Establishing a healthy growth trajectory from birth: The Baby Milk Trial

Raj Lakshman
Clinical Investigator Scientist & Consultant in Public Health Medicine
Outline

- Infant feeding in obesity prevention

- The *Baby Milk* trial (669 Formula-fed babies, 93% FU at 6 months)

- The *Baby Milk* intervention (MRC Framework for complex interventions, social cognitive theory)

- Results (significant changes in maternal attitudes, baby’s milk intake, weight gain to 6 months)

- Conclusions & next steps
Why infancy?

- In UK over 1 in 5 children overweight (13%) or obese (10%) by 6yrs National Child Measurement Programme 2011

- Rapid weight gain during infancy is associated with later obesity

- Infancy is a period of rapid growth and habit formation

- Evidence of programming
  - Appetite
  - Flavour
  - Metabolic

Ekelund et al 2006 AJCN
Why infancy and energy intake?

- Maximum growth velocity during infancy
- First year weight triples: 3kg to 9kg
- Energy used for growth
  - 40% 1st month
  - 3% at 12 months
  - 1-2% till adolescence
- Energy intake predicts growth
Why formula-milk?

- Formula-fed babies grow faster
- In UK 78% of babies are formula-fed at 6 weeks [Infant Feeding Survey 2010]
- 2004 FAO/WHO/UNU recommendations 15-20% lower than 1985
- Formula-fed babies likely to be overfed
- Larger portion sizes, overriding satiety cues
What is the Baby Milk Trial?

- Explanatory RCT to examine the **safety, acceptability and effectiveness** of the *Baby Milk* intervention
  - Prevent excess weight gain during infancy
  - Reduce formula milk intake

- Understand the underlying psychological mediators
How we designed the intervention & evaluation

- Systematic Reviews
- Qualitative studies
- Questionnaire development
- Iterative process
- Multi-disciplinary team

Campbell; 2007; BMJ Framework for complex interventions
Aim: how parents decide on how much and how often to feed their babies?

23 studies
No literature on this

Inadequate information and support
Negative emotions- guilt, worry, sense of failure
Mistakes in feed preparation
Frequent formula-feed changes
Guide to bottle feeding
How to prepare infant formula and sterilise feeding equipment to minimise the risks to your baby

Infant milks in the UK

Helen Crawley and Susan Westland
THE CAROLINE WALKER TRUST

New moth formula milk, researchers said.
Developing a programme for healthy growth and nutrition during infancy: understanding user perspectives

R. Lakshman,*† J. R. Landsbaugh,*† A. Schiff,*† S. Cohn,‡ S. Griffin*† and K. K. Ong*†§

- Interviews, Focus groups
- Mothers, Healthcare providers

‘I had no advice on bottle feeding and he was crying so much that I was feeding him every ten minutes…..’

‘He drank for six and a half hours and he was swallowing for six and a half hours. He would drink about two and a half bottles. .....sometimes he’d have nine bottles a day.’
The Baby Milk intervention

I intend to follow the *Baby Milk Feeding Guidelines*

This is how I plan to put the *Baby Milk Feeding Guidelines* into action

This is how I will stick to the *Baby Milk Feeding Guidelines* when the going gets tough

Techniques

Communication skills

Motivation

Action Planning

Coping Planning
The Baby Milk intervention

What if the baby cries between feeds?

Trying to figure out why your baby is crying can be tricky at first until a schedule is established. It is easy to make the mistake of assuming that crying always means your baby must be hungry and needs feeding. However, babies cry for different reasons. They may be thirsty, tired, cold, hot, have a dirty nappy or want some attention. When following the new recommendations it is important to give your baby some cooled, boiled water between feeds so that your baby gets sufficient fluids.

It will be very helpful if you can keep a record of how closely you follow the recommendations each day. List any difficulties that you have in following the recommendations so that we can discuss these at each of your visits.

How do I know if my baby is getting sufficient milk?

The most accurate way to know if your baby is getting sufficient milk is to monitor their growth. In the days immediately after birth it is normal for a baby to lose some weight. However, babies usually regain their birth weight within the first two weeks. Babies also go through periods when they grow fast and other times when they do not grow as fast. It is therefore recommended that babies do not need to be measured more often than:

- once a month for the first six months
- once every two months from six months to one year
- once every three months after one year.

