

Effectiveness of an educational intervention on complementary feeding practices and growth in rural China: a cluster randomised controlled trial

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Abstract

Objective: Inappropriate complementary feeding is one of the major causes of malnutrition in young children in developing countries. We developed an educational intervention, delivered by local health-care providers, aimed at improving complementary feeding practices and child nutrition.

Design: Eight townships in Laishui, a rural area in China, were randomly assigned to the educational intervention or control group. A total of 599 healthy infants were enrolled at age 2–4 months and followed up until 1 year of age. In the intervention group, educational messages and enhanced home-prepared recipes were disseminated to caregivers through group trainings and home visits. Questionnaire surveys and anthropometric measurements were taken at baseline and ages 6, 9 and 12 months. Analysis was by intention to treat.

Results: It was found that food diversity, meal frequency and hygiene practices were improved in the intervention group. Infants in the intervention group gained 0.22 kg more weight (95% CI 0.003, 0.45 kg, $P=0.047$) and gained 0.66 cm more length (95% CI 0.03, 1.29 cm, $P=0.04$) than did controls over the study period.

Conclusions: Findings from the study suggest that an educational intervention delivered through local health-care providers can lead to substantial behavioural changes of caregivers and improve infant growth.

Keywords
Complementary feeding
Educational intervention
China

Inappropriate complementary feeding practices, such as too early introduction of complementary foods, restriction in food selection and insufficient amounts of complementary foods, have been identified as one of the major causes of malnutrition in young children in the developing world^(1,2). In China, for example, despite the rapid pace of social and economic development, poor complementary feeding practices remain prevalent in rural areas. Rural children are often given food that is mainly carbohydrate and low in protein and fat⁽³⁾. Less than a quarter of infants and young children in rural China consume dairy and animal-source foods daily⁽⁴⁾, and about 15% of young children have never been fed meat, eggs or bean products⁽⁵⁾. Previous studies have found that caregivers do not give available quality foods such as meats, vegetables, oil and eggs to infants because of traditional beliefs that these foods are too 'heavy' for infants to digest^(6,7). The poor complementary feeding practices in rural areas have resulted in great disparities in growth and nutritional status between rural and urban

children. Data from the Chinese Child Nutrition Surveillance Programme show that the prevalence of stunting in rural children was 20.5% in 2000, much higher than that of 2.9% among their urban counterparts⁽⁸⁾. The prevalence of underweight was highest between 6 and 24 months of age, with 13.9% of rural children being underweight compared with 3.0% of children living in cities⁽⁸⁾.

Effective interventions are therefore needed in rural China to improve complementary feeding practices and enhance child nutrition and health. A number of nutrition educational interventions have been carried out in developing countries aimed to provide caregivers with information and motivation to alter feeding practices^(2,9–19). These studies provide evidence that educational interventions can improve caregiver feeding practices and child dietary intake^(2,10,12,14,15,18,19). However there is a paucity of knowledge about how to deal with deep-rooted cultures and traditions through educational interventions. There also remains heterogeneity

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across studies on the impact of these interventions on child growth, thereby hindering the efforts of local, national and international organisations to advocate for such behavioural interventions. Therefore we conducted a randomised controlled trial in rural China to assess the effects of an educational intervention delivered through health-care providers on caregiver feeding practices and child growth.

Methods

Study area and participants

The study was conducted in Laishui County of Hebei Province in north-west China, with a population of 340 000 and a per capita gross domestic product of \$US 500 in 2006. There is one general hospital and one Maternal and Child Health hospital in the county. Each of the fifteen administrative townships has its own government-funded hospital. Each village also has a doctor trained in modern medicine or traditional medicine.

Eight townships were selected that each had at least two primary health-care providers who could provide intervention and evaluation for the study. Townships were paired based on population, geographic type and economic condition. We avoided pairing up directly adjacent sites. The paired townships were listed alphabetically in blocks of two and assigned randomly to be intervention or control sites.

All infants in the selected townships who were full-term (gestational age >37 weeks), singletons, without major birth defects, and aged 2–4 months at the time of the baseline survey were eligible for the study. The eligible infants and their families were identified through birth registration and household registration, and recruited by local primary health-care providers. Written informed consent was obtained from the children's parents. In total, 599 infants were enrolled between April and September of 2006.

Procedures

During the developmental stage of the intervention, we reviewed literature to identify previous successful intervention strategies. Existing documents including routine registration, clinical records and survey results were examined to understand the local population, climate, geography, economy, children's morbidity and mortality, malnutrition prevalence and health services. Primary health-care providers were interviewed about local infant feeding patterns, the ingredients and methods of preparation of typical meals for infants, and cultural beliefs regarding food selection and preparation.

Based on the findings from this formative research, we developed an intervention plan comprising four major components: (i) group training sessions on food selection, preparation and hygiene, childhood nutrition and growth, and responsive feeding style; (ii) demonstration

of preparing enhanced weaning food recipes which were formulated using locally available, affordable, acceptable and nutrient-dense foods such as egg, tomato, beans, meat, chicken and liver; (iii) booklets which contained infant feeding guidance and methods of preparing the recommended recipes; and (iv) home visits every three months to identify possible feeding problems and provide individual counselling. Important family members, mainly husbands and parents-in-law, and community members such as the village doctors and committee leaders were involved in the intervention so they could provide a supportive environment for changing feeding practices. The control group received a standard package of child health care from the township hospitals which included breast-feeding counselling, but did not contain other than standard counselling on complementary feeding.

Before the initiation of the intervention, the health-care providers in the intervention areas were trained by the study team on child nutrition, breast-feeding, complementary feeding and counselling skills. They then conducted group training sessions with the village committee leaders, child caregivers and key family members on the benefits of breast-feeding, timing of introduction of complementary foods, continued breast-feeding in the first year of age, nutritional value of major foods, symptoms and hazards of childhood malnutrition, and quality and quantity of complementary foods. A demonstration of the preparation of the recommended recipes followed the group training. The recipes were designed based on local typical meals and modified to increase the energy and nutrient density of the diet. For example, a local common food *bubu* (Dough Drop Soup), which is made from flour and water, was improved by adding carrot, onion, cabbage, potato, pumpkin, egg and cooking oil. The trained health-care providers explained the benefits of the ingredients in the recipes and showed caregivers how to prepare the recipes. The recipes were then fed to children, and the caregivers were asked to evaluate what they liked or disliked about the recipes, whether they had any difficulty in using the recipe, and if they would use the recipes in future.

A 30 min questionnaire was administered by local health-care providers to the mothers of the infants at baseline, and 6, 9 and 12 months of age. The questionnaires collected information on infant feeding practices, health status, caregiver's knowledge, beliefs and behaviours, and household sociodemographic background. At the end of each survey questionnaire, the weights and lengths of the infants were measured following standard procedures⁽²⁰⁾. Infants were weighed in light clothing using electric weight scales with 0.01 kg accuracy. Their supine lengths were measured barefooted and bareheaded using standard infant length boards with 0.1 cm accuracy. Parental weights were measured using electric weight scales to the nearest 0.01 kg, and heights were measured using stadiometer to the nearest 0.1 cm. The measurements of weight and length/height were

repeated twice by two trained primary health-care providers cooperatively. Infants' birth weight and length were obtained from birth records.

The major outcomes of the study were caregivers' complementary feeding practices and infants' physical growth. Complementary feeding practices were measured by the following indicators: (i) meal frequency; (ii) the proportions of children consuming a variety of food groups; (iii) caregivers preparing easy-to-digest foods for children; (iv) washing hands before feeding, using soap and clean water; and (v) encouraging the child to eat when the child refuses. Physical growth was assessed by attained weight and length (i.e. observed weight and length at each measurement point) and incremental weight and length (i.e. increase in weight and length between baseline and the final observation point).

Ethics committee approval

The study was approved by the institutional review boards of the Johns Hopkins Bloomberg School of Public Health and Peking University Health Science Center.

Statistical analysis

For budget and logistical reasons, we could only enrol four townships per treatment group. There was no information available about inter-cluster coefficient of variation, but we expected the inter-cluster variation to be low at 0.01. Assuming the standard deviation for weight was 1 kg and average weight was 9 kg in the control group, to detect a 0.3 kg difference in weight between the intervention and control groups with 80% power and 5% significance level, and to account for the cluster effect and 20% loss to follow-up, we estimated a sample size of 600 in total (seventy-five per cluster).

Analysis was by intention to treat. Differences between groups were tested first using the Student *t* test for continuous variables and the χ^2 or Fisher exact test for categorical variables, and then using multivariate regression models to control for possible confounding effects of sociodemographic covariates. Township was used as the treatment unit, but the correlation in the outcomes within townships was low at about 0.01 and the within-township correlation was not significant in the random-effect model; therefore we omitted the intra-cluster correlation during final analyses. Random-effect regression models were used to examine the effects of the intervention on growth addressing the correlations among repeated measures on the same subject. Data management and statistical analysis were performed with the Stata statistical software package version 8.0 (Stata Corp., College Station, TX, USA).

Results

A total of 599 infants were recruited at baseline, 294 in the intervention group and 305 in the control group. Infants

in the intervention group did not differ significantly from controls with respect to infant gender, age, birth weight and length, parents' age, ethnicity, education, number of siblings, household possessions, as well as parents' weight and height (Table 1). However, more mothers at intervention sites than controls engaged in agriculture work (57.1% *v.* 49.8%, $P < 0.05$) and more fathers at intervention sites than controls were migrant labourers who worked temporarily in cities (67.3% *v.* 55.7%, $P < 0.05$).

Children available for the follow-up visits at 6, 9 and 12 months of age numbered 528 (88.1%), 473 (79.0%) and 490 (81.8%), respectively (Fig. 1). The main reasons for loss to follow-up were that the families moved out of the area, decided not to participate or were not at home at the time of the survey.

Summarised in Table 2 are reported infant feeding practices at baseline (2–4 months), 6, 9 and 12 months of age. The two groups were comparable at baseline in terms of current breast-feeding rate, breast-feeding frequency, introduction of complementary foods, and caregivers' hand-washing practice. Breast-feeding practices did not differ between groups at any of the follow-up points. Most infants (93.6% in the intervention group and 93.9% in the control group, $P = 0.88$) were breast-fed at 6 months. By 1 year of age, 85.1% in the intervention group and 85.4% in controls were still breast-fed ($P = 0.92$).

Overall, improved complementary feeding practices were observed in the intervention group. A significantly higher proportion of children in the intervention group consumed meats, eggs, dark green leafy vegetables, fruits, cooking oils and beans than did controls at 6, 9 and 12 months. By 12 months, more infants in the intervention group than controls received all food groups except for grains. The biggest differences were found in the percentage consuming meats or organ meats (96.9% *v.* 58.2%, $P < 0.001$), beans (92.1% *v.* 67.2%, $P < 0.001$) and yellow or orange foods (97.2% *v.* 76.7%, $P < 0.001$). Children in the intervention group had more meals (semi-solid or solid foods) per day than did their counterparts at 6 months (1.60 *v.* 1.05, $P < 0.001$), 9 months (3.77 *v.* 2.53, $P < 0.001$) and 12 months (4.19 *v.* 2.90, $P < 0.001$; Table 2).

At 6 and 12 months, more mothers in the intervention group reported that they washed their own hands and their children's hands before meals than did mothers in the control group. They were also more likely to wash hands using soap and clean water than mothers in the control group. More mothers in the intervention group than the control group cooked easy-to-digest foods separately for their children and encouraged children to eat when they refused food (Table 2).

Infant growth results are shown in Table 3. At baseline, there were no significant differences in the mean weights and lengths between the intervention and control groups (weight: 6.51 *v.* 6.66 kg, $P = 0.09$; length: 60.75 *v.* 61.10 cm, $P = 0.17$). By the age of 12 months, the intervention group reached a mean weight of 9.70 kg and a

Table 1 Characteristics of children and their households at baseline: healthy infants (*n* 599), aged 2–4 months at baseline (April–September 2006), from eight townships in Laishui County of Hebei Province, rural north-west China

Characteristic	Intervention (<i>n</i> 294)		Control (<i>n</i> 305)	
	<i>n</i> or Mean	% or SD	<i>n</i> or Mean	% or SD
Child				
Sex (<i>n</i> , %)				
Male	142	48.3	162	53.1
Female	152	51.7	143	46.9
Age (months)	2.7	0.5	2.8	0.6
Birth weight (g)	3308.8	431.5	3271.7	470.8
Birth length (cm)	49.8	1.9	49.9	1.7
Parents and household				
Mother's age (years)	27.2	4.3	26.6	4.4
Father's age (years)	27.7	4.2	27.7	4.3
Mother's ethnicity (<i>n</i> , %)				
Han	286	97.3	291	95.4
Minority	8	2.7	14	4.6
Father's ethnicity (<i>n</i> , %)				
Han	289	98.3	290	95.1
Minority	4	1.4	13	4.3
Mother's employment* (<i>n</i> , %)				
Migrant workert	81	27.6	84	27.5
Farmer	168	57.1	152	49.8
Business	17	5.8	33	10.8
Public sectors‡	28	9.5	36	11.8
Father's employment* (<i>n</i> , %)				
Migrant workert	198	67.3	170	55.7
Farmer	44	15.0	44	14.4
Business	24	8.2	59	19.3
Public sectors‡	28	9.5	32	10.5
Mother's education (<i>n</i> , %)				
Primary school 1–3 grade or less	6	2.0	8	2.6
Primary school 4–6 grade	45	15.3	42	13.8
Junior high school	202	68.7	218	71.4
High school or above	37	12.6	35	11.4
Father's education (<i>n</i> , %)				
Primary school 1–3 grade or less	1	0.3	3	1.0
Primary school 4–6 grade	21	7.1	23	7.5
Junior high school	223	75.9	230	75.4
High school or above	42	14.3	45	14.7
Number of siblings (<i>n</i> , %)				
1	189	64.3	200	65.6
2 or more	105	35.7	105	34.4
Number of possessions§ (<i>n</i> , %)				
0–1	6	2.0	6	2.0
2–4	163	55.4	148	48.5
5–6	125	42.5	151	49.5
Mother's weight (kg)	63.9	9.6	63.8	9.8
Father's weight (kg)	69.8	11.3	68.9	10.1
Mother's height (cm)	159.6	4.8	159.1	7.3
Father's height (cm)	171.5	4.5	171.8	4.7

Data are number and percentage (*n*, %) or mean and standard deviation.

* $P < 0.05$ for mother's employment: Farmer and Business; Father's employment: Migrant worker and Business.

†Farmers leave the village and work temporarily in urban areas, usually working in construction, in factories or as domestic helpers.

‡Working at state-owned factories, education or health-care sectors, or government.

§Refrigerator, television set, cable television, VCR/DVD player, radio and telephone.

mean length of 74.70 cm, 0.06 kg heavier and 0.21 cm longer than controls; these differences were not statistically significant (95% CI: -0.15 , 0.28 kg, $P = 0.56$; and -0.29 , 0.71 cm, $P = 0.4$, respectively).

The intervention group, however, gained more weight and length over the study period. Infants in the intervention group increased 3.26 kg in mean weight and 14.16 cm in mean length between baseline and 12 months of age, whereas the control group increased 3.02 kg in mean weight and 13.47 cm in mean length. The inter-

vention group gained 0.24 kg more weight (95% CI 0.02, 0.46 kg, $P = 0.03$) and 0.69 cm more length (95% CI 0.10, 1.28 cm, $P = 0.02$) than did controls (Table 3). Effects of the intervention on incremental weight and length remained significant after adjusting for infants' and parents' sociodemographic covariates. The multivariate regression results show that the intervention group gained 0.22 kg more weight (95% CI 0.003, 0.45 kg, $P = 0.047$) and gained 0.66 cm more length (95% CI 0.03, 1.29 cm, $P = 0.04$; Table 3). We further adjusted for the

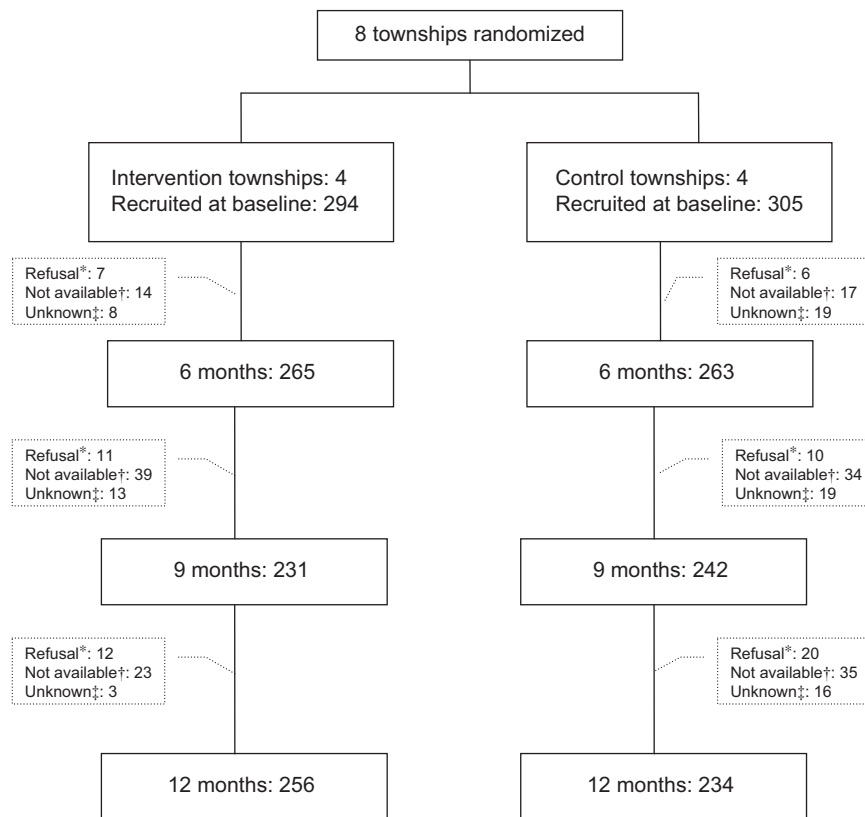


Fig. 1 Trial profile (*Refusal: the subject decided not to participate; †Not available: the subject moved out of the area or was not at home at the time of the survey; ‡Unknown: the subject dropped out of the study while the interviewer did not record the reason for drop-out)

infants' initial weight or length and age at baseline, but the results did not change substantially for weight increment (0.20 kg, 95% CI -0.02, 0.42 kg, $P = 0.08$) or length increment (0.66 cm, 95% CI 0.06, 1.27 cm, $P = 0.03$).

Random-effect models were used to examine the effect of the intervention on growth over time adjusting for correlations within subjects across observation points. The intervention group attained faster growth velocities in weight (0.04 kg/month, 95% CI 0.02, 0.06 kg/month, $P < 0.001$) and length (0.11 cm/month, 95% CI 0.05, 0.17 cm/month, $P < 0.001$). As shown in Fig. 2, the intervention group gained weight and length more quickly than did controls.

Discussion

Our findings show that an educational intervention delivered through local health-care providers can effectively change caregivers' complementary feeding practices and improve infants' growth status. The intervention activities in the current study were culturally sensitive, comprehensive, and integrated with local resources. When developing the intervention plan, we evaluated how traditional complementary foods were prepared, whether local foods were sufficient to meet nutrient

requirements, and whether the recipes were acceptable, affordable and convenient for local families. The educational messages were simple, focused and illustrated. A key element in the success of the study is that the intervention was implemented through existing health-care services. Over 80% of the surveyed mothers ranked health-care providers as their most trusted source of information on child care and feeding. In addition, health-care providers have ready access to local families through routine health services, which makes them the most viable resource to deliver the intervention. Thus, integrating educational activities on complementary feeding into the existing health-care system may result in greater sustainability over the long term.

The intervention group showed greater incremental growth, of the order of 0.24 kg and 0.69 cm, from 2–4 to 12 months of age. Although not strictly comparable, this improvement in linear growth is consistent with the summary effect on linear growth of 1.14 cm from 6 to 18 months for comparable educational interventions reported by Bhutta *et al.* in the recent *Lancet* series on maternal and child undernutrition⁽²¹⁾. There were no significant differences observed in attained weight and length between group, but the intervention group was somewhat lighter and shorter than the control group at baseline

Table 2 Infant feeding practices at each follow-up point by treatment: healthy infants, aged 2–4 months at baseline (April–September 2006), from eight townships in Laishui County of Hebei Province, rural north-west China

	2–4 months*					6 months†					9 months‡					12 months§				
	Intervention		Control		<i>P</i>	Intervention		Control		<i>P</i>	Intervention		Control		<i>P</i>	Intervention		Control		<i>P</i>
	<i>n</i> or Mean	% or SD	<i>n</i> or Mean	% or SD		<i>n</i> or Mean	% or SD	<i>n</i> or Mean	% or SD		<i>n</i> or Mean	% or SD	<i>n</i> or Mean	% or SD		<i>n</i> or Mean	% or SD			
Currently breast-feeding (<i>n</i> , %)	284	96.6	288	94.4	0.21	248	93.6	247	93.9	0.88	217	93.9	228	94.6	0.76	217	85.1	199	85.4	0.92
Breast-feeding frequency	8.87	2.58	8.97	2.85	0.33	7.66	2.28	7.40	2.33	0.20	7.30	2.20	8.00	2.75	0.004	6.61	2.12	7.48	1.83	0.36
Ever been fed (<i>n</i> , %):																				
Bread, rice, noodles	6	2.0	13	4.3	0.12	214	80.8	155	58.9	<0.001	228	99.1	233	96.3	0.04	254	100.0	229	98.3	0.11
Roots or tubers	0	0	0	0	1.00	65	24.5	61	23.2	0.72	187	81.7	178	73.6	0.04	231	90.9	172	73.8	<0.001
Yellow/orange foods	3	1.0	8	2.6	0.14	126	47.6	100	38.0	0.03	213	92.6	194	80.2	<0.001	247	97.2	178	76.7	<0.001
Green leafy vegetables	0	0	2	0.7	0.16	95	35.9	53	20.2	<0.001	216	93.9	188	77.7	<0.001	248	97.6	204	87.9	<0.001
Beans/peas/lentils	0	0	0	0	1.00	96	36.2	43	16.4	<0.001	203	88.3	149	61.6	<0.001	234	92.1	156	67.2	<0.001
Fruits	23	7.8	24	7.9	0.98	211	79.6	181	68.8	<0.001	229	99.6	231	95.5	0.005	253	99.6	224	96.6	0.04
Eggs	5	1.7	6	2.0	0.81	220	83.0	172	65.4	<0.001	227	98.7	229	94.6	0.02	252	98.8	214	92.2	0.002
Meat or organ meats	0	0	0	0	1.00	80	30.3	28	10.7	<0.001	211	91.7	137	56.6	<0.001	246	96.9	135	58.2	<0.001
Cooking oil/fats	1	0.3	0	0	0.31	87	32.8	45	17.2	<0.001	207	90.0	183	75.6	<0.001	245	96.5	185	79.7	<0.001
Meal frequency	–	–	–	–	–	1.62	1.50	1.05	1.18	<0.001	3.77	1.62	2.53	1.82	<0.001	4.17	–	2.90	1.85	<0.001
Cook for child (<i>n</i> , %)	–	–	–	–	–	104	39.3	60	22.8	<0.001	55	23.8	28	11.6	<0.001	68	26.6	46	18.7	0.07
Wash hands before feeding (<i>n</i> , %)	134	45.6	126	41.3	0.29	154	58.1	119	45.3	0.003	–	–	–	–	–	206	80.5	159	67.9	0.001
Use soap and clean water for washing hands (<i>n</i> , %)	–	–	–	–	–	138	52.1	112	42.6	0.03	–	–	–	–	–	160	62.5	105	44.9	<0.001
Encourage child to eat when child refuses (<i>n</i> , %)	–	–	–	–	–	–	–	–	–	–	140	60.6	41	16.9	<0.001	–	–	–	–	–

Data are number and percentage (*n*, %) or mean and standard deviation.
 – indicates data not available because the item was not asked at the survey.

*Intervention group *n* 294, control group *n* 305.

†Intervention group *n* 265, control group *n* 263.

‡Intervention group *n* 231, control group *n* 242.

§Intervention group *n* 256, control group *n* 234.

Table 3 Child growth by treatment group: healthy infants, aged 2–4 months at baseline (April–September 2006), from eight townships in Laishui County of Hebei Province, rural north-west China

	Intervention		Control		Unadjusted difference			Adjusted difