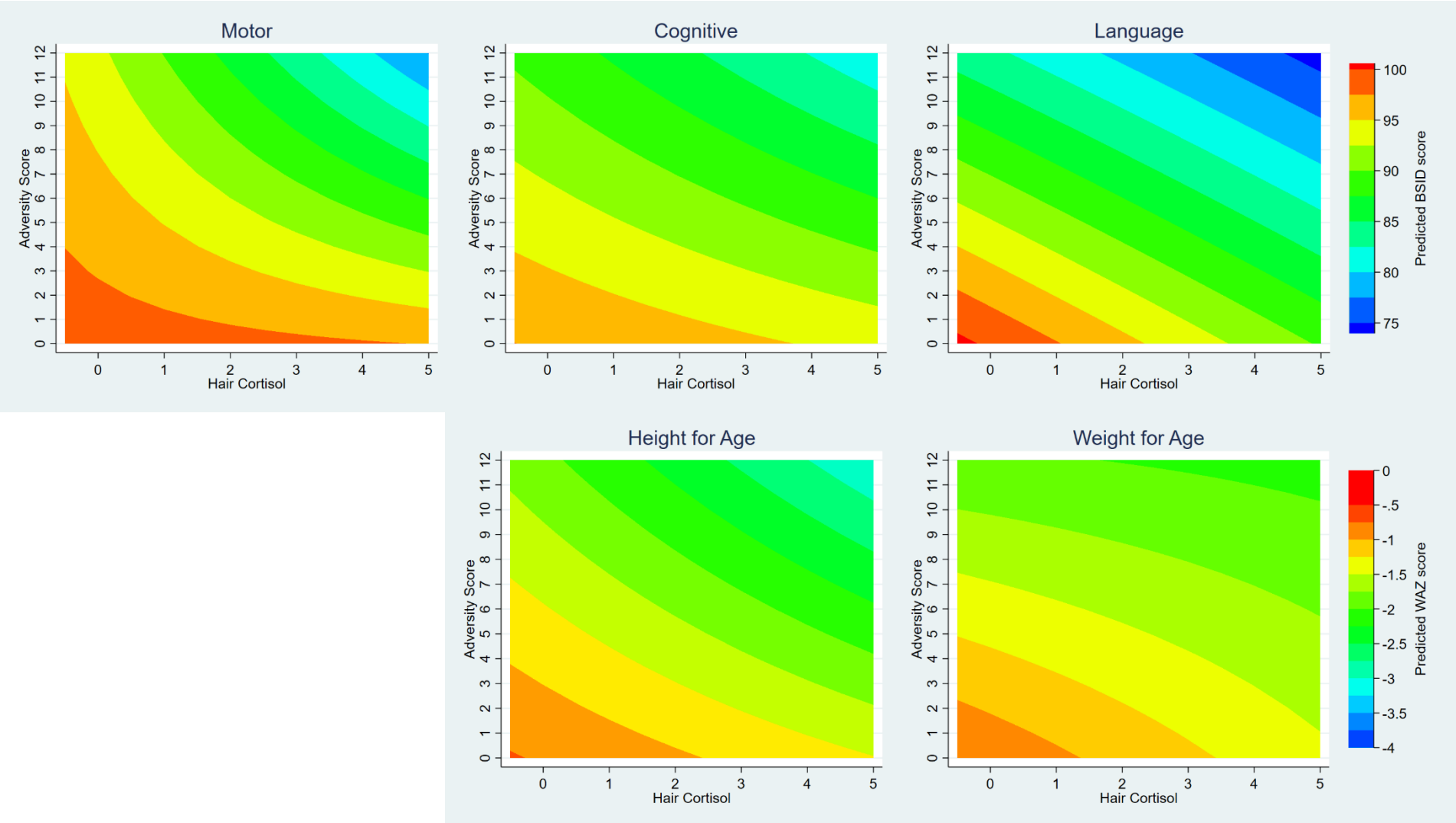

Figure 4: Prediction of three BSID-III scale scores, and two growth measures modelled using log hair cortisol concentration (log pg/mg) and total adversity score including an interaction term. The coloured band represents the predicted outcome score from highest (red colour) to lowest (blue colour) as outlined in the key.

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Chapter 10 (Paper 5): Using the Mothers Object Relations Scale as an indicator of Early Childhood Development in rural India: Findings from the Early Life Stress Sub-study of the SPRING Cluster Randomised Controlled Trial (SPRING-ELS)

Bhopal S, Verma D, Kumar D, Roy R, Khan B, Soremekun S, Oates J, Divan G, Kirkwood BR

Child: Care, Health & Development (Under Review)

The 14-item Mothers Object Relations Scale (MORS-SF) was used to measure difficulties in the early mother-infant relationship by asking a mother to rate her mother's perceptions of her infant's behaviour. This paper first describes cultural adaptation of MORS-SF, using the process which used for all tools in SPRING and SPRING-ELS. It then goes on to describe associations between MORS-SF and measures of early childhood development because MORS-SF may be a useful indicator of developmental status given that it assesses the mother-child relationship, and that it is relatively easy to administer. This was the first time the scale had been used in India.

Note regarding this multi-author work:

The Early Life Stress sub-study of SPRING (SPRING-ELS) was funded by the Wellcome Trust as a fellowship to me, with Betty Kirkwood as my supervisor. I spent 18 months at the study site in Haryana, India as an integrated member of the SPRING trial team and was heavily involved in all aspects of design and conduct of the trial.

The idea of introducing the Mothers Object Relations Scale was suggested by Prof Jane Barlow, University of Oxford. I obtained funding, ethical & regulatory approvals, and led the fieldwork, administration and finance for this sub-study.

This paper also draws on data from SPRING which was led by Betty Kirkwood as principal investigator, Gauri Divan (India Principal Investigator) and Reetabrata Roy (India Trial Director). I contributed to all aspects of this data collection including cultural adaptation, preparation of tools, fieldwork planning and fieldworker organisation.

I performed all data analysis and wrote this paper.

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RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

Student	Dr Sunil Bhopal
Principal Supervisor	Prof Betty Kirkwood
Thesis Title	Early childhood stress, adversity, growth & development: findings from the SPRING home visits cluster randomised controlled trial in rural India

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	N/A		
When was the work published?	N/A		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	N/A		
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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Child: Care, Health and Development
Please list the paper's authors in the intended authorship order:	Bhopal S, Verma D, Kumar D, Roy R, Khan B, Soremekun S, Oates J, Divan G, Kirkwood B
Stage of publication	Under Review

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	See previous page

Student Signature: [redacted] **Date:** 12 January 2019

Supervisor Signature: **Date:** 12 January 2019

Using the Mothers Object Relations Scale as an indicator of Early Childhood Development in rural India: Findings from the Early Life Stress Sub-study of the SPRING Cluster Randomised Controlled Trial (SPRING-ELS)

ABSTRACT

Introduction: The recent Nurturing Care Framework for Early Childhood Development recommends promotion of responsive caregiving to support all children to thrive. Measuring child development is resource-intensive and requires expertise which is in short-supply in low- and middle-income countries. The 14 item Mother's Object Relations Scales – Short Form (MORS-SF) may be a useful addition to commonly used tools because of its relation to responsive-caregiving and its basis in attachment theory.

Methods: MORS-SF was culturally adapted for administration by non-specialist outcome assessors and administered with all mothers in the SPRING home visits trial when their infants were 12 months old. The same mother-infant dyads were assessed using the HOME inventory concurrently and Bayley Scales of Infant Development III at 18 months of age. Mixed effects linear regression was used to examine associations between MORS-SF (explanatory variable) and HOME-IT and the cognitive, language and motor domains of BSID-III (outcome variables).

Results: 1273 dyads completed 12 and 18 month assessments. For the motor and language BSID-III scales and for HOME-IT there were strong and positive associations with the MORS-SF warmth sub-scale, and strong and negative associations with the invasion sub-scale. Important but less strong associations were seen with the BSID-III cognitive scale. There was evidence of interaction suggesting that, as predicted, the warmth and invasion sub-scales do not act independently and that both are important for child development.

Discussion: This is the first time MORS-SF has been used in India where optimising responsive caregiving is of importance in supporting all children to reach their potential. It is also the first time that the tool has been used in relation to child development. Feasibility of administration at scale means that MORS-SF could be a valuable addition to evaluation of work in early childhood development.

INTRODUCTION

The Lancet Series on Early Childhood Development (ECD) concluded that 250 million children under the age of five years who live in low- and middle-income countries (LMICs) are at high risk of not reaching their developmental potential (Black et al., 2017). Momentum is now growing to improve this situation through improved nutrition, protection from threats, provision of learning opportunities, and caregiver interactions that are stimulating, responsive, and emotionally supportive.

The recently launched World Health Organization Nurturing Care Framework for Early Childhood Development has a strong focus on responsive caregiving as a way in which to create a world where all children have the opportunity to thrive (World Health Organization, United Nations Children's Fund, World Bank Group, 2018). This sort of high-quality caregiver support is an important influence in mitigating risks to children's development (Daelmans et al., 2017) and caring interactions allow children to grow, learn and develop. Mothers do much of this care in young children. Mothers who are physically and mentally well, have adequate social support and are able to provide an age-appropriate and safe environment to their children are more likely to be able to care well for their children (Shonkoff & Phillips, 2000).

Measuring child development is a resource-intensive activity requiring expertise which is in short-supply in LMICs. The gold-standard for infant assessment is the Bayley Scales of Infant Development-III (BSID-III). This assessment, however, takes several hours and requires highly trained administrators. The Home Observation for Measurement of the Environment – Infant/Toddler (HOME-IT) is also used by researchers and practitioners worldwide. It assesses the quality of the home environment with respect to child development, but again requires a highly trained administrator. It must be done in the child's home and so involves additional logistic complications. A challenge for the ECD field then, is to identify other proxy

and intermediary measures for child development that are easy to administer. The Mother's Object Relations Scales – Short Form (MORS-SF) is a suitable candidate because of its relation to responsive-caregiving and its basis in attachment theory, both of which are crucial for optimal child development.

The MORS-SF was developed in the 1990s as a screening tool for assessing areas of difficulty in the early mother-infant relationship (J. Oates & Gervai, 1984). The premise is that a mother's perception of her infant influences the ways in which the mother-child dyad interact, and that this impacts on a child's health and wellbeing. MORS-SF measures the mother's internal representation of their child in two dimensions: warmth-coldness (the 'warmth' sub-scale) and invasion-withdrawal (the 'invasion' sub-scale). It contains 14 statements derived from a previous 44-item scale (MORS), for each of which a mother is asked to rate agreement on a Likert-type scale from 0-5. It has previously been administered in English, Hungarian, Polish and Chinese languages. Previous work suggests that mothers who are stressed, anxious or depressed tend to score their infants more highly on the 'invasiveness' sub-scale of MORS-SF and this is likely to be problematic for infant wellbeing and development (Lefkovics et al., 2018; J. M. Oates, Gervai, Danis, & Tsaroucha, 2005). Mother's and father's MORS-SF scores for the same child are not highly correlated, supporting the assertion that the tool measures parental perception over child characteristics. MORS-SF has been successfully validated against several measures of maternal reported infant temperament and maternal depression in both Britain and Hungary, including a crying/fussing diary, Mother and Baby Scales, the Infant Behaviour Questionnaire, Infant Characteristics Questionnaire, the General Health Questionnaire-12, Edinburgh Postnatal Depression Scale and the Cambridge Worry Scale (J. M. Oates & Gervai, 2003; J. M. Oates et al., 2005; Simkiss et al., 2013).

In this paper we first describe our adaptation of MORS-SF for first-time use in India, and then present findings of how this tool relates to BSID-III - the gold standard child developmental assessment tool - and HOME-IT, the most commonly used tool for measuring the home environment in over 1000 mothers enrolled in the Early Life Stress (ELS) sub-study of the SPRING cluster randomised controlled trial.

METHODS

SPRING cluster randomised controlled trial: Early Life Stress sub-study (SPRING-ELS)

SPRING-ELS was a sub-study of the SPRING cluster randomised controlled trial in India. It explored the role of stress and adversity in early childhood and growth. SPRING-ELS methods are described in detail elsewhere (Bhopal et al., 2019), as are SPRING trial methods (http://spring.lshtm.ac.uk, clinicaltrials.gov registration NCT02059863). Briefly, SPRING in India was an innovative, feasible, affordable and sustainable community-based intervention in Rewari district, Haryana, India aiming to improve early child growth and development through home visiting by a new cadre of community-based worker through monthly visits to all pregnant women and children under 2 years. A parallel trial in Pakistan had the same aim but operated through health system structures. SPRING was evaluated by cluster randomised controlled trial. Clusters were defined by health sub-centre catchment areas. 12 clusters were allocated to the intervention arm, and 12 to control. Primary outcomes were the motor, cognitive and language scales of BSID-III - the gold standard assessment of infant development (Bayley, 2006) – and height-for-age, the best early childhood predictor of human capital (Victora et al., 2008), at 18 months of age.

The study was conducted across a total population of around 200,000. Rewari is predominantly rural and has health and demographic indicators around average for the state where the literacy rate is 76% (female literacy of 67%) (Ministry of Home Affairs Government of India, 2018). The sex ratio is 879 females per 1000 males (Ministry of Home Affairs Government of India, 2018) – amongst the lowest ratio in India. Infant mortality is 33/1000 live births (National Institution for Transforming India, Government of India, 2016) – slightly above the national average and similar to regional estimates. More than one third of under-five year old children are stunted

(very low height-for-age) (National Family Health Survey - 4: 2015-16, 2017), this is amongst the highest stunting rates in the world.

The date of full implementation of SPRING was 18 June 2015. All children who were born after this date and lived in the study area were eligible for inclusion. Reasons for exclusion were congenital anomaly (9 children) or mother not able to complete assessments (for example due hearing impairment; 3 children).

Cultural Adaptation of MORS-SF

The 14 MORS-SF statements are presented in Table 1. The tool was adapted for administration by local non-specialist female outcome assessors, resident in the study site for use when SPRING children were 12 months old.

Adaptation followed a six step process, adapted from previous work (Khan & Avan, 2014):

1) Translation into Hindi was carried out separately by DK (background in public health and mental health) and DV (background in public health and physical anthropology).

2) Assessing technical equivalence of translation: this was carried out by the adaptation team (SB, DV, DK, BK, RR, BRK, GD) in discussion with JO, the original MORS-SF author. The aim was to ensure that the translation matched the original meaning for each item. Where multiple translations achieved technical equivalence, all were field tested along with new suggested translations from team discussion.

3) Field research: the aim was to assess the ways in which translations were being understood by respondents. This was done in two focus group discussions facilitated by DV & DK. The first comprised SPRING trial surveillance fieldworkers who were residents of the study area and were themselves mothers. They had no technical expertise in child health or development. The second was held with

mothers resident in the study site who had children aged two to five years old. Both discussions were held in the SPRING site office. Recruitment was done through field staff with the aim of identifying those who would engage in detailed discussion. The facilitators explained that they were not seeking direct answers to the questions from participants but rather wanted help to select words that mothers of young children in Rewari would find it easy to understand, with the aim of administering the tool in future. This was done as follows; the facilitator read out the translation for each statement and asked a participant to repeat it back using their own words. Where the participant's description differed from the item meaning, the facilitator asked why those words were used and discussed this amongst the group. The facilitators then asked the group for input on the statement and the individual words used within it. They asked for suggestions of improved ways of asking the same question and for the group to point out words they felt mothers would not understand.

4) Finalisation of tool for pre-testing: field results were reviewed by the adaptation team, and a revised tool prepared for pretesting. Steps 1-3 are summarised in Table 1 showing that five of the 14 items were uncontroversial and the translation agreed at step 2 (technical equivalence) was acceptable throughout further testing.

Back translation was also performed at this point by an independent bilingual public health specialist who did not know the tool; results were excellent and no changes were needed for pretesting.

5) Pretesting was done with eight mothers of children aged 2-5 years individually in their home, by DV accompanied by a note-taker who recorded their perceptions of tool administration. It was clear that all participants understood the translations and concepts and were able to give examples of each of the items, backing up their answers to questions around meaning. Field notes document that mothers had

expressive faces which matched their answers – for example, in response to the statement “my child smiles at me”, a mother smiled back at the research associate. All individual statements worked as expected. A small clarification was needed for item 3 - in response to the statement “my child likes doing things with me” two mothers asked “what type of things?”. We therefore edited the training manual that if asked, assessors should indicate that this applies ‘to all things’.

Pretesting also addressed administration of the MORS-SF by assessors. It is usually self-administered but this was not feasible in our setting with many non-literate mothers. We presented the Likert-type scale presented in Figure 1 to mothers and read a statement asking them to point at the number they most agreed with. Mothers understood the system and it was quick to administer. DV circled the number pointed to by the mother, allowing the mother to see the choice recorded for the item.

6) Assessor training & pilot-testing: 12 assessors were trained by DV, DK & SB in the classroom using a combination of didactic methods and role-play. Pilot-testing was done alongside other tools being administered at the 12 month assessment. 12 assessors worked in pairs and visited mothers at home, which also allowed them to become familiar with travelling around the study site, and to appreciate some of the challenges associated with assessing mother-child dyads in the home. Each assessor conducted 2 assessments with children 11-13 months old. Their partner scored the same assessment simultaneously, giving a total of 4 assessments per pair. Inter-rater reliability assessed the similarity in recorded responses between the two assessors for any given assessment. This was greater than 95% for all six assessor-pairs. All assessors were observed performing a minimum of one assessment by a member of the adaptation team.

Data Collection

Children and their mothers were assessed at 12 and 18 months of age as described below. All assessments were done in the child's home. All data were collected on paper forms which were double-entered and verified using a computer program written in C Sharp with an SQL Server 2008 database at the site office.

Explanatory Variables

We visited families when enrolled children were 12 months of age to administer a range of SPRING and SPRING-ELS assessments including MORS-SF which was administered using the pointing system described in cultural adaptation. There were three MORS-SF explanatory variables. The 'warmth' sub-scale score was calculated by summing the scores of the seven warmth items giving a score of 0-35. Similarly, 'invasion' scores were calculated by summing the scores of the seven invasion items. In addition, MORS-SF 'concern' levels were calculated using a combination of these two sub-scale scores as described by Milford et al (Milford & Oates, 2009) and displayed in Table 2.

Outcome Variables

Assessors did child development assessments at 18 months of age using the motor, cognitive and language scales of the BSID-III in the home(Bayley, 2006). They did two BSID-III assessments per day in pairs. Each assessment took 2-3 hours to complete. Each BSID-III scale consists of a series of progressively more difficult activities which children are asked to do whilst interacting with an assessor. Each item was scored 1 if the activity was demonstrated, otherwise it was scored 0. Assessment on each scale started at the item marked 'K' (start point for 16.5 – 19.5 month old children). We did comprehensive cultural adaptation and inter-rater reliability (IRR) checks, finding mean agreement between assessors of greater than 97%.

Assessors also did the 45-item HOME-IT assessment at this visit to assess the degree to which the home environment is supportive of child development. HOME-IT uses a mixture of questions to the mother and assessor observations and is done over an hour. Each item is scored 0 or 1. Some items can only be scored positively if observed, e.g “Mother spontaneously praises child at least twice”. Others are asked directly e.g - “Does child’s father or father figure help with looking after [child’s name]?”.

Statistical Methods

Sample size was determined by the requirements of the main SPRING trial which aimed with 90% power to detect a minimum effect size of 0.38 given an assumed intra-cluster correlation of 0.05 and significance level of 0.05. We therefore assessed all children being assessed for SPRING which was at least the first 50 children born in each of the 24 clusters from 18 June 2015 (minimum total sample size 1200).

We initially used mixed effects linear regression to assess the relationship between the three explanatory variables and the four outcome variables. All models were adjusted for the clustered design of the SPRING trial by including cluster as a random effect, and for trial arm as a fixed effect to account for any impact of the intervention. We next predicted values for the outcome variables for interacting values of the explanatory variables ‘warmth’ and ‘invasion’ and present these results both in tabular and also graphical form.

We used Stata 15 for all statistical analyses (StataCorp LLC: College Station, TX, USA).

Ethics

Approval was obtained from the London School of Hygiene & Tropical Medicine research ethics committee (23 June 2011, approval number 5983; 19 May 2015, approval number 9886) and the Sangath Institutional Review board (IRB) (19 February 2014; 27 May 2015). Approval was also granted by the Indian Council of Medical Research's Health Ministry Screening Committee (HMSC) (24 November 2014; 6 October 2015). Informed written consent was obtained from mothers at enrolment into the trial surveillance system and again before a child's first birthday for detailed assessments.

RESULTS

SPRING-ELS sub-sample

1726 liveborn babies were recruited into SPRING-ELS. 1273 (73.8%) of these completed 12 and 18 month assessments. Children who missed either were consider lost to follow-up. The flowchart describing this is presented elsewhere (Bhopal et al., 2019) together with a table showing no evidence of selection bias comparing those included versus lost to follow-up with respect to socioeconomic status, caste, sex, multiple pregnancy, being delivered in a facility, and mother's education and age. Reasons for loss to follow-up include not being available for assessment at 12 months (12.0%) or 18 months (0.8%), consent refusal (6.1%), having moved away (4.8%), and death of mother or child (2.6%).

MORS-SF Responses

Figure 2 shows considerable variation in responses to MORS-SF statements. In the warmth sub-scale the majority of mothers responded 'nearly all the time' to statements: "My baby… 'smiles at me', 'likes me', 'laughs', and 'likes to please me'". Positive ratings were less frequent for the statements: "My baby… 'likes doing things with me', 'talks to me' and 'is affectionate towards me'". In the invasion sub-scale, most mothers responded 'never' to the statements: "my child winds me up" and "my child dominates me", however a considerable proportion indicated in response to the statements "my baby annoys me" and "my baby irritates me" that this happens rarely, sometimes or quite often. Many mothers responded to the statement "my baby wants too much attention" with 'nearly all of the time'.

The mean warmth score was 28.2 and invasion score was 10.9 (possible range 0-35). Figure 3 shows histograms for warmth and invasion scores, and illustrates the relationship between these scores. 17.1% of dyads were categorised as 'no concern' in the relationship, 32.6% as low-concern, 45.7% as moderate-concern and 4.6% as high concern ; the majority of moderate-concern categorisation was

due to high invasion scores (508 children) rather than low warmth (74 children) (Figure 3 C).

Association of MORS-SF with Child Development Indicators

Mean HOME-IT score was 31.6. Mean BSID-III scores were 94.5, 92.6 & 90.7 for the motor, cognitive & language domains.

For the motor and language BSID-III scales and for HOME-IT there were strong and positive associations with the warmth sub-scale, and strong and negative associations with the invasion sub-scale. Similar associations were seen with the BSID-III cognitive scale but with smaller point estimates and wider confidence intervals (Table 3).

Table 4 shows the results of models including both warmth and invasion; these also included an interaction term to allow for the possibility that these two explanatory variables did not act independently. The models for BSID-III motor and language scales show strong evidence of interaction which is illustrated in Figure 4 in two ways. In the top half of the figure, each of the eight lines on the graph represent a warmth sub-scale score in five point increments from 0 to 35. The invasion sub-scale score is plotted on the x-axis. The predicted BSID-III score for any given combination of these scores can then be read from the y-axis, showing that compared with the motor and cognitive scores, there is a much larger difference in the language score as warmth scores change. These graphs also show that higher invasion scores are associated with lower BSID-III scores overall, but that this relationship is attenuated by high warmth, particularly in motor and language BSID-III scales. The contour plots in the bottom half of Figure 4 illustrate these same relationships in a different way, giving the predicted BSID-III score in a colour for any given level of invasion (read on the y axis) and warmth (read on the x axis). The strong interaction shows on these graphs as curved lines in the language and motor

scales, whereas for cognitive the boundary lines are parallel which is indicative of no interaction.

Similar illustrations are presented in Figure 5 for HOME-IT; on the left side, lines representing warmth scores diverge as the invasion score increases, and on the right side the contour plot shows that the boundary lines between predicted outcome scores are curved. Both of these illustrate the strong evidence that warmth and invasion scores interact with respect to HOME-IT scores.

Association of MORS-SF level of concern with child development indicators

There were consistent and negative associations between MORS-SF concern levels and BSID-III & HOME-IT scores. Between MORS-SF high & no concern levels this associated decrease in HOME-IT score was 2.5 points (approximately 0.5SD), nearly 9 points in the BSID-III language domain (0.6SD), nearly 4 points in the cognitive domain (0.35SD), and 4.6 points in the motor domain (0.47SD). These relationships are outlined in *Table 5* and are illustrated in Figure 6 which shows decreasing developmental scores as MORS-SF concern level increases from no-concern to high-concern.

DISCUSSION

We adapted the MORS-SF for use with mothers in Haryana, India and found that scores were associated with lower infant development scores in the motor, cognitive and language domains of the BSID-III scale, and with lower HOME-IT scores indicating a lower quality of the home environment. This was the first time that MORS-SF has been examined with respect to these child developmental assessment tools and our study provides exciting new insight into a possible tool for measuring the mother-infant relationship in community-based settings in low- & middle-income countries. This is particularly important as the child survival agenda expands to incorporate nurturing care and early childhood development in these settings, with an emphasis on improved carer-child interactions and increasing carer responsiveness, both of which are closely related to a mother's working model of her infant as explored in MORS-SF.

The finding that warmth scores were reasonably high, and contributing relatively less to MORS concern levels than the invasion scores is noteworthy, suggesting that whilst mothers may feel warm and affectionate towards their infants they may nevertheless feel that their infants overly impinge on their own being (e.g by endorsing statements such as 'my baby annoys me' and 'my baby irritates me'). Our group's previous work in this area of India found that mothers are busy and stretched for time(Lingam et al., 2014) and it is possible that this accounts for some of this feeling of invasion when interaction with young babies is one amongst a range of activities competing for a mother's time. This possibility is backed up by the >40% of mothers responding with "nearly all the time" to the statement "My baby wants too much attention". Both the warmth and invasion scores are similar to those presented in the original MORS-SF British cohort when infants were 2-6 months old (warmth mean (SD): 29 (3.7); invasion mean (SD): 11.3 (4.3)). Warmth scores are similar to a Hungarian cohort of 97 mothers when infants were 6 months of age

(mean (SD): 28.4 (3.8)), however invasion scores are a little higher (mean (SD): 7.8 (3.9)). This general consistency across the three diverse settings of the United Kingdom, Hungary and India is striking and lends support to the contention that (with rigorous adaptation) this is a tool that could be of use in multi-country assessments for child wellbeing.

Possible reasons for the MORS-SF and HOME-IT associations include that mothers who have high warmth or low invasion scores on MORS-SF may score higher in the mother-child interaction section of HOME-IT. It is also possible that there are material changes in home environments, for example of play materials connected to the mother's internal representation of her child. The overall finding is useful because HOME-IT is used as a proxy measure for multiple elements of child development in the research setting but is too cumbersome to use at-scale for tracking progress – indeed it took two assessors at least an hour to complete HOME-IT in our setting.

The finding that the relationship of BSID scores was similar with each of the warmth & invasion sub-scales in initial models suggests that these individual sub-scales are equally important for predicting development. The final model including the interaction term shows that for language, at any given level of invasion score, a mother's high warmth score of 35 is associated with the highest language score (and similarly for other very high warmth scores). For the motor scale, the relationship is the opposite; the model predicts that if warmth is low then invasion score has minimal influence on motor scores. This suggests that combining the two sub-scales is crucial to use of MORS-SF.

Another advantage of MORS-SF is that scores can be quickly calculated, and results are intuitive to non-specialists. The tool has been used by health visitors in the United Kingdom who have used results to engage directly with families. Using MORS-SF as a screening and initial management tool may be of interest in LMICs.

This is the first time that the MORS-SF has been examined with respect to child development. Our novel results fit within the larger body of literature supporting the role of parental affect, the mother-child relationship and attachment status in affecting child developmental outcomes (Bowlby & Ainsworth, 2013; Cummings & Davies, 1994; Parpal & Maccoby, 1985). Strengths include the novel and important research question, and that this is the largest sample to have been assessed using MORS-SF. We adjusted for possible clustering in the data, and for allocation to trial group because of possible confounding.

MORS-SF could be a valuable addition to the more commonly used HOME-IT and BSID-III tools in LMIC research and monitoring because of a) its focus on assessing the mother's perceptions of her child in the warmth & invasion domains which may be useful to encouraging improved responsiveness and b) the feasibility of administration at scale.

Cultural adaptation required a team with in-depth understanding of at least two cultures, multiple languages and of the tool. Careful thought and fieldwork was needed to understand how to best adapt specific meanings to a new context. We allocated time and resources to produce a tool that made sense to participants and gave reliable results. Whilst no consensus exists on the ideal format of cross-cultural validation studies (Epstein, Santo, & Guillemin, 2015), the strengths of our approach are well described and include: 1) translation involving a clinical psychologist with considerable understanding and experience of test development principles (Hambleton & Patsula, 1999); 2) reconciliation of two independent translations (Koller et al., 2012); 3) multidisciplinary and multilingual review by multiple persons (Bracken & Barona, 1991); 4) avoidance of over-reliance on back-translation (Epstein et al., 2015; Geisinger, 1994); 5) focus on the meaning of individual words and items in focus groups & cognitive interviews (Arredondo, Mendelson, Holub, Espinoza, & Marshall, 2012; Bracken & Barona, 1991;

Hambleton & Patsula, 1999) 6) involvement of the original tool author (Beaton, Bombardier, Guillemin, & Ferraz, 2000) and 7) pre-testing by a research associate with understanding of the tool, the adaptation process and both languages(Epstein et al., 2015).

