Systematic review of the efficacy and effectiveness of complementary feeding interventions

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Complementary feeding is a key window for intervention

- Age range of complementary feeding (6-24 mo) is the time of peak incidence of
  - Growth faltering
  - Micronutrient deficiencies
  - Morbidity, e.g. diarrheal disease
- After 2 years, difficult to reverse effects of malnutrition
  - Stunting
  - Effects on brain function due to micronutrient deficiency?
- A food-based, comprehensive approach may be more effective and sustainable than programs targeting individual nutrient deficiencies

Guiding principles for complementary feeding of the breastfed child (PAHO/WHO 2003)

1. Age of introduction of complementary foods
2. Maintenance of breastfeeding
3. Responsive feeding
4. Safe preparation & storage of complementary foods
5. Amount of complementary foods needed
6. Food consistency
7. Meal frequency and energy density
8. Nutrient content of complementary foods
9. Use of vitamin/mineral supplements or fortified products
10. Feeding during and after illness

Scope of Review

- Interventions in developing countries that targeted children 6-24 mo
- Outcomes measured: growth, morbidity, child development, micronutrient intake, micronutrient status
- Studies that assessed only the impact on feeding practices were not included
- Generally focused on reports from 1996-2006

Number of papers included

Source	Efficacy trials	Effectiveness studies/program reports
PubMed	12	0
Snowball technique	11	7
Personal contacts	6	6
Total (42)	29	13

Intervention Strategies

- Education as the main treatment
- Complementary food or a food product offering extra energy (with or without added micronutrients) provided as the only treatment
- Provision of food combined with some other strategy, usually education for mothers
- Fortification of complementary foods (central or home-fortification) with micronutrients (with no difference in energy provided to intervention vs. control groups)
- Increased energy density and/or nutrient bioavailability of complementary foods via simple technologies

$$\text{Effect size (ES)} = \frac{\text{Difference betw. intervention \& control groups}}{\text{Pooled SD}}$$

Impact on growth outcomes via educational approaches: efficacy trials

Author, date	Site	N	ES, weight	ES, length
Bhandari, 2001	India	188	0.14	0.08
Bhandari, 2004	India	829	0.02	0.05
Penny, 2005	Peru	338	0.34*	0.49*
Roy, 2005	Bangladesh	183	0.58*	0.09
Santos, 2001	Brazil	404	0.09	0.04
Vitolo, 2005	Brazil	397	-	NS

Impact on growth outcomes via educational approaches: effectiveness/program studies

Author, date	Site	N	ES, weight	ES, length
Gulden, 2000	China	495	0.96*	0.64*
Guyon, 2005	Madagascar	NA	-0.06	0.14
Kilaru, 2005	India	242	0.16	-
Maluccio, 2004	Nicaragua	NA	-	0.12

Impact on growth outcomes via provision of complementary food

Author, date	Site	N	ES, weight	ES, length
Adu-Afarwuah, 2006	Ghana	194	0.31*	0.26*
Beckett, 2000	Indonesia	78	0.03	0.02
Kuusipalo, 2006	Malawi	112	0.51*	0.67*
Lartey, 1999	Ghana	190	0.57*	0.69*
Obatolu, 2003	Nigeria	60	2.99*	1.81*
Oelofse, 2003	South Africa	30	-0.02	-0.04
Owino, in press	Zambia	106	0.30	0.37*
Santos, 2005	Brazil	191	0.10	-0.02

Impact on growth outcomes via comp. food + education: efficacy trials

Author, date	Site	N	ES, weight	ES, length
Bhandari, 2001	India	178	0.32*	0.25
Roy, 2005	Bangladesh	189	0.66*	0.32^

^significant in children < 15 mo and low in WAZ or LAZ at baseline

Impact on growth outcomes via comp. food + education: effectiveness/program studies

Author, date	Site	N	ES, weight	ES, length
Gartner, 2007	Senegal	1676	NS	NS
Hossain, 2005	Bangladesh	2388	NS	NS
Lutter, 2006	Ecuador	319	0.24*	0.14
Lopez de Romana, 2000	Peru	NA	NA	NS
Rivera, 2004	Mexico	650	NA	0.12^
Schroeder, 2002	Vietnam	230	0.18^^	0^^

^significant only in children < 6 mo at baseline

^^significant only in children < 15 mo and underweight or stunted at baseline

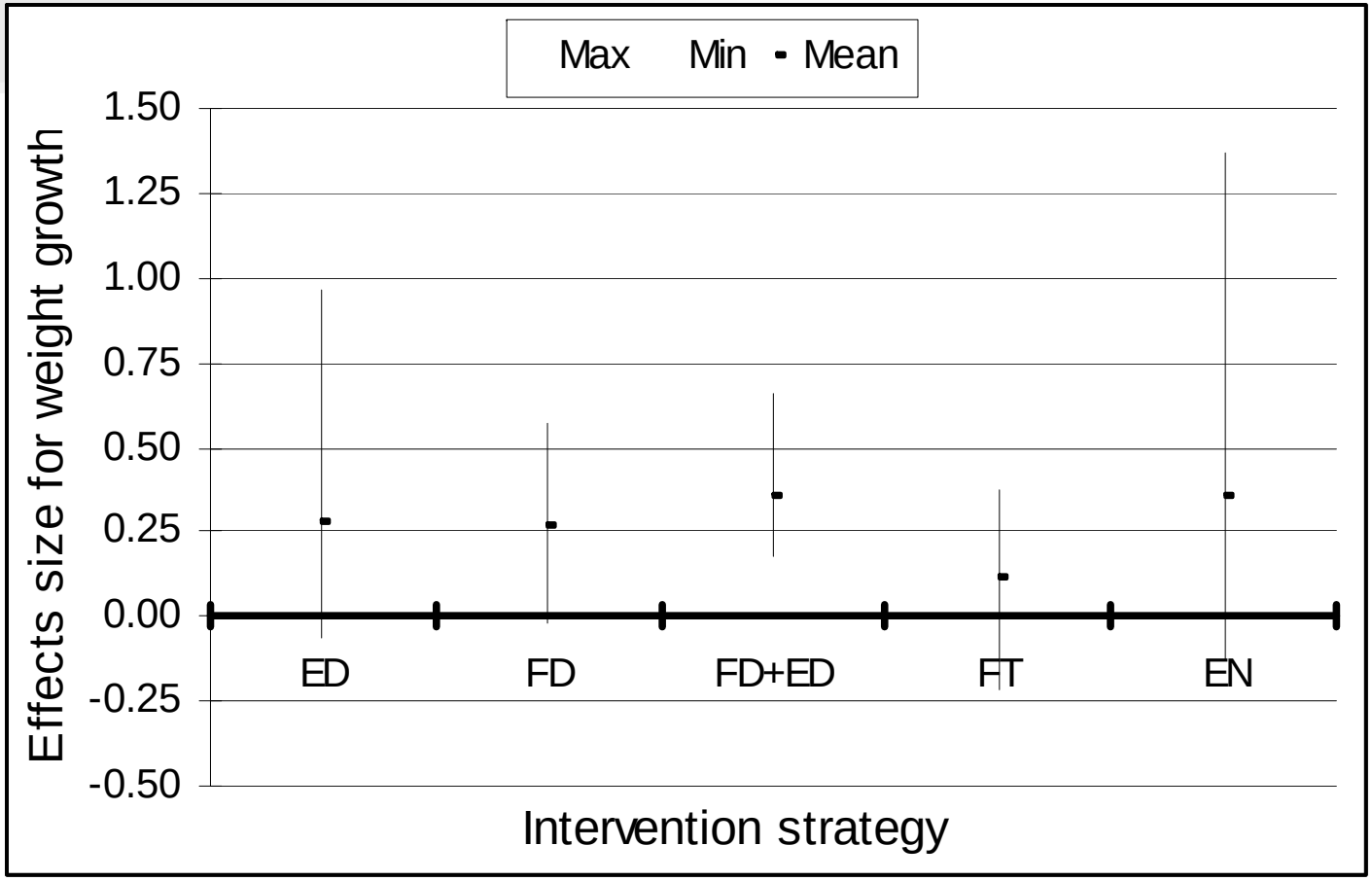
Impact on growth outcomes via fortification of comp. foods: efficacy trials

Author, date	Site	N	ES, weight	ES, length
Adu-Afarwuah, 2007	Ghana	296	0.03	-0.02
Dhingra, 2004	India	570	0.37*	0.45*
Faber, 2005	South Africa	292	0.00	0.11
Giovannini, 2006	Cambodia	127	-0.22	0.07
Lartey, 1999	Ghana	190	0.20	0.08
Smuts, 2005	South Africa	99	0.29	0.05

Impact on growth outcomes via interventions to increase energy density of complementary foods

Author, date	Site	N	ES, weight	ES, Length
Hossain, 2005	Bangladesh	100	0.25	0.32
John, 1993	India	42	1.37*	0.71*
Mamiro, 2004	Tanzania	258	NA	-0.04
Moursi, 2003	Congo	75	-0.13	0.40*
Owino, 2007	Zambia	113	-0.07	-0.25

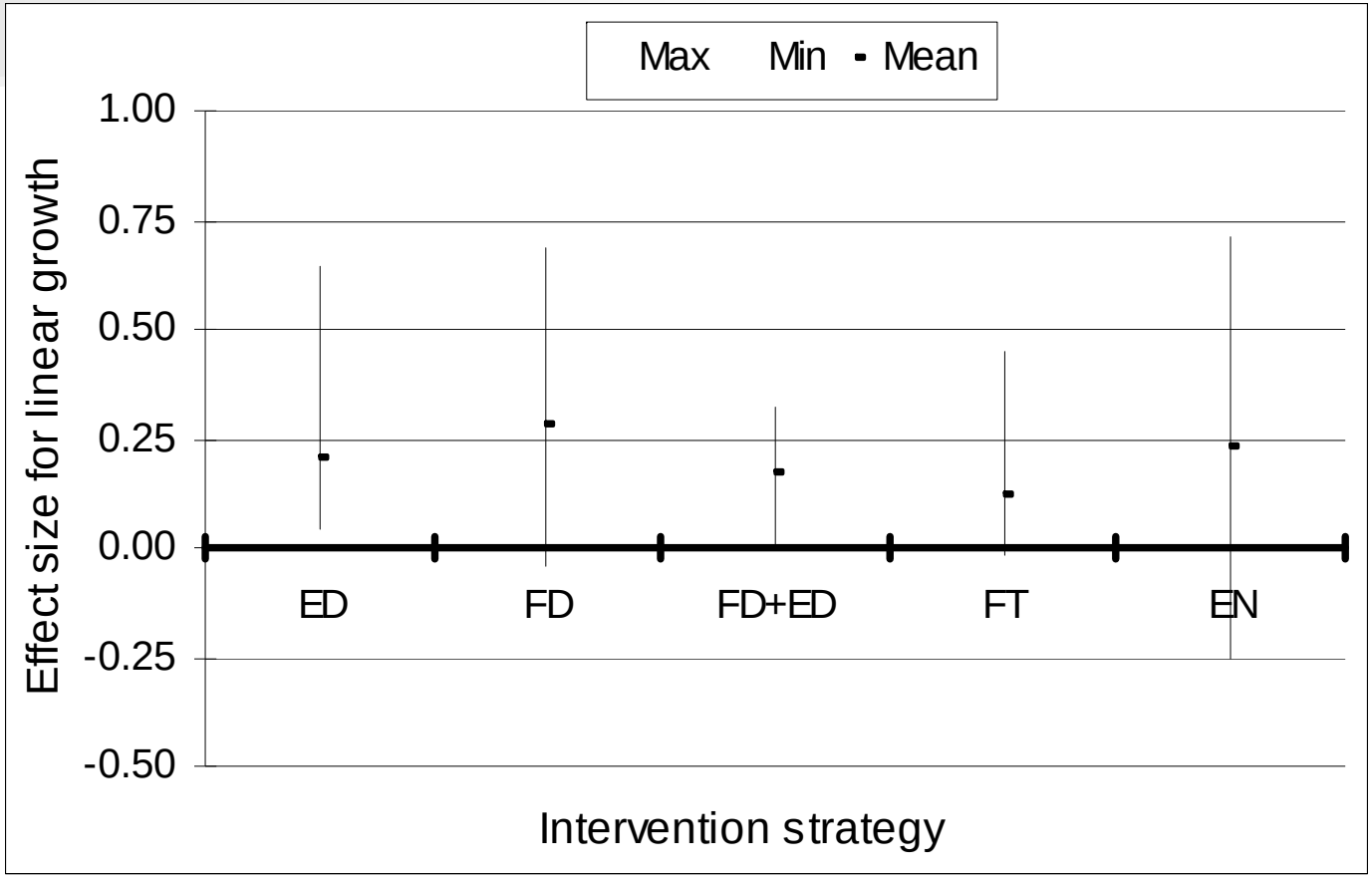
Effect size for weight growth of different intervention strategies