On a day-to-day basis, a baby who is getting sufficient milk will be settled between feeds, have awake and alert periods, and have at least six wet nappies over 24 hours. Babies will also give signals that they have had enough milk such as spitting out the feed, playing with the test, falling asleep during the feed or not drinking. It is important to pay attention to these signals and not to force your baby to finish all the milk in the bottle.

<table>
<thead>
<tr>
<th>Age</th>
<th>Feeds per day</th>
<th>Scoops per feed</th>
<th>ml</th>
<th>Total scoops/ml per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth – 1 month</td>
<td>6</td>
<td>3</td>
<td>6x90</td>
<td>18 scoops/540ml</td>
</tr>
<tr>
<td>1-2 months</td>
<td>6</td>
<td>3 feeds of 3 scoops 3 feeds of 4 scoops</td>
<td>3x90 3x120</td>
<td>21 scoops/630ml</td>
</tr>
<tr>
<td>2-4 months</td>
<td>5</td>
<td>3 feeds of 4 scoops 2 feeds of 5 scoops</td>
<td>3x120 2x150</td>
<td>22 scoops/660ml</td>
</tr>
<tr>
<td>4-6 months</td>
<td>5</td>
<td>6</td>
<td>5x180</td>
<td>30 scoops/900ml</td>
</tr>
<tr>
<td>6-7 months</td>
<td>4</td>
<td>7</td>
<td>4x210</td>
<td>28 scoops/840ml</td>
</tr>
<tr>
<td>7 months onward</td>
<td>3</td>
<td>7</td>
<td>3x210</td>
<td>21 scoops/630ml</td>
</tr>
</tbody>
</table>
Babies introduced to formula feeds within 14 weeks of birth

Baseline visit (n=669, mean age 2.3 months)

Intervention (n= 340)

Control (n= 329)

Behavioural intervention

Standard advice

Baby’s age 6 months: End of intervention

93% 6 months (n= 310) 6 months (n= 314)

88% 12 months (n= 293) 12 months (n= 293)
Results: Baseline characteristics, babies

<table>
<thead>
<tr>
<th></th>
<th>Control (n=329)</th>
<th>Intervention (n=340)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, months</td>
<td>2.3 (1.0)</td>
<td>2.3 (1.0)</td>
</tr>
<tr>
<td>Gestational age, weeks</td>
<td>39.6 (2.7)</td>
<td>39.7 (1.4)</td>
</tr>
<tr>
<td>Female (%)</td>
<td>150 (45.6%)</td>
<td>158 (46.5%)</td>
</tr>
<tr>
<td>Fully formula-fed (%)</td>
<td>277 (93.3%)</td>
<td>277 (95.5%)</td>
</tr>
<tr>
<td>First born (%)</td>
<td>167 (53.0%)</td>
<td>174 (51.9%)</td>
</tr>
<tr>
<td>Birth weight, kg</td>
<td>3.41 (0.5)</td>
<td>3.47 (0.5)</td>
</tr>
</tbody>
</table>

Means (SD) for continuous variables, Numbers (%) for categorical variables; SDS using WHO 2006 growth charts
## Results: Baseline characteristics, mothers

<table>
<thead>
<tr>
<th></th>
<th>Control n=329</th>
<th>Intervention n=340</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, years</strong></td>
<td>31.3 (5.8)</td>
<td>31.9 (5.9)</td>
</tr>
<tr>
<td><strong>BMI, kg/m^2</strong></td>
<td>27.8 (5.4)</td>
<td>28.1 (5.5)</td>
</tr>
<tr>
<td><strong>Pregnancy weight gain, kg</strong></td>
<td>12.7 (6.9)</td>
<td>13.0 (6.8)</td>
</tr>
<tr>
<td><strong>Age completed education, years</strong></td>
<td>19.5 (3.6)</td>
<td>19.6 (3.5)</td>
</tr>
<tr>
<td><strong>Degree or higher</strong></td>
<td>38.3%</td>
<td>37.4%</td>
</tr>
<tr>
<td><strong>Professional, higher managerial, administrative occupation</strong></td>
<td>52.3%</td>
<td>43.3%</td>
</tr>
<tr>
<td><strong>White ethnicity</strong></td>
<td>93.1%</td>
<td>95.8%</td>
</tr>
<tr>
<td><strong>Married</strong></td>
<td>58.2%</td>
<td>56.9%</td>
</tr>
<tr>
<td><strong>Smoked during pregnancy</strong></td>
<td>12.0%</td>
<td>11.3%</td>
</tr>
<tr>
<td><strong>Consumed alcohol during pregnancy</strong></td>
<td>20.2%</td>
<td>17.2%</td>
</tr>
</tbody>
</table>

Means (SD) for continuous variables
Numbers (%) for categorical variables
Results: Differences in milk intake ml/d

![Graph showing differences in milk intake ml/d across different % starting solids and age groups. The graph compares Control, Intervention, and Estimated Average Requirement (assuming exclusive milk-fed).](image-url)
Results: Differences in weight SDS to 6mo

*Change in weight SDS from baseline to 6 months (adjusted for baseline)
-0.08,
[95% CI; -0.17, -0.004]
Results: % crossing 1 centile (0.67 SDS) to 6mo

OR: 0.74
[0.51, 1.07]
Explanatory RCT: Causal modelling

Socio-economic, cultural, antenatal factors

Behavioural Determinants

Behaviour

Growth

Health Outcomes

Attitudes, self-efficacy, outcome-expectancy, intentions, - Questionnaires at baseline and 6-months

Milk feeding – Questionnaires at baseline, 3, 4, 5, 6 months, Diet diary at 8 months

Anthropometry at baseline, 6 and 12 months, USS and skin-folds at 12 months

Modelling long term outcomes, cost-effectiveness analyses, long term follow-up
## Study Measures

<table>
<thead>
<tr>
<th>Questionnaire measures</th>
<th>Baseline</th>
<th>6 mo</th>
<th>8 mo</th>
<th>12 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnancy, Demography, Lifestyle etc</td>
<td>I,C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk feeds (also at 3, 4, 5 mo)</td>
<td>I,C</td>
<td>I,C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Feeding and psychological mediators</strong></td>
<td>I,C</td>
<td>I,C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperament, sleep, eating behaviour</td>
<td>I,C</td>
<td>I,C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-day diet diary</td>
<td>I,C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health service utilisation</td>
<td>I,C</td>
<td></td>
<td>I,C</td>
<td></td>
</tr>
<tr>
<td>Maternal QoL</td>
<td>I,C</td>
<td>I,C</td>
<td>I,C</td>
<td></td>
</tr>
<tr>
<td>Intervention evaluation</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>

### Anthropometry

| Parents’ anthropometry                                                               | I,C      | I,C  | I,C  |       |
| Baby’s anthropometry                                                                | I,C      | I,C  | I,C  |       |

I- Intervention, C- Control group
Social Cognitive Theory

- **Self-Efficacy**
  - Confidence in performing a particular behaviour and in overcoming barriers to that behaviour
  - Baby cries, friends, partner/family, general

- **Outcome Expectancy**
  - Thoughts or beliefs about the results or consequences of a behaviour
  - Baby will be healthy, hungry, wake-up, best for baby, feel good

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Luszczynska A et al, 2005, Predicting Health Behaviours

Outcome expectancies:
- Physical
- Social
- Self-evaluative

Sociostructural factors:
- Facilitators
- Impediments

Development of a questionnaire to assess maternal attitudes towards infant growth and milk feeding practices

Rajalakshmi R Lakshman, Jill R Landsbaugh, Annie Schiff, Wendy Hardeman, Ken K Ong and Simon J Griffin

MRC | Medical Research Council
Results: changes in maternal attitudes
assessed on a 5-point Likert scale

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Difference in change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Important to monitor growth</td>
<td>0.05 [-0.03, 0.14]</td>
</tr>
<tr>
<td>Confident to get baby measured</td>
<td>0.00 [-0.09, 0.08]</td>
</tr>
<tr>
<td>Worried if too much weight gain</td>
<td>0.23 [0.12, 0.34]</td>
</tr>
<tr>
<td>Worried if too little weight gain</td>
<td>0.05 [-0.05, 0.15]</td>
</tr>
<tr>
<td>Possible to feed too much</td>
<td>0.46 [0.29, 0.62]</td>
</tr>
<tr>
<td>Possible to feed too little</td>
<td>0.16 [0.00, 0.31]</td>
</tr>
<tr>
<td>Confident to feed so not too much weight gain</td>
<td>0.18 [0.07, 0.30]</td>
</tr>
<tr>
<td>Confident to feed so enough weight gain</td>
<td>0.06 [-0.04, 0.17]</td>
</tr>
</tbody>
</table>

Favours control       Favours intervention
Results: changes in theory-based psychological mediators

<table>
<thead>
<tr>
<th>Mediator</th>
<th>Difference in change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-efficacy (3 items)</strong></td>
<td>1.26 [0.98, 1.54]</td>
</tr>
<tr>
<td>Self-efficacy (1 item*)</td>
<td>-0.14 [-0.30, 0.01]</td>
</tr>
<tr>
<td><strong>Outcome expectancy (5 items)</strong></td>
<td>0.98 [0.55, 1.40]</td>
</tr>
<tr>
<td><strong>Intensions (2 items)</strong></td>
<td>1.12 [0.91, 1.34]</td>
</tr>
</tbody>
</table>

* Items for self-efficacy were combined if Cronbach alpha ≥ 0.6. One self-efficacy item (“difficult to follow feeding recommendations without partner/family support”) was analysed separately as its inclusion in the combined self-efficacy score gave a Cronbach alpha of 0.4
Explanatory RCT: Causal modelling

- **Behavioural Determinants**
  - Attitudes, self-efficacy, outcome-expectancy, intentions,
    - Questionnaires at baseline and 6-months

- **Behaviour**
  - Milk feeding – Questionnaires at baseline, 3, 4, 5, 6 months, Diet diary at 8 months

- **Growth**
  - Anthropometry at baseline, 6 and 12 months, USS and skin-folds at 12 months

- **Health Outcomes**
  - Modelling long term outcomes, cost-effectiveness analyses, long term follow-up

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Socio-economic, cultural, antenatal factors
Results: Differences in weight SDS to 12 months

Change in weight SDS from baseline to 12 months (adjusted for baseline)

-0.04 [95% CI; -0.14, 0.07]
Results: % crossing 1 centile (0.67 SDS) to 12mo

OR: 0.84
[0.59, 1.17]
Summary & next steps

- A theory-based behavioural intervention to reduce formula-milk intake was **acceptable, safe** and **effective** in reducing milk intake, and slowed weight gain **to 6 months**

- But effects on calorie intake and weight were **not sustained**. Energy intakes at 8 months in both groups exceeded WHO recommendations (773kcal/day versus the WHO recommendations of 666kcal/day)
Summary & next steps

- A theory-based behavioural intervention to reduce formula-milk intake was **acceptable**, **safe** and **effective** in reducing milk intake, and slowed weight gain to 6 months.

- But effects on calorie intake and weight were **not sustained**. Energy intakes at 8 months in both groups exceeded WHO recommendations (773kcal/day versus the WHO recommendations of 666kcal/day).

- **Research in this area is recent and limited**.
Results in context

- The most recent systematic review identified 26 interventions (none targeted formula-milk intake) Blake-Lamb et al 2016

- 2 effective interventions altered the composition of formula-milk (hydrolysed/lower protein formula-milk)

- 7 effective interventions were behavioural (breastfeeding, sleep, weaning, maternal - child diet and physical activity)

  - Effective behavioural interventions were delivered for ~1 to 10 years

  - No interventions have shown long-term persisting effectiveness (i.e. months to years after the intervention ended)
## Summary of effective behavioural interventions

<table>
<thead>
<tr>
<th>Trial</th>
<th>Reference</th>
<th>Intervention target</th>
<th>Intervention duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRIP</td>
<td>Hakenen 2006</td>
<td>Family diet &amp; PA</td>
<td>Birth to 10yrs</td>
</tr>
<tr>
<td>Healthy Beginnings</td>
<td>Wen 2012</td>
<td>Family-child diet &amp; PA, breastfeeding</td>
<td>Pregnancy to 2 yrs</td>
</tr>
<tr>
<td>Lifestyle Counselling</td>
<td>Mustilla 2012</td>
<td>Mother diet &amp; PA</td>
<td>2mo to 4 yrs</td>
</tr>
<tr>
<td>Prevention of overweight</td>
<td>Verbesteel 2013</td>
<td>Family diet &amp; PA</td>
<td>9mo to 3 yrs</td>
</tr>
<tr>
<td>Maternal-child Pastoral</td>
<td>Navarro 2013</td>
<td>Mother-child diet, parenting</td>
<td>Pregnancy to 2 yrs</td>
</tr>
<tr>
<td>NOURISH</td>
<td>Daniels 2013</td>
<td>Diet- anticipatory guidance</td>
<td>4 to 15 mo</td>
</tr>
<tr>
<td>SLIMTIME</td>
<td>Paul 2011</td>
<td>Sleep &amp; diet</td>
<td>2wks to 6 mo</td>
</tr>
<tr>
<td><strong>INSIGHT</strong></td>
<td>Savage 2016</td>
<td><strong>Sleep, diet &amp; PA- responsive parenting</strong></td>
<td>2wks to 9 mo</td>
</tr>
</tbody>
</table>
Summary & next steps

• A theory-based behavioural intervention to reduce formula-milk intake was acceptable, safe and effective in reducing milk intake, and slowed weight gain to 6 months.

• But effects on calorie intake and weight were not sustained. Energy intakes at 8 months in both groups exceeded WHO recommendations (773kcal/day versus the WHO recommendations of 666kcal/day).

• Research in this area is recent and limited.

• Baby Milk would complement other interventions that target sleep, activity, the weaning period and beyond...

• **Population-level** change is required in addition to **individual-level** intervention.
ACKNOWLEDGEMENT

This work was undertaken by the Centre for Diet and Activity Research (CEDAR), a UKCRC Public Health Research Centre of Excellence. Funding from the British Heart Foundation, Economic and Social Research Council, Medical Research Council, the National Institute for Health Research, and the Wellcome Trust, under the auspices of the UK Clinical Research Collaboration, is gratefully acknowledged.

The trial is funded by the National Prevention Research Initiative (http://www.npri.org.uk). The Funding Partners relevant to this award are (in alphabetical order): Alzheimer's Research Trust; Alzheimer's Society; Biotechnology and Biological Sciences Research Council; British Heart Foundation; Cancer Research UK; Chief Scientist Office, Scottish Government Health Directorate; Department of Health; Diabetes UK; Economic and Social Research Council; Health and Social Care Research and Development Division of the Public Health Agency (HSC R&D Division); Medical Research Council; The Stroke Association; Wellcome Trust; Welsh Assembly Government; and World Cancer Research Fund.
The Baby Milk Team
http://www.mrc-epid.cam.ac.uk/research/studies/babymilk/

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Karen Forbes
Karen Poloka
Elizabeth White

**Measurement Team**
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Sarah Arnold
Chrissy-May Hall
Esther Fakeye
Richard Powell
Ruth Watson
With help from
Ema De Lucia Rolfe

**Study Management**
Fiona Whittle
Annie Schiff
Giesela Baker
With help from
James Sylvester
Gwen Bikerley
Susie Boatman

**The Scientists**
Raj Lakshman - Chief Investigator
Ken Ong - Programme Leader, MRC
Simon Griffin - Professor of Primary Care, MRC
Wendy Hardeman - Senior Lecturer, UEA
Simon Cohn - Senior Lecturer, UCAM
Marc Suhrcke - Prof Health Economics, UEA
Ed Wilson - Lecturer Health Economics, UCAM
Stephen Sharp - Senior statistician, UCAM
What determines obesity-related behaviours in young children?

- Obesity is common even in young children and habits formed in early life persist.
- A literature review on factors influencing behaviour has helped identify which ones to target with interventions to change behaviour.
- Parenting practices, such as role modelling, monitoring and feeding practices, are important influences across all behaviours.
- Provider training and nutrition policies are also positive influences in the early years setting.
1 in 5 children are overweight or obese when they start school and obesity tracks into later life, hence early prevention is important

Key issues

- Obesity is common even in young children and habits formed in early life persist.
- In order to change behaviour we need to understand the factors that influence the behaviour.
- Factors influencing children’s behaviours act at multiple levels (child, parents/family, childcare/preschool, community, policy).
- The study found that parental practices and early years settings (childcare/preschool) influenced young children’s behaviour.
- It found unhealthy behaviours cluster (e.g. sugar-sweetened beverage intake & TV viewing) and may be targeted together.

What we did

A literature review was conducted on the factors influencing:

1. Sugar sweetened beverage intake
2. Fruit & vegetable intake and
3. Physical activity & sedentary behaviours

in children under seven with the aim of informing interventions/policies to change these behaviours.

What next?

Knowledge gained from these reviews will inform early life obesity prevention interventions and guide future research.

Findings and implications

- Multi-level interventions (child, parents, early years settings) show promise in changing obesity-related behaviours in young children.
- Parental practices and factors in the early years settings are important modifiable determinants of these behaviours and should be targeted in future interventions.
- Research in this age-group is recent (mainly since 2007) and very few community or policy-level interventions have been evaluated.
- Sustainability, scalability and impact on inequalities need to be considered in future interventions.

References:


Prospero registration CRD42012002881

SPHR Contact/Find out more about this study at:

http://www.iph.cam.ac.uk/nihr-sphr/research/obesity/