Design limitations of this study include that we administered MORS-SF with mothers only, but we recognise that much care is provided by the wider family. Future work in such a context could assess other family members' responses to MORS-SF to more deeply understand the contribution of each family member.

We found that MORS-SF - a standardised measure of a mother's perception of her infant - could be culturally adapted for use in rural India, and that the results of this adapted tool were associated with other indicators of early childhood development which are more commonly used in LMICs. MORS-SF is short, understandable and has shown great potential for incorporation into studies examining responsive caregiving and early childhood, particularly for the majority of the world's children who live in low and middle-income countries where access to assessment tools for early childhood development is sorely lacking.

Table 1: MORS-SF items with summary of translation

Statement	Sub-scale	Original	Comments on Translation
1	W	My baby smiles at me	Translation uncontroversial
2	I	My baby annoys me	We trialled two Hindi translations: *"mera bacha mujhe satata hai"* and *"mera bacha mujhe khija deta hai"* – the second was considered to be less accurate, meaning 'imitating' or 'copying'. *"Satata hai"* implies a state of continuing annoyance without implication of action and was therefore chosen.
3	W	My baby likes doing things with me	The direct translation of '*things'* ("*cheez")* was not appropriate to this sentence and needed to be explored in the sessions. Our suggestion of *"gatividhiya"* ('*activities'*) was equivalent but the first focus group participants were not sure on whether it would be understandable in the community. Subsequent sessions confirmed that "*gatividhiya"* was both understood and acceptable.
4	W	My baby talks to me	Translation uncontroversial
5	I	My baby irritates me	Our original translation (*"Mera baccha mujhe chida deta hai"*) was misunderstood by participants because the meaning of *"chida"* varies with context. Without further context the implication was widely understood as *'teasing'*. The words *"jhunjhula"* and *"chidchidha"* were suggested by the two FGD groups and tested in subsequent interviews. "*Jhunjhula"* was selected because it is equivalent to *"irritate"* and was easily understood.
6	W	My baby likes me	Translation uncontroversial
7	I	My baby wants too much attention	This item presented a translation challenge as in English it is clear that *'too much attentio*n' implies negativity on the part of the respondent and is not equivalent to *'a lot of attention'*. In Hindi we had to make this clear. *"Jarurat se jyada"* achieved this meaning.

8	W	My baby laughs	Translation uncontroversial
9	I	My baby gets moody	There was no directly equivalent word in Hindi for *'moody'* - meaning a negative mood – so we trialed the English word *'mood'* which we thought may be understood. Of note, in English it is implicit that this mood must be negative. In Hindi, this isn't so clear and so we added *"kharaab"* ('bad') to clarify. Participants agreed and gave examples of child behaviours when a child has a negative mood.
10	I	My baby dominates me	We trialled three translation versions – "mera bacha muhe par haavi ho jaata hai", "bacha mujhe kubad kar deta hai" and "mera bacha mujhe apni ungli par nachata hai". The first was understood as *'getting angry'* which wasn't correct. The second was understood as *'doing mischief'*, again not appropriate. The final is a local idiom which was understandable (direct translation: *'my child makes me dance on their finger'*). There is a similar idiom in British-English: *'my child has me wrapped around their little finger'*. The original tool author preferred using this idiom and agreed that it matches the underlying construct.
11	W	My baby likes to please me	Translation uncontroversial
12	I	My baby cries for no obvious reason	We tried various translations to account for the word 'obvious' which needed to account for simple things that young infants cry for – being hungry and so on. *"bina kisi baat ke"* (*'no matter what'*) and *"bina kisi wajah"* (*'without any reason*') were both acceptable translations but "*bina kisi wajah"* was most equivalent to the original tool.
13	W	My baby is affectionate towards me	Our suggested translation *"mera bacha mere prati pyaar dikhata hai"*, was understood but the first FGD suggested adding the word *"aur"* to emphasise that this affection must be towards the mother to count. This was understood in subsequent sessions.

14	I	My baby winds me up	This English idiom was the most difficult of the items to translate. The original tool author clarified that the underlying meaning is that the child repeatedly does things to raise the caregiver's level of tension, so *'winding up'* like for a clockwork motor. The emphasis is on the accumulative, and a suggestion that the child does it purposely. Our three potential translations were "Mera baccha intna pareshan", "tang karta hai ki sehan" "bardast karna mushkil ho jaata hai". We preferred *"tang"* to *"pareshan"* because it makes it clear that this word relates more to a child's perceived mischevious behaviour over their actions in general, fitting with the tool author's emphasis on the child's purposive behaviour. We chose *"bardast"* over *"sehan karna"* to emphasise the implication of repeated actions leading to the 'winding up'. The second FGD understood the reformulated translation, with one participant giving an example: "when a mother is cooking food and the child keeps throwing things around even when told not to, repeatedly, it becomes intolerable for the mother". In further sessions we found the translation to be working well.

Table 2: Definition of MORS-SF concern levels

MORS-SF concern level	Warmth scale	Invasion scale
None	26-30	0-6
Low	23-25	0-6
	23-35	7-11
Moderate	23-35	12-35
	0-22	0-11
High	0-22	12-35

Table 3: MORS-SF: Association between each of warmth & invasion sub-scale and child developmental outcomes (adjusted for clustering & SPRING trial allocation) *Mean outcome score when explanatory variable (warmth or invasion) is equal to 0.

	Overall Mean (SD)	Warmth Models			Invasion Models		
		Mean at 0 (95% CI)*	Change for increase (95% CI)	p	Mean at 0 (95% CI)*	Change for increase (95% CI)	p
Motor	94.5 (9.7)	88.2 (84.9, 91.5)	0.22 (0.10, 0.33)	<0.001	96.9 (95.2, 98.5)	-0.23 (-0.34, -0.13)	<0.001
Cognitive	92.6 (10.6)	89.5 (85.8, 93.1)	0.10 (-0.02, 0.22)	0.099	93.7 (91.8, 95.6)	-0.13 (-0.25, -0.02)	0.026
Language	90.7 (14.2)	81.1 (76.1, 86.1)	0.33 (0.17, 0.48)	<0.001	93.2 (90.3, 96.1)	-0.27 (-0.42, -0.12)	0.001
HOME-IT	31.6 (4.1)	29.7 (28.2, 31.2)	0.08 (0.04, 0.13)	<0.001	32.8 (31.9, 33.8)	-0.08 (-0.12, -0.04)	<0.001

Table 4: MORS-SF: Association between warmth and invasion sub-scales in one model and child developmental outcomes *slope when other explanatory variable (warmth & invasion) is equal to zero

	Warmth & Invasion Models						
	Mean at Warmth=0 & Invasion=0 (95% CI)	Warmth		Invasion		Interaction term	p model
		Slope*	p	Slope*	p		
Motor	88.7 (81.1, 96.3)	0.27 (0.02, 0.53)	0.035	0.07 (-0.55, 0.68)	0.832	-0.009 (-0.03, 0.01)	<0.001
Cognitive	91.4 (83.0, 99.8)	0.08 (-0.20, 0.36)	0.589	-0.11 (-0.78, 0.57)	0.750	-0.0002 (-0.02, 0.02)	0.150
Language	96.7 (85.7, 107.7)	-0.14 (-0.50, 0.23)	0.466	-1.31 (-2.19, -0.42)	0.004	0.039 (0.008, 0.069)	<0.001
HOME-IT	32.0 (28.9, 35.2)	0.02 (-0.08, 0.13)	0.645	-0.18 (-0.43, 0.07)	0.156	0.004 (-0.005, 0.013)	<0.001

Table 5: MORS-SF concern categories: association with child developmental outcomes

MORS concern category	N	%	Predicted mean (95% CI) BSID-III scores			Predicted Mean (95% CI) HOME-IT scores
			Motor	Cognitive	Language	
None	217	17.1	96.3 (94.6, 98.0)	93.5 (91.5, 95.4)	92.7 (89.7, 95.6)	32.6 (31.6, 33.6)
Low	415	32.6	95.1 (91.8, 98.4)	93.1 (89.4, 96.7)	91.0 (85.8, 96.2)	32.2 (30.6, 33.8)
Moderate	582	45.7	93.3 (90.1, 96.6)	91.6 (88.0, 95.2)	89.6 (84.5, 94.7)	31.8 (30.2, 33.4)
High	59	4.6	91.7 (87.2, 96.1)	89.7 (84.7, 94.6)	83.8 (76.9, 90.7)	29.9 (27.8, 32.0)
p-trend			<0.001	0.025	<0.001	<0.001
Overall Mean (SD)			94.5 (9.7)	92.6 (10.6)	90.7 (14.2)	31.6 (4.1)

The first statement is: “My child smiles at me”. Please can you give me an idea of how much this happens? ***[Point at 0-5 scale].*** Does it never happen ***[Point at 0]***? Does it happen nearly all the time ***[Point at 5]***? Or somewhere in the middle ***[Point at 1-4]***?					
Never	Rarely	Sometimes	Quite often	Very often	Nearly all the time
0	1	2	3	4	5

Figure 1: MORS-SF instructions to be read by assessor printed on the form. Actions outlined in bold. Mothers were asked to point at the box which most clearly represented their response to each item

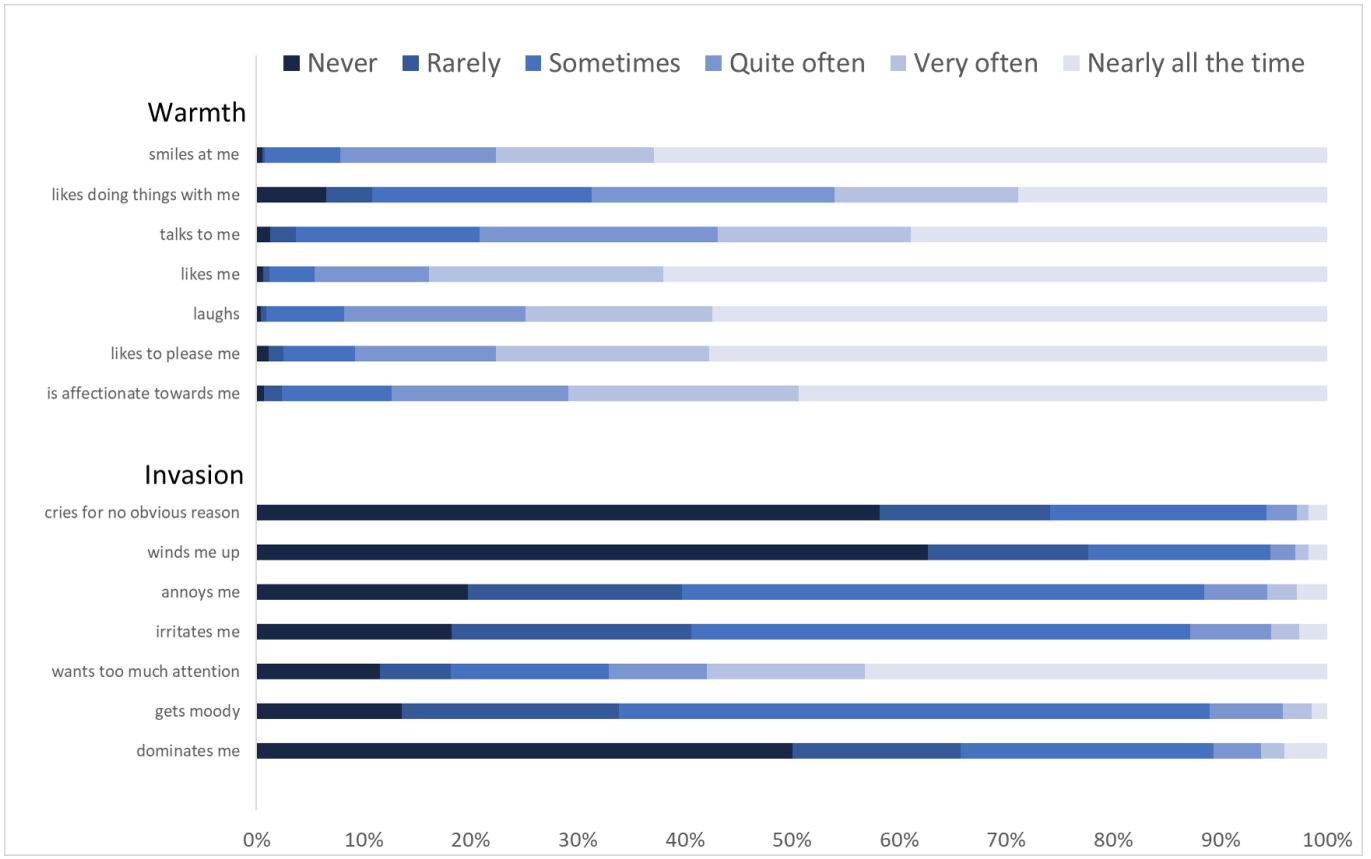

Figure 2: MORS-SF: percentage of responses to each of 14 items grouped within the warmth and invasion sub-scales

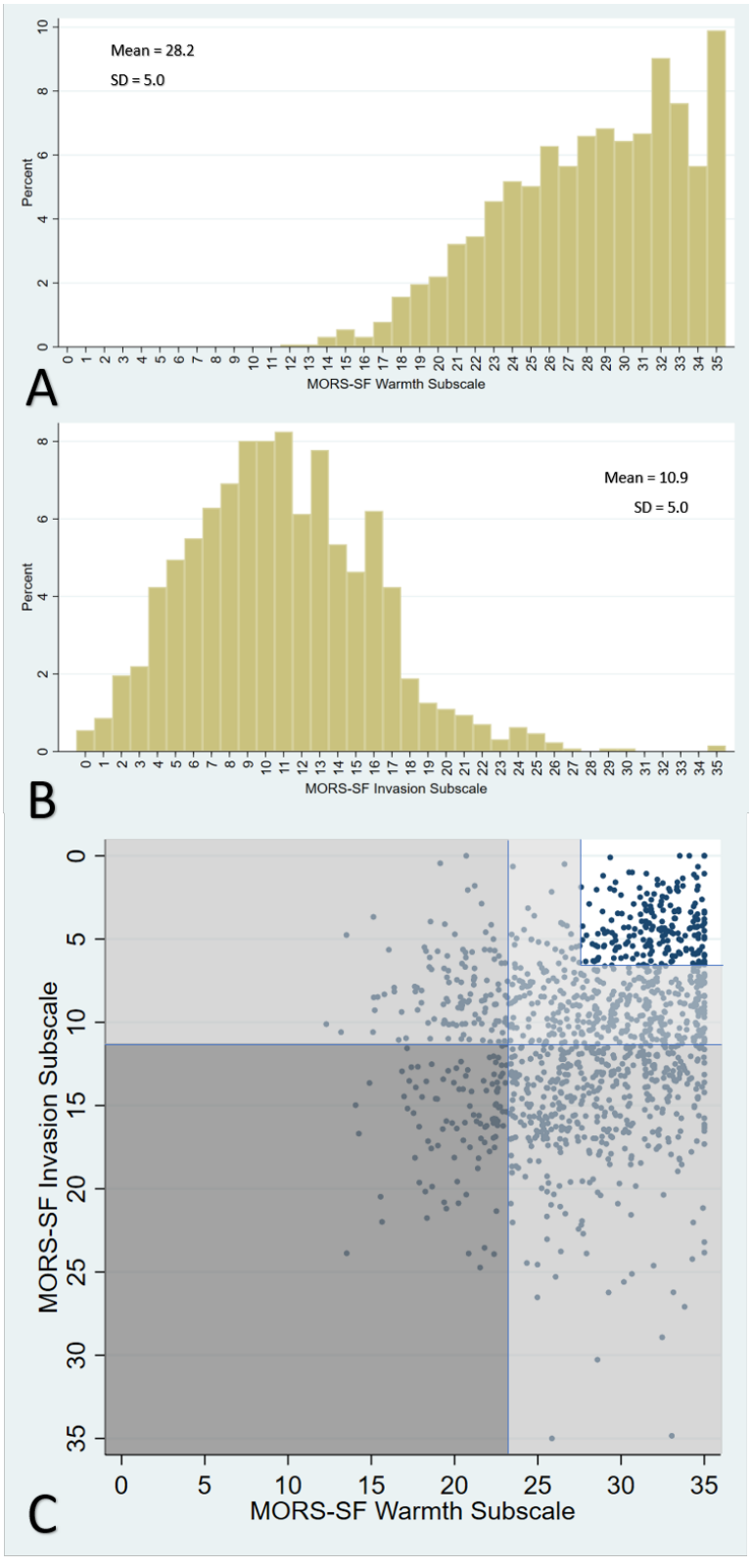

Figure 3: MORS-SF: distribution of scores in the Warmth (Panel A) and Invasion (Panel B) sub-scales and scatterplot of relationship between these scores, including categorisation of concern levels shaded in dark grey (high), medium grey (moderate) light grey (low) and white (no concern) (Panel C)

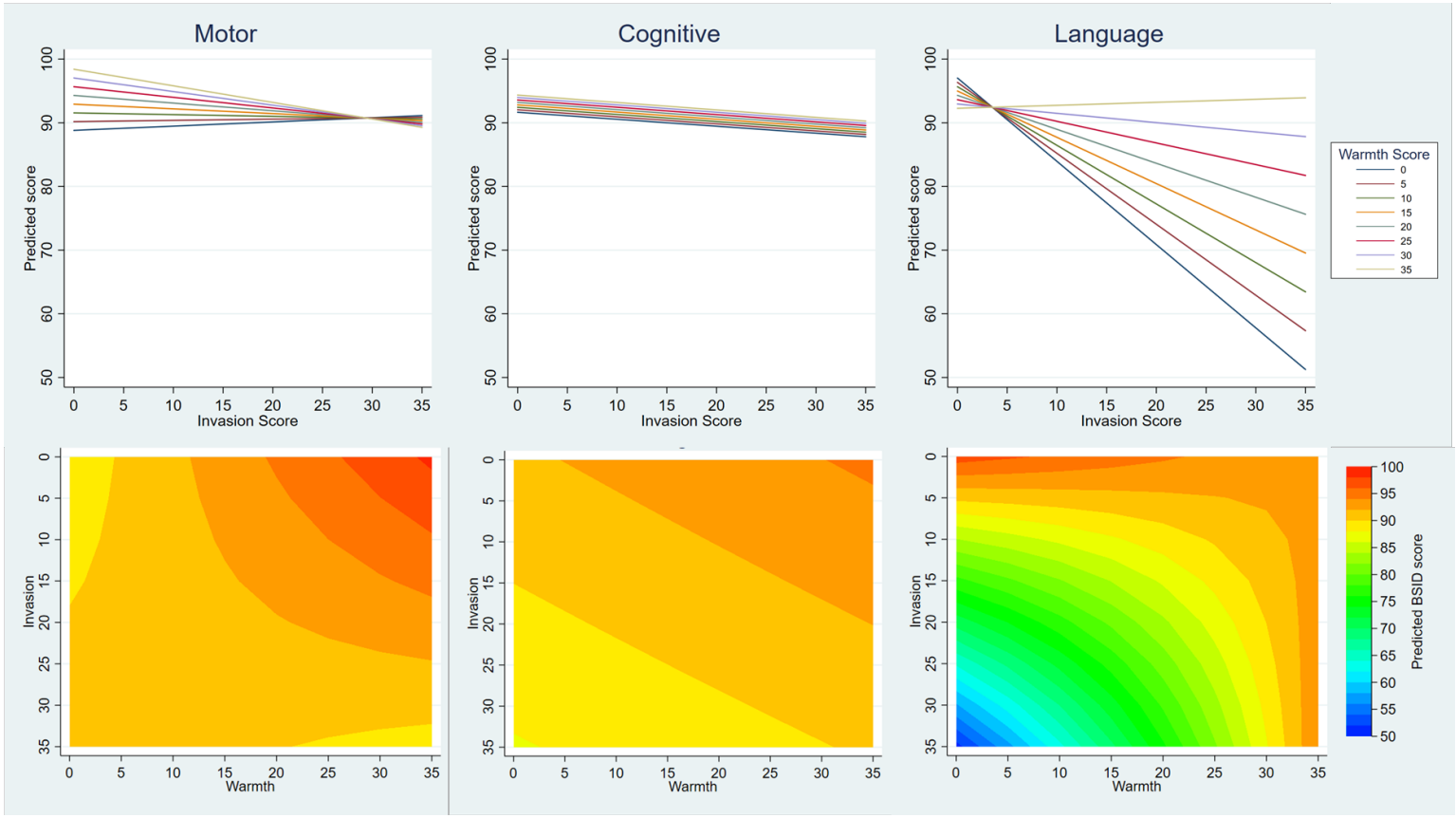

Figure 4: MORS-SF & BSID-III – illustration of final models including interaction term. The upper graphs show the interaction of the effects of invasion and warmth on child development – the y axis shows the model predicted scores in the motor cognitive and language domains, the x-axis shows how this varies by invasion, and the coloured lines show how this varies by warmth. The lower contour plots show how predicted BSID scores (contoured colours) are affected by the interaction of warmth and invasion scores (x and y axes). The more curved the contours, the greater the interaction between these two scores

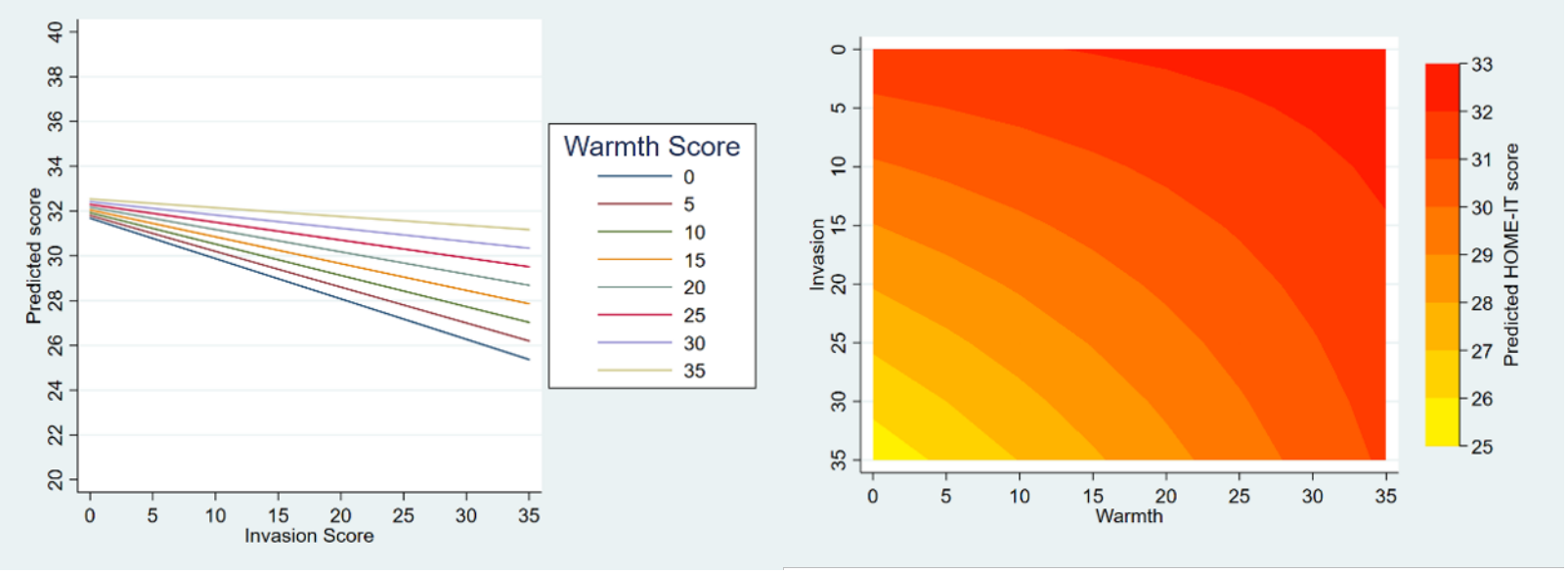

Figure 5: HOME-IT illustration of final models including interaction term. The left hand graph shows the interaction of the effects of invasion and warmth on HOME-IT – the y axis shows the model predicted score, the x-axis shows how this varies by invasion, and the coloured lines show how this varies by warmth. The right hand of the figure (contour plot) shows how predicted HOME-IT score (contoured colours) is affected by the interaction of warmth and invasion scores (x and y axes). The curved lines suggest interaction between these two scores

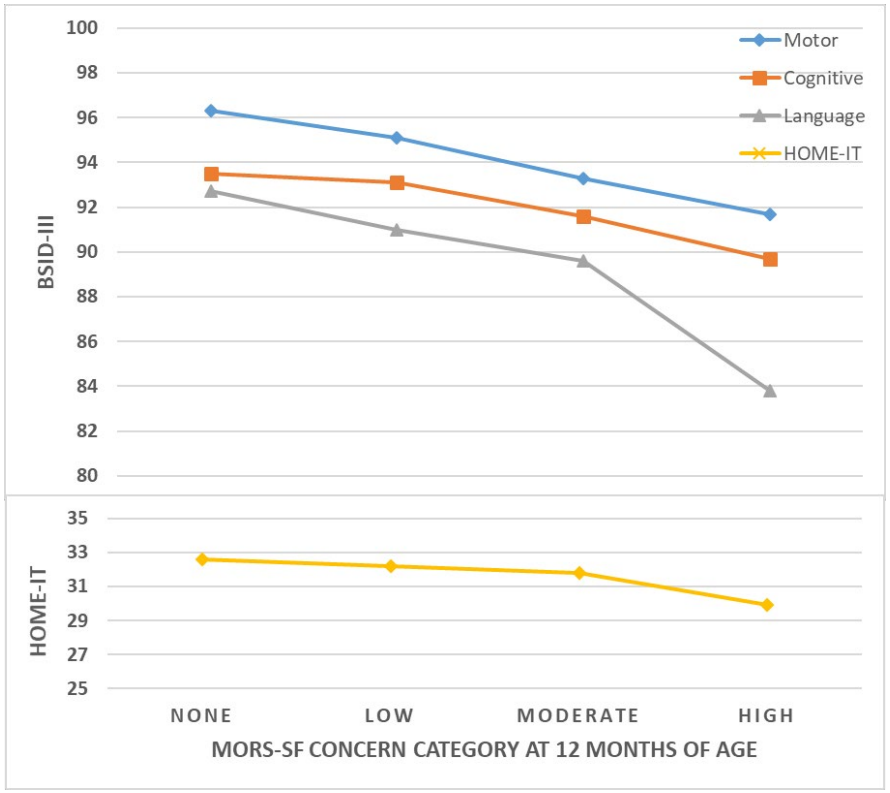

Figure 6: Association between MORS-SF concern category at 12 months of age and BSID-III developmental domain scores at 18 months of age

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SECTION D: CONCLUSIONS AND RECOMMENDATIONS

Chapter 11: Key Findings

Objective 1: To understand mothers' perspectives on early childhood adversity and stress and how this relates to health and development of young children

- All mothers who took part in focus group discussions described situations in which adversity had an impact on childhood wellbeing within their own communities
- All mothers identified several causes of adversity and stress. These included: poverty, neglect, violence in the home, and alcohol use of father
- Mothers were clear that the effect of these vary from child to child and that it is difficult to understand which child will be affected by adversity
- The mothers' explanations of the effects of adversity and stress on the developing child were broadly aligned with current biomedical thinking with regards to: the wide range of adversities faced by children; potential consequences throughout the lifecourse; and adult love and care as the key to prevention and treatment
- Mothers described adversity reflecting in emotional and behavioural consequences for children in the short term. There was broad agreement that these consequences can persist into later child- and adulthood and that reversing these becomes increasingly difficult as children grow older
- A key difference between mothers' and biomedical understanding was the widely held view of mothers that children in the first two years of life are "too young to understand" and therefore unable to be affected by adversity.

Objective 2: To develop a framework for assessing early life adversity in rural India, using both existing tools and developing new tools where required

- A framework for measuring early life adversity was developed around the following four domains: socioeconomic; carer-child relationships; maternal stress; and child-related factors based on formative research with mothers, literature reviews and advice from child development experts.
- This framework comprised 22 adversity items collected using a combination of new questions to mothers which included her age at marriage, family debt, death of family members, family preference for a boy child and sibling violence against her child, established tools measuring maternal depression (PHQ9), the quality of the home environment (HOME infant/toddler) violence against women (WHO questionnaire), difficulties in the mother-child relationship (MORS-SF) and a new Observed Feeding Index developed to measure carer-child interaction during a mealtime.
- All SPRING and SPRING-ELS instruments underwent comprehensive cultural adaptation as per best-practice to ensure that they could be reliably administered by non-specialist assessors

Objective 3: To determine the impact of the number and types of adversity on childhood growth & development in rural Indian infants

- The burden of adversity faced by children in this part of India during their first year of life was enormous. Most (90.6%) faced at least 1 of these 22 adversities. Nearly 50% of children faced four or more. The maximum a child faced was 12 adversities
- The number of adversities was strongly associated with both poorer growth and development at 18 months of age - there was no evidence of a threshold effect. Each additional adversity was associated with a:
    - 1.1 point (95% CI 0.9, 1.3) decrease in the composite Bayley-III motor development score
    - 0.8 point (95% CI 0.6, 1.0) decrease in the Bayley-III cognitive score
    - 1.4 point (95% CI 1.1, 1.9) decrease in the composite Bayley-III language score
    - 0.09 (0.06, 0.11) decrease in weight-for-age z-score
    - 0.12 (95% CI 0.09, 0.14) decrease in height-for-age z score
- Similar negative associations were seen for each of the four adversity domain scores
- These findings were robust to adjustment for other domains of adversity for the carer-child relationship and child-related domains, but not for maternal stress where the relationship was less strong and p values very high for the models for each outcome
- The difference between children with the least adversities (zero) and those with the most (8+) was a:
    - 10.3 point decrease in composite Bayley-III motor development scores
    - 7.8 point decrease in the Bayley-III cognitive score
    - 11.5 point decrease in the Bayley-III composite language score
    - 0.91 decrease in weight-for-age z score
    - 1.12 decrease in height-for-age z-score

Objective 4: To develop understanding of the influence of the number and types of adversity on cortisol measures of early life stress in rural Indian infants

- This was one of the first studies to take cortisol measures from young children in the home in a low/middle-income country setting
- Challenges included consent refusals (16.7% for hair, 1.8% for saliva) and logistical difficulties of taking six samples within short time-windows
- The number of adversities was associated with increasing concentration of cortisol in hair of 12-month old infants (with hair cortisol increasing by 6.1% (95% CI 2.8, 9.4) for each adversity)
- Similar positive associations were seen for the three adversity sub-scales related to socioeconomic factors, child-carer relationship factors and child-factors but not to the maternal stress domain
- There was no association between adversity and the two diurnal salivary cortisol measures area-under-the-curve (representing total amount of cortisol over two days), and diurnal slope (measuring the decrease in cortisol from morning until late afternoon)

Objective 5: To examine the role of early life stress as measured by cortisol in early child growth and development

- There was a strong negative association between hair cortisol concentration at 12-months of age and growth and development measured at 18 months of age. Each log pg/mg increase in hair cortisol was associated with a:
    - 1.1 point (95% CI 0.3, 1.8) decrease in Bayley-III motor score
    - 1.3 point (95% CI 0.6, 2.0) decrease in Bayley-III cognitive score
    - 2.3 point (95% CI 1.3, 3.3) decrease in Bayley-III language score
    - 0.15 z-score (0.07, 0.22) decrease in weight-for-age
    - 0.12 z-score (0.05, 0.19) decrease in height-for-age
- Although related, the link between cortisol measures and growth and development outcomes was not completely explained by number of adversities

Using the Mothers Object Relations Scale as an indicator of Early Childhood Development

- This scale measures difficulties in the early mother-child relationship. Mothers were asked to rate 14 statements related to their child's actions
- Each item is scored from 0 (never) to 5 (nearly all the time) giving a total of 35 points on a warmth subscale and 35 points on an invasion subscale
- This was the first time the scale had been used in India and the first time it had been examined in relation to early childhood development
- Each increase in warmth subscale score was associated with a:
    - 0.22 point increase in the Bayley-III composite motor score
    - 0.10 point increase in the Bayley-III cognitive score
    - 0.33 point increase in the Bayley-III composite language score
- For the invasion subscale, this was:
    - 0.23 point decrease in Bayley-III composite motor score
    - 0.13 point decrease in the Bayley-III cognitive score
    - 0.27 point decrease in the Bayley-III composite language score

Chapter 12: Recommendations

12.1 Programme Recommendations

- **Promoting Early Childhood Development must remain a global priority.** Urgent multisectoral action is needed to improve life chances for all children. from their earliest moments because the brain is developing most rapidly through pregnancy and the first two years of life and responds most quickly to intervention
- **Policy makers and programmers should consider the profound role of adversity in early childhood development programmes** because of the crucial role of adversity in sub-optimal development. Adversity should be central to hypothesised change-pathways and consideration should be given to whether a particular intervention is likely to tackle a large enough proportion of these wide ranging factors in order to make a difference for children
- **Attention should be paid to family understanding of early childhood development and nurturing care** because parents and other caregivers are critical to support children's wellbeing, and fundamental misunderstandings -including around the age at which nurturing care is important – may mean that interventions do not have their desired impact
- **Programmes should counter widespread cultural norms** including that what children cannot 'understand' or remember cannot harm them
- **Action is needed now** because the huge benefits of nurturing care interventions is known, and there are existing opportunities to intervene through health, nutrition, education and social service systems to improve life chances particularly for children living in low- and middle-income countries

12.2 Recommended future research directions

We have shown that adversity in the earliest years has a negative impact on child growth and development at only 18 months of age. We have also shown that there are negative implications for biological systems including the hypothalamic-pituitary-adrenal stress axis. Yet, important gaps exist. Future research should consider:

- **Developing deeper understanding of the timing of adversity:** Pinpointing the most effective time for intervention in the pre-conception, pregnancy and early childhood periods is necessary for programmes to incorporate interventions that work, at a time that will make a difference.
    - Longitudinal studies, including follow-up of the children assessed in this study, are crucial to further understand this
- **Examining the impact of early childhood development programmes on biological outcomes including cortisol:** this would provide a point measure of programme success and could be used for tracking progress
- **Further exploration of biological measures of early life stress and implications for early childhood development:** New studies should include biomarkers which have been underused in low/middle-income countries. These include C-reactive protein, Interleukins and epigenetic markers which are becoming increasingly feasible to sample and analyse
- **Development of improved measurement tools for early childhood development in low- and middle-income countries:** given the crucial importance of early childhood development, and given the logistical difficulties and cost implications of conducting developmental assessments, future research should aim to produce a measure which is quick to administer, non-intrusive, low-cost and can be administered by non-specialists with minimal training. This is likely to include new technologies and biological measures as well as behavioural and environmental measures

Chapter 13: Summary

- This PhD investigated the relationships between childhood adversity, early life stress and growth and development of children in the first 18 months of life
- It was part of the SPRING-ELS sub-study of the SPRING cluster randomised controlled trial in India
- Children were found to be at-risk of suboptimal growth and development at 18 months of age because of the number of adversities they are exposed to
    - The importance of adversity was acknowledged in the latest Lancet ECD series however a conservative estimate of child at risk of suboptimal development was generated using stunting (extremely low height-for-age) as a proxy. We used height-for-age as an outcome rather than an adversity and measured many other adversities directly
- Adversity also had damaging effects on children's developing hypothalamic-pituitary-adrenal stress axis in SPRING-ELS children
- Findings emphasise that children are never too young to absorb what is happening around them. This is of particular negative consequence for young children aged 0-2, a time period which is crucial for optimal brain development and is a key predictor of future health and wellbeing
- There is global high-level support to improve the life chances of young children through nurturing care interventions which address early childhood development with the aim that all children have the opportunity to thrive. Urgent national action is now needed
- Findings from this PhD are a reminder that action should be multisectoral and simultaneously address many potential impediments to wellbeing. This is likely to be required to really make a difference for those that need it the most, wherever in the world they live

SECTION E: APPENDICES

Appendix 1: Literature Searches

Multiple literature searches were performed over the course of the PhD period using PubMed for the five papers described and work that preceded the thesis including the funding application. The following groups of search terms were used in combination to identify literature that would be of interest to the specific paper in question. For example, whilst preparing paper 2 related to childhood adversity and growth/development, the domains 'child', 'adversity', 'socioeconomic status', 'child-carer relationships' and 'maternal stress' were used in combination with the terms related to 'child development' and 'growth'.

Domain	Terms
Child	(Child[MeSH Terms] OR Infant[MeSH Terms] OR Child, Preschool[MeSH Terms] OR child[tiab] OR infant[tiab] OR Adolescent[MeSH Terms] OR Pediatrics[MeSH Terms] OR pediatric*[tiab] OR paediatric*[tiab] OR child*[tiab] OR infant*[tiab] OR adolesce*[tiab] OR infancy[tiab])
Hair Cortisol	(Pituitary-Adrenal System[MeSH Terms] OR Hydrocortisone[MeSH Terms] OR cortisol[tiab]) AND (Hair[MeSH Terms] OR hair cortisol concentration[tiab] OR hair cortisol*[tiab]) OR (("hair"[MeSH Terms] OR "hair"[All Fields]) AND ("hydrocortisone"[MeSH Terms] OR "hydrocortisone"[All Fields] OR "cortisol"[All Fields]))
Salivary Cortisol	(Pituitary-Adrenal System[MeSH Terms] OR Hydrocortisone[MeSH Terms] OR cortisol[tiab]) AND (Saliva[MeSH Terms] OR saliva*[tiab])

Adversity	(Stress, Psychological[MeSH Terms] OR Life Change Events[MeSH Terms] OR ADULT SURVIVORS OF CHILD ADVERSE EVENTS[MeSH Terms] "adverse childhood experiences"[MeSH Terms] OR ("adverse"[All Fields] AND "childhood"[All Fields] AND "experiences"[All Fields]) OR "adverse childhood experiences"[All Fields] OR (early[All Fields] AND ("stress, psychological"[MeSH Terms] OR ("stress"[All Fields] AND "psychological"[All Fields]) OR "psychological stress"[All Fields] OR ("life"[All Fields] AND "stress"[All Fields]) OR "life stress"[All Fields])) OR ("stress"[All Fields])
Socioeconomic Status	"social class"[MeSH Terms] OR ("social"[All Fields] AND "class"[All Fields]) OR "social class"[All Fields] OR ("socioeconomic"[All Fields] AND "status"[All Fields]) OR "socioeconomic status"[All Fields]
Child-carer relationships	(("mothers"[MeSH Terms] OR "mothers"[All Fields] OR "maternal"[All Fields]) AND ("child"[MeSH Terms] OR "child"[All Fields]) AND "interaction"[All Fields]) OR ((("mother"[All Fields] AND "child"[All Fields]) OR "mother child"[All Fields]) AND care[All Fields]) OR (("caregivers"[MeSH Terms] OR "caregivers"[All Fields] OR "carer"[All Fields]) AND ("child care"[MeSH Terms] OR ("child"[All Fields] AND "care"[All Fields]) OR "child care"[All Fields])) OR (("fathers"[MeSH Terms] OR "fathers"[All Fields] OR "father"[All Fields]) AND ("child care"[MeSH Terms] OR

	("child"[All Fields] AND "care"[All Fields]) OR "child care"[All Fields]))
Maternal Stress	(("mothers"[MeSH Terms] OR "mothers"[All Fields] OR "maternal"[All Fields]) AND "stress"[All Fields]) OR (("mothers"[MeSH Terms] OR "mothers"[All Fields] OR "maternal"[All Fields]) AND difficulty[All Fields]) OR ("depression, postpartum"[MeSH Terms] OR ("depression"[All Fields] AND "postpartum"[All Fields]) OR "postpartum depression"[All Fields] OR ("postpartum"[All Fields] AND "depression"[All Fields])) OR (("mothers"[MeSH Terms] OR "mothers"[All Fields] OR "maternal"[All Fields]) AND ("depressive disorder"[MeSH Terms] OR ("depressive"[All Fields] AND "disorder"[All Fields]) OR "depressive disorder"[All Fields] OR "depression"[All Fields] OR "depression"[MeSH Terms]))
Child Development	("child development"[MeSH Terms] OR ("child"[All Fields] AND "development"[All Fields]) OR "child development"[All Fields]) OR (early[All Fields] AND ("child development"[MeSH Terms] OR ("child"[All Fields] AND "development"[All Fields]) OR "child development"[All Fields] OR ("childhood"[All Fields] AND "development"[All Fields]) OR "childhood development"[All Fields])) OR (("cognitive"[All Fields] AND "development"[All Fields]) OR "cognitive development"[All Fields]) OR ("language development"[MeSH Terms] OR ("language"[All Fields] AND "development"[All Fields]) OR "language development"[All Fields])

Growth	("growth and development"[Subheading] OR ("growth"[All Fields] AND "development"[All Fields]) OR "growth and development"[All Fields] OR "growth"[All Fields] OR "growth"[MeSH Terms]) OR ("nutritional status"[MeSH Terms] OR ("nutritional"[All Fields] AND "status"[All Fields]) OR "nutritional status"[All Fields] OR ("nutrition"[All Fields] AND "status"[All Fields]) OR "nutrition status"[All Fields]) OR ("anthropometry"[MeSH Terms] OR "anthropometry"[All Fields])
Explanatory Model	(explanatory[All Fields] AND model[All Fields]) OR ("culture"[MeSH Terms] OR "culture"[All Fields] OR "cultural"[All Fields]) OR (qualitative[All Fields]) OR ("patients"[MeSH Terms] OR "patients"[All Fields] OR ("patient"[All Fields]) AND ("comprehension"[MeSH Terms] OR "comprehension"[All Fields] OR "understanding"[All Fields])) OR (illness[All Fields] AND experience[All Fields])

After running a search using a combination of these terms, limits were placed to select those articles in the English language which were related to humans only (a small amount of animal literature is cited in the papers, but this was not a focus of the literature searches).

Titles were screened and abstracts read. If papers appeared to be of interest, they tagged with keywords and added to the candidate's online repository (using the Zotero software) for access whilst writing papers. For literature reviews, reference lists were checked for additional papers of interest.

Additional literature was accessed through recommendations by colleagues, journal alerts, national press, following related academics on social media including Twitter, and unstructured Google Scholar searches. Literature obtained through these avenues were added to the same Zotero repository.

Appendix 2: Ethical Approvals

London School of Hygiene & Tropical Medicine
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www.lshtm.ac.uk

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Observational / Interventions Research Ethics Committee

Professor Betty Kirkwood
Professor of Epidemiology & International Health
Department of Population Health (DPH)
LSHTM

19 May 2015

Dear Professor Kirkwood

Study Title: SPRING: Sustainable Programme Incorporating Nutrition & Games for maximising child development, growth & survival

LSHTM Ethics Ref: '9886 - 3'

Thank you for your application for the above amendment to the existing ethically approved study and submitting revised documentation. The amendment application has been considered by the Interventions Committee.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above amendment to research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval for the amendment having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Other	SPRING ELS Phase 1 information sheets & consent forms	01/04/2015	1

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

An annual report should be submitted to the committee using an Annual Report form on the anniversary of the approval of the study during the lifetime of the study.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

Professor John DH Porter
Chair

ethics@lshtm.ac.uk
http://www.lshtm.ac.uk/ethics/

Improving health worldwide

SANGATH INSTITUTIONAL REVIEW BOARD

Sangath

Title of study: Sustainable Programme Incorporating Nutrition & Games (SPRING) for MDGs

Members:

Raj Vaidya:
Pharmacist, Chairperson

Dr. Amit Dias:
Epidemiologist

Anant Bhan
Bio-ethicist

Gracy Andrew:
Clinical Psychologist

Dr. Neerja Chowdhary:
Psychiatrist

Dr. Sheela Gupte
Medical Practitioner

Mr. Vishram Gupte
Lawyer

Prof. Vikram Patel
Psychiatrist

Larissa Rodrigues
Community Representative

Dr Abhijit Nadkarni
Psychiatrist, Member Secretary

Decision:

Opinion of the Sangath Institutional review board:

1. Approved ☑*
2. Approved subject to suggested modifications
   (Does not need further committee review) ☐
3. Not approved ☐
   (Can be resubmitted but will need second review)
4. Not approved ☐

*Amendment application to investigate the role of *early life stress* (ELS) in a sub-sample of participating children.

The researcher is hereby informed that the Sangath Institutional review board will require the following:

1. A progress report to be submitted to the board annually
2. Upon completion of the study a final study report to be submitted
3. Any adverse event that is serious and un expected it is to be reported to the IRB within 72 hours of coming to notice of the PI.
4. One board member would be conducting a site visit and any adverse conditions reported by the member regarding the ethical considerations of the project would subject to a fresh review of the project.

**Prof Vikram Patel recused himself from decision making on this proposal.*

Date: 27th May 2015

Raj Vaidya
Chairperson

Appendix 3: Hair cortisol laboratory analysis protocol

Protocol developed by S Bhopal from Davenport 2006[1], Kirschbaum 2009[2] and discussion with Dr Matt Bristow, University of East Anglia.

Stage 1: Preparation and washing

1. Place entire hair sample into a 15 ml Falcon tube, and add 2.5 ml isopropanol. Mix gently on an overhead rotator for 3 min.
2. Decant, and repeat step 1 twice more.
3. Dry for at least 12 – 24 hours until hair is completely dry

Stage 2: Cutting

4. Hand cut each sample into very small pieces. Keep cutting for 5 minutes.

Stage 3: Extraction of cortisol

5. Weigh 25mg of hair and transfer into a 2 ml cryogenic vial.
6. Add 1.5 ml of pure methanol
7. Slowly rotate vials over 24 h for steroid extraction
8. Spin samples in a micro-centrifuge at 3000rcf for 2 min. The aim is that the hair is pelleted to the bottom so that the methanol can be extracted without the hair
9. Transfer 1 ml of the clear supernatant into a new 2 ml cryogenic vial

Stage 4: Analysis

10. Evaporate ethanol at 60 °C under a constant stream of nitrogen until the samples are completely dried (duration: approximately 20 min)
11. Add 0.4 ml of assay buffer
12. Vortex tube for 15 seconds
13. Remove 25 microliters from the vial and use for cortisol determination with Salimetrics immunoassay kit
14. Convert immunoassay result to pictograms of cortisol per milligram of hair

Appendix 4: Addressing Cultural Barriers to Hair Sampling

To gain initial understanding of socio-cultural barriers to hair sampling we ran a focus group discussion with five SPRING fieldwork supervisors in the study site office. They were all permanent residents of the study area and knew the local languages and customs around haircutting in young children. They had all been working in SPRING for at least a year and so were knowledgeable about working with families in the area. This discussion focussed on terminology used to describe hair and haircutting, practicalities for the first ceremonial haircut and reasons for doing it, and practicalities of hair cutting including who might be an appropriate worker to do this task and where it might be done.

We conducted three further focus groups with mothers of young children aged 0-2 years to explore rituals and ceremonies around young child haircutting and local terminology for these, elicit views about allowing their child to be involved in a study cutting hair and to develop solutions to overcome any barriers identified. The first of these groups was done with four mothers and the latter two with six mothers each.

Finally, we held two in-depth interviews with barbers working in the study area to explore their role in haircut rituals. We piloted haircutting with 13 children aged 9-14 months including discussing acceptability of the haircut. We also took the opportunity to ask about details of haircut ceremonies and perceptions of barriers to sampling with each of their families. Findings from these are as follows.

Prior to the first haircut, hair is called *'achoota baal'* (untouched hair). The first haircut is extremely important in many families and is often done with a religious ceremony. There is no set age for these ceremonies but they are usually done around the time of a child's first birthday. Ceremonies have a variety of names including *'jathula'* (hair), *'bal utarvana'* (hair removal), '*jaat lagwana'* (hair offering) and *'dhok khilana'* (seeking blessings). They are usually performed around Hindu festival times including Holi

festival which is celebrated across India, usually in March, and two major Navratri festivals usually celebrated in April and October. Ceremonies can be done in a temple, shrine or other holy place and are sometimes done at home. Hair is usually cut by a professional barber and sometimes by a female family member. Either a small piece of hair is cut or the entire head is shaved. Head shaving is more common in summer when the climate is extremely hot. The cut hair is given as a holy-offering at a religious place. The ceremonies are done in order to support a child's good health and to eliminate the effects of the 'evil eye' ('*Nazar'* in Hindi). This phenomenon is reported in locations around the world and in historical texts dating back millennia. In the study site, the phrase relates to the negative impacts felt by young children due to malevolent looks from strangers, bad luck brought about by overly praising young children and a range of other negative experiences which can lead to disease and poor health. Hair is also used in 'black magic' in this region so hair that has been cut - particularly in young children - can be closely guarded and families view those who might wish to take such hair with suspicion.

In pilot sampling, consent was refused for four of 13 children because the first haircut was not done. The remaining nine families were happy with the method the research associate used to cut the hair, and were satisfied that the cosmetic appearance of the child's hair was not interrupted by the haircutting. Cutting was done with the child sitting on the mother or grandmother's lap whilst sitting down and was technically straightforward.

Haircutting is considered by some to be unacceptable on certain days – in particular Tuesdays, but also Thursdays and Saturdays. In addition, cutting is taboo on Hindu fasting days – that is, days where adults are not permitted to eat for the day – and religious festival-days. There are at least 15 of these days per year.

Barriers understood from this formative work were therefore in five main categories:

- Families may not consent to participate prior to the first ceremonial haircut being performed and this may relate to a large proportion of families
- Children often have short hair, especially in summer, so may not have enough hair length to participate.
- Haircutting is not acceptable in public places
- Families may be suspicious of our motives in wanting to cut young children's hair – particularly because of its association with black magic and the evil-eye.
- Haircutting may not be acceptable on Tuesdays for religious reasons – it may also be unacceptable on Thursdays and Saturdays as well as during religious festival periods

In order to maximise chances of successful execution of the project given these potential barriers, we did the following:

- Planned for a large number of consent refusals and potential for children to have short hair
- Planned for all haircutting to be done inside the home as opposed to in a public place
- Instituted two visits to families in the weeks prior to sampling in order that our assessors made acquaintance with the family and were able to answer queries and discuss problems raised by various decision makers in the family. We trained assessors to emphasise the plan to analyse samples in the laboratory to emphasise the links between the hair cutting and the scientific work.
- Ensured that we were prepared to make return visits to households if the day was deemed acceptable to families

Appendix 5: Poster and Oral Presentations from this PhD

1. Early childhood stress, adversity, growth and development: findings from the SPRING home visits cluster randomised controlled trial in rural India. Invited oral presentation. **Wellcome Trust Bloomsbury Centre for Global Health.** Banjul, Gambia. January 2019.

2. Early childhood stress, adversity, growth and development: findings from the SPRING home visits cluster randomised controlled trial in rural India. Invited oral presentation. **Northern Centre for Mood Disorders.** Newcastle upon Tyne. September 2018.

3. **Bhopal S.** Early childhood development, stress and adversity in rural India: findings from the early life stress sub-study of the SPRING cluster randomised controlled trial (SPRING-ELS). Poster presentation. **International Society for Social Paediatrics and Child Health,** Bonn. September 2018.

4. **Bhopal S.** Improving experience of early childhood in low- and middle-income countries. Oral presentation. **Global Challenges Academy,** Newcastle upon Tyne. July 2018.

5. Kumar D, Divan G, Tauqeer A, Verma D, Jamil A, Khan B, Avan B, **Bhopal S**, Roy R, Sikander S, Kirkwood B. Child Development Assessments for Field Administration: Experiences from Pakistan and India. Oral Presentation. **International Developmental Paediatrics Congress**, Mumbai. November 2017.

6. **Bhopal S**, Verma D, Roy R, Kumar D, Divan G, Kirkwood B. Assessing the infant hypothalamic–pituitary–adrenal axis in SPRING, a large community-based cluster randomised controlled trial in rural India assessing the impact of a home visits intervention on early child growth and development (The SPRING-ELS sub-study). Accepted for poster presentation. **International Society of Psychoneuroendocrinology.** Zurich. September 2017.

7. **Bhopal S** & Kumar D. Integration of mental health into the SPRING home visits intervention trial. Centre for Global Mental Health. LSHTM. September 2017.

8. **Bhopal S** & Kirkwood B. SPRING cluster randomised controlled trial: promoting early child growth & development. Child development in the SDG era: what are the big implementation, measurement and research questions? MARCH Centre. LSHTM. May 2017.

9. Bhopal S. Early life stress of infants in the SPRING home visits intervention promoting child growth and development in rural India. Invited oral presentation. **Wellcome Trust Bloomsbury Centre for Global Health Research Scientific Meeting.** Mangochi, Malawi. March 2017.

10. Bhopal S, Verma D, Divan G, Hill Z, Barlow J, Roy R, Kirkwood B. Introducing Biological and Environmental Measures of Early Life Stress into the SPRING Home Visits Intervention Trial: Challenges and Solutions. Oral Presentation. **Academic Paediatrics Association of Great Britain & Ireland Annual Meeting.** Trinity College, Dublin. March 2017 **(prize for best presentation).**

11. Bhopal S, Verma D, Divan G, Hill Z, Barlow J, Roy R, Kirkwood B. Early life stress of infants in the SPRING home visits intervention promoting child growth and development in rural India. Poster presentation. **Research Degree Students Poster Day. London School of Hygiene & Tropical Medicine.** London, UK. February 2017.

12. Bhopal S, Verma D, Divan G, Hill Z, Barlow J, Roy R, Kirkwood B. Early life stress of infants in the SPRING home visits intervention promoting child growth and development in rural India. Poster presentation. **Academy of Medical Sciences Spring Meeting for Clinician Scientists in Training.** London, UK. February 2017.

13. Bhopal S. The Role of Early Life Stress in Early Child Development in Rural India: SPRING-ELS. Invited presentation. **Celebrating our success: Fellows' showcase**. London School of Hygiene & Tropical Medicine. London, UK. November 2016.

14. Bhopal S, Divan G, Avan B, Hill Z, Roy R, Barlow J, Patel V, Kirkwood B. The Role of Early Life Stress in Early Child Development in Rural India: SPRING-ELS. Poster presentation. **International Developmental Paediatrics Congress.** Istanbul, Turkey. November 2015.

Appendix 6: Training as part of this PhD

LSHTM Masters Modules (full registration)

- Epidemiology in Practice 2016-17 (20 credits; 60 contact hours)
- Extended Epidemiology 2016-17 (15 credits; 55 contact hours)
- Statistical Methods in Epidemiology 2016-17 (15 credits; 38.5 contact hours)
- Advanced Statistical Methods in Epidemiology 2016-17(15 credits; 48 contact hours)

LSHTM Short Courses and Transferable Skills Programme

- Advanced STATA 2016: Programming and other techniques to make your life easier (5 days)
- Introduction to Geographical Information Systems (GIS) and ArcGIS 2016 (2 days)
- Introduction to NVIVO 2016 (1 day)
- Staff Development Course 2017: Marking and Feedback (8 hours)

Other

- Bayley Scales of Infant and Toddler Development (2 days)
- National Institute for Health Research Paediatric Clinical Academics 2nd National Residential Training Weekend (2 days)
- British Medical Association Leadership Training (1 day)
- Royal College of Paediatrics & Child Health Media training (1 day)
- Royal College of Paediatrics & Child Health Parliamentary training (1 day)

Appendix 7: Data Collection Tools

The following tools were used in this PhD and are presented in this appendix.

1. **One Year Visit Form**
2. **ELS Questionnaire**
3. **PHQ9 (Patient Health Questionnaire-9)**
4. **Duke Social Support and Stress Scale**
5. **Observed Feeding Index**
6. **Home – Infant/Toddler**
7. **Samples and Anthropometry**
8. **18 Month Visit Form**
9. **Bayley Scales of Infant Development 3rd Edition**

Kilkaari 12 Month Outcome Assessment: 1 year visit form - Day 1

Identifying information		**Form type**
Cluster		CLUSTER
Village		VILLAGE
Household number		HH
Mother name	Husband name	
Child name	Child DOB & Sex (label only)	
Woman ID	# # # # #	WOMANID
Child ID	CHILD # # # # # #	CHILDID

Date of visit	d d - M M M - y y y y	DATEVISITD1	OA code		OACODED1
विज़िट की दिनांक	d d - M M M - y y y y	DATEVISITD1	JOA code		JOACODED1

SECTION A: Check whether assessment can go ahead today			
Please check that mother and child are both present and that the assessment can start	1. Yes	2. No	GOAHEADD1

If visit can go ahead then draw a line through next table and go to Section B.

If not possible to go ahead, stop the visit. Circle reasons below and inform your supervisor.

	Yes	No	
Mother not present	1	2	MOTHAWAYD1
Child not present	1	2	CHILDAWAYD1
Mother unwell	1	2	MOTHUNWELLD1
Child unwell	1	2	CHILDUNWELLD1
Family event	1	2	FAMEVENTD1
Other	1	2	OTHERD1
Specify event or other			SPECIFYNOGOD1

Say to mother: *"*I will try to come back another day. Please can I check with you in a few days to reschedule".

SECTION B: Check child's health			
Does your child have any of the following, or did they have it yesterday during the day or last night?			
	Fever	1. Yes 2. No	FEVER24HRD1
	Diarrhoea	1. Yes 2. No	DIARRHOEA24HRD1
	Vomiting	1. Yes 2. No	VOMIT24HRD1
	Cough	1. Yes 2. No	COUGH24HRD1
	Cold or runny nose	1. Yes 2. No	COLD24HRD1

If 'Yes' to any of these, please do not go ahead with saliva sampling. Say: "Because [child's name] has had [above condition] recently, we won't be able to take saliva samples. We will do everything else".

If answer is 'No' to all five of these, continue to Section C.

SECTION C: Check for steroid medication use	
Has [child's name] used steroid medications in the last 7 days? ***[Show card]*** 1. Yes 2. No	CHILDSTEROIDSD1

If yes – continue with visit but do not take saliva samples.
If no – continue with whole visit.

Section D: Work completion status

	Done	Not done						
		Consent refused	Refused this sample	Child too unsettled	Recent steroid use	Hair too short	Other reason (specify)	
Saliva 1	1	2	3	4	5		7	SALIVA1DONE
Saliva 2	1	2	3	4	5		7	SALIVA2DONE
Saliva 3	1	2	3	4	5		7	SALIVA3DONE
Hair	1	2	3	4		6	7	HAIRDONED1

	Done	Not done				
		Consent refused	Equipment problem	Child too unsettled	Other reason (specify)	
Weight	1	2	3	4	5	WEIGHTDONE
Length	1	2	3	4	5	LENGTHDONE

Anthropometry referral slip given	1. Yes 2. No	ANTHROREFSLIP

	Done	Not done							
		Consent refused	Mother not present	Family interrupted	Mother refused to answer	No mealtime took place	Child not yet eating food	Other reason (specify)	
HOMEIT	1	2	3	4	5			6	HOMEITDONE
OBS Feeding	1	2	3	4	5	7	8	6	OBSFEEDDONE
ELS Questionnaire	1	2	3	4	5			6	ELSQUSDONE

Instruction for Assessor: AT END OF VISIT COMPLETE FOLLOWING QUESTION ON PAGE 4

Hair sample to be taken on day 2? 1. Yes 2. No
Please double check if sample was taken on day 1 (See page 2). If not, try to take it today.

Day **2**

Date of visit	d d - M M M - y Y Y Y	DATEVISITD2	JOA code	JOACODED2

SECTION A: Check whether assessment can go ahead today			
Please check that mother and child are both present and that the assessment can start	1. Yes	2. No	GOAHEADD2

If visit can go ahead then draw a line through next table and go to Section B.

If not possible to go ahead, stop the visit. Circle reasons below and inform your supervisor.

	Yes	No	
Mother not present	1	2	MOTHAWAYD2
Child not present	1	2	CHILDAWAYD2
Mother unwell	1	2	MOTHUNWELLD2
Child unwell	1	2	CHILDUNWELLD2
Family event	1	2	FAMEVENTD2
Other	1	2	OTHERNOGOD2
Specify other			SPECIFYNOGOD2

Say to mother: *"*I will try to come back another day. Please can I check with you in a few days to reschedule".

SECTION B: Check child's health:			
Does your child have any of the following, or did they have it yesterday during the day or last night?			
	Fever	1. Yes 2. No	FEVER24HRD2
	Diarrhoea	1. Yes 2. No	DIARRHOEA24HRD2
	Vomiting	1. Yes 2. No	VOMIT24HRD2
	Cough	1. Yes 2. No	COUGH24HRD2
	Cold or runny nose	1. Yes 2. No	COLD24HRD2

If 'Yes' to any of these, please do not go ahead with saliva sampling. Say: "Because [child's name] has had [above condition] recently, I won't be able to take saliva samples. I will do the rest of the visit".

If answer is no to all five of these, continue to Section C.

SECTION C: Check for steroid medication use	
Has [child's name] used steroid medications in the last 7 days? ***[Show card]*** 1. Yes 2. No	CHILDSTEROIDSD2

If yes – continue with visit but do not take saliva samples.
If no – continue with whole visit.

Please double check if sample was taken on day 1 (See page 2). If not, try to take it today.
Hair sample to be taken on day 2? 1. Yes 2. No

Section D: Work completion status

	Done	Not done						
		Consent refused	Refused this sample	Child too unsettled	Recent steroid use	Done on Day 1	Other reason (specify)	
Saliva 4	1	2	3	4	5		7	SALIVA4DONE
Saliva 5	1	2	3	4	5		7	SALIVA5DONE
Saliva 6	1	2	3	4	5		7	SALIVA6DONE
Hair	1	2	3	4		6	7	HAIRDONED2

	Done	Not done					
		Consent refused	Mother not present	Family interrupted	Mother refused to answer	Other reason (specify)	
Complementary Feeding	1	2	3	4	5	6	COMPFEEDDONE
Maternal Knowledge	1	2	3	4	5	6	MATKNOWDONE
PHQ9	1	2	3	4	5	6	PHQ9DONE
Duke SSS	1	2	3	4	5	6	DUKESSSDONE

PHQ9 referral slip given	1. Yes 2. No	PHQ9REFSLIP

For office use only		
Hair length	☐☐ . ☐ cm	HAIRLENGTH
Hair length ok	1. Yes 2. No	HAIRLENGTHOK
Hair weight ok	1. Yes 2. No	HAIRWEIGHTOK
Sent to lab?	1. Sent 2. Discarded	HAIRSENTLAB
Supervisor Code	☐☐	HAIRSUPERVISOR

Kilkaari 12 Month Outcome Assessment: ELS Questionnaire

Identifying information		**Form type**
Cluster		CLUSTER
Village		VILLAGE
Household number		HH
Mother name	Husband name	
Child name	Child DOB & Sex (label only)	
Woman ID	# # # # #	WOMANID
Child ID	CHILD # # # # #	CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d / M M M / y y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify)	FORMSTATUS
Privacy	1. Possible 2. Not possible	PRIVACY
Twin	1. Yes 2. No	TWIN

Instruction to assessor: If there are other family members within hearing distance, ask mother-in-law or other senior family member politely if it is possible to go to a space to ask the woman some questions alone. If this is possible, go to that private space before asking the questions. If not, consider how best to conduct these questions privately. This may mean waiting for a suitable time later in the assessment.

Section A – MORS (Mothers Object Relations Scale)

Now I'd like to ask some questions which will help me learn about you and your child.

I'm going to start by reading you some statements. These statements reflect the fact that all children are different. There is no correct or ideal answer.

The first statement is: "My child smiles at me". Please can you give me an idea of how much this happens? ***[Point at 0-5 scale].*** Does it never happen ***[Point at 0]***? Does it happen nearly all the time ***[Point at 5]***? Or somewhere in the middle ***[Point at 1-4]***?

Never	Rarely	Sometimes	Quite often	Very often	Nearly all the time
0	1	2	3	4	5

Instruction to assessor: circle whichever number the respondent points to. If she points in between numbers, ensure she chooses one whole number and circle it. Repeat this procedure for each statement.

	Statement	Never	Rarely	Sometimes	Quite often	Very often	Nearly all the time	
A1	My child smiles at me	0	1	2	3	4	5	SMILES
A2	My child annoys me	0	1	2	3	4	5	ANNOYS
A3	My child likes doing things with me	0	1	2	3	4	5	LIKESDOING
A4	My child talks to me	0	1	2	3	4	5	TALKS
A5	My child irritates me	0	1	2	3	4	5	IRRITATES
A6	My child likes me	0	1	2	3	4	5	LIKES
A7	My child wants too much attention	0	1	2	3	4	5	ATTENTION
A8	My child laughs	0	1	2	3	4	5	LAUGHS
A9	My child gets moody	0	1	2	3	4	5	MOODY
A10	My child dominates me	0	1	2	3	4	5	DOMINATE
A11	My child likes to please me	0	1	2	3	4	5	PLEASE
A12	My child cries for no obvious reason	0	1	2	3	4	5	CRIES
A13	My child is affectionate towards me	0	1	2	3	4	5	AFFECTION
A14	My child winds me up	0	1	2	3	4	5	WINDSUP
A15	Compared to other children of the same age, how easy or difficult do you think [child's name] has been to take care of? ***[read options 1-3]***							CHCOMPARE
A16	1. Easier 2. Similar to other children	3. More difficult 4. Refuse to answer						CHCOMPARE

Section B – Infant

Now I'd like to ask you some questions about [child's name].

B1	Was [child's name] born early? 1. Yes 2. No 8. Don't know	BORNEARLY
B2	Where were they delivered? 1. Home 2. Dai's residence 3. Private hospital 4. Subcentre 5. Primary health centre 6. Community health centre 7. District hospital 10. On the way to facility	DELIVERYPLACE
B3	What type of delivery did you have? 1. Normal vaginal delivery 2. Forceps/ventouse delivery 3. Caesarian section without general anaesthetic 4. Caesarian section with general anaesthetic	DELIVERYMODE

B4	Did [child's name] have to stay overnight in a hospital during the first week of life because they were ill or needed medical care? 1. Yes 2. No					HOSPWK1
B5	***If no, draw line over this whole question***					
	B5.1 How many days was this stay in total?..... ☐☐					HOSPWK1DAYS
	B5.2 Did you or somebody who was close to [child's name] stay with them - all of the time, part of the time or not at all? 1. All the time 2. Part of the time 3. Not at all					HOSPWK1ACC
	Did they need any of the following treatments?		Yes	No	Don't know	
	B5.3	Warmer	1	2	8	WARMER
	B5.4	Incubator	1	2	8	INCUBATOR
	B5.5	Overhead lights	1	2	8	LIGHTS
	B5.6	Antibiotics by drip	1	2	8	ANTIBIOTIC
	B5.7	Blood transfusion	1	2	8	BLOODTRANS
	B5.8	Kangaroo Mother Care	1	2	8	KANGAROO
	B5.9	Feeding through tube in nose or mouth	1	2	8	FEEDINGNOSE
	B5.10	Feeding through vein	1	2	8	FEEDINGVEIN
	B5.11	Breathing through tube connected to machine (ventilator)	1	2	8	BREATHSUPPORT

B6	Did [child's name] get admitted to hospital any time after this? 1. Yes 2. No	HOSPADMIT
B7	***If 'no', write '99' in B7.1 and circle '9' in B7.2.***	
	B7.1 How many days was this stay in total?..... ☐☐	HOSPDAYS
	B7.2 Did you or somebody who was close to [child's name] stay with them all of the time, part of the time or not at all? 1. All the time 2. Part of the time 3. Not at all 9. Not applicable	HOSPACCOMP

B8	B8.1 What is the longest time you and [child's name] have been apart in days? ☐☐ **Enter '00' if a mother and child have never been apart or have been apart for just a few hours at a time and circle '9' in next question**	AWAYTIME
	B8.2 What was the main reason on this occasion? 1. Mother sick 4. Mother with relatives 8. Can't remember 2. Child sick 5. Mother's job or study 9. Not applicable 3. Child with relatives 6. Family emergency 10. Refuse to answer	AWAYREASON

B9	Sometimes adults taking care of children have to leave the house to go to the market, to go to work, to visit relatives or for other reasons and have to leave young children at home. In the past week on how many days was [child's name]:	
	B9.1 left alone for more than an hour?..... ☐	DAYSALONE1HR
	B9.2 left in the care of another child, that is, someone less than 10 years old, for more than an hour?..... ☐	DAYSCHILDCARER

B10	**If no older children live in the house, circle '9' (not applicable) for all**	
	B10.1 In the last week have any older children who live in the house played with [child's name]? 1. Yes 2. No 9. Not Applicable	OLDCHILDPLAY
	B10.2 In the last week have any older children who live in the house said anything to make [child's name] cry or make them unhappy 1. Yes 2. No 9. Not Applicable	OLDCHSAYABUSE
	B10.3 In the last week have any of these children hit/punched/kicked or bit [child's name] on purpose to make them unhappy? 1. Yes 2. No 9. Not Applicable	OLDCHPHYABUSE

B11 **If child is a boy, draw a diagonal line across whole table and go to next section.**		
If child is a girl, ask the following questions.		
B11.1	When you found out your baby was a girl were you happy, unhappy or didn't mind whether you had a girl or a boy? 1. Happy 2. Unhappy 3. Didn't mind 4. Refuse to answer 8. Don't know 9. Not Applicable	GIRLYOU
B11.2	And what about now? Are you happy she's a girl or do you wish that she was a boy? 1. Happy she is a girl 2. Wish was a boy 4. Refuse to answer 8. Don't know 9. Not Applicable	NOWGIRLYOU
B11.3	And what about your husband, how did he feel when he found out your baby was a girl? Was he happy, unhappy or didn't he mind whether you had a girl or boy? 1. Happy 2. Unhappy 3. Didn't mind 4. Refuse to answer 8. Don't know 9. Not Applicable	GIRLHUSB
B11.4	And what about now? Is he happy she's a girl or does he wish she was a boy? 1. Happy she is a girl 2. Wish was a boy 4. Refuse to answer 8. Don't know 9. Not Applicable	NOWGIRLHUSB
B11.5	And what about your mother, how did she feel when she found out – happy, unhappy or didn't mind? 1. Happy 2. Unhappy 3. Didn't mind 4. Refuse to answer 8. Don't know 9. Not Applicable	GIRLMOTH
B11.6	And what about now? Is she happy [child's name] is a girl or does she wish [child's name] was a boy? 1. Happy she is a girl 2. Wish was a boy 4. Refuse to answer 8. Don't know 9. Not Applicable	NOWGIRLMOTH
B11.7	And what about your mother in law, how did she feel when she found out – happy, unhappy or didn't mind? 1. Happy 2. Unhappy 3. Didn't mind 4. Refuse to answer 8. Don't know 9. Not Applicable	GIRLMIL
B11.8	And what about now? Is she happy [child's name] is a girl or does she wish [child's name] was a boy? 1. Happy she is a girl 2. Wish was a boy 4. Refuse to answer 8. Don't know 9. Not Applicable	NOWGIRLMIL

Section C – MOTHERS LIFE EVENTS

Now I would like to ask you about whether any of the following difficult situations have happened to you since you became pregnant with [child's name]?

C1	Have you become widowed, divorced or separated? 1. Widowed 2. Divorced/separated 3. No 4. Refuse to answer	WIDDIVSEP

C2	Since you became pregnant did any of the following people in your life die? ***[Read each option. If YES, ask whether this was during pregnancy or since child was born. Circle number in corresponding column. Circle 'both' (3) if two people died, one during pregnancy and the other after the child was born]***						
	Person		**During pregnancy**	**Since child born**	**Both**	**No**	
	C2.1	Your own parent	1	2	3	4	PARENTDIED
	C2.2	Your real brother or sister	1	2	3	4	SIBLINGDIED
	C2.3	Your child	1	2	3	4	CHILDDIED
	C2.4	Any other close family member	1	2	3	4	OTHERFAMDIED
	C2.5	Any close friend	1	2	3	4	FRIENDDIED

C3	Whilst you were pregnant, did <u>you</u> have any serious illness or have you been seriously injured? 1. Yes 2. No 3. Refuse to answer	ILLPREG
C4	And what about since [child's name] was born? Have <u>you</u> had a serious illness or have you been seriously injured? 1. Yes 2. No 3. Refuse to answer	ILLMOTHER
C5	And have <u>any close family members</u> had a serious illness or injury since [child's name] was born? 1. Yes 2. No 3. Refuse to answer	ILLCLOSEFAM

C6	Since you became pregnant, how well do you feel your family has been managing financially? ***[Read 1-5]*** 1. Living comfortably 2. Doing alright 3. Just about getting by 4. Finding it difficult to manage 5. Finding it very difficult to manage 6. Refuse to answer 8. Don't know	FINANCE
C7	Since you became pregnant, have you ever been hungry because you could not afford to buy food? 1. Yes 2. No 3. Refuse to answer	HUNGRY
C8	And what about [child's name]. Do they ever go hungry because you could not afford to buy food? 1. Yes 2. No 3. Refuse to answer	CHILDHUNGRY

C9	Since you became pregnant, have you or your immediate family who live with you been in debt? 1. Yes 2. No 3. Refuse to answer	FAMDEBT

If no, draw a line through C10

C10 What were the reasons for this debt? ***[circle '1' for all reasons mentioned, circle '2' if reason not mentioned. "Don't know" should only be selected if no other reason is mentioned.]***

	Reason	Mentioned	Not mentioned	
C10.1	Expenses around marriage	1	2	DEBTMARRIAGE
C10.2	Expenses after birth of child	1	2	DEBTCHILD
C10.3	Illness, medication, hospitalisation or operation	1	2	DEBTILLNESS
C10.4	Setting up new business	1	2	DEBTNEWBUSIN
C10.5	Purchasing items for home	1	2	DEBTHOMEITEMS
C10.6	Purchasing animal(s)	1	2	DEBTANIMAL
C10.7	House construction	1	2	DEBTCONSTRUC
C10.8	Crop failure	1	2	DEBTCROP
C10.9	No Employment	1	2	DEBTUNEMPLOY
C10.10	Don't know	1	2	DEBTNOREASON
C10.11	Other (please specify)	1	2	DEBTOTHER

C11 *Since becoming pregnant, can you tell me if you have been physically beaten, sexually abused or mistreated in another way by any of the following people?* ***[Read each option in turn and circle '1' or '2' to indicate 'Yes' or 'No' for each person named]***

	Person	Yes	No	Refuse to answer	
C11.1	Your neighbour	1	2	3	NEIGHBABUSE
C11.2	Your teacher	1	2	3	TEACHABUSE
C11.3	Your employer	1	2	3	EMPLOYABUSE
C11.4	A stranger	1	2	3	STRANGERMISTREAT
C11.5	Your sister	1	2	3	SISMISTREAT
C11.6	Your brother	1	2	3	BROMISTREAT
C11.7	Your sister in law	1	2	3	SISINLAWMISTREAT
C11.8	Your brother in law	1	2	3	BROINLAWMISTREAT
C11.9	Any other relative	1	2	3	RELATIVEMISTREAT
C11.10	Your mother in law	1	2	3	MOTHINLAWMISTREAT
C11.11	Your father in law	1	2	3	FILMISTREAT
C11.12	Your father	1	2	3	FATHMISTREAT
C11.13	Your mother	1	2	3	MOTHMISTREAT

Section D: Marriage

D1	What does / did ***(if widowed)*** your husband do? 1. At home 2. Paid employee outside the home 3. Self-employed e.g. tailoring 4. Farming from own land 5. Seasonally employed e.g working in the field 6. Casual labourer 8. Don't Know	HUSBOCC
D2	How old were you when you married your husband?..... ☐☐ ***Code completed years. 88=don't know***	MARRIAGEAGE
D3	Was this your first marriage? 1. Yes 2. No	FIRSTMARR
D4	***If married once, code '99'.*** How old were you at the time of your first marriage?..... ☐☐ ***Code completed years. 88=don't know***	AGEFIRSTMARR

IF HUSBAND HAS DIED DRAW A LINE THROUGH rest of section D and go to Section E.

D5	I want to ask about some difficult things that might have happened to you with your husband since you became pregnant. These questions are about things that happen to many women. Since you became pregnant has your husband…	***If "yes", ask:*** can you tell me how many times this has happened? Was it once, a few times or many times? ***[Circle number in appropriate column]***					
		Yes – Once	Yes – Few times	Yes – Many times	No	Refuse to answer	
D5.1	insulted you or made you feel bad about yourself?	1	2	3	4	5	INSULT
D5.2	belittled or humiliated you in front of other people?	1	2	3	4	5	BELITT
D5.3	done things to scare or intimidate you on purpose (e.g. by the way he looked at you, by shouting or smashing things)?	1	2	3	4	5	SCARE
D5.4	threatened to hurt you or someone you care about?	1	2	3	4	5	THREAT
D5.5	slapped you or thrown something at you that could hurt you?	1	2	3	4	5	SLAPP
D5.6	pushed you or shoved you or pulled your hair?	1	2	3	4	5	PUSH
D5.7	hit you with his fist or with something else that could hurt you?	1	2	3	4	5	HITFIST
D5.8	kicked you, dragged you or beaten you up?	1	2	3	4	5	KICKED
D5.9	choked or burnt you on purpose?	1	2	3	4	5	CHOKE
D5.10	threatened to use or actually used a gun, knife or other weapon against you?	1	2	3	4	5	GUN
D5.11	physically forced you to have sexual intercourse when you did not want to?	1	2	3	4	5	FORCESEX
D5.12	Since you became pregnant have you had sexual intercourse when you did not want to because you were afraid of what your husband might do?	1	2	3	4	5	SEXAFRAID
D5.13	Since you became pregnant has your husband forced you to do something sexual that you found degrading or humiliating?	1	2	3	4	5	SEXDEGRAD
D5.14	Since you became pregnant has your husband had a relationship with any other women? **if divorced/separated add:** whilst you were still together	1	2	3	4	5	HUSBSEXOTH

D6	Can I check if your husband takes any of the following substances?						
If mother answers yes, ask: does this cause any problems for you?		**No**	**Yes – doesn't cause problems**	**Yes – causes problems**	**Refuse to answer**	**Don't know**	
D6.1	Gutka or paan?	1	2	3	4	8	GUTKA
D6.2	Bidis or cigarettes?	1	2	3	4	8	BIDICIG
D6.3	Afim?	1	2	3	4	8	AFIM
D6.4	Ganja?	1	2	3	4	8	GANJA
D6.5	Injection?	1	2	3	4	8	INJECT
D6.6	Alcohol?	1	2	3	4	8	ALCOHOL

If husband does not drink alcohol, do not ask D7 & D8 and circle '9', not applicable				
D7	How often does he drink alcohol? Rarely, sometimes or often?			ALCOFT
	1. Rarely	3. Often	8. Don't know	
	2. Sometimes	4. Refuse to answer	9. Not applicable	
D8	How often do you see him drunk? Rarely, sometimes or often?			DRUNKOFT
	1. Rarely	3. Often	8. Don't know	
	2. Sometimes	4. Refuse to answer	9. Not applicable	

D9	***If divorced, circle '9' (not applicable).***			RELATDIFF
	All couples sometimes have difficulties in their relationships. On the whole, how satisfied are you with your relationship with your husband? Satisfied, somewhat satisfied or not satisfied?			
	1. Satisfied	3. Not satisfied	8. Don't know	
	2. Somewhat satisfied	4. Refuse to answer	9. Not applicable	

SECTION E: Home visits

Now I would like to ask you whether you have received any advice about your child's health and wellbeing from the following people? I am particularly interested in advice that has been given in your home.

	Have you had any visits from:		**Since you became pregnant, total number of home visits**	When was last the last visit?	
E1	ASHA worker?	1. Yes 2. No	☐☐	1. During last week 2. During last month but before last week 3. More than 1 month ago 9. Not applicable	ASHAYES ASHAVISITS ASHALAST
E2	ANM?	1. Yes 2. No	☐☐	1. During last week 2. During last month but before last week 3. More than 1 month ago 9. Not applicable	ANMYES ANMVISITS ANMLAST
E3	AWW?	1. Yes 2. No	☐☐	1. During last week 2. During last month but before last week 3. More than 1 month ago 9. Not applicable	AWWYES AWWVISITS AWWLAST
E4	Kilkaari worker using mobile phone to ask questions? [show picture card 1]	1. Yes 2. No	☐☐	1. During last week 2. During last month but before last week 3. More than 1 month ago 9. Not applicable	SFWYES SFWVISITS SFWLAST
E5	Kilkaari worker using a booklet with pictures like this [show picture card 2]?	1. Yes 2. No	☐☐	1. During last week 2. During last month but before last week 3. More than 1 month ago 9. Not applicable	KWYES KWVISITS KWLAST
E6a	Any other person?	1. Yes 2. No	☐☐	1. During last week 2. During last month but before last week 3. More than 1 month ago 9. Not applicable	OTHERYES OTHERVISITS OTHERLAST
E6b	Specify other people who made visits				TYPEOTHER

End: ***Thank you very much for answering these questions. I know some of them may have been difficult for you. That is all the questions I want to ask today.***

Note: IF LINE DRAWN ACROSS ANY TABLE, DATA ENTRY OPERATOR SHOULD CODE ALL ENTRIES AS 9 or 99 'not applicable'

Kilkaari 12 Month Outcome Assessment: Patient Health Questionnaire (PHQ-9)

Identifying information		**Form type**
Cluster		CLUSTER
Village		VILLAGE
Household number		HH
Mother name	Husband name	
Child name	Child DOB & Sex (label only)	
Woman ID	# # # # #	WOMANID
Child ID	CHILD # # # # # #	CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	D d - m m M - y Y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify)	FORMSTATUS
Privacy	1. Possible 2. Not possible	PRIVACY

For this questionnaire, I would like to discuss with you some problems that some people experience. For each problem, I would like you to tell me whether you have experienced it at all in the last two weeks and if so how much.

[Instruction to Assessor: Start by saying: "have you had any of the following problems in the last two weeks?" **then read statement 1. If the answer is 'no' then circle '0'. If yes, please say:** "was it 'nearly every day' - that means 12-14 days; or more than half the days (8-11 days) or just some days (1-7 days)?". **Then read each statement in turn and follow the same procedure.**

END OF ASSESSMENT: Instruction to Assessor: At the end of this questionnaire you will need to refer some mothers as follows depending on whether they score 20 or more:

Total score 20 or more and/or Question 9 answer is '3' 'nearly every day': based on what you've told me today I have come to know that you are very stressed and should be seen by a doctor. I will give you a referral slip. We suggest you go to the primary health centre or to a doctor and take this with you.

Total score 1-19: Thank you for sharing this information. This will help us to understand how common these sorts of problems are for women in this area.

	Have you had any of the following problems in the last two weeks?	Not at all	Some Days	More than half the days	Nearly every day	Variable Name
1.	Trouble falling or staying asleep or sleeping too much?	0	1	2	3	SLEEP
	Instruction to assessor: if mother is struggling to define a category, say: "I don't need the exact number, just an idea of which category – was it 'nearly every day'- that means 12-14 days, or more than half the days 8-11 days, or just some days (1-7 days)?". Repeat for all items as required.					
2.	Feeling tired or having little energy?	0	1	2	3	TIRED
3.	Poor appetite or overeating?	0	1	2	3	APPETITE
4.	Trouble concentrating on things, such as reading the newspaper or watching the television?	0	1	2	3	CONCENTR
5.	Little interest or pleasure in doing activities you enjoyed previously?	0	1	2	3	PLEASURE
6.	Feeling depressed, hopeless or low in mood?	0	1	2	3	DEPRESSED
7.	Feeling bad about yourself – or that you are a failure or have let yourself or your family down?	0	1	2	3	FEELBAD
8.	Moving or speaking so slowly that people could have noticed? Or being so restless that you move around a lot more than usual?	0	1	2	3	MOVING
9.	Thoughts that you would be better off dead, or of hurting yourself in some way?	0	1	2	3	SUIC
	ASK QUESTION 10 BEFORE DOING SCORING **Scoring (add the numbers circled in each column)**	**0**	+	+	+	
	Total score (add column scores) =					PHQSCORE

Instruction to assessor: If all responses are 0 (not at all), skip question 10. Then circle '9' (not applicable) and say: *"Thank you very much. I'm pleased to hear that you're not having any of these problems"*					
10. Considering the problems you have told me about, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people? ***[Read options]***					
0 Not difficult at all	1 Somewhat difficult	2 Very difficult	3 Extremely difficult	9 Not applicable (scored zero for all answers)	DIFFICULT

Instruction to assessor: Now go back to Page 1 'END OF ASSESSMENT' and follow instructions.

Kilkaari 12 Month Outcome Assessment: Duke Social Support and Stress Scale

Identifying information		**Form type**
Cluster		CLUSTER
Village		VILLAGE
Household number		HH
Mother name	Husband name	
Child name	Child DOB & Sex (label only)	
Woman ID	# # # # #	WOMANID
Child ID	CHILD # # # # # #	CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d - M M M - y y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify)	FORMSTATUS
Privacy	1. Possible 2. Not possible	PRIVACY

A: SUPPORT

Explain purpose of next set of questions: We are interested to know about the people who give personal support to you. These are people who are helpful, who listen to you, or who back you up when you are in trouble.

I will read out from a list of questions one by one and you have to decide how much each person (or group of persons) is supportive for you **nowadays in your life**. I would like you to tell me if the support they provide you is: none, some or a lot. If there is no such person in your life, please tell me.

Instruction to assessor: please circle number in appropriate column for each question.

Question		None (0)	Some (1)	A Lot (2)	There is no such person (9)	Variable Name
A1	Your husband	0	1	2	9	SUPHUSB
A2	Your children	0	1	2	9	SUPCHILD
A3	Your own parents or grandparents	0	1	2	9	SUPPARENT
A4	Your own brothers or sisters	0	1	2	9	SUPSIBLING
A5	Your other blood relatives (e.g., uncle, aunty, cousin)	0	1	2	9	SUPOTHBLOOD
A6	Your relatives by marriage (e.g., parents-in-law, sister or brother-in-law)	0	1	2	9	SUPINLAW
A7	Your neighbours	0	1	2	9	SUPNEIGH
A8	Your co-workers (such as job, labour, work in other person's field)	0	1	2	9	SUPCOWORK
A9	ASHAs in your village	0	1	2	9	SUPASHA
A10	AWWs/AW helper in your village	0	1	2	9	SUPAWW
A11	Kilkaari project workers in your village	0	1	2	9	SUPKILK
A12	ANMs in your area	0	1	2	9	SUPANM
A13	Workers from any other projects	0	1	2	9	SUPNGO
A14	People in any local community groups you are a member of (e.g., committees, panchayat, religious groups, prayer groups, self-help groups)	0	1	2	9	SUPCOMM
A15	Your other friends	0	1	2	9	SUPFRIENDS
A16a	Any other people		1	2	9	SUPPEOPLE
A16b	Please tell me who these other people are					SUPSPECIFY

A17	Is there any particular person whom you trust and to whom you can go with personal difficulties? **[If names more than one person – circle'1' 'yes' and ask mother to choose the one person who is most supportive]**	1. Yes 2. No	***If 2, circle '99' in A18 and go to Section B***	SUPPARTICPERS
A18	Please can you tell me the type of person this is. ***Instruction to assessor: Please circle relevant response (do not read list)***	1. Your husband 2. Your children 3. Your own parents or grandparents 4. Your own brothers or sisters 5. Your other blood relatives (e.g., uncle, aunty, cousin) 6. Your relatives by marriage (e.g., parents-in-law, sister or brother-in-law) 7. Your neighbours 8. Your co-workers (such as job, labour, work in other person's field) 9. ASHA 10. AWW/AW helper 11. Kilkaari project worker 12. ANM 13. Workers from any other projects 14. People in any local community groups you are a member of (e.g., committees, panchayat, religious groups, prayer groups, self-help groups) 15. Your other friends 16. Any other people 99. Not Applicable		SUPPARTICTYPE

B: STRESS

Now I would like to ask about people who cause you personal stress. A person who stresses you is one who causes problems for you or makes your life more difficult.

This time, for each type of person I would like you to tell me how much they cause stress for you **at this time in your life**: none, some or a lot. If there is no such person in your life, please tell me.

Instruction to assessor: please circle number in appropriate column for each question.

Question		None (0)	Some (1)	A Lot (2)	There is no such person (9)	Variable Name
B1	Your husband	0	1	2	9	STRESSHUSB
B2	Your children	0	1	2	9	STRESSCHILD
B3	Your own parents or grandparents	0	1	2	9	STRESSPARENT
B4	Your own brothers or sisters	0	1	2	9	STRESSSIBLING
B5	Your other blood relatives (e.g., uncle, aunty, cousin)	0	1	2	9	STRESSOTHBLOOD
B6	Your relatives by marriage (e.g., parents-in-law, sister or brother-in-law)	0	1	2	9	STRESSINLAW
B7	Your neighbours	0	1	2	9	STRESSNEIGH
B8	Your co-workers (such as job, labour, work in other person's field)	0	1	2	9	STRESSCOWORK
B9	ASHAs in your village	0	1	2	9	STRESSASHA
B10	AWWs/AW helper in your village	0	1	2	9	STRESSAWW
B11	Kilkaari project workers in your village	0	1	2	9	STRESSKILK
B12	ANMs in your area	0	1	2	9	STRESSANM
B13	Workers from any other projects	0	1	2	9	STRESSNGO
B14	People in any local community groups you are a member of (e.g., committees, panchayat, religious groups, prayer groups, self-help groups)	0	1	2	9	STRESSCOMM
B15	Your other friends	0	1	2	9	STRESSFRIENDS
B16a	Any other people		1	2	9	STRESSPEOPLE

B16b	Please tell me who these other people are			STRESSSPECIFY
B17	Do you have any particular person around you, who causes you stress now-a-days? **[If names more than one person – circle'1' 'yes' and ask mother to choose the one person who causes the most stress]**	1. Yes 2. No	***If 2, circle '99' in B18 and go to Ending***	STRESSPARTICPERS
B18	Please can you tell me the type of person this is? ***Instruction to assessor: Please circle relevant response (do not read list)***	1. Your husband 2. Your children 3. Your own parents or grandparents 4. Your own brothers or sisters 5. Your other blood relatives (e.g., uncle, aunty, cousin) 6. Your relatives by marriage (e.g., parents-in-law, sister or brother-in-law) 7. Your neighbours 8. Your co-workers (such as job, labour, work in other person's field) 9. ASHA 10. AWW/AW helper 11. Kilkaari project worker 12. ANM 13. Workers from any other projects 14. People in any local community groups you are a member of (e.g., committees, panchayat, religious groups, prayer groups, self-help groups) 15. Your other friends 16. Any other people 99. Not Applicable		STRESSPARTICTYPE

Ending:

Thank you. That is the end of this set of questions.

Kilkaari 12 month assessment: Observed Feeding Session

Identifying information		**Form type**
Cluster		CLUSTER
Village		VILLAGE
Household number		HH
Mother name	Husband name	
Child name	Child DOB & Sex (label only)	
Woman ID	# # # # #	WOMANID
Child ID	CHILD # # # # # #	CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d - M M M - y Y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify on ONEYRVISITFORM) 3. Child not yet feeding 4. No meal during day	FORMSTATUS
Start Time	h h : m m	TIMESTART
End Time	h h : m m	TIMEEND
Video Taken	1. Yes 2. No	VIDEORECORD
Video Consent taken	1. Yes 2. No	VIDEOCONSENT

Now that you're feeding [child's name] I am just going to sit at the side here and focus on my papers. Please ignore me and continue with your feeding as you usually do, and be as normal as possible. I know it's a bit strange but I'm going to be completely silent because I don't want to interrupt the feeding. Please don't worry about me, look at me or talk to me. I also won't talk to you during the meal.

Take your time with the meal, I'm not in any rush. Whenever you finish just do everything normally as I'll have some writing to do for 5 minutes after. We'll talk again after this is finished.

A1	***Were the child's hands washed before the meal started?***	1. Yes 2. No	CHILDWASH
A2	***Did the person feeding wash their hands before the meal started?***	1. Yes 2. No	MOTHWASH

Mouthfuls of food

B1. Self fed:		B2. Mother fed:	
□□□□□ □□□□□ □□□□□ □□□□□ □□□□□ □□□□□	SELFFED	□□□□□ □□□□□ □□□□□ □□□□□ □□□□□ □□□□□	MOTFED

SELF FEEDING

C1. Mother encourages or helps

✓				
0	1	2	3+	MOTSELFPOS

C2. Mother discourages or stops

✓				
0	1	2	3+	MOTSELFNEG

ENCOURAGEMENT

C3. Mother says things like 'eat, eat', 'chappati is nice', or 'you are so good' *(not in response to child's request – that would be C5)*

✓				
0	1	2	3+	MOTVERBALACTPOS

C4. Mother imitates feeding or plays positive food games

✓				
0	1	2	3+	MOTGAMESACTPOS

REACTING TO CHILD

C5. Mother responds positively to child's needs - for example when child indicates they want food, mother gives food. When child indicates food is too hot, mother makes it cooler.

✓				
0	1	2	3+	MOTRESPPOSNEEDS

C6. If child seems bored, says 'no' or tries to stop feeding: mother tries using a different positive strategy to keep child's interest

✓				
0	1	2	3+	MOTRESPPOSSTRATEGY

HARSHNESS

C7. Mother force feeds, holds child's head still to give food, shakes child, threatens child, uses an angry tone of voice, shouts or berates child

✓				
0	1	2	3+	MOTACTNEG

CHILD'S INTEREST IN FOOD

C8. Tries to get food by asking, pointing to food, reaching for food, touching food or opening mouth

✓				
0	1	2	3+	CHILDACTPOS

C9. Shows disinterest in having food, e.g says no, sticks out tongue, closes mouth, turns or moves away

✓				
0	1	2	3+	CHILDACTNEG

Instruction to Assessor: Turn over the page as meal is finishing

D1.	***Were any of the following true when meal ended?***		
	D1.1 Child consumed only a few mouthfuls throughout the meal	1. Yes 2. No	FEWMOUTHEND
	D1.2 Child refused food once and mother ended meal with no additional encouragement	1. Yes 2. No	REFUSED1XEND
	D1.3 Child refused last two mouthfuls	1. Yes 2. No	REFUSED2XEND
	D1.4 Meal ended because child was self-feeding and stopped independently	1. Yes 2. No	INDEPENDENTEND
	D1.5 All Food prepared for child was finished	1. Yes 2. No	FOODFINISHEDEND
	D1.6 Child looked for more food to eat after meal ended	1. Yes 2. No	STILLHUNGRY
D2	***Who was mainly in charge of feeding the child this meal?*** 1. Child's Mother 2. Child's Grandmother 3. Child's Father 4. Child's Brother 5. Child's Sister 6. Other Adult 7. Other Child		FEDCHILD

[Ask the next two questions when convenient for the mother]

D3	Why did you feed [child's name] at this time today? **[Do not read options]**	1. Food was ready 2. Other family members eating 3. Child hungry 4. Child always eats at this time 5. Because assessor wanted to see 6. Other – specify _____ 8. Don't know	WHYFEEDNOW
D4	Do you normally feed [child's name]? 1. Yes 2. No		TYPICALFEEDER
D5	Is this where [child's name] is normally fed? 1. Yes 2. No		TYPICALPLACE
D6	Is this the sort of food that [child's name] normally eats? 1. Yes 2. No **[If 'no' ask why not and specify below]**		TYPICALFOOD
	Specify: _____		TYPFOODSPECIFY

Thank you. I will just do a little bit more writing and be finished soon.

Junior Assessor should manage household environment until Outcome Assessor has completed section E.

SECTION E		
During the meal, did the mother and child talk about things apart from food, sing songs, touch each other, smile, look at each other, laugh?		
E1	**Mother** 1. Throughout the meal 2. Sometimes during the meal 3. Not at all	MOTLAUGHTALK
E2	**Child** 1. Throughout the meal 2. Sometimes during the meal 3. Not at all	CHILDLAUGHTALK
E3	**Did the mother stop feeding or leave the feeding place during the meal?** 1. Never or one time 2. Two or more times	MOTSTOPLEAVE
E4	**Did the mother give the child full attention during feeding?** 1. All the time or most of the time 2. Some of the time 3. Not at all	MOTFULLATTN

E5	***Did the child have their own plate or bowl?***	1. Yes 2. No	OWNPLATE
E6	***Approximately how many katoris of food did the child eat? Please circle the amount that they definitely finished.*** 1. Less than a quarter 4. Three quarters 7. One and a half 2. Quarter 5. One 8. One and three quarters 3. Half 6. One and a quarter 9. Two		KATORIS
E7	***Did any of the following people eat with the child?***		
	Child's Mother	1. Yes 2. No	EATWMOTHER
	Child's Grandmother	1. Yes 2. No	EATWGMOTHER
	Child's Father	1. Yes 2. No	EATWFATHER
	Child's Brother	1. Yes 2. No	EATWBROTHER
	Child's Sister	1. Yes 2. No	EATWSISTER
	Other Family Member	1. Yes 2. No	EATWOTHER
E8	***Was feeding done in one place or many places?*** 1. One place 2. Many places – mother following child around 3. Many places – mother moving child from place to place		FEEDPLACES
E9	***Record all the places in which the meal took place:***		
	E9.1 Inside a room in the house	1. Yes 2. No	FEEDHOUSE
	E9.2 Inside the courtyard or on the verandah (paved floor)	1. Yes 2. No	FEEDPAVED
	E9.3 Inside the courtyard or on the verandah (mud or dust floor)	1. Yes 2. No	FEEDMUD

E10	***Which of the following food items were <u>offered</u> to the child?***		
E10.1	Roti / chappati	1. Yes 2. No	OBSCHAPPATI
E10.2	Rice	1. Yes 2. No	OBSRICE
E10.3	Sabzi – first type	1. Yes 2. No	OBSSABZI1
E10.4	Sabzi – second type	1. Yes 2. No	OBSSABZI2
E10.5	Daal	1. Yes 2. No	OBSDAAL
E10.6	Cudhi	1. Yes 2. No	OBSCUDHI
E10.7	Dalia	1. Yes 2. No	OBSDALIA
E10.8	Khichdi	1. Yes 2. No	OBSKICHIDI
E10.9	Uncooked vegetables	1. Yes 2. No	OBSVEGRAW
E10.10	Uncooked fruit	1. Yes 2. No	OBSFRUITRAW
E10.11	Yoghurt	1. Yes 2. No	OBSYOGHURT
E10.12	Eggs	1. Yes 2. No	OBSEGGS
E10.13	Meat	1. Yes 2. No	OBSMEAT
E10.14	Fish, prawns or seafood	1. Yes 2. No	OBSFISH
E10.15	Other – specify: _____		OBSOTHERFOOD1
E10.16	Other – specify: _____		OBSOTHERFOOD2
E10.17	Other – specify: _____		OBSOTHERFOOD3

Kilkaari 12 month outcome assessment: HOMEIT

Identifying information		**HOMEIT**
Cluster		CLUSTER
Village		VILLAGE
Household number		HH
Mother name	Husband name	
Child name	Child DOB & Sex (label only)	
Woman ID	# # # # #	WOMANID
Child ID	CHILD # # # # #	CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d - M M M - y y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify on 1 YR VISIT FORM)	FORMSTATUS
Privacy	1. Possible 2. Not possible	PRIVACY
Start Time	h h : m m	TIMESTART
End Time	h h : m m	TIMEEND

NOTE: If the respondent is not the mother of the child ask for the mother. If she cannot be available then stop the interview and reschedule the interview. Only continue if the respondent is the mother of the child. Make sure that child is awake and likely to be awake for the next hour.

Instructions for the Assessor

There are four types of assessment procedures in HOME: I, O, O* and E, following are the details:

TYPE	INSTRUCTIONS
I: Interview	Ask questions as written
O: Observation	Circle as soon as observed
O*: Observe throughout, circle at end	Circle before asking questions for 'E' items.
E: Either	Circle as soon as observed – if not seen during observation period, ask mother questions to check – see Question Guide. After asking mother, make sure to observe item before circling 'Yes'.

There are three sections – A, B & C. Start the HOME assessment by asking the questions about caregivers in section A and then starting the interview items. You should mark answers to observation items in Section B. Section C is a question guide for asking about 'Either' items.

Start the HOME assessment by asking the questions in section A. Take your time – you should aim to spend about an hour chatting to the mother and observing her and the child.

Throughout the assessment, don't forget to keep observing and circle observations on their respective items.

Section A: Interview

Now I am going to ask you some questions. This is to find out more about you and [child's name]. I need [child's name] to be around whilst we talk. so please try to keep them near you. Shall we start?

Section A1: Caregiver Information

Please tell me who all in the house help you in looking after and taking care of [child's name]?

[Instruction: Circle '1', 'yes' for all the people the mother reports]

Paternal		Var	Maternal		Var
Dadi (Grandmother)	1. Yes 2. No	HELPGRANMDADI	Nani (Grandmother)	1. Yes 2. No	HELPGRANMNANI
Pita (Father)	1. Yes 2. No	HELPFATHERPITA	Nana (Grandfather)	1. Yes 2. No	HELPGRANFNANA
Dada(Grandfather)	1. Yes 2. No	HELPGRFDADA	Maami (Aunt)	1. Yes 2. No	HELPAUNTMAAMI
Bua (Aunt)	1. Yes 2. No	HELPAUNTBUA	Maasi (Aunt)	1. Yes 2. No	HELPAUNTMAASI
Chachi (younger aunt)	1. Yes 2. No	HELPAUNTCHACHI			
Taai (elder aunt)	1. Yes 2. No	HELPAUNTTAAI	**OTHERS OR NO-ONE**		
Chacha (younger uncle)	1. Yes 2. No	HELPUNCCHACHA	Others (specify)	1. Yes 2. No	HELPOTHER
Tau (elder uncle)	1. Yes 2. No	HELPUNCLETAU	Nobody helps the mother	1. Yes 2. No	HELPNOBODY

If '0-3 people mentioned', draw a diagonal line over next table and start interview with item 1.

Now please tell me up to three people who most significantly help you in looking after and taking care of [child's name]?

[Instruction: Circle '1', 'yes' for up to three people mother reports]

Paternal		Var	Maternal		Var
Dadi (Grandmother)	1. Yes 2. No	MHELPGRANMDADI	Nani (Grandmother)	1. Yes 2. No	MHELPGRANMNANI
Pita (Father)	1. Yes 2. No	MHELPFATHERPITA	Nana (Grandfather)	1. Yes 2. No	MHELPGRANFNANA
Dada(Grandfather)	1. Yes 2. No	MHELPGRFDADA	Maami (Aunt)	1. Yes 2. No	MHELPAUNTMAAMI
Bua (Aunt)	1. Yes 2. No	MHELPAUNTBUA	Maasi (Aunt)	1. Yes 2. No	MHELPAUNTMAASI
Chachi (younger aunt)	1. Yes 2. No	MHELPAUNTCHACHI			
Taai (elder aunt)	1. Yes 2. No	MHELPAUNTTAAI			
Chacha (younger uncle)	1. Yes 2. No	MHELPUNCCHACHA	**OTHERS**		
Tau (elder uncle)	1. Yes 2. No	MHELPUNCLETAU	Others (specify)	1. Yes 2. No	MHELPOTHER

Section A2: HOME-IT Interview Questions				
		Yes	**No**	
H1	Children of [child's name]'s age can be difficult to manage. Sometimes they love to play in things that get them all messy and dirty—mud, water, their food, and so on. Is [child's name] allowed to do this? **[Instruction: Circle '1', 'yes' if child ever allowed to do this]**	**1**	**2**	MESSYPLAY
H20	Do you spend time away from your child outside of the home? **[wait for response]** **[If no-probe] Has this ever happened?** **[If so]** Who takes care of [child's name] for you when you're away? **[Probe: anyone else?]** **Tally** □ □ □ **[Instruction: Circle '1', 'Yes' if 1-3 carers are named or the mother never leaves the child]**	**1**	**2**	MAX3SUBCARER
H21	Could you please tell me if [child's name] is taken to a grocery shop, vegetable shop or market, or sweet shop **(Indian sweets)** at least once a week? **[Instruction: circle '1', 'yes' if child taken to a grocery shop, vegetable shop or market, or sweet shop at least once a week]**	**1**	**2**	MIN1SHOPWK
H22	Please can you tell me about some places outside the house that [child's name] is taken to? **[Wait for answer]** In a week, roughly how often is [child's name] taken to these places? **[Instruction: Circle '1', 'yes' if child taken outside household premises 4 times per week or more]**	**1**	**2**	MINOUTSIDE4WK
H23	Has [child's name] been taken regularly for checkups or vaccinations?	**1**	**2**	REGCHECKUP
H35	When you do housework do you concentrate entirely on it, or do you sometimes make conversation with [child's name] as you do your work?	**1**	**2**	HWORKTALK
H36	What are some of the things you and other caregivers try to teach child to do that could help in their development **[Instruction: circle '1', 'yes' if mother mentions 1 thing. Examples include holding the child's hand and teaching them to walk, pointing and naming objects or body parts, counting, helping them play new games, encouraging new things and then praising]**	**1**	**2**	ENCOURDMENT

H37	How do you or other caregivers get [child's name] to play with a toy that you think is good for them to learn something new from? **[Instruction: Circle '1' for 'yes' if mother gives at least one positive strategy]**	**1**	**2**	ATTNMATTOYS
H38	Does [child's name] ever go from playing happily to getting bored, maybe whining or crying? If this happens what do you or other caregivers do to encourage them to play more? **[Instruction: Circle '1', 'yes' if mother mentions at least one 1 strategy. For example, showing different ways to play with a toy]**	**1**	**2**	GUIDEPLAY
H39	Have you or other caregivers recently provided toys that you thought were too difficult for them?	**1**	**2**	DIFFICULTTOYS
H41	Does child's father or father figure help with looking after [child's name]? **[Only if yes]** Does he do this every day? How long for each day? **[Instruction: Circle '1', 'yes' if father or father-figure cares for child at least once daily for 15 minutes or more]**	**1**	**2**	FATHCAREDAILY
H42	Do you or other caregivers read any children's storybooks or magazines to [child's name]? **[If yes]** how many times each week would you say you or another caregiver do this? **[Instruction: circle '1', 'yes' if 3 or more times weekly, otherwise circle '2' 'no']**	**1**	**2**	READMIN3WK
H43	Do you, [child's name] and child's father or father-figure ever eat together? **[if yes]** How often is this? **[Instruction: circle '1', 'yes' if mother, father or father figure and child eat at least one meal together daily]**	**1**	**2**	ALLEATDAILY
H44	How often do you go and see your relatives and friends (and take your child) and how often do they visit you? Would you say it's once a month or less often than this? **[Instruction: Circle '1', 'yes' if visits are at least once a month]**	**1**	**2**	RELATVISIT1MTH
H12	Of course, babies don't always do what we want them to do. We know some parents and caregivers punish their children by doing things like grabbing, shaking, slapping, ear pulling, tossing onto the bed or sofa, or poking with a finger. In the last week did you or other caregivers have to do these things? **[If yes]** How many times? **[Instruction: Circle '1', 'Yes' if 0 or 1 time]**	**1**	**2**	MAX1PUNISHXWK

SECTION B: HOME-IT Checklist Table

TYPE	INSTRUCTIONS
O	**mark as soon as observed**
O*	**mark at end of assessment**
E	**Either items (mark as soon as observed – if not seen during observation period, ask mother questions to check – see next page)**

		Yes	No	
I. RESPONSIVITY		हाँ	नही	
H1: INTERVIEW ITEM – SEE SECTION A				
H2 **O**	*Mother spontaneously vocalises to the child at least twice.* **[Instruction: Circle '1', 'Yes' if mother speaks or makes sounds towards the child without any reason at least twice. Negative vocalization such as scolding are not included]** Tally □ □	**1**	**2**	SPONTANVOC
H3 **O**	*Mother responds verbally to the child's sounds or words* **[Instruction: Circle '1', 'yes' if mother responds using sounds or words when the child makes sounds or words]**	**1**	**2**	VERBRESPOND
H4 **O**	*Mother tells child name of object or person during assessment* **[Instruction: Circle '1', 'yes' if mother tell name of a person such as aunty or sister, or name of any object such as banana or a piece of furniture]**	**1**	**2**	NAMEOBJECT
H5 **O**	*Mother's speech is distinct, can be heard clearly and is easily understandable*	**1**	**2**	SPEECHCLEAR
H6 **O**	*Mother initiates conversation with the assessor* **[Instruction: Circle '1', 'yes' if mother asks questions, makes spontaneous comments or explains or elaborates something]**	**1**	**2**	INITIATINTERAC
H7 **O**	*Mother converses freely and easily*	**1**	**2**	CONVERSEEASE
H8 **O**	*Mother spontaneously praises child at least twice* **[Instruction: Circle '1', 'yes' if mother praises the child such as by clapping, saying "well done" or saying with pride "my child has started walking" or "my child has a good disposition" for example]** Tally □ □	**1**	**2**	TWOSPONTPRAIS
H9 **O**	*Mother's voice conveys positive feelings towards child* **[Instruction: Circle '1', 'yes' if mother sounds pleased or happy with child]**	**1**	**2**	VOICEPOSITIVE
H10 **O**	*Mother caresses or kisses child at least once* **[Instruction: Caresses include hugs or stroking affectionately parts of child's body]**	**1**	**2**	CARESSKISS
H11 **O**	*Mother responds positively when the assessor praises the child* **[Instruction: Give praise such as "oh your child is walking already" or "your child has beautiful eyes" or "your child smiles a lot". Circle '1', 'yes' if mother responds positively by smiling, nodding, or agreeing with these comments]**	**1**	**2**	PRAISEPOSRESP

II. ACCEPTANCE		**Yes**	**No**	
H12: INTERVIEW ITEM – SEE SECTION A				
H13 **E**	Family has a pet **Question if not seen:** Are there any animals that your family look after, and that [child's name] can look at or play with?	**1**	**2**	FAMILYPET
H14 **O**	*Mother does not shout at child* **[Instruction: Circle '1' 'yes' if mother does not shout or raise her voice]**	**1**	**2**	NOSHOUT
H15 **O**	*Mother does not express overt annoyance with or hostility to child* **[Instruction: circle '1', 'yes' if for example mother does not complain that the child is difficult to take care of]**	**1**	**2**	NOANNOYANCE
H16 **O**	*Mother neither slaps nor spanks child during assessment*	**1**	**2**	NOSLAPSPANK
H17 **O**	*Mother does not scold or criticize child during assessment*	**1**	**2**	NOSCOLD
H18 **O**	*Mother does not interfere with or restrict child more than three times during assessment* **[Instruction: This does not include when mother tries to protect child from harm. Circle '1', 'yes' if 0-3 times. Circle '2', 'no' if 4 or more times]** **Tally** □ □ □ □		**2**	MAX3RESTRICT
H19 **E**	At least ten books are present and visible **[Instruction: Include books belonging to the child, older children and adults. These must be visible to the assessor]** **Question if not seen:** Do you have books in the house? Please can you show me them?	**1**	**2**	MIN10BOOKS
III. ORGANIZATION		**Yes**	**No**	
H20 – H23: INTERVIEW ITEMS – SEE SECTION A				
H24 **E**	Child has a special place to keep toys **[Instruction: The special place needs to include the child's ability to either physically access the toys or point to them]** **Question if not seen:** Where do you keep most of [child's name]'s toys? Please can you show me?	**1**	**2**	SPECIATOYPLAC
H25 **O***	Place where child plays is safe	**1**	**2**	SAFEENVIRON

IV. LEARNING MATERIALS			Yes	No	
H26 E	Toys which require the use of arms or legs, for example: jhunjhuna (rattle), walker, a walker made of wood which the child pushes while walking, a ball which a child crawls towards, rocking horse, pull and go vehicle, corn popper etc. **Question if not seen:** Does [child's name] have any toys which require the use of 'hands or legs', for example: a jhunjhuna (rattle), a walker, a walker made of wood which the child pushes while walking, a ball which a child crawls towards, rocking horse, pull and go vehicle or a corn popper? Please can you show me?		**1**	**2**	MUSCTOYS
H27 E	Push or pull toys such as a string attached to an object or a chair for pushing **Question if not seen:** Are there any toys which [child's name] can push or pull? Maybe a string attached to an object or a chair for pushing?		**1**	**2**	PUSHPULLTOY
H28 E	Stroller, car for riding on, walker with wheels, scooter, tricycle **Question if not seen:** Does [child's name] have a stroller, a walker with wheels, a car for riding on, or any scooter or tricycle? Please can you show me?		**1**	**2**	STROLLCAR
H29 E	Cuddly toys or those with which one can play imaginative or imitating games **[Instruction: Examples includes teddy bear, doll, soft toys such as dog, cat, lion or kitchen set]** **Question if not seen:** Does [child's name] have cuddly toys or toys for playing imaginative or imitating games? I'm thinking of things like a teddy bear, a doll, soft toys like a dog, cat, lion, or maybe a kitchen set.		**1**	**2**	CUDDLYTOY
H30 E	Equipment that helps child's learning - hanging mobile, a child's table & chair, high chair, special rug/floor mat, patchwork rug, low height cot **Question if not seen:** Do you have any equipment which you use to help [child's name] learn? I'm thinking of a hanging mobile, a child's table and chair set, a high chair, or a special rug, floor mat, patchwork rug or low height cot - which is specifically used for [child's name] to play.		**1**	**2**	LEARNEQUIP
H31 E	Simple hand-eye coordination toys for example: small balls, marbles, blocks or colourful rings for stacking, a container for putting things in, or cups for stacking or pouring **Question if not seen:** Do you have any small toys to help [child's name] learn to use their hands well? I'm thinking of small balls, marbles, blocks or colourful rings for stacking, a box for putting things in or cups for stacking or pouring		**1**	**2**	HANDEYEEASY
H32 E	Difficult hand-eye coordination toys for example: lego bricks, jigsaws or shape sorter puzzles **Question if not seen:** Do you have any small toys to help [child's name] learn to use their hands in a more difficult way? I'm thinking of things like lego bricks, jigsaws or shape sorter puzzles?		**1**	**2**	HANDEYEHARD
H33 E	a. At least one literature toy for example: book or speaking book on CD, cassette, MP3 or mobile phone, picture book or books with illustration based stories **Question if not seen:** Do you have any books, or speaking books on CD, cassette, MP3 or mobile phone, picture book or books with illustration based stories?	☐	**1**	**2**	LITMUSICTOY
	b. At least one toy for music, example: toy instrument that a child can play (harmonium/casio/piano), child is allowed to choose music on mobile phone, radio or CD player, talking doll. **[Instruction: only circle '1', 'Yes' if H33a and H33b both ticked]** **Question if not seen:** Do you have any musical toys for [child's name]? I'm thinking of a toy instrument (harmonium/casio/piano) that the child can play, or maybe your child is allowed to choose music on the mobile phone, radio or CD player or has a talking doll?	☐			
H34 O*	*Mother provides toys for child to play with throughout assessment*		**1**	**2**	TOYSALLTIME

V. INVOLVEMENT		**Yes**	**No**	
H35 – H39: INTERVIEW ITEMS – SEE SECTION A				
H40 **O***	*Mother keeps child within visual range and looks at often*	**1**	**2**	VISUALRANGE
VI. VARIETY		**Yes**	**No**	
H41 – H44 INTERVIEW ITEMS – SEE SECTION A				
H45 **E**	Child has three or more books of their own **[Instruction: If 3 or more circle '1', 'Yes'. If 0-2 circle '2', 'No']** **Question if not seen:** Does [child's name] have any books that are completely their own? About how many?	**1**	**2**	OWN3BOOKS

Kilkaari 12 Month Assessment: Saliva & Hair Samples and Anthropometry - Day 1

Identifying information			**Form type**
Cluster			CLUSTER
Village			VILLAGE
Household number			HH
Mother name		Husband name	
Child name		Child DOB & Sex (label only)	
Woman ID			WOMANID
Child ID	CHILD #		CHILDID

Date of visit	d d - M M M - y y y y	DATEVISIT

	Saliva 1		**Saliva 2**		**Saliva 3**	
Last food/milk time	h h : m m	S1LASTFOOD	h h : m m	S2LASTFOOD	h h : m m	S3LASTFOOD
Last wake time	h h : m m	S1LASTWAKE	h h : m m	S2LASTWAKE	h h : m m	S3LASTWAKE
Time taken	h h : m m	S1TIME	h h : m m	S2TIME	h h : m m	S3TIME
Sample ID	Affix label	SALIVA1ID	Affix label	SALIVA2ID	Affix label	SALIVA3ID
Assessor Code		S1ASSESSOR		S2ASSESSOR		S3ASSESSOR

Hair sample					
h h : m m	D1HAIRTIME	Affix label	D1HAIRID		D1HAIRASSESSOR

MEASUREMENT	RECORDING			Variable Name
वज़न	If it is not possible to weigh the child undressed: first weigh dressed and write the weight in A below. Then weigh the clothes separately and write the weight in B below. Finally subtract B from A and write this weight in C. If it is possible to weigh the child unclothed: draw a line through A and B below and write the weight in C.			
	A. **कपड़ों के साथ वज़न**	.	**Kg**	WEIGHTDRESSED12M
	B. **कपड़ों का वज़न**	.	**Kg**	WEIGHTCLOTHES12M
	C. **सही वज़न**	.	**Kg**	WEIGHT12M
लम्बाई		.	**cm**	LENGTH12M
	OA Code	OACODE	JOA Code	JOACODE

Check for low weight and low length for boys and girls in the following table and complete the questions:

	Boy	***Girl***			
Weight	***6.900 Kg***	***6.300 Kg***	Is child's weight low for their sex?	1. Yes 2. No	WEIGHT12MREFER
Length	***68.6 cm***	***66.3 cm***	Is child's length low for their sex?	1. Yes 2. No	LENGTH12MREFER

If either answer is yes, say *"I have measured your child and their* ***[length/weight/length & weight]*** *is lagging behind compared to what this ought to be for a 12 month old. Your baby needs to be seen by a doctor. I will give you a referral slip – please take your child with this slip to the District Hospital in Rewari.*
Now complete and give a referral slip to mother.

Kilkaari 18 Month Outcome Assessment: 18 month BSID visit form

Identifying information	**18MONTHBSIDVISIT**	AW:	BATCHNO
Cluster			CLUSTER
Village			VILLAGE
Household No			HH
Mother name		**Husband Name**	
Child name		**Child DOB & Sex**	&
Twin	-------- **Woman ID**	# # # #	WOMANID
	Child ID	CHILD # # # # #	CHILDID

Date of visit	d d - M M M - y y y y	DATEVISIT	Primary Assessor Code	PACODE

SECTION A: Check whether assessment can go ahead today			
Please check that mother and child are both present and that the assessment can start	1. Yes	2. No	GOAHEAD

If visit can go ahead then draw a line through next table and go to Section B.
If not possible to go ahead, stop the visit. Circle reasons below and inform your supervisor.

	Yes	No	**Variable Name**
Mother not present	1	2	MOTHAWAY
Child not present	1	2	CHILDAWAY
Mother unwell	1	2	MOTHUNWELL
Child unwell	1	2	CHILDUNWELL
Child sleeping	1	2	CHILDSLEEP
Family event	1	2	FAMEVENT
Other	1	2	OTHER
Specify event or other			SPECIFYNOGO

Say to mother: *"*I will try to come back another day. Please can I check with you in a few days to reschedule".

Section B: Work completion status

	Done	**Not done**					**Variable Name**
		Consent withdrawn	**Child too unsettled**	**Child too tired**	**Mother/family refused to continue**	**Other reason (specify)**	
Fine Motor	1	2	3	4	5	6	FINEDONE
Cognitive	1	2	3	4	5	6	COGNITIVEDONE
Receptive language	1	2	3	4	5	6	RECEPTIVEDONE
Expressive language	1	2	3	4	5	6	EXPRESSIVEDONE
Gross Motor	1	2	3	4	5	6	GROSSDONE
Social Emotional	1	2	3	4	5	6	SOCIALEMODONE

BSID referral	1. Yes 2. No	BSIDREF

	Done	Not done				Variable Name
		Consent withdrawn	Equipment problem	Child too unsettled	Other reason (specify)	
Weight	1	2	3	4	5	WEIGHTDONE
Length	1	2	3	4	5	LENGTHDONE

MEASUREMENT	RECORDING						Variable Name
	If it is not possible to weigh the child undressed: first weigh dressed and write the weight in A below. Then weigh the clothes separately and write the weight in B below. Finally subtract B from A and write this weight in C. If it is possible to weigh the child unclothed: draw a line through A and B below and write the weight in C.						
Weight	A. Child's Weight with clothes						WEIGHTDRESSED18M
	B. Weight of clothes						WEIGHTCLOTHES18M
	C. Actual weight						WEIGHT18M
Length							LENGTH18M
	OA1 Code		OA1CODE		OA2 Code		OA2CODE

Check weight and length against the values in the following table.
Answer YES if the measurement is the same as or lower than the value in the table – use the column for boy or girl as appropriate.

	Boy	*Girl*
Weight	***7.800 Kg***	***7.200 Kg***
Length	***74.2 cm***	***72.0 cm***

Is child's weight low for their sex?	1. Yes 2. No	WEIGHT18MREFER
Is child's length low for their sex?	1. Yes 2. No	LENGTH18MREFER

If either answer is yes, say *"I have measured your child and their* ***[length/weight/length & weight]*** *is lagging behind compared to what this ought to be for a 18 month old. Your baby needs to be seen by a doctor. I will give you a referral slip – please take your child with this slip to the Doctor in Rewari.*
Now complete and give a referral slip to mother.

Anthropometry referral	1. Yes 2. No	ANTHROREF

SPRING 18 Months Assessment: Bayley Scales of Infant and Toddler Development-III
Motor Scale: Fine

Identifying information	**FINEMOTOR**		AW:	BATCHNO
Cluster				CLUSTER
Village				VILLAGE
Household No				HH
Mother name		Husband Name		
Child name		Child DOB & Sex	&	
Twin	-------- Woman ID	# # # #		WOMANID
	Child ID	CHILD # # # # #		CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d - M M M - y y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify on 18MONTHVISIT FORM)	FORMSTATUS
Supervisor Code (If present)		SUPERVISOR

Say to the mother (caregiver): "Hello! As you already know, we are here to spend some time with [Child's Name]. Today, we will be playing some games with them. Does the child have any nick name that everybody calls them with? We want to see how [Child's name] does different kinds of activities. This may take about 2 hours.

Please remember that this is not a test and we want to see how best your child does by themselves.

You may sit next to the [Child's Name] but do not tell them how to do things or make them do anything by holding their hands or by pushing them. We will ask you when we need your help. We are not here to see what [Child's Name] cannot do but what they can do. We understand that the child may not do some things in front of us that they usually do as we are not known to the child. If they are not able to do a certain activity, do not worry. Let them do things the way they want to.

We will need a separate room to play these games. We would also like to request that no other family member or children are there when we are playing with [Child's Name] as it may distract them. Can we start?

START THE ASSESSMENT AT ITEM 28 ITEMS 22-27 will be completed depending on RESPONSES TO ITEMS 28-30 (as explained later on page 4 after item 30)			
Item no.	**Fine Motor**	**Score**	**Variable Name**
***I** **22**	**Holds Block: Block without holes** **Place the block without hole directly in front of the child, within their reach.** Allow the child time to reach for the block. If they don't reach – place it in their hand and allow them time to gain interest. Once child is interested, try again. **Child uses the pad of their thumb and a fingertip** to grasp the block	**0 1**	BFM22
23	**Brings block or spoons to midline: Blocks without holes or spoons** **Hold either a block without hole** (**or spoon**) **in each of your hands and bang together.** Offer the two blocks (or spoons) to the child and invite them to copy you. Watch the child. Child **brings the blocks (or spoons) together at their midline** (Note: midline is imaginary vertical line between the right and left hand sides of the body)	**0 1**	BFM23
24	**Holds food pellet** **Place the food pellet 8-10 inches from the edge of the table, in front of the child.** Attract the child's attention to the pellet. Child grasps the pellet so that the **thumb is at least partially opposed** to the fingers or fingertips	**0 1**	BFM24
25	**Lifts cup by handle: Cup with handle** **Place the cup within the child's reach– with handle pointing to child.** Allow time for them to pick up the cup. Child lifts cup **by the handle** using **one hand**	**0 1**	BFM25
***J** **26**	**Holds Food pellet** **Place the food pellet 8-10 inches from the edge of the table, in front of the child.** Attract the child's attention to the pellet. Child uses **pads of the thumb and any fingertip** to grasp the pellet	**0 1**	BFM26
27	**Turns pages of book: Picture book** **Place book in front of child.** Open to the first page and encourage them to hold it, turn the pages and look at the pictures. You can help them to hold the book and can demonstrate turning pages. Child **attempts to turn a page**, even if the effort is clumsy and they don't manage to turn the page completely	**0 1**	BFM27

START THE ASSESSMENT HERE

Item no.	Fine Motor	Score	Variable Name
*K/L 28	**Grasp: Crayons and sheet of paper** **Place sheet of blank paper on the table, in front of the child. Place one crayon or pencil in the middle of the paper.** Encourage the child to make marks on the paper. If the child does not grasp the crayon or pencil, you can demonstrate how to make marks on the paper using a second crayon or pencil. **Observe how the child grasps crayon and makes mark on the paper:** Circle type of grasp in table below and enter number in BFM-GRASP. Complete codes for items BFM28, BFM34, BFM37 & BFM48 as indicated	☐	BFM_ GRASP
	0 1		BFM28

Type of grasp while making a mark on the paper	BFM28 code	BFM34 Code	BFM37 code	BFM48 code
1. Not able to grasp crayon	0	0	0	0
2. Palmar grasp (whole hand, fisted, fingers close around crayon)	1	0	0	0
3. Fingers and partial thumb opposition. The writing end of the crayon or pencil must be at the thumb & index finger side. The grasp is usually on the middle to proximal portion of the crayon.	1	1	0	0
4. Static tripod (thumb & two fingers) or quadruped (thumb & three fingers) grasp. The wax colour or pencil should be held about one-third to one-half from its writing end.	1	1	1	0
5. Mature, controlled, dynamic grasp with wrist movement.	1	1	1	1

Code in **BFM34: 0 1**
Code in **BFM37: 0 1**
Code in **BFM48: 0 1**
ALSO CODE BFM30 (child spontaneously scribbles)
Code in **BFM30: 0 1**

29	**Isolates extended index finger: Pegboard** **Place the pegboard on the table in front of the child.** Poke a finger into the holes on the board so the child can see the holes. Do not guide the child's hand or fingers at all. If the child tries to pick up the pegboard, hold it down at the corners. **Code 1 if** Child touches pegboard with **extended index finger** whilst keeping others curled. (They do not need to put a finger into the hole, to score '1')	**0 1**	BFM29
30	**Scribbles spontaneously** **Child spontaneously scribbles** on the paper on purpose (Accidentally marking the paper whilst playing with the crayon doesn't count)	**0 1**	BFM30

NEXT STEPS

CHECK CODES FOR ITEMS 28, 29 & 30 and proceed as indicated:

ITEMS 28, 29 & 30: ALL 1s	ACTION
YES	**1.** Strikethrough items 22-27 **2.** Continue from item 31
NO & ITEM 28=1	**1.** Administer items 26 & 27: a. If both 1: Strikethrough items 22-25 and continue from item 31 b. If either 0: Administer items 22- 25
NO & ITEM 28=0	1. Administer items 22 – 27 2. Review codes for items 22-27: Check that there are at least 3 consecutive 1s a. If YES, go to item 31 b. If NO, stop this assessment here and complete a Referral slip

Stopping Rule: Assessment stops when 5 consecutive items are coded 0.

***M/N 31**	**Block Stacking: All 12 blocks** **Trial 1:** Place 12 blocks on the table in front of you. Stack 3 blocks and say **"look at my tower"**. Place 3 blocks in front of the child and say **"now you make a big tower"** and point to a point on the table near your tower. If they can do this, push the remaining 9 blocks to them and say **"make your tower as big as you can. Use all the blocks"**. **Trial 2 & 3:** Push all 12 blocks to the child. Say **"build another tower. Make it as big as you can".** **All trials:** Do not give the child any blocks. Do not direct or guide the building of the structure at all. **Number of blocks in tallest tower** **Code 1 if, the tallest tower** is at least 2 blocks **Code 1 if, the tallest tower** is at least 6 blocks Code in **BFM38: 0 1**		BFM_ TOWER BFM31

32	**<u>Imitates Stroke: Crayons (or pencils) and blank paper</u>** **Place sheet of blank paper on the table in front of the child. Place one crayon on the paper.** With the other crayon, do the following in order: 1. Draw a straight vertical line, moving quickly toward the child whilst saying **"See? It goes zip! You do it!"** Allow the child time to copy you. Draw a horizontal line moving from your left to the right while saying, **"Make it go this way. Zip! You do it."** You may hold the paper for the child if required. **Code as follows:** **BFM32: Code 1 if child draws a stroke in any direction** **Code 1 in BFM39 if child holds the paper in place with one hand** whilst scribbling or drawing with the other **Code in BFM39: 0 1** **IF BFM32 IS 0, CODE 0 FOR BFM40, BFM41 AND BFM43 and CONTINUE TO NEXT ITEM** **Code 1 in BFM40 if** child 's **horizontal stroke** is within approximately 30degrees of yours **Code in BFM40: 0 1** **Code 1 in BFM41 if** child's **vertical stroke** is within approximately 30 degrees of yours **Code in BFM41: 0 1** 2. Make circular strokes and say, **"Now make it go this way. You do it."** **Code 1 in BFM43 if** child draws a **mostly curved shape** (There should be no more than a one inch gap between the beginning & end of the circle) **Code in BFM43: 0 1**	**0 1**	BFM32
33	**<u>Places pellets in bottle: Food pellets, bottle and stopwatch</u>** **Place 2 pellets and the bottle on the table in front of you.** Pick up a pellet and drop it into the bottle whilst the child is watching. Place 10 pellets in front of the child so that they are not touching each other or the bottle. Say: **"I want to find out how many pellets you can put into the bottle as fast as you can. I'll tell you when to stop. Ready…Go!"** Hold the bottle for the child. **Start timing** when the child picks up the first pellet. Stop after 60 seconds or when all 10 pellets are in the bottle. If the child tries to drop more than one pellet in the bottle at one time continue timing but say **"no, just one at a time".** If child does not pick up pellet, continue timing as you place the other pellet in front of you into the bottle and repeat the instruction. Child **places 10 pellets** in the bottle in **60 seconds or less**, **one pellet at a time** (If the child repeatedly places more than one at a time, code 0)	**0 1**	BFM33
34	**Grasp: Holding a crayon** ***Copy response for BFM34 from item 28***	**0 1**	BFM34
***O 35**	**<u>Coins in slot: Coin bank and 5 coins</u>** **Place the coin bank in front of the child.** Show the child the five coins. Place one coin in front of the child and ask them to put it in the bank whilst pointing to the slot in the bank. You can demonstrate by putting a maximum of two coins into the bank. Give the remaining coins one at a time. **Child places at least 3 coins** into the slot	**0 1**	BFM35

36	**<u>Connecting blocks (Apart): 6 connecting blocks</u>** **Connect the connecting blocks as a small, stacked unit.** Show it to the child and demonstrate removing all the blocks. Put them back together again. Give it to the child and ask them to take **all** the blocks apart. Child takes all the blocks apart	**0 1**	BFM36
37	**Grasp: Holding a crayon** ***Copy response for BFM37 from item 28***	**0 1**	BFM37
***P** **38**	**Block Stacking** ***Copy response for BFM38 from item 31***	**0 1**	BFM38
39	**Uses hand to hold paper** ***Copy response for BFM39 from item 32***	**0 1**	BFM39
40	**Imitates stroke** ***Copy response for BFM40 from item 32***	**0 1**	BFM40
41	**Imitates stroke** ***Copy response for BFM41 from item 32***	**0 1**	BFM41
42	**<u>Connecting blocks (Together): 6 connecting blocks</u>** **Disconnect all the blocks.** Place them on the table in front of you and **demonstrate connecting three of them.** Disconnect all the blocks and give six to the child. Ask them to put all the blocks together. **Child puts all the blocks together** (At least 2 connector knobs on each block must be correctly aligned and secured to another block)	**0 1**	BFM42
***Q** **43**	**Imitates stroke** ***Copy response for BFM43 from item 32***	**0 1**	BFM43
44	**<u>Builds Train: 10 Blocks</u>** **Demonstrate as follows:** 1. Place four blocks touching each other in a row whilst saying: **"Look how I make a train. Like this and this and this and this"** 2. Place a fifth block on top of the first block whilst saying: **"and here is the engine. See how it goes"** 3. **Push the train on the** table whilst saying: **"choo-choo-choo"** **Push the remaining 5 blocks towards the child and say: "make a train (choo-choo) just like mine"** **Child places at least four blocks in a row. Each block must touch the next with no gaps** (The fifth block doesn't need to be on top to code 1 here)	**0 1**	BFM44
45	**<u>Strings 3 blocks: 3 blocks with holes and shoelace</u>** **Demonstrate stringing the shoelace** through the three blocks. **Remove the blocks from the shoelace** and say **"now it's your turn".** Place everything in front of the child. Encourage the child to place all three blocks onto the shoelace. If the child stops or takes off blocks before finishing stringing the three blocks say: **"Put some more blocks on. See how many you can put on"** **Child strings all three blocks** on the shoelace to at least 1 inch (Blocks do not all have to be on the shoelace at the same time)	**0 1**	BFM45

46	**<u>Imitates hand movements</u>** **Part A:** Say **"we are going to play a game with our hands. Watch me".** Clap your hands three times with a 1 second gap between claps. Say **"Now you do it".** If child does this correctly, go to part B – otherwise, repeat part A one more time and then go on to Part B. **Part B: Demonstrate 3 hand movements – tick the box if child is able to copy** ☐ **Movement 1:** Hold your hands out in front of you and touch each index finger to the thumb on that hand to make a circle. Lower your hands and say: **"now you do it."** ☐ **Movement 2:** Touch your right hand to your right ear at the same time as touching your left hand to your left ear. Lower your hands and say:**"now you do it."** ☐ **Movement 3:** With hands open, hold them out in front of you and make small circular movements (approx. 6 inches circumference). Move your left hand clockwise and right hand counter-clockwise. Lower your hands and say: **"now you do it."** (tick if child makes circular movements, but the direction is not important) **Code 1 if** child gets at least 2 ticks	**0**	**1**	BFM46
47	**<u>Snips paper: 2 blank index cards and scissors</u>** Take out 2 index cards. Show the scissors and index card to the child. **Demonstrate** cutting 3 or 4 snips along the edge of the card. The snips should be at least ½ inch (13mm) long. Place the other index card and scissors on the table in front of the child. Say: **"it's your turn to cut"** Encourage the child to make several snips. Do not guide the child's hands but you can give verbal encouragement or reminders. **Child makes two snips at least ½ inch (13mm) long**	**0**	**1**	BFM47
48	**Grasp: Holding a crayon** ***Copy response for BFM48 from item 28***	**0**	**1**	BFM48
49	**<u>Tactilely discriminates shapes: 2 Blocks without holes, 2 pegs, 2 blue square puzzle pieces and a drawstring bag</u>** 1. **Place 1 block, 1 peg & 1 square piece in your lap so the child can't see them.** 2. Now place in order **another** block, peg, and square piece in a row on the table in front of the child (from child's right to left): 3. Show the child the bag and say: **"I am going to hide something like one of these (point to objects on table) in the bag."** 4. Take the peg from your lap, and place it in the bag. Make sure you keep it hidden, and make sure the child can't see what you still have in your lap. 5. Say **"Reach in and hold what's inside, but don't look."** Encourage the child to feel the object and allow them to manipulate it for several seconds – do not allow them to remove it. 6. Say: **"Show me the toy that is like the one hidden in your bag"** (as you point to each object in front of them). **If child doesn't identify the peg correctly** – point to the peg on the table and say: **"This is what is in the bag. Let's play the game again."** Now repeat using the block, and then the square piece. **Tick the objects** that the child correctly identifies: ☐ Peg ☐ Block ☐ Square piece **Code 1 if child correctly identifies at least 2 objects**	**0**	**1**	BFM49

Last item tested:			BFMLASTITEM

SPRING 18 Months Assessment: Bayley Scales of Infant and Toddler Development-III
Motor Scale: Gross

Identifying information		**GROSSMOTOR**	AW:	BATCHNO
Cluster				CLUSTER
Village				VILLAGE
Household No				HH
Mother name		Husband Name		
Child name		Child DOB & Sex	&	
Twin	-------- Woman ID	# # # # #		WOMANID
	Child ID	CHILD # # # # #		CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d - M M M - y y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify on 18MONTHVISIT FORM)	FORMSTATUS
Supervisor Code (If present)		SUPERVISOR

START THE ASSESSMENT AT ITEM 42 ITEMS 35-41 will be completed depending on RESPONSES TO ITEMS 42-44 (as explained later on page 3 after item 45)			
Item no.	**Gross motor**	**Score**	**Variable Name**
*I 35	**Raises self to standing position** **Observe the child: Child stands up from being seated on the floor** (using a chair or other object for support)	**0 1**	BGM35
36	**Bounces while standing** **Stand the child on the floor and hold their hands so that their arms are extended at shoulder height.** **Encourage them to bounce by modelling or gently move their arms up and down to encourage bouncing.** **Child bounces up and down whilst standing at least twice** (by bending and straightening the knees)	**0 1**	BGM36
37	**Walks** **Child walks with support** by making coordinated, alternating stepping movement	**0 1**	BGM37
38	**Walks sideways** **Stand the child next to supportive furniture and see if they move from one point to another by walking sideways.** **Child walks sideways** while holding onto furniture for support and balance	**0 1**	BGM38
*J 39	**Sits down with control** **Watch the child when they sit from standing** Child sits down from standing with control	**0 1**	BGM39
40	**Stands alone** **Stand the child on the floor and hold their hands so that their arms are extended at shoulder height. Slowly let go of their hands.** **Child stands alone for at least 3 seconds** after you let go of their hands	**0 1**	BGM40
41	**Stands up: Alone** **Lie the child on their back and then encourage them to stand up** Child stands without any support	**0 1**	BGM41

	START THE ASSESSMENT HERE		
Item no.	**Gross motor**	**Score**	**Variable Name**
आइटम न.	**ग्रॉस मोटर**	**स्कोर**	**Variable Name**
*K 42	**Walks: Alone** **Stand the child on the floor and encourage them to walk towards you.** **If they are unable to walk without support then hold their hands so that their arms are extended at shoulder height. Slowly release their hands and encourage them to walk towards you.** **Child takes at least three steps without support**, even if gait is stiff-legged and wobbly	**0 1**	BGM42
43	**Walks: Alone** **Child takes at least five steps independently**, displaying **coordination** and balance	**0 1**	BGM43
44	**Throws ball: Small ball** **Throw small ball gently to child using an overhand motion. Encourage the child to throw it.** Child **throws small ball** forward on purpose	**0 1**	BGM44

NEXT STEPS

CHECK CODES FOR ITEMS 42, 43 & 44 and proceed as indicated:

ITEMS 42, 43 & 44: ALL 1s	ACTION
YES	1. Strikethrough items 35-41 2. Continue from item 45
NO	1. Administer items 39-41 2. Review codes for items 39-41: Check that there are at least 3 consecutive 1s a. If YES: Strikethrough items 35-38 and continue from item 45 b. If NO: Administer items 35-38 3. Review codes for items 35-41: Check that there are at least 3 consecutive 1s a. If YES, go to item 45 b. If NO, stop this assessment here and complete a Referral slip

Stopping Rule: Assessment stops when 5 consecutive items are coded 0.

***L 45**	**Squats without support** **Place object on floor whilst child is standing. Encourage child to pick it up.** Child **squats then stands back up** while maintaining balance **without using any support**	**0 1**	BGM45
46	**Stands up: Alone (without support)** **Lie the child on their back and then encourage them to stand up.** Child rolls to one side, sits upright, without first going on hands and knees & stands without support	**0 1**	BGM46
47	**Walking upstairs: Set of Stairs** **Watch child walk up stairs – if they can do this with support of wall, encourage them to walk upstairs without.** Walks up at least 3 steps using wall for support. Two feet on each step Walks up at least 3 steps without using the wall for support. Two feet on each step Code in **BGM57: 0 1** Walks up at least 2 steps without using wall & alternates feet on each step Code in **BGM64: 0 1**	**0 1**	BGM47
***M/N 48**	**Walking backwards** **Demonstrate walking backwards whilst holding child's hand and encouraging them to copy. Release child's hand and encourage them to continue.** Child takes at least 2 steps backward without help	**0 1**	BGM48
49	**Walking downstairs: Set of stairs** **Watch child walk down stairs – if they can do this with wall, encourage them to walk downstairs without.** Walks down at least 3 steps using wall. Two feet on each step Walks down at least 3 steps without using wall for support. Two feet on each step Code in **BGM58: 0 1** Walks down at least 2 steps without using wall & alternates feet on each step Code in **BGM67: 0 1**	**0 1**	BGM49
50	**Runs with coordination: Large Ball** **Roll the large ball across floor and encourage child to run and get it.** Child runs with good coordination	**0 1**	BGM50

*O 51	**Balances on right foot** **Stand beside child and hold one of their hands. Demonstrate by lifting your left foot and then ask the child to do the same (or point to their left foot to indicate which foot you are asking them to lift) - Time how long they can balance.** Time child balances Child balances on right foot for at least 2 seconds while you hold one of their hands **Try to let go off their hand and refer item BGM60**	☐ **0 1**	RFBALS BGM51
52	**Balances on left foot** **Do the same with their right foot** Time child balances Child balances on left foot for at least 2 seconds while you hold one of their hands **Try to let go off their hand and refer item BGM61**	☐ **0 1**	LFBALS BGM52
53	**Walks sideways** **Demonstrate walking sideways, whilst holding child's hand. Now release the hand and encourage them to continue.** Child takes at least two steps sideways without support	**0 1**	BGM53
*P 54	**Jumping from bottom step: Set of stairs** **Demonstrate jumping from the lowest stair to the child. Position child on lowest stair. Stand in front of them and encourage them to jump down.** Child jumps to floor	**0 1**	BGM54
55	**Kicks Ball: Large ball** **Place large ball on floor then kick it forwards. Retrieve the ball and place in front of child. Encourage them to kick. Give three trials.** Child maintains balance while kicking ball in a forward direction at least 2 feet	**0 1**	BGM55
56	**Walks forward on path: Stepping path** **Lay stepping path on ground. Walk forward along entire path, taking small strides & placing both feet on path. Ask child to do the same.** Child walks forward with at least one foot (either left foot or right foot) on path for at least 5 feet	**0 1**	BGM56
*Q 57	**Walks upstairs** ***Copy response for BGM57 from item 47***	**0 1**	BGM57
58	**Walks downstairs** ***Copy response for BGM58 from item 49***	**0 1**	BGM58
59	**Jumps forward: Stepping path** **Demonstrate jumping on the stepping path. Now ask child to stand on stepping path and encourage them to jump as far as they can. You can demonstrate jumping up to three times to encourage child. Measure distance child jumps. Give three trials and measure distance:** **Distance 1…… Distance 2…… Distance 3……** **Code 1 if** child jumps 4 inches or more in any trial	**0 1**	BGM59
60	**Balances on right foot** **Stand beside child and hold one of their hands. Demonstrate by lifting your left foot and then say: "Please lift your left foot off the ground" (if needed, point to indicate which foot you mean). Then let go of their hand and time how long they can balance on their right foot without support.** Time child balances Balances on right foot for at least 2 seconds, without support	☐ **0 1**	RFWSBALS BGM60

61	**Balancing on left foot** **Do the same for the right foot: Say "Lift your right foot off the ground." Time how long the child can balance on their left foot without support.** Time child balances ☐ Balances on left foot for at least 2 seconds, without support	**0 1**	LFWSBALS BGM61
62	**Walk on tiptoes: Stepping path** **Lay down the stepping path. Remove child's shoes. Walk on your tiptoes along entire length of path as you say "See? I'm walking on my tiptoes. You do it. Tiptoe all the way down this line"** **Child takes at least four steps on tiptoes** unassisted without touching heels to the floor	**0 1**	BGM62
63	**Walking backwards: Stepping path** **Demonstrate walking backwards on the stepping path to the child. Then ask the child to walk backwards along the stepping path. Measure how far they are able to go staying close to the path.** **Child walks backward unassisted close to the path for at least 5 feet**	**0 1**	BGM63
64	**Walks upstairs** ***Copy response for BGM64 from item 47***	**0 1**	BGM64
65	**Imitates postures** **Position the child across from you, approx. 6 feet away. Say: "We are going to play a game. I am going to stand in different ways and want you to copy me. Are you ready?"** **Tick which of these positions the child can copy:** ☐ Place one foot in front of the other foot, heel-to-toe, holding your arms straight out to your sides and at shoulder height. To ensure that the child notices what you are doing, say: **"Look at my feet and arms – can you copy me".** ☐ Place your left hand on your left hip and bend to the right ☐ Hold your left arm straight up and your right arm straight out to the side and at shoulder height **Code 1 if** child correctly imitates at least 2 of these positions	**0 1**	BGM65
66	**Stops from a full run: Stepping path** **Lay down the stepping path. Position the child at one end of the path and say "Stand here - when I say go, run as fast as you can until you reach the end of the path, then stop as fast as you can. Remember, run when I say 'go', and stop at the end of this mat. Are you ready – Go!"** **Ask the child to do this 3 times. Code 1 if:** Child stops in a controlled fashion within two steps of end of the stepping path, in at least two of the three trials	**0 1**	BGM66
67	**Walks downstairs** ***Copy response for BGM67 from item 49***	**0 1**	BGM67

Last item tested:			BGMLASTITEM

SPRING 18 Months Assessment: Bayley Scales of Infant and Toddler Development-III
Cognitive Scale

Identifying information	**COGNITIVE**	AW:	BATCHNO
Cluster			CLUSTER
Village			VILLAGE
Household No			HH
Mother name		Husband Name	
Child name		Child DOB & Sex	&
Twin	-------- Woman ID	# # # #	WOMANID
	Child ID	CHILD # # # # #	CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d - M M M - y y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify on 18MONTHVISIT FORM)	FORMSTATUS
Supervisor Code (If present)		SUPERVISOR

START THE ASSESSMENT AT ITEM 40 ITEMS 31-39 will be completed depending on RESPONSES TO ITEMS 40-42 (as explained later on page 5 after item 42)			
Item no.	**Cognitive**	**Score**	**Variable Name**
*I 31	**Bell Ringing** 1. Hold the bell in front of child, above the table. 2. Gently ring the bell while child is looking at it. 3. Put bell down within child's reach. 4. If child doesn't pick up the bell: Ring it again slightly harder and then give it to the child. 5. If child is more interested in banging the bell on the table, move them away from the table after they have picked up the bell. **Child holds bell by handle with 1 or both hands and purposely rings (showing evidence of listening to the sound it makes)**	**0 1**	BCOG31
32	**Looks at Picture: Picture Book** 1. Put the Picture Book on the table in front of the child, open at page 10-11. Attract child's attention to book. 2. Give child an opportunity to hold the book, turn the pages, and look at the pictures. (Help hold the book if the child seems frustrated by its moving around). **Child looks at one or more specific picture with interest or recognition** **This includes: pointing to touching, or staring at a picture/pictures. Short duration of looking counts**	**0 1**	BCOG32
33	**Picks up block: 3 Blocks without hole** 1. Place 1 block without hole on table within child's reach. 2. Give child time to pick this up, before you place the second block on the table. 3. If child doesn't pick up either block: hold up one of the blocks and offer it to them. 4. Place both blocks in child's hands if they don't grasp them. 5. Put **the 3rd block on table and observe child.** **Child keeps first two blocks in their hands for at least 3 seconds after seeing 3rd block**	**0 1**	BCOG33
*J 34	**Searching for missing objects: 3 Blocks without holes & Cup with handle** 1. Place the 3 blocks in the cup and gently shake it whilst child is watching. 2. Empty blocks onto the table so they are in front of the child. 3. Immediately put blocks back into cup and shake again. 4. Hold cup where child can't see it for a very short time and remove the blocks. 5. Hand empty cup to child and see if they try to find the blocks. 6. If child doesn't try to find the blocks, repeat steps 1-5. **Child tries to find blocks**	**0 1**	BCOG34
35	**Takes blocks out of cup: 3 Blocks without holes, Cup with handle & Stopwatch** 1. Put cup and 3 blocks in front of child. 2. Whilst child is watching – place the blocks into cup. 3. Tell child to take the blocks out of cup. 4. Start timer. 5. Stop when 120 seconds (2 minutes) is finished or if child stops engaging with the task. **Child takes all 3 blocks out of cup within 120 seconds (2 minutes)** **Either individually or by dumping them all out simultaneously. Accidental spillages don't count**	**0 1**	BCOG35

36	**Puts block in cup: 9 Blocks & Cup with handle** 1. Place cup on table within child's reach and with handle pointing towards you. 2. Keep 8 blocks out of child's sight. 3. Place other block in the cup. 4. Take block out and hand it to child. 5. Tell child to **put the block** in the cup as you point from block to the cup (you can encourage them several times). 6. If child knocks over the cup: reposition it. Hold the cup steady for the child by holding onto handle. 7. If child puts the block into the cup, place the 8 other blocks on the table and repeat **step 5 but by tell the child to put all the blocks into the cup.** **Number of blocks child puts in cup** **Child puts at least 1 block in the cup OR child puts at least 1 block over the cup even if they don't release it** **The following all count:** 1. Child puts their hand into the cup along with the block 2. Cup is knocked over after putting block in/above 3. Blocks spill out of cup after putting in/above **Child puts all 9 blocks inside the cup at one time** Code in **BCOG54: 0 1**	 ☐☐ **0 1**	 NUMBLOCKS36 BCOG36
37	**Picks up block: 3 Blocks without holes** 1. Place 1 block without hole on table within child's reach. 2. Give child time to pick this up, before you place the second block on the table. 3. If child doesn't pick up either block: hold up one of the blocks and offer it to them. 4. Place both blocks in child's hands if they don't grasp them. 5. Put **the 3rd block on table and observe child.** **Child keeps first two blocks in their hands and attempts to secure 3rd block**	 **0 1**	 BCOG37
38	**Explores holes: Pegboard** 1. Place pegboard on table in front of child. 2. Poke your finger into one hole and then another to show child where they are. 3. See if child tries to copy you (do not encourage by saying or doing anything). Do not guide child's fingers or hand in any way. **Child pokes a finger or thumb into at least 1 hole on purpose**	 **0 1**	 BCOG38
39	**Pushes Car: Toy Car** 1. Slowly push car across table and make sure they can see it. 2. Push car to child. **Child intentionally pushes car so all 4 wheels stay on the table**	 **0 1**	 BCOG39

START THE ASSESSMENT HERE

Item no.	Cognitive	Score	Variable Name
*K 40	**Finds hidden objects: Bracelet & washcloths (Game 1)** 1. Place bracelet and 2 washcloths on table in a horizontal row within child's reach. 2. If **the child tries to grab the bracelet or washcloths:** ask caregiver to help keep the child's hands off the table while you place the objects 3. Show bracelet to child and say: "**see the bracelet. I am going to hide it. Look. I'm hiding it under here".** 4. Make sure child is watching. Put bracelet under washcloth to child's **left** and say "**can you find it? Where has it gone?"** 5. Tick the box for Trial 1 left if the child finds the bracelet by lifting the correct washcloth first. 6. Now do it again but hide bracelet under the washcloth on child's **right**. **Trial 1** ☐ **Left** ☐ **Right** **Trial 2 (if needed)** ☐ **Left** ☐ **Right** 7. If child fails to find the bracelet on either side, carry out a **second trial** exactly as before, hiding the bracelet first under the washcloth on the left and then under the washcloth on the right. **Child identifies hidden bracelet on both left and right sides, not necessarily in the same trial**	**0 1**	BCOG40
	Finds hidden objects: Bracelet and washcloths (Game 2) 1. Play the game again but this time, swap the washcloths around after you have hidden the bracelet 2. Two trials allowed **Trial 1** ☐ **Right** ☐ **Left** **Trial 2 (if needed)** ☐ **Right** ☐ **Left** **Child identifies hidden bracelet on both left and right sides, not necessarily in the same trial** Code in **BCOG45: 0 1**		
	Finds hidden objects: Bracelet & washcloths (Game 3) 1. This time, put bracelet under washcloth to child's left and immediately uncover the bracelet and put it under the washcloth on the right. 2. In a playful voice say: **I'm hiding it again.** Ask child to **find the bracelet** 3. Repeat but start on the child's right hand side instead. 4. Two trials allowed. **Trial 1** ☐ **Right** ☐ **Left** **Trial 2 (if needed)** ☐ **Right** ☐ **Left** **Child identifies hidden bracelet on both left and right sides, not necessarily in the same trial** Code in **BCOG50: 0 1**		
41	**Suspends Ring: Ring with string** 1. Hold the ring by the string about 4-10 inch (10-25 cm) in front of the middle of the child's face, with the bottom of the ring is at the level of their eyes. 2. Move ring slightly to get the child's attention, and then hold it stationary. 3. Place ring on the table out of child's reach, and extend string towards the child so that they can easily reach it. 4. Watch child trying to copy you. 5. If **the child can't hold the ring up without it touching the table:** demonstrate again but away from the table, and reposition the child so they can try again away from the table. **Child gets ring and holds it by the string so that the ring does not touch the table surface**	**0 1**	BCOG41

42	**Removes Pellet: Bottle (without lid) & food pellet** 1. Put pellet and bottle on the table in front of the child. 2. Put the pellet in the bottle and shake it so that the child can see the pellet moving. 3. Give the bottle to child and say **"can you get it out?"** 4. Note: the child can get the pellet out in lots of ways. They might turn the bottle upside down or shake the bottle. The important thing is that they do it on purpose; watching where the child is looking will help you to decide this. 5. You can **demonstrate this up to 3 times**, if the child doesn't manage to do it on the first trial. **Child removes the pellet from the bottle on purpose**	**0 1**	BCOG42

NEXT STEPS

A. CHECK CODES FOR ITEMS 40, 41 & 42 and proceed as indicated:

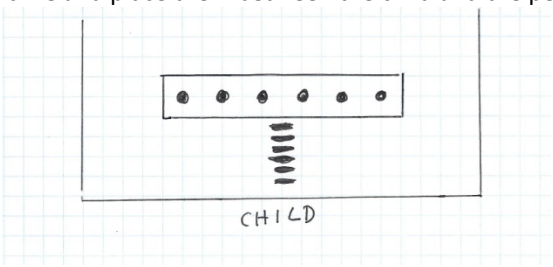
ITEMS 40, 41 & 42: ALL 1s	ACTION
YES	1. Strikethrough items 31-39 2. Continue from item 43
NO	1. Administer items 34-36 2. Go to STEP B

B. CHECK CODES FOR ITEMS 34-36 IF ADMINISTERED and proceed as indicated:

ITEMS 34-36: ALL 1s	ACTION
YES	1. Strikethrough items 31-33 2. Complete items 37–39 and continue from item 43
NO	1. Administer items 31-33 2. Review codes for items 31-36: Check that there are at least 3 consecutive 1s a. If YES, Complete items 37–39 and continue from item 43 b. If NO, stop this assessment here and complete a Referral slip

Stopping Rule: Assessment stops when 5 consecutive items are coded 0.

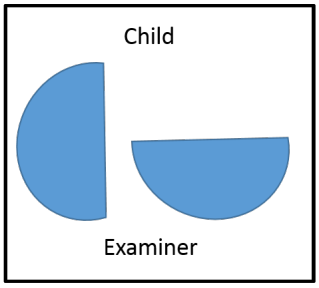
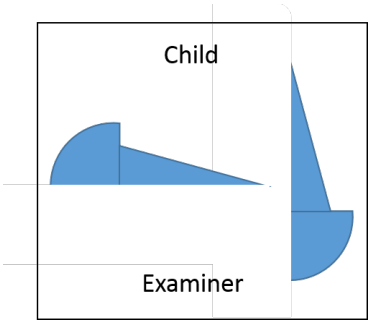
Item no.	Cognitive	Score	Variable Name
43	**Clear box (Front): Clear box & small object of interest** 1. Put a small object of interest on the table and cover it with the clear box with the open end facing child, and with the object against the side farthest from the opening. 2. Make sure the box is close enough to the child so that they can see the object only through the top (this means they can't see the object through the open end 3. Hold box down by placing your thumb and forefinger on its back corners so your hands & fingers don't obscure the child's view of the object. 4. Say: **Get the [object name]. Go ahead. Get it.** 5. Start timer and watch for 20 seconds **Child retrieves object through open end of box within 20 seconds**	**0 1**	BCOG43
	Clear box (Sides): Clear box & small object of interest 1. Repeat game, but this time put the open end of the clear box facing child's left so that the object is against the side farthest from the opening. 2. Turn the box around so the opening is on the right and repeat. **Child gets object through open end of box within 20 seconds on both left and right sides** Code in **BCOG52: 0 1**		
44	**Squeezes object: Yellow Rubber Duck** 1. Place squeeze toy on table in front of child. 2. Squeeze it so that it squeaks whilst child is watching. 3. Give toy to child and allow them time to squeeze it. **Child tries to squeeze toy to make the sound (the toy does not need to make a squeaking noise)**	**0 1**	BCOG44
*L/M 45	**Finding Hidden Objects** ***Copy response for BCOG45 from item 40***	**0 1**	BCOG45
46	**Removes Lid: Bottle with Lid** 1. Screw the lid one revolution onto the bottle whilst the child is watching. The lid should be loose. 2. Put the bottle on the table in front of the child. 3. Ask the child to **remove the lid** (make sure you don't show them how to do this). **Child unscrews lid until it comes off (pulling the lid off without trying to unscrew doesn't count)**	**0 1**	BCOG46

Item no.	Cognitive	Score	Variable Name
47	**Pegboard: Pegboard, 6 yellow pegs & stopwatch** 1. Make sure the child can't see you – insert 6 yellow pegs into the pegboard. 2. Put pegboard on table directly in front of child within their reach. 3. Remove pegs one at a time and place them between the child and the pegboard in their midline:  4. Point to the pegs and then to the holes and say: **Put them all in**. Start the timer when child picks up first peg. 5. Stop timer when child has puts all six pegs in the pegboard or when 70 seconds have elapsed. **Child puts at least 1 peg 2+ times into in the same or different holes (only 1 trial allowed)** **Child puts all 6 pegs in the pegboard within 70 seconds (3 trials allowed)** Code in **BCOG55: 0 1** 6. Note: 3 trials allowed for testing whether child can put all 6 pegs in pegboard within 70 seconds. Time taken to put all 6 pegs in hole (Sec) Trial 1 Trial 2 Trial 3 **Child puts all 6 pegs in the pegboard <u>within 25 seconds</u> in Trial 1** Code in **BCOG62: 0 1**	**0 1**	BCOG47 ALLPEGS1 ALLPEGS2 ALLPEGS3
48	**<u>Relational Play: Doll, bear, plastic cup, spoons, small ball, washcloths, & several blocks</u>** 1. Put the above objects in front of the child. 2. Say: **I'm thirsty. I need a drink.** Take a cup and pretend to drink from it. 3. See if the child picks up an object and starts to play. If they do not, encourage them by playing with the objects yourself. 4. Watch to see whether the child pretends to use items as they are intended (e.g., pretends to eat using the spoon or pretends to wash their face with the washcloth). This can be either on themselves or on others (you, their mother, doll or bear). 5. Note: the child must not simply copy what you did. The important thing here is that they are pretending to do things. **Child pretend plays using objects as they are intended on themselves (or on others)** **Child pretend plays using objects as they are intended on others** Code in **BCOG53: 0 1**	**0 1**	BCOG48

Item no.	Cognitive	Score	Variable Name
*N 49	**Pink Board: Pink board, red block set & stopwatch** 1. Without child seeing, put pieces from the red block set (square, circle, triangle) into the pink board. Do this on your lap or under the table. 2. Place board on the table, directly in front of the child, with circle piece nearest them. 3. Remove pieces from the board and place them between the board and child in this order: Square, circle, triangle (start at child's left and move to right). 4. Gesture towards the board (do not show) and tell child **to put the pieces in.** Be careful not to indicate any specific area of the board. 5. Start timer. Stop when child has placed all pieces correctly or 180 seconds have elapsed. **Observation time (sec)** ☐☐☐ **Child puts at least 1 piece in board correctly within 180 seconds** **Child puts all 3 pieces in board correctly within 180 seconds** Code in **BCOG56: 0 1** **Number of pieces placed correctly within 180 second**	 **0 1** ☐☐	BC49TIME BCOG49 BC49PIECES
	Pink Board: Pink Board, red block Set (Rotated) 1. Without child seeing, put pieces from the red block set (square, circle, triangle) into the pink board. 2. Place board on the table, directly in front of the child, with circle piece nearest them. 3. Remove pieces from the board and place them between the board and child in this order: Square, circle, triangle (start at child's left and move to right). 4. Say: **Watch what I do** 5. Leave the board on the table and slowly and carefully rotate it so that the square hole is now at the child's right. Then with a gesture towards the board, say: **Now you put them back** 6. Note: **do not let the child turn the board back to its original position** **Child correctly places all 3 pieces while board is in rotated position** Code in **BCOG60: 0 1**		
50	**Finding Hidden Objects** ***Copy response for BCOG50 from item 40***	**0 1**	BCOG50

Item no.	Cognitive	Score	Variable Name
51	<u>**Blue Board: Blue board, blue block set & stopwatch**</u> 1. Put all 9 pieces of the blue block set (4 round, 5 squares) on the side of the table nearest you. 2. Put the blue board on the table in front of the child 3. Give the child a round piece and start the timer when they grasp it 4. Motion towards the holes and say: **Put it where it belongs** 5. Do not give the child any more information about whether to put the pieces 6. Now give the child a square piece then a round piece alternately, one at a time, until the child is satisfied with how they have placed each one. 7. Stop when all 9 pieces are placed correctly or 150 seconds have elapsed.		
	Observation time (sec) ☐☐☐		BC51TIME
	Number of pieces placed correctly	☐☐	BC51PIECES
	Child puts at least 1 piece completely in the hole within 150 seconds (removing the piece after correctly placing it still counts)	0 1	BCOG51
	Child puts at least 4 pieces within 150 seconds Code in **BCOG58: 0 1**		
	Child puts all 9 pieces within 75 seconds Code in **BCOG66: 0 1**		
52	**Clear box: sides** ***Copy response for BCOG52 from item 43***	0 1	BCOG52
53	**Relational Play** ***Copy response for BCOG53 from item 48***	0 1	BCOG53
54	<u>**Puts blocks in cup: 9 Blocks & Cup with handle**</u> 1. Place cup on table within child's reach and with handle pointing towards you. 2. Keep 8 blocks out of child's sight. 3. Place other block in the cup. 4. Take block out and hand it to child. 5. Tell child to **put the block** in the cup as you point from block to the cup (you can encourage them several times). 6. If child knocks over the cup: reposition it. Hold the cup steady for the child by holding onto handle. 7. Child puts the block into the cup, place the 8 other blocks on the table and repeat **step 5 but by tell the child to put all the blocks into the cup.**		
	Number of blocks child puts in cup	☐☐	NUMBLOCKS54
	Child puts all 9 blocks inside the cup at one time **The following all count:** 1. Child puts their hand into the cup along with the block 2. Cup is knocked over after putting block in/above 3. Blocks spill out of cup after putting in/above	0 1	BCOG54
55	**Pegboard: 6 pegs** ***Copy response for BCOG55 from item 47***	0 1	BCOG55
*N 56	**Pink Board: Completes** ***Copy response for BCOG56 from item 49***	0 1	BCOG56

Item no.	Cognitive	Score	Variable Name
57	**Use pencil to obtain object: Pencil & Small red duck** 1. Place small red duck on table far enough from child so that they need to use 3 or 4 motions of their pencil to get it. 2. With a sweeping motion, use the side of the pencil to push the duck towards the child whilst saying: "**See how I make the duck come to you?"** 3. Put duck back to its original position and put the pencil within the child's reach. Say: "**Make the duck come to you."** 4. The important thing is for the child to use a sweeping motion with the pencil to try and get the duck. It doesn't count if the child hits or pushes the duck with the pencil, using random swings without intending to bring the duck towards them. 5. If **child does not respond, or doesn't respond correctly:** a. Reposition yourself beside the child and demonstrate what you want them to do. Say: **'Come here duck. Come here duck"** b. Put duck back to its original position and put the pencil within the child's reach. **Child uses a sweeping motion with the pencil to try to get the duck (even if they don't manage to secure it)**	**0 1**	BCOG57
58	**Blue board: 4 pieces** ***Copy response for BCOG58 from item 51***	**0 1**	BCOG58
59	**Attends to story: Story Book** 1. Put story book on the table in front of the child 2. Open to page 1 and say: **Look!** 3. Allow child to explore the book, look at the pictures and turn the pages if they want 4. Say: **Let's read the story** 5. Reposition yourself so you are beside the child. Take the book from the child, open it and start reading by saying: **Listen** **Child attends to entire story** **(This means they decrease their movements, look at the pictures, listen to the words or talk to you about the pictures as you read. Not paying attention for short moments is fine)**	**0 1**	BCOG59
*O 60	**Pink board: rotated** ***Copy response for BCOG60 from item 49***	**0 1**	BCOG60

Item no.	Cognitive	Score	Variable Name
61	**Object Assembly: Ball puzzle & stopwatch** 1. Put the two pieces of the ball puzzle on the table, about 6 inches (15cm) in front of the child as shown below:  2. Slowly assemble the puzzle and say: **these pieces make a ball. See, they fit together like this.** 3. Allow the child to look at the completed puzzle for around 3 seconds. 4. Take the puzzle apart. 5. Put the pieces back on the table as in step 1 and say: **Now you try. Do it as fast as you can.** 6. Start timer after giving directions or when the child starts to work on the puzzle (whichever is first 7. Allow the child 90 seconds to complete the puzzle. 8. If they don't succeed, demonstrate again and ask them to try again. 9. Correct assembly means that the pieces are separated by no more than ¼ inch (0.6cm) and that the edges are no more than ¼ inch (0.6cm) misaligned. **Child puts the object together correctly**	**0 1**	BCOG61
62	**Pegboard: 6 pegs (25 seconds)** ***Copy response for BCOG62 from item 47***	**0 1**	BCOG62
*P 63	**Object Assembly: Ice cream cone puzzle & stopwatch** 1. Put the two pieces of the ice cream cone puzzle on the table, about 6 inches (15cm) in front of the child as shown below.  2. Slowly assemble the puzzle and say: **these pieces make an ice cream. See, they fit together like this.** 3. Allow the child to look at the completed puzzle for around 3 seconds. 4. Take the puzzle apart. 5. Put the pieces back on the table as in step 1and say: **Now you try. Do it as fast as you can** 6. Start timer after giving directions or when the child starts to work on the puzzle (whichever is first). 7. Allow the child 90 seconds to complete the puzzle. 8. If they don't succeed, demonstrate again and ask them to try again. 9. Correct assembly means that the pieces are separated by no more than ¼ inch (0.6cm) and that the edges are no more than ¼ inch (0.6cm) misaligned. **Child puts the object together correctly**	**0 1**	BCOG63

Item no.	Cognitive	Score	Variable Name
64	**Matches pictures: Stimulus book** (Item 64a – 64d; pg. 17-23) 1. Open book on table directly in front of the child to cognitive item 64a (pg. 17). 2. Point to the airplane in the upper half of the page and say: **this is an airplane** 3. Use a sweeping motion of your hand across the lower half of the page and say: show me another airplane down here. 4. If child does not respond correctly – point to the airplane in the lower half of the page and say: **here is another airplane; it looks just like this one.** 5. Now repeat steps 1-4 for items 64b (tricycle), 64c (tree) and 64d (telephone). 6. **Tick below for each item the child identifies correctly.** 7. **If the child points to more than one picture on a page ask: which one is it?** If child still points to more than one picture – do not tick. ☐ Airplane ☐ Tricycle ☐ Tree ☐ Telephone **Child gets at least 3 ticks in boxes above**	**0 1**	BCOG64
65	**Representational Play: Plastic cup, spoon, doll, washcloths, block, & other objects of interest** 1. Place 4 or 5 of the objects mentioned above) in front of the child on the table and say: **Look at these. Let's play with them.** 2. To show them what you mean, first demonstrate a play while saying**: "The doll needs to take a bath. See this is soap and the doll will bathe with this**." And use the block to represent soap. 3. Then give the child some time and see if they pick up any of these objects and plays with them. 4. Watch to see whether the child takes an item and pretends that it is something else. 5. Note: the child must initiate this and not simply copy what you did. **Child takes an object and pretends that it is something else**	**0 1**	BCOG65
66	**Blue board: 9 pieces** ***Copy response for BCOG66 from item 51***	**0 1**	BCOG66
*Q 67	**Imitates two-step action: Small yellow duck & spoon** 1. Place the spoon on the table with its bowl facing upwards. 2. Put the small yellow duck on the end of the spoon handle (Step 1). 3. Hit the bowl of the spoon with your hand and make the duck fly into the air (Step 2). 4. Ask the child to copy what you did. 5. Allow them 3 trials to achieve this. **Child successfully copies step 1 and 2 and makes the duck fly into the air**	**0 1**	BCOG67

Item no.	Cognitive	Score	Variable Name
68	**Matches three colours: Stimulus book, red, yellow, blue & green disks** **(Item 68; pg. 25)** 1. Open the book on the on the table directly in front of the child to cognitive item 68 (pg. 25). 2. Put the red disk in front of the child. 3. Point to the red disk and then to the red crayon on the page and say: **Red. They are both red.** **4.** Move the disk towards the child and say: **Put this red one here [point to the red crayon on the page].** 5. If the child seems confused about what to do with the red disk, repeat the demonstration and instructions and give the child time to respond. 6. Take away the red disk and do not give the child any more help. 7. Put the green disk in front of the child. Point to the page and say: **Where does this go?** Allow the child time to respond. 8. Regardless of the child's performance, remove the green disk and repeat the procedure with the yellow disk then the blue disk. 9. Tick for each disk the child puts on or near the matching colored crayon in the stimulus book. (Placing the red disk doesn't count as this was part of the demonstration). ☐ **Green** ☐ **Yellow** ☐ **Blue** **Child gets 3 ticks in above boxes**	**0 1**	BCOG68
69	**Imaginary Play: Plastic cup, spoon, doll, teddy bear, washcloths & small ball** 1. Place 4 or 5 of the above mentioned objects in front of the child on the table and say: **Look at these. Let's play with them** 2. Demonstrate a play routine the child. Say: **the baby is tired. She's going to sleep"** - and lay the doll down and cover her up with an **imaginary** blanket. 3. Watch to see if the child picks up an object and begins to play. 4. Note: the child must initiate imaginary play and not simply copy what you did. Examples are: child puts an imaginary bandage on the teddy bear, brushes the doll's hair with an imaginary comb, or cups one hand as a bowl and uses an imaginary spoon to eat imaginary soup. **Combination Play** 5. Also observe whether the child demonstrates a combination of two activities while they are playing: For example: feeds doll and pats doll on the back (activity 1) and then puts the doll to bed by covering with the washcloth (activity 2). 6. If you do not observe this, encourage the child and see if they can copy you by, for example, saying: **I am going to clean the kitchen.** Use the washcloth to clean the table and the cups. Next position one hand as if you are holding a pan. Position the other and pretend to 'stir' the food. Say: **Now I can make dinner.** **Child uses imaginary objects in their play** **Child demonstrates play with a combination of two activities** Code in **BCOG71: 0 1**	**0 1**	BCOG69
70	**Understands concept of one: 3 Blocks without holes & Stopwatch** 1. Put 3 blocks on the table in front of the child. 2. Hold out your hand and say: **Hand me one block.** 3. Only pull your hand back when the child shows that they have finished or when 5 seconds have finished with no response from the child. **Child hands you 1 block only**	**0 1**	BCOG70
71	**Combination Play** ***Copy response for BCOG71 from item 69***	**0 1**	BCOG71

Item no.	Cognitive	Score	Variable Name
72	**Concept Grouping (Colour): Big & little ducks (blue & yellow)** 1. Arrange the ducks on the table in the following order: **CHILD** **Big Blue / Little Yellow / Big Yellow / Little Blue** **EXAMINER** 2. Say: **Show me all of the blue ducks.** Give the child time to show you. If they hesitate you can encourage them to respond. **Child correctly identifies both blue ducks**	**0 1**	BCOG72

Last item tested:			BCOGLASTITEM

SPRING 18 Months Assessment: Bayley Scales of Infant and Toddler Development-III
Language Scale: Expressive

Identifying information	**RECEPTIVELANG**	AW:	BATCHNO
Cluster			CLUSTER
Village			VILLAGE
Household No			HH
Mother name		Husband Name	
Child name		Child DOB & Sex	&
Twin	-------- Woman ID	# # # #	WOMANID
	Child ID	CHILD # # # # #	CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d - M M M - y y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify on 18MONTHVISIT FORM)	FORMSTATUS
Supervisor Code (If present)		SUPERVISOR

START THE ASSESSMENT AT ITEM 14 ITEMS 7-13 will be completed depending on RESPONSES TO ITEMS 14-16 (as explained later on page 3 after item 16)			
Item no.	**Expressive Language**	**Score**	**Variable Name**
***I 7**	**Gets attention** **At any time during the assessment note has the child attempted to get anyone's attention? If no:** 1. Engage with the child, then turn away. 2. Watch them in your peripheral vision to see if they try to get attention by speaking, making noises, reaching for you, gesturing or grabbing you. **Child tries to get attention from you or others**	**0 1**	BEL7
8	**Consonant sounds: Rattle & teddy bear** **At any time during the assessment has the child made at least two different consonant sounds (eg 'm', 'p', 'g', 'b')? If yes, circle 1 and go to next item.** **If no, try to encourage this by making different sounds yourself. For example:** 1. Bang rattle on table and say 'buh-buh-buh' 2. Gently tickle child and say 'da-da-da' 3. Make the teddy bear jump up and down and say 'jump-jump-jump' **Child made 2 or more different consonant sounds**	**0 1**	BEL8
9	**Uses gestures** **At any time during the assessment, has the child used any body part to gesture to try to communicate? This can be anything but could include:** 1. Reaching for (or pointing towards) something that they want. 2. Shaking or nodding their head to indicate 'yes' or 'no'. 3. Pushing away something to show they don't want it. 4. Reaching to be picked up. The gesture must be enough and not need any supporting words or noises to make it clear what was being communicated. **Child uses at least 1 gesture to make their wants or needs known**	**0 1**	BEL9
***J 10**	**Consonant vowel combination** **At any time during the assessment, has the child made any consonant-vowel combinations? If not, try to encourage this -** Play with the child and repeat different combinations such as 'gagaga', 'bababa', 'dadada', 'mamama'. **Child makes at least 1 repetitive consonant-vowel combination** **Child makes at least 4 different repetitive consonant-vowel combination** Code in **BEL13**: **0 1**	**0 1**	BEL10
11	**Participates in play routine: Ball or washcloth** **Play with the child in a play routine that they know. This could be, 'peek-a-boo', 'pat-a-cake', 'catching or rolling a ball back and forth' or any other.** **Child actively takes part in at least 1 play routine** For example, child pulls your hands away in peek-a-boo, or tries to clap hands in pat-a-cake (Watching but not actively participating doesn't count)	**0 1**	BEL11

12	**Jabbers expressively** **At any time during the assessment, has the child altered the pitch or tone of their voice? This should be expressive and something like how adults do this whilst speaking. They don't need to use proper words.** **Child's voice is expressive & contains alterations in pitch or tone at least once during the assessment**	**0 1**	BEL12
13	**Consonant vowel combination** ***Copy response for BEL13 from item 10***	**0 1**	BEL13

START THE ASSESSMENT HERE

Item no.	Expressive Language	Score	Variable Name
***K 14**	**Uses one word approximations** **At any time during the assessment, have you observed the child naming people, objects or toys? They don't need to be the correct words or properly pronounced but sounds need to be used consistently to refer to specific things.** **Child has done this at least 1 time**	**0 1**	BEL14
15	**Directs attention of others** **At any time during the assessment, has the child directed your or the caregiver's attention to an object during play? If yes, code 1 and go to next item. If not:** 1. Place some objects (teddy bear, duck, bracelet, bell) within the child's reach. 2. Pick up one of the objects and show it to the child. 3. See if child points to another object or if they hand an object to you to show it to you. **Child points to or shows you (or caregiver) at least 1 object**	**0 1**	BEL15
16	**Imitates word** **At any time during the assessment, has the child imitated your words? If yes, circle 1 and go to next item. If not:** • Use a playful tone to say several words: 'mama', 'dada', 'all-gone', 'uh oh', 'up', 'ball', 'thank you', 'baby' and see if the child copies • You can also ask the caregiver to try and encourage the child to imitate some familiar words **Child imitates at least 1 word (even if imitation consists only of vowel sounds)** **The imitation needs to come immediately after the word.**	**0 1**	BEL16

NEXT STEPS

CHECK CODES FOR ITEMS 14, 15 & 16 and proceed as indicated:

ITEMS 14, 15 & 16: ALL 1s	ACTION
YES	1. Strikethrough items 7-13 2. Continue from item 17
NO	1. Administer items 10-13 2. Review codes for items 10-13: Check that there are at least 3 consecutive 1s a. If YES: Strikethrough items 7-9, and go to item 17 b. If NO: Administer items 7-9 3. Review codes for items 7-13: Check that there are at least 3 consecutive 1s a. If YES, go to item 17 b. If NO, stop this assessment here and complete a Referral slip

Stopping Rule: Assessment stops when 5 consecutive items are coded 0.

*L 17	**Initiates play interaction** **At any time during the assessment, has the child initiated any play interactions with you? This could include:** • Smiling at you, then hiding, during the peek-a-boo • Handing you the washcloth to play peek-a-boo • Dropping an object from the table repeatedly and waiting for you to pick it up • Offering you an object then snatching it away when you reach for it • Breaks the tower of blocks and smiles at you **If not, encourage the child to play with you, for example by playing peek-a-boo with a blanket or cloth, and then wait for the child to initiate some play interactions with you.** **Child initiates at least 1 play interaction**	**0 1**	BEL17
18	**Uses words appropriately** **During the assessment has the child used any words with meaning for an object or situation without copying another person? If yes, circle 1 and go to next item. Otherwise:** 1. Show the child some familiar objects 2. See if they use words to describe them Words that child might use include mama, dada, baba, uh-oh, ball, cup. They need to use different words with meaning even if poorly articulated (copying words said by others does not count) Count the number of words the child has used**.....** **Child uses at least 2 words appropriately** **Child uses at least 8 words appropriately** Code in **BEL23: 0 1**	**0 1**	BEL18
19	**Uses words to make wants known** **At any time during the assessment, has the child used words to make their wants or needs known to others? These might include: up, down, more, less, mine, yours, no, yes, want, please, bottle** **Child uses at least 1 word to make their wants or needs known**	**0 1**	BEL19
*M/N 20	**Names Object: Story book, small ball, doll, spoon & plastic cup** 1. Place all the above objects on the table within child's reach. 2. Give child time to explore the objects. 3. As child picks up an object say: **"what do you have?"** or **"what is that?"** 4. If child does not pick up every object – pick up the leftover objects one by one and say: **"what is this?"** or **"what do I have?"** 5. Tick items child correctly names ☐ Story book ☐ Ball ☐ Doll ☐ Spoon ☐ Plastic cup **Child correctly names at least 1 object (poor articulation is ok as long as meaning is clear)** **Child correctly names at least 3 objects (poor articulation is ok as long as meaning is clear)** Code in **BEL27: 0 1**	**0 1** **0 1**	BEL20
21	**Combines word and gesture** **At any time during the assessment, has the child used a gesture along with a word to express themselves? For example, saying "go" and pointing to the door, or saying "ball" and reaching for the ball?** **Child uses at least 1 word & gesture combinations**	**0 1**	BEL21

22	**Names pictures: Picture Book** 1. **Put the Picture Book on the table in front of the child, open at page 10-11.** 2. Bring the child's attention to the pictures of the baby & dog. Ask child to name pictures as you point to them by saying something like: **"tell me, what is this?"** or **"what is this?"** 3. After they have understood the task with the baby & dog (the training items) go to page 12 and ask them **to name each of the pictures** on pages 12-15. **Point to the picture and say "tell me, what is this" or "what is this" to prompt child.** 4. Tick each item they get one correct: ☐ Ball ☐ spoon ☐ kitten ☐ Bed ☐ Bird ☐ shoe(s) ☐ balloon ☐ Apple ☐ Bottle ☐ Biscuit ☐ car ☐ book **Child gets at least 1 tick in above boxes** **Child gets at least 5 ticks in above boxes** Code in **BEL28: 0 1**	**0 1**	BEL22
***O 23**	**Uses words appropriately** ***Copy response for BEL23 from item 18***	**0 1**	BEL23
24	**Answers Yes or No verbally** **Play with the child. Ask them yes/no questions about the things they are playing with. For example: "do you like that____?" or "do you want the _____?" or "can I have the _____?"** **Child uses yes and/or no (and variations such as 'yeah' & 'uh-huh') appropriately at least 2 times**	**0 1**	BEL24
25	**Imitates two word utterance** **At any time the assessment, has the child imitated any two or more word phrases? If yes, code 1 and go to next item.** **If not, prompt the child to do this by speaking to them in a playful or sing-song voice and say things like "mama go", "daddy eat", "baby drink", "put here", "my ball", "big dog", "what's this?".** **Child imitates phrases with at least 2 different words (poor articulation is ok as long as meaning is clear)**	**0 1**	BEL25
26	**Uses two-word utterance** **At any time during the assessment, has the child spontaneously made two-word utterances, such as "you do", "where dada", "want bottle", "no night night", "more cookie".** **Note each word must contribute a different meaning. Sentences like "oh no", "all gone" or "bye bye" don't count.** **Child did this at least 1 time**	**0 1**	BEL26
***P 27**	**Names objects** ***Copy response for BEL27 from item 20***	**0 1**	BEL27
28	**Names pictures** ***Copy response for BEL28 from item 22***	**0 1**	BEL28
29	**Uses multiple-word utterance** **At any time during the assessment, has the child used any 3 or more word sentences?** These can include anything and doesn't need to be grammatically correct. Examples include: "daddy go home", "give me toy", "do it again", "I want that", "me get ball". **Child has done this at least 2 times**	**0 1**	BEL29

*Q 30	**Uses pronouns: Doll & several blocks without holes** **At any time during the assessment, has the child used any of the following pronouns 1 or more times: me, my, mine, I, you, it, he, she, we, us, they, them, him, her, our, their, yours, his, hers, ours, theirs**. If yes, code 1 and go to next item. Otherwise, try and get the child to do this, by setting up play situations and prompting the child to describe them. For example: 1. Have the doll fall over. Say to the child: **"uh oh, what happened?"** 2. Build a tower with the blocks and then knock the blocks down. Ask the child, **"What happened?"** Build it again and encourage them to knock it down. Ask them **"who knocked it down"?** 3. Show the blocks to the child. Take one and say **"here's my block".** Move another one to the child and say **"and here's____"** **Child uses at least 1 pronoun. They don't have to use the word correctly**	**0 1**	BEL30
31	**Names action pictures: Picture book** **Put the Picture Book on the table in front of the child, open at page 16-17.** **Ask the child to describe the action in the pictures on pages 16-21, as you point to each one. You can prompt by saying "what's happening?" or "what's he/she doing?" Tick each time they get one right.** **Page 16-17**: ☐ Sleeping ☐ Eating ☐ Playing ☐ Swimming **Page 18-19**: ☐ running ☐ kicking ☐ hugging ☐ swinging **Page 20-21**: ☐ yawning ☐ mopping ☐ washing ☐ vacuuming **Child gets at least 1 tick in above boxes** **Child gets at least 3 ticks in above boxes** Code in **BEL35: 0 1** **Child gets at least 5 or ticks in above boxes** Code in **BEL37: 0 1**	**0 1**	**BEL31**
32	**Poses multiple word questions** **At any time during the assessment, has the child used any 2 or more word questions, such as: "who's that?", "what's that?", "where we going?", "mummy go?"** The question doesn't need to be grammatically correct **Child has done this at least 1 time**	**0 1**	BEL32
32	**बहुत सारे शब्द वाले प्रश्न पूछना** **मुल्यांकन के दौरान किसी भी समय, क्या बच्चे ने दो या उससे अधिक शब्दों वाले प्रश्नों का इस्तेमाल किया, जैसे कि "वो कौन है?", "वह क्या है?", " हम कहाँ जा रहे हैं?"** जरुरी नहीं है कि प्रश्न व्याकरण के अनुसार सही हो। **बच्चे ने कम से कम 1 बार ऐसा किया**	**0 1**	BEL32

33	**Makes a contingent utterance** **At any time during the assessment, has the child said a sentence which adds additional information to something you said?** Examples are: you said "here's a car" and the child said "car green" you said "the baby is tired" and the child said "tired, go to sleep"' you said "here's your ball", and the child said "big ball" **Child has done this at least 1 time**	**0 1**	BEL33
34	**Uses Verb + ing: Stimulus book** **(Item 34; pg. 151)** Open the book on the table directly in front of the child to expressive item 34 (pg. 151) Direct the child's attention to the picture on the left side of the page and say **"Look. This girl is sitting (eating)".** Now, • Point to the lower right and say: **"what about this baby?"** • Point to the upper right and say: **"Tell me about this boy"** **Child uses at least 1 verb ending in –ing to describe actions in the pictures, for example: "eating", "sleeping"**	**0 1**	BEL34
35	**Names action pictures** ***Copy response for BEL35 from item 31***	**0 1**	BEL35
36	**Uses different word combinations** **At any time during the assessment, has the child used any sentences with 2 or more words? If yes, tick the sentence structures used by the child:** ☐ noun + verb (e.g., mommy go) ☐ verb + noun (e.g., want toy) ☐ adjective + noun (e.g., big dog, blue car) ☐ Noun + verb + location (e.g., baby go home) ☐ Noun + verb + adjective (e.g., cookies are good) ☐ Other (e.g., my bear, daddy's car, mummy's shoe, who that? mummy me play?) **Child gets at least 3 ticks in above boxes**	**0 1**	BEL36
37	**Names action pictures** ***Copy response for BEL37 from item 31***	**0 1**	BEL37
38	**Uses plurals: Stimulus book** **(Item 38; pg. 153)** Open the book on the table directly in front of the child to expressive item 38 (pg. 153). Direct the child's attention to each of the pictures and say: **"what are these?"** or **"tell me what these are".** Tick the pictures the child correctly names, using a plural. This means that they say, for example, "horses", not "horse". ☐ Shoes ☐ Horses ☐ Socks ☐ Cookies ☐ Babies ☐ Blocks ☐ Books **Child gets at least 5 ticks in above boxes**	**0 1**	BEL38

39	**Answers what and where questions: Stimulus book** **(Item 39; pg. 155)** Open the book on the table directly in front of the child to expressive Item 39 (pg. 155). Direct the child's attention to the pictures: ☐ Point to the left and say: "what is he going to do?" [answer is: go to sleep] ☐ Point to the upper right and say: "what does he have?" [answer is: blocks] ☐ Point to the lower right and say: "where is this boy?" [answer is: in the car] Tick each one the child gets correct. **Child gets at least 2 ticks in above boxes**	**0 1**	BEL39
40	**Uses Possessives: Stimulus book** **(Item 40; pg. 157)** Open book on the table directly in front of the child to expressive Item 40 (pg. 157). Direct the child's attention to the pictures and: 1. Say **"This is the boy's cat. Whose cat is this?"** Tick if: ☐ Child says "his cat" or "boy's cat". Saying "boy cat" doesn't count 2. Say **"This is the dog's food. Whose food is this?"** Tick if: ☐ Child says "his food", "her food" or "dog's food". Saying "dog food" doesn't count. **Child gets at least 1 tick in above boxes**	**0 1**	BEL40
41	**Names colours: Stimulus book** **(Item 41; pg. 159)** Open book on the table directly in front of the child to expressive Item 41 (pg. 159). Direct the child's attention to the picture of the crayons and ask them to name each colour by saying something like **"what colour is this?"** or **"tell me what colour this crayon is"**. ☐ Red ☐ White ☐ Green ☐ Brown ☐ Yellow ☐ Purple **Child gets at least 4 ticks in above boxes**	**0 1**	BEL41
42	**Answers questions logically** **Tell the child you want to ask them some questions.** First do a practice question. Say: **"what do you do if you are hungry?"** You can give a hint or model a response for this practice item. Now do the real questions by asking the following and ticking if they give a logical response: ☐ **"What do you do if you are sleepy?"** [responses include: "go to sleep", "go to bed"] ☐ **"What do you do if your hands are dirty?"** [responses include: "wash them", "use some soap"] ☐ **"What do you do if you are cold?"** [responses include: "put a jacket/sweater on", "put a hat on, get inside the blanket"] **Child gets at least 2 ticks in above boxes**	**0 1**	BEL42

Last item tested:			BELLASTITEM

SPRING 18 Months Assessment: Bayley Scales of Infant and Toddler Development-III

Language Scale: Receptive

Identifying information	**RECEPTIVELANG**	AW:	BATCHNO
Cluster			CLUSTER
Village			VILLAGE
Household No			HH
Mother name		Husband Name	
Child name		Child DOB & Sex	&
Twin	-------- Woman ID	# # # #	WOMANID
	Child ID	CHILD # # # # #	CHILDID

Visit Information		
Assessor code		ASSESSOR
Date of visit	d d - M M M - y y y y	DATEVISIT
Form status	1. Completed 2. Incomplete (Please specify on 18MONTHVISIT FORM)	FORMSTATUS
Supervisor Code (If present)		SUPERVISOR

START THE ASSESSMENT AT ITEM 13 ITEMS 8-12 will be completed depending on RESPONSES TO ITEMS 13-15 (as explained later on page 3 after item 15)			
Item no.	**Receptive Language**	**Score**	**Variable Name**
*I 8	**Sustained play with objects** **Play with child using different objects of interest and try to keep them interested.** **Child uses objects for at least 60 seconds** (Code 1 if they have very none or only short lapses of attention)	**0 1**	BRL8
9	**Responds to name** **During the assessment, have you seen the child respond to their name?** If yes – code 1. If no, do the following: 1. Stand beside child and call them by their name. 2. Wait briefly, then call the child by an unfamiliar name. 3. Wait briefly and call them by their name again. **Child turns their head both time their name is called but not when the unfamiliar name is called**	**0 1**	BRL9
*J 10	**Interrupts activity when name called** 1. Engage child's interest in an object. 2. Allow them to play independently. 3. Call child's name. **Child looks up and briefly pauses during play when you call their name**	**0 1**	BRL10
11	**Recognizes 2 familiar words** 1. Attract child's attention and talk to them using words that won't interest a child 2. Don't change volume or emphasis – now use words that are familiar to child (original example ball, mommy, bottle, baby) 3. Observe child's response 4. Use the names of two separate objects (avoid two word sentences) **Child responds differently to at least 2 familiar words** by changing facial expression, vocalizing or trying to imitate the words. The child might also look around for the object named	**0 1**	BRL11
12	**Responds to No-No** **Place an object that the child seems interested in within their reach.** When the child reaches for it say **"no-no"** in a firm voice **Child stops reaching for the object when you say "no-no"** (either permanently or for a brief moment)	**0 1**	BRL12

START THE ASSESSMENT HERE			
Item no.	**Receptive Language**	**Score**	**Variable Name**

***K/L 13**	**Attends to other's play routine** **Start a play routine with the child** (or ask the mother/grandmother to do it). This might include: pat-a-cake, tickle games, peek-a-boo, how big is the baby? So big!, itsy-bitsy spider, roll the ball from one to another **Child maintains attention and enjoys interacting with you or the caregiver in this routine for at least 60 seconds** (Code 1 even if the child doesn't actively participate but is maintaining attention and enjoying)	**0 1**	BRL13
14	**Responds to request for social routines** **Ask child to perform a social routine.** This might include: pat-a-cake, peek-a-boo, saying hello, blowing kisses or anything the child is familiar with. (Don't do waving 'bye-bye' during the middle of a testing session). **Child responds appropriately to at least 1 spoken request**	**0 1**	BRL14
***M 15**	**Identifies Object: Story book, Plastic cup, spoon, small ball & doll** **Place all the above items in a line in front of the child.** Ask child to identify each object (in any order – not the same as the order you put them on the table) by saying **"where's the book?"**or **"show me the book"** or **"get the book". Tick correct responses** ☐ Story book ☐ Ball ☐ Doll ☐ Spoon ☐ Plastic cup **Child correctly identifies at least 1 object by pointing, touching, looking at clearly, picking it up, giving it to you** **Child correctly identifies at least 3 objects** Code in **BRL19: 0 1**	**0 1**	BRL15

NEXT STEPS

CHECK CODES FOR ITEMS 13, 14 & 15 and proceed as indicated:

ITEMS 13, 14 & 15: ALL 1s	ACTION
YES	1. Strikethrough items 8-12 2. Continue from item 16
NO	1. Administer items 8-12 2. Review codes for items 8-12: Check that there are at least 3 consecutive 1s a. If YES, go to item 16 b. If NO, stop this assessment here and complete a Referral slip

Stopping Rule: Assessment stops when 5 consecutive items are coded 0.

Item no.	Receptive Language	Score	Variable Name
16	**Identifies objects in the environment** 1. Identify an object that the child's caregiver indicates that the child is familiar with. (Don't use anything used in the previous items) 2. Make sure caregiver doesn't identify the object by naming & pointing 3. Ask child to show you the object by saying **"where is your bed"** or **"show me your shoes"**, **"table?"** **DO this only once with any one object** **Child correctly identifies object by pointing, touching, looking at clearly, picking up, giving to you**	**0 1**	BRL16

17	**Identifies Pictures: Picture book** 1. Open picture book to page 1 and place on table in front of child. 2. Direct child's attention to the training items. Say: **"show me the baby & the dog".** 3. If they don't do this – point to the pictures & name them 4. Now show pages 2-3 and then 4-5. Say **"show me the…"**for each of the assessment items below (tick when identified correctly): ☐ Ball ☐ Bed ☐ Kitten ☐ Spoon ☐ Shoe ☐ Book ☐ Car ☐ Apple ☐ Bird ☐ Cookie ☐ Bottle ☐ Balloons **Child gets at least 1 tick in above boxes** Child gets at least 3 ticks in above boxes Code in **BRL21: 0 1**	**0 1**	BRL17
18	**Understands inhibitory words: 6 blocks without holes** **Play with the child as follows:** 1. Stack 6 blocks and knock them down 2. Stack the blocks and let the child knock them down, encourage the child if necessary 3. Stack the blocks again – if the child reaches for the blocks say **"Wait!"** or **"Not yet!"** 4. See if the child responds **Child pauses in response to your words**	**0 1**	BRL18
***N 19**	**Identifies objects** ***Copy response for BRL19 from item 15***	**0 1**	BRL19
20	**Follows one-part direction: Spoon, comb, washcloth & doll** **Sit doll on table within the child's reach.** Draw the child's attention to the doll. Do not point at the doll. Do the following: ☐ Hand spoon to child and say **"The baby is hungry. Feed the baby"** ☐ Offer the comb to the child in exchange for the spoon. Say: **"Comb the doll's hair"** ☐ Offer a washcloth in exchange for the comb. Say: **"Wipe the doll's nose (mouth)"** **Tick actions child carries out correctly** If the child does something else, like combing their own hair – repeat the instructions but do not point at the doll. **Child responds correctly to at least 2 directions with doll**	**0 1**	BRL20
21	**Identifies pictures** ***Copy response for BRL21 from item 17***	**0 1**	BRL21

*O 22	**Identifies clothing items** Ask the child to identify the clothing items listed below that you, the child, or the mother (or caregiver) is wearing. Say: **"show me/point to my/your/your mother's _____"** for the following items (tick when identified): ☐ shoes ☐ shirt ☐ pants ☐ socks ☐ shorts ☐ hat ☐ skirt **Child gets at least 3 ticks in above boxes**	**0 1**	BRL22
23	**Identifies action pictures: Picture book** Show pages 6-7, and then 8-9. Ask the child to identify the actions. Say: **"show me" or "point to"** (tick if identified correctly)**:** Page 6-7: ☐ Sleeping ☐ Eating ☐ Riding ☐ Waving Page 8-9: ☐ Drinking ☐ Washing ☐ Reading ☐ Running **Child gets at least 1 tick in above boxes** **Child gets at least 3 ticks in above boxes** Code in **BRL26: 0 1** **Child gets at least 5 ticks in above boxes** Code in **BRL29: 0 1**	**0 1**	BRL23
24	**Identifies body parts** 1. Say to the child: **Show me your hair"** or **"Touch your hair"** 2. Then repeat for all items below (tick when identified correctly) ☐ Hair ☐ Hands ☐ Feet ☐ Eyes ☐ Nose ☐ Ears ☐ Mouth ☐ Stomach/Tummy ☐ Head **Child gets at least 5 ticks in above boxes**	**0 1**	BRL24
*P 25	**Follows 2 part directions: Spoon, Small Ball & Bracelet** Select three objects the child has previously shown interest in. Put them near the child but not on the assessment table. Say: ☐ **"Get the spoon and put it on the table"** ☐ **"Pick up the ball and give it to me"** ☐ **"Pick up the bracelet and give it to mommy"** Tick if the child correctly follows both steps in at least one of the two-part direction. **Child gets at least 1 tick**	**0 1**	BRL25
26	**Identifies action pictures** ***Copy response for BRL26 from item 23***	**0 1**	BRL26

27

Understands use of objects: Stimulus book
(Item 27; pg. 79)
Open the book in front of the child at receptive item 27 (pg. 79). Say:

"show me" or **"point to"**:	**Tick Correct Answers**	
(a) What you ride	Tricycle	
(b) What you wear in foot	Shoe	
(c) What you use to drink water	Glass	
(d) What you draw with	Crayon	
(e) What you cook with (What does mommy makes tea with)	Pot	
(f) What you use to cut hair	Scissors	

Child gets at least 3 ticks in above boxes **0 1** BRL27

***Q 28**

Understands part/whole relationships: Stimulus book
(Item 28; pg. 81)
Open on the table directly in front of the child at receptive item 28 (pg. 81).

Ask the child to point to the following items in the picture.
Say **"show me _____"** or **"point to_____"**

☐ **Wheels** of the car
☐ **Nose** of the dog
☐ **Tail** of the dog
☐ **Door** of the car

Child gets at least 3 ticks in above boxes **0 1** BRL28

29

Identifies action pictures

Copy response for BRL29 from item 23 **0 1** BRL29

30

Understands pronouns: Doll , 3 plastic cups & 3 spoons

1. Sit the baby (doll) up between you and the child.
2. Place the 3 plastic cups and 3 spoons in a pile in front of the child.
3. Say: **"This is a baby. Let's play house. Help me get ready. You take a cup."**
4. Then, without using gestures, head nods, or looking at the one who gets the cup & spoon say the following:
   - **(a) Give a cup to him**
   - **(b) Now give a cup to me**
   - **(c) Where is my cup?**
   - **(d) You take a spoon**
   - **(e) Now give a spoon to me**
   - **(f) Give one spoon to him**
   - **(g) Where is my spoon?**
   - **(h) Show me your spoon**
5. Tick instructions that the child responds correctly to.
6. Then spend a brief time playing house before telling child this is over and everything needs to be put away.
7. Tick boxes below for the pronouns that the child understood (at least once)

☐ Him ☐ Me ☐ My ☐ You ☐ Your

Child gets at least 3 ticks in above boxes **0 1** BRL30

31	**<u>Understands sizes: Stimulus book</u>** **(Item 31; pg. 83)** Open the book on the table directly in front of the child at receptive item 31 **(**pg. 83). Say the following and tick if the child identifies both **big** & **little** item: ☐ **"Look at the shoes"** (point to the shoes)**. "Show me the big shoe. Show me the little shoe"** ☐ **"Here are two trucks"** (point to the trucks)**. "Point to the little truck. Point to the big truck"** ☐ **"Look. Two dogs"** (point to the dogs)**. "Which one is little? Which one is big?"** **Child gets at least 2 ticks in above boxes**	**0 1**	BRL31
32	**<u>Understands Prepositions: Cup with handle (upside down), shoelace & one block with hole</u>** **Place all the above items on the table within child's reach.** **Say the following and tick if the child correctly carries out the instruction and understands the preposition (these are the words underlined)** ☐ **Put the block <u>on</u> the cup** ☐ **Put the string <u>through</u> the block** ☐ **Put the string <u>around</u> the cup** ☐ **Put the block <u>against</u> the cup** **Place the cup and string on the table, approximately 4 inches (10 cm) apart. Place the block near the string on the side farthest from the cup. Say:** ☐ **Put the block <u>between</u> the cup and the string** **Place a cup and a block in the child's hands. Say:** ☐ **Put the block <u>in</u> the cup <u>after</u> you put the cup on the table** **Child gets at least 2 ticks in above boxes**	**0 1**	BRL32
33	**<u>Understands Possessives: Stimulus book</u>** **(Item 33a - c; pg. 85 – 87)** Open the book on the table directly in front of the child at receptive item 33a (pg. 85) Say: **"Show me the _____"** or **"Point to the_____"** and tick if the child identifies by pointing to or touching correctly: ☐ **33a: boy's car** ☐ **33b: baby's bear** ☐ **33c: cat's ball** **Child gets at least 2 ticks in above boxes**	**0 1**	BRL33
34	**<u>Understands Verb: Stimulus book</u>** **(Item 34a – b; pg. 91 – 93)** Open the book on the table directly in front of the child at receptive item 34a (pg. 88). Say: **"show me the picture where_____"** and tick if the child identifies by pointing to or touching correctly: ☐ **34a. The girl is brushing her teeth** ☐ **34b. The children are swimming** **Child gets ticks in both the above boxes**	**0 1**	BRL34

35	**<u>Identifies colours: Stimulus book</u>** **(Item 35; pg. 95)** Open the on the table directly in front of the child at receptive item 35 (pg. 95). Say **"Look at all the crayons. Show me the _____ one"** or **"Point to the _____one";** and tick if the child identifies by pointing to or touching correctly: ☐ **Red** ☐ **white** ☐ **Green** ☐ **Brown** ☐ **Yellow** ☐ **Purple** **Child gets at least 4 ticks in above boxes**	**0**	**1**	BRL35
36	**<u>Understands Label of One: Stimulus book</u>** **(Item 36; pg.97)** Open the book on the table directly in front of the child at receptive item 36 (pg.97). Say: **"**These children are holding balloons. Show me the child holding **one** balloon" **Child identifies correct picture** by pointing or touching	**0**	**1**	BRL36
37	**<u>Understands Pronouns: Stimulus book</u>** **(Item 37a – c; pg. 99-103)** Open book on the table directly in front of the child at receptive item 37a (pg. 99). Say: **"Show me where_____";** and tick if the child identifies by pointing to or touching correctly ☐ **37a: they are playing** ☐ **37b: she is on the stairs** ☐ **37c: he is in the pool** **Child gets at least 2 ticks in above boxes**	**0**	**1**	BRL37
38	**<u>Understands Pronouns: Stimulus book</u>** **(Item 38; pg. 105)** Open book on the table directly in front of the child at receptive item 38 (pg. 105). Say: **"Look at these children"** [point in order to relevant picture and tick if child correctly identifies both *his* and *her* in that item]: ☐ (Upper left) They put their shoes on to go outside & play. Show me **his** shoes. Show me **her** shoes. ☐ (Upper right) These children are wearing jackets. Show me **her** jacket. Show me **his** jacket ☐ (Lower left) Look at these children. They have their hats on. Show me **his** hat. Show me **her** hat ☐ (Lower right) These children are playing with blocks. Point to **her** blocks. Point to **his** blocks **Child gets at least 3 ticks in above boxes**	**0**	**1**	BRL38
39	**<u>Understands Plurals: Stimulus book</u>** **(Item 39; pg. 107)** Open book on the table directly in front of the child at receptive item 39 (pg. 107). Say: **"show me the picture where_____"** and tick if the child identifies by pointing or touching correctly: ☐ **The boy is holding his balloon** ☐ **The girl is holding her balloon** ☐ **The boy is holding his balloons** ☐ **The girl is holding her balloons** **All 4 boxes are ticked**	**0**	**1**	BRL39

40	**<u>Understands More: Stimulus book</u>** **(Item 40a – b; pg. 109 – 111)** Open the book on the table directly in front of the child at receptive item 40a (pg. 109) Say: **"show me"** and tick if the child identifies by pointing to or touching correctly: ☐ **40a. Who picked more apples?** ☐ **40b. Who has more blocks?** **Child identifies both pictures correctly**	**0 1**	BRL40

Last item tested:			BRLLASTITEM