ED = Education; FD = Complementary food; FD+ED = Education + complementary food; FT = Fortification of comp. foods; EN = Increased energy density

Excluding Obatolu, 2003 (outlier)

Effect size for linear growth of different intervention strategies



ED = Education; FD = Complementary food; FD+ED = Education + complementary food; FT = Fortification of comp. foods; EN = Increased energy density

Excluding Obatolu, 2003 (outlier)

Impact of complementary feeding interventions on morbidity outcomes

- Only 10 of 42 papers presented data on morbidity
- Most showed no impact, but generally not designed or powered to evaluate morbidity as a primary outcome

Impact of complementary feeding interventions on morbidity outcomes

- 4 studies showed reduced morbidity:
  - Education only; Brazil (Vitolo, 2005)
    - Reduced diarrhea and URI
  - Food + education; Vietnam (Schroeder, 2002)
    - Reduced URI
  - Fortified CF; India (Sazawal, 2007)
    - Reduced diarrhea, LRI and fever
  - Fortified CF; Pakistan (Sharieff, 2006)
    - Reduced diarrhea and fever

Impact of complementary feeding interventions on morbidity outcomes

- 2 studies showed increased morbidity:
  - Food + education; India (Bhandari, 2001)
    - Increased fever & dysentery
    - Possibly due to reduced breastfeeding
  - Increased energy density (Moursi, 2003)
    - Increased URI

Impact of complementary feeding interventions on child development

- Only 4 of 42 papers presented data on development
- Home-fortification improved gross motor development in Ghana (Adu-Afarwuah, 2007):
  - % walking at 12 mo:
  - – 25% in non-intervention group
  - – 36% with foodlet; 39% with Sprinkles; 49% with fat-based fortified product
- No significant impact of fortification in South Africa (Oelofse, 2003) or India (Dhingra, 2004)
- Provision of extra energy increased mental scores in Indonesia, but only in the subgroup with low initial length-for-age (Pollitt, 2002)

Impact of complementary feeding interventions on micronutrient intake

- Education alone can increase intake of Fe (by ~24%) and Zn (by ~26%)
- Soaking + germination had no significant effect in Tanzania (Mamiro, 2004)
- Fortification strategies can have a much larger impact
  - Fe intake increased by 145-207%
  - Zn intake increased by 201-271%
  - Vit A intake increased by 107-2300%

Impact of complementary feeding interventions on Fe status

- Education alone improved Fe status in some sites (India; China) but not others (Brazil; Nicaragua)
  - Overall impact +4 g/L Hb, -5 PP anemia
- Provision of Fe-fortified food
  - Overall impact +4-6 g/L Hb, -13-17 PP anemia (12 studies)
- Home fortification
  - Overall impact +8 g/L Hb, - 21 PP anemia (7 studies)

Impact of complementary feeding interventions on Zn status

- Only 5 studies reported plasma Zn
- Four studies evaluated a fortified comp. food (3-6.5 mg/d Zn); none had signif. impact
- One study (South Africa) showed increased plasma Zn with home-fortification (10 mg/d Zn)

Impact of complementary feeding interventions on vitamin A status

- 7 studies reported vitamin A status
- All involved a fortified comp. food or home fortification
- Amount of vitamin A provided ranged widely: 83-658 ug RE/d
- Significant increase in serum vitamin A in 4 of the 5 studies with fortified comp. foods
- No significant impact in 2 studies of home-fortification, probably due to vit A supplementation programs

Conclusions

- No single universal “best” package of components in complementary feeding interventions
- Impact is context-specific
  - Initial prevalence of malnutrition
  - Degree of household food insecurity
  - Energy density of traditional complementary foods
  - Availability of micronutrient-rich local foods

Conclusions - Growth

- Growth may not be the most sensitive indicator of impact
- Impact may be greater in younger age groups: should begin CF programs during infancy
- Effect sizes generally modest (0.1-0.5), but potential larger if optimal design and implementation (0.5-0.6)

Conclusions – Growth (cont.)

- Educational approaches more likely to have impact if there is an emphasis on nutrient-rich animal-source foods
- Provision of food – variable results
  - Greater impact in Africa & S Asia – due to food insecurity?
  - 2 studies compared food + education vs. education only: somewhat greater impact when food included

Conclusions – Growth (cont.)

- Most of the foods provided were fortified, so can't distinguish impact of increased energy/protein/fat from micronutrients
  - In Ghana, impact on weight gain partially explained by increased energy intake, but impact on length gain related to change in plasma fatty acid profile
- Micronutrient fortification alone has little effect on growth
  - Exception: relatively large study in India in which many children stunted at baseline & fortified product resulted in reduced morbidity

Conclusions – Growth (cont.)

- Interventions to increase energy density – results mixed
  - 3 of 5 studies had no impact on energy intake or growth
  - 2 of 5 studies had positive impact on growth
- May be effective when traditional CF has low energy density & infant unable to compensate by increasing volume of food consumed or feeding frequency

Conclusions - Morbidity

- Few studies had adequate N to evaluate morbidity
- Mixed results
  - Beneficial impact in 4 studies
  - Adverse impact in 2 studies
- CF interventions need to include counseling on maintaining breastfeeding, responsive feeding and hygienic practices

Conclusions - Development

- Very few studies evaluated behavioral development
- Promising results in Ghana using specially designed fortified fat-based complementary foods
- Future evaluations of CF interventions should include assessment of child development – may be more sensitive than growth

Conclusions – Micronutrient intake

- Very difficult to achieve adequate Fe intake from local foods without fortification, at 6-12 mo
- Fortification increased Fe intake by 5-11 mg/d
- Can achieve adequate Zn and Vit A intakes from local foods, but requires careful attention to dietary choices
- Fortification can help ensure Zn and Vit A intakes when nutrient-rich local foods are costly or unavailable (e.g. seasonally)

Conclusions – Micronutrient status

- Education can have a positive impact on Fe status if Fe-rich foods are emphasized
- A larger impact on Fe status can be expected from use of fortified products (reduction of 13-21 percentage points in prevalence of anemia)
- Little or no impact of fortification on plasma zinc – due to low absorption?
- Results mixed regarding fortification with Vit A
  - Positive impact in several studies
  - Little impact in some studies, probably due to concomitant vit A capsule distribution programs

Overall Conclusions

- Educational approaches can be effective, but in many situations a greater impact may be seen when combined with home-fortification or provision of fortified foods
- To be most cost-effective and avoid displacement of breast milk, the amount of food provided should be modest: no more than 200 kcal/d at 6-12 mo
- Biggest challenge: going to scale with a combination of the most cost-effective components, while assuring adequate delivery and sustainability