Nutritional Deficiency – Impact on Toddler Development

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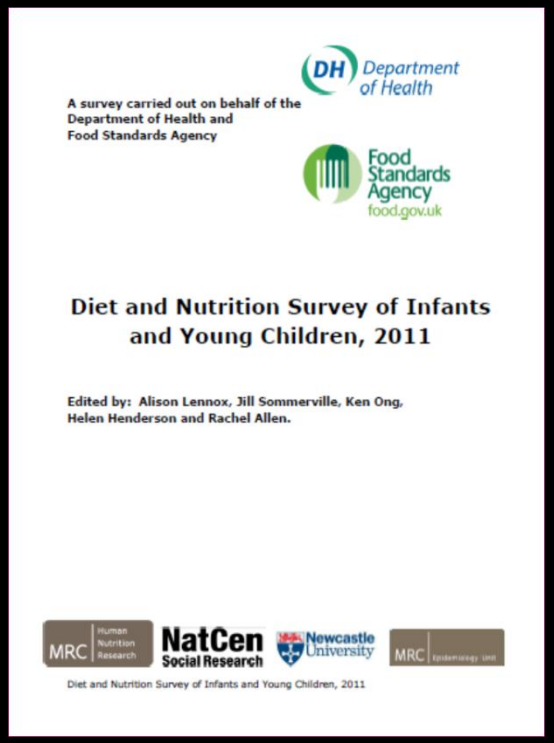
Aims of Discussion

- What do we know about toddler nutrition?
- Which Nutrients are at risk?
- What is the impact of nutritional deficiency on toddler development ?
- What can be done?

UK Dietary Surveys

NDNS

DNSIYC



UK Dietary Surveys

DH Department of Health

- National Diet and Nutrition Survey
- Age surveyed has changed
  - 1½ - 4 ½ (1995)
  - 1½ - 3 (2011)

UK Dietary Surveys

DH Department of Health

- Diet and Nutrition Survey of Infants and Young Children
  - 4-18 months (2011)

NDNS Rolling Survey

- Intakes of most vitamins met the RNI
  - **Except Vit D** – RNI 7 µg/day
- Mean intake 1.9 µg/day
  - 27% of RNI
  - 32% including supplements

DNSIYC Survey

- Intakes of most vitamins met the RNI
  - **–Except vitamin D**
- Mean intake 4 µg/day
  - –57% of RNI
- Higher intakes in younger
- All breastfed below RNI

About Vitamin D

- Essential nutrient
- Needed for healthy bones
- Control blood calcium
- Associations with a range of diseases reported from observational studies
  - Cardiovascular disease
  - Cancers

About Vitamin D

- Only vitamin that cannot be met by diet alone
- Sunlight is the major source
- Supplements may be needed
- Two dietary forms
  - D_2 - Ergocholecalciferol
  - D_3 - Cholecalciferol

Vitamin D Deficiency

- Resurgence
  - Excessive sun protection
  - Lack of supplementation
  - Belief certain foods are high in vitamin D e.g. milk
  - Higher vitamin D requirements
  - Ethnic groups
    - 20-40% prevalence in UK Asian toddlers

At Risk Groups

- **Pregnant and breastfeeding**
  - **Teenagers and young women**
- **Children under 5 years**
  - **6 months to 3 years**
- **Adolescents**
- **Elderly**

At Risk Groups

- Strict vegetarians and vegans
- Prolonged breastfeeding
  - Poor weaning
- Exclusion diets
- Malabsorption
- Disease states (liver, renal)
- Some drugs

At Risk Groups

- People with low sun exposure
  - Covering up for cultural reasons
  - Housebound
- People with darker skin
  - Cannot convert to active form so well

Vit D Status

- Assessment
- Insufficient
  - Plasma 25-OHD ≤ 50 nmol/l
    - Sub-optimal e.g. for bone health
- Deficient
  - Plasma 25 OHD ≤ 25 nmol/l
    - Associated with disease

Vit D status – UK toddlers

- DNSIYC 2011
  - Mean 25-OH-D
    - 5-11 months of age = 68.6 nmol/l
    - 12+ months of age = 64.3 nmol/l
  - Only a small percentage of this sample were deficient

Deficiency and Risks

- **Bone disease**
  - **Ricketts**
  - **Oesteomalacia**
- **Possible role in**
  - **Cancer**
  - **Heart disease**
  - **Diabetes**
  - **Multiple sclerosis**
  - **Arthritis**

Deficiency - Symptoms

- Infants
  - Seizures
  - Cardiomyopathy
- Children
  - Poor growth
  - Rickets

Food Sources

- Oily fish (trout, salmon, mackerel, herring, sardine, tuna) 5-10 µg/100g
- Egg yolk 5 µg/100g
- Red meat 1µg/100g
- Breast milk 0.07µg/100ml
- **Fortified Foods**
- Breakfast cereals 3-8 µg/100g
- Margarine 7.5 µg/100g
- Infant Formula ~1.2 µg/100ml

Toddler Sources

- DNSIYC in µg/day
  - –Infant formula 1.0
  - –Milk & Products 0.6
  - –Fat spreads 0.4
  - –Meat 0.5
  - –Commercial foods 0.3
  - –Fish ~0.05

Deficiency Returns

- **West Midlands in 2001 - 24 children under 5** present with symptomatic vitamin D deficiency
- Manchester child health clinic – reports a rickets prevalence of 1.6%
- Glasgow -160 cases including 3 white children
- Southampton - 8% of mostly white children attending a paediatric orthopaedic clinic had biochemical deficiency
- Camden – reports 5 cases of rickets last year

Vitamin D Sources

- Adequate exposure to sunlight
  - 20 – 30 minutes 2-3 times per week in summer
  - Dark skinned need greater exposure (2-10 times longer)
- Sunscreens
    - Avoid overuse but..
    - Avoid redness/burning

Bridging the Gap

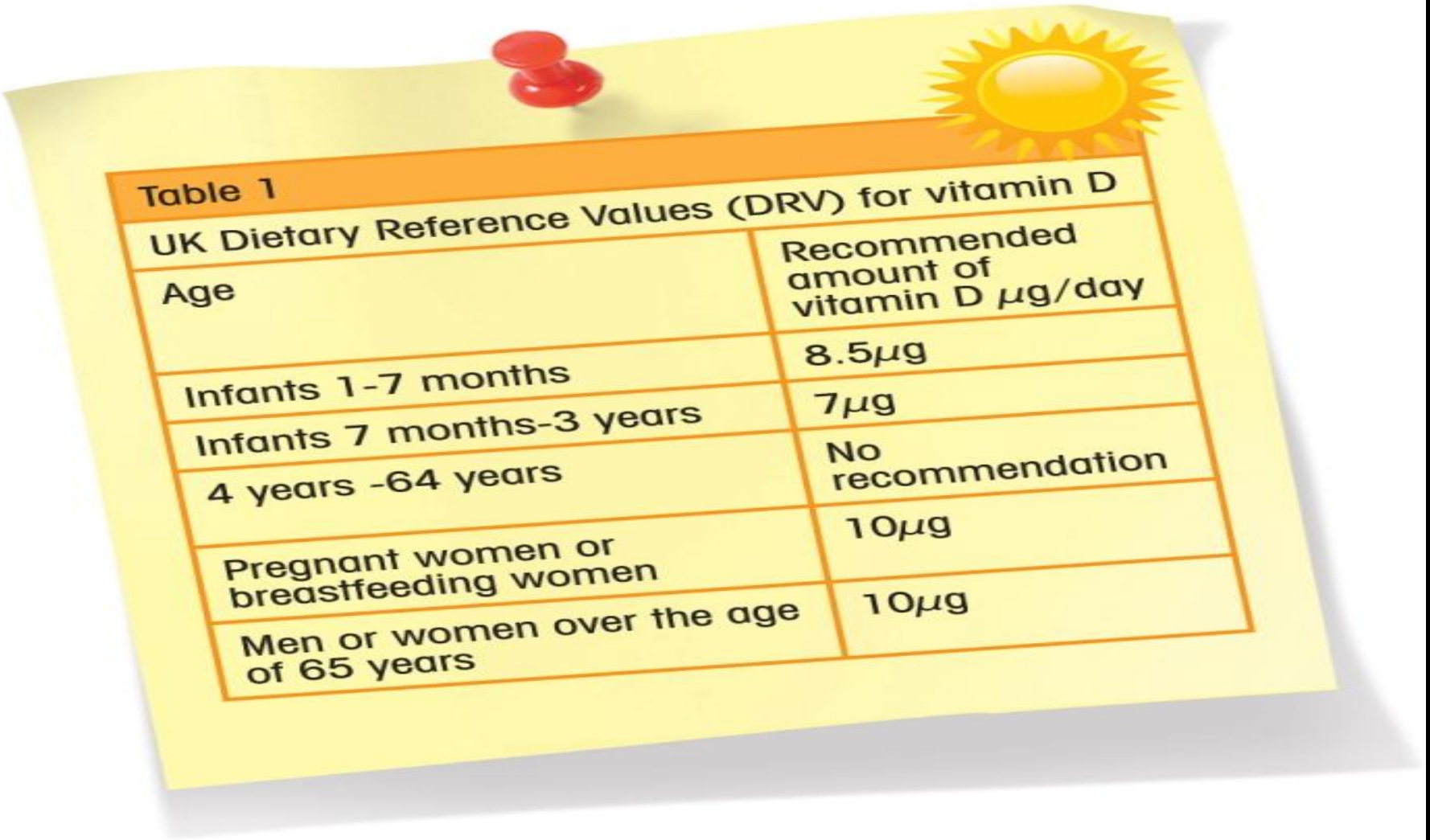


Table 1

UK Dietary Reference Values (DRV) for vitamin D

Age	Recommended amount of vitamin D µg/day
Infants 1-7 months	8.5µg
Infants 7 months-3 years	7µg
4 years -64 years	No recommendation
Pregnant women or breastfeeding women	10µg
Men or women over the age of 65 years	10µg

Preventing Deficiency

Category	Dose IU	Dose ug	Examples of supplements
Newborn up to 1 month	300 – 400 units daily	7.5 – 10 daily	Abidec, Dalivit, Baby D drops and Healthy Start
1 month – 18 years	400 – 1,000 units dail	10 – 25 daily	Abidec, Dalivit, Boots high strength vitamin D drops, Holland and Barrett Sunvite D3, Dlux oral spray, SunVitD3 and Vitabiotics tablets

Adapted from RCPCH Guide for Vitamin D in childhood

Treating Deficiency

- Should only be done under medical supervision

Category	Dose IU	Dose ug	Duration
Up to 6 months	1,000 to 3,000 units daily	25 – 75 daily	4 – 8 weeks
6 months – 12 years	6,000 units daily	150 daily	4 – 8 weeks
12 – 18 years	10,000 units daily	250 daily	4 – 8 weeks

Adapted from RCPCH Guide for Vitamin D in childhood
http://www.rcpch.ac.uk/child-health/standards-care/nutrition-and-growth/guide-vitamin-d-childhood/guide-vitamin-d-childhood

Vitamin Supplements

	A	D	C
	IU	ug	mg
Healthy Start	700	7.5	20
Abidec	1333	10	40
Dalivit	5000	10	50
Haliborange	200	**3.25**	25
Well Kid	400	**5**	40
Ddrops		10	

Healthy Start Vitamins

- Recommended for:
- All children up to age 5
- Pregnant & Breastfeeding mothers
- Infants
  - Breastfed where mothers may have low vitamin status
  - Formula fed receiving <500 mls formula daily

http://www.healthystart.nhs.uk/for-health-professionals/vitamins/

Uptake

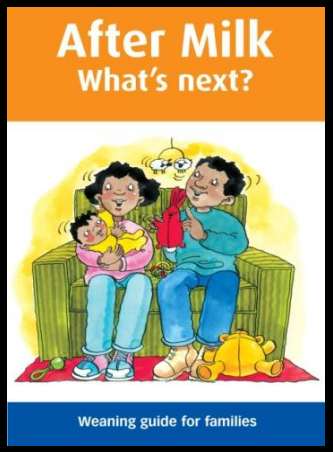
- Survey of 13 PCTs in England
- < 10% of eligible families take up scheme
- Reasons
  - Poor accessibility
  - Low promotion by HCPs
  - Poor awareness
  - Motivation/beliefs

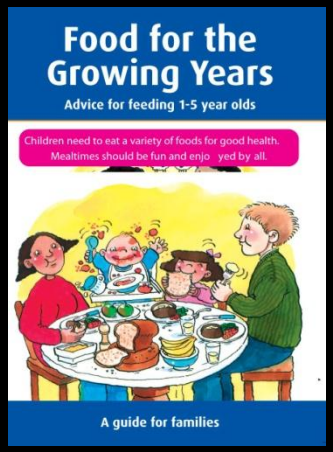
Jessiman et al, 2013

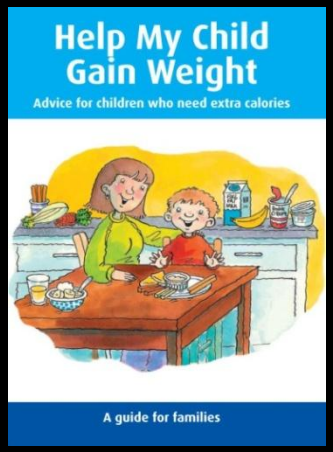
What can HCPs do

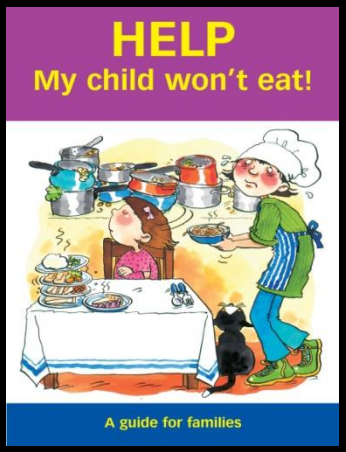
- Raise awareness
- Help set up an interest group
- Work with EYPs e.g. In Sure Start Centres
- Promote supplements, diet and outdoor play
- Refer families to already established groups
- Apply for funding e.g. Feeding For Life Best Practice Grant Scheme – Now Open
- http://www.feedingforlifefoundation.co.uk/home.aspx

Provide Resources









Order from Nutrition and Diet Resources UK (NDR-UK). For more information visit www.ndr-uk.org or call 0141 202 0690.

Provide Resources

- A practical approach to vitamin D supplementation in pregnant and breastfeeing women, infants and toddlers.
- Available at :
- http://www.feedingforlifefoundation.co.uk
- Preventing vitamin D deficiency in toddlers
- Available at:
- https://www.infantandtoddlerforum.org

Headline News

"Low Vitamin D Levels Raise Anaemia Risk in children"

- Complex interplay between low levels of vitamin D and haemoglobin
- Regulation of immune inflammation
  - A catalyst for anaemia
- Not causal – associated with other factors

Atkinson et al., 2013

Iron and Development

- Brain development
  - Most rapid growth
- Iron needed for
  - Myelin formation
  - Biochemical syntheses
  - Neuronal growth/metabolism

Iron Requirements

- Highly conserved nutrient
  - No mechanism for excretion
  - Risk of overload
  - Very reactive
  - Useful to microbes
  - Supplement with caution

Iron Requirements

- Healthy term infants use stores in first 6 months
- Dietary requirement is low
  - UK RNI
    - 0-3 months 1.7 mg/day
    - 4-6 months 4.3 mg/day
    - 7-12 months 7.8
- Toddlers 1-3 years 6.9 mg/day

Iron Intake

- RNI 6.9 mg/day
- NDNS 2011 – age 1.5-4 years
  - Median intake 6.1 mg/day
    - 88% of RNI
- DNSIYC 2011 – age 12-18 mths
  - Mean intake 6.4 mg/day
    - 82% of RNI (7.8 mg/day)

Iron Deficiency

- Insufficient to maintain normal functions
  - Absorption is inadequate for needs
  - Long-term negative balance
  - Decrease in stores
- May be accompanied by symptoms (anaemia)

Iron Deficiency

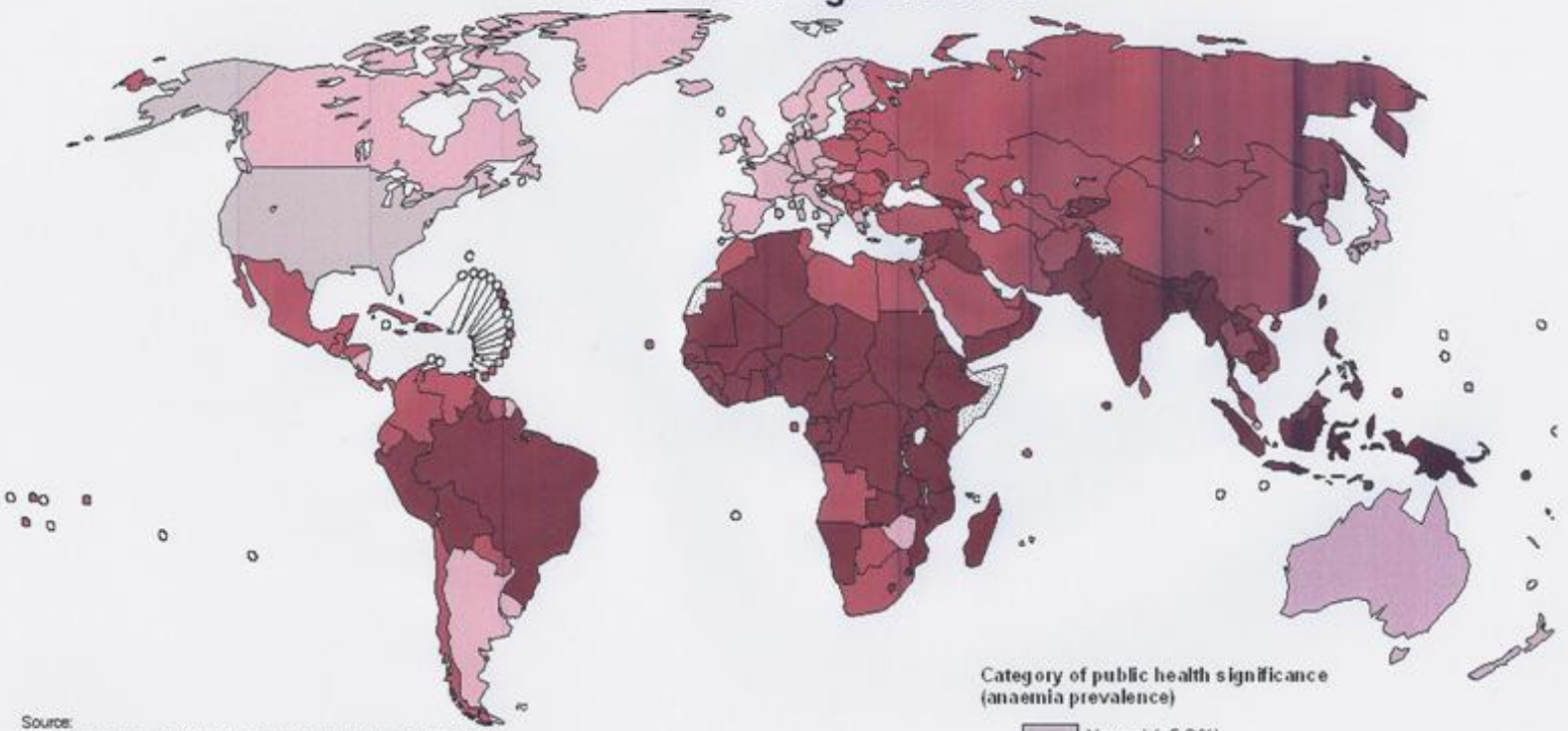
- Main cause is poor intake
  - Dietary
    - Foods low in iron
  - Impaired absorption
  - Transport
  - Losses
  - Disease states

At Risk - Iron

- Iron Deficiency (ID)
  - High prevalence globally
  - Affects up to 50% children
  - Can lead to iron deficiency anaemia (IDA)
    - Deficiency with disease symptoms
    - CMO ~26% UK children affected

Micronutrient Malnutrition Unit
Nutrition for Health and Development

Anaemia as a public health problem by country: Preschool-age children



Source:
de Benoist B et al., eds. Worldwide prevalence of anaemia 1993-2005.
WHO Global Database on Anaemia. Geneva, World Health Organization, 2008

Risk Factors

- Low birthweight
- Early cord clamping
- Males
- Social Factors
- Low meat intake
- High intake of cow’s milk

Assessing Iron Status

- Serum Iron:
  - Amount in blood – level may be normal even if the total amount of iron in the body is low
- Serum Ferritin:
  - Amount in stores
- Transferrin
  - Amount carried in blood

Identifying Deficiency

- Haemoglobin - anaemia
  - Less than 11.0 g/dL for both male and female children aged ≥ 10 months (WHO, 2001)
- Ferritin - stores
  - Serum Ferritin less than 12 µg/l for both male and female children aged ≥ 10 months (SACN 2010, WHO, 2001)

At Risk - Iron

- Iron deficiency in pregnancy linked to
  - IntraUterine Growth Retardation
  - Preterm birth
  - Low birtweight

At Risk - Iron

- Toddlers are at high risk due to rapid growth and high needs
- Prevalence
  - 12-30%
  - Depending on
    - Population
    - screening method

Iron Status

- Anaemia in UK Preshoolers
- NDNS1995
  - 13%
- ALSPAC
  - 17%
- DNSIYC 2011
  - 2%

At Risk - Iron

- Ethnicity – high prevalence of anaemia in UK Asian families
  - Bradford 1986 – 25% of children aged 6-48 months admitted to hospital
  - Sheffield 1991 – 17%
  - England-wide – 20-30%

(Ehrhardt, 1986; Duggan, 1991; Lawson, 1998)

Possible Factors

- Restricted Diets
  - Vegetarian/Vegan
  - Cultural Exclusions
- Dietary Inhibitors of Iron
  - Phytates Tannins
  - Cows milk
- Lack of Dietary Facilitators

Impact of Deficiency

- IDA associated with:
  - Lower development scores in toddlers

    Lozoff, Pediatrics, 1987
  - Reduced mental performance and behavioural problems

    Lozoff, Nutrition Reviews, 2006
    McCann, AJCN, 2007

Impact of Deficiency

- ALSPAC
- Longitudinal Study of Parents and Children
- Low Haemoglobin in infancy associated with poorer development in toddlers

Sherriff, 2001

Limitations of Studies

- Mainly Observational
  - Short Term Studies
- Lack
  - Randomised design
    - Confounded by other factors
  - Robust measures
  - Long Term Follow Up
- Unable to show causality

Aims of Discussion

- What do we know about toddler nutrition?
- Which Nutrients are at risk?
- What is the impact of nutritional deficiency on toddler development ?
- What can be done?

Interventions

- Randomised Controlled Trials (RCT)
- Iron Supplementation:
  - –No immediate benefits on psychomotor development
  - –Evidence lacking for long-term effects

Systematic Reviews

- Meta-analyses
  - Conflicting
- Sachdev 2005
  - Small benefit for **M**ental **D**evelopment **I**ndex with extra iron – 14 trials
- Szajewska 2010
  - Improvements in **P**sychomotor **D**evelopement **I**ndex - 3 studies
- Wang 2013
  - No improvement for MDI or PDI

Systematic Reviews

- Effect of Iron Interventions on growth
  - 21 RCTs found no effect overall
  - Small effect in children ≥ 6 years of high dose supplement (>40mg/d)
- Developing countries
  - 26 RCTS benefits in deficient/anaemic only
  - Dose and duration important
  - Targeted approach may be useful

(Vesna Vucic et al., 2013, Iannotti et al., 2006)

Interventions – At Risk

- RCT of iron supplements in low birthweight infants
- Supplementation at 1-6 months compared with placebo
- Supplementation reduced behavioural problems at 3 years of age
- Main outcome:
  - Behaviour assessed using a checklist
  - Subjective measure

Berglund et al., 2013

Toddler Iron Sources

- DNSIYC in mg/day
  - Infant formula 1.1
  - Cereals 2.6
  - Infant cereals <0.1
  - Eggs <0.1

Food Sources- Iron

	mg/100g
• Red meat (Beef highest)	1-3
• Fish (Oily highest)	0.5-5
• Eggs (Yolk highest)	2
• Dried Fruits	2-6
• Nuts	2-6
• Pulses	2-3
• Soya	2-4
• Root vegetables	0.5-1
• Green Leafy Veg	1.5-2

Food Sources - Iron

	mg/100g
• **Fortified Foods**	
• Breakfast cereals	2-20
• Bread	1-3.5
– Wholegrains highest	
• Breast milk	0.07
• Infant Formula	1.4
• Curry Powders	30-60

Food Sources- Iron

- Haem iron
  - Found in foods of animal origin (Meat)
  - Most bioavailable
- Non-haem iron
- found in Plant foods and fortified cereals
  - If eaten with Vitamin C absorption improved
  - May be destroyed during cooking
- Inhibitors of Iron
- Tannins (tea), Phosphates, Phytate,Bran, Lignin, Cows' milk

Summary - Iron

- IDA is a risk in toddlers
- Associated with cognitive and behavioural deficits
- Supplements may help at risk children
- Early screening may be helpful
- **But**
- Only a small number of trials
- Lacking:
  - Objective measures
  - Long term follow up
  - RCTs of iron interventions needed

Conclusions

- Toddlers are at risk of deficiencies in vitamin D and iron
- The risk is greater for certain groups of people - especially those with darker skin
- Supplementation can bridge the gap for vitamin D
- There is insufficient evidence to recommend universal supplementation with iron
- HCPs have an important role to play in providing appropriate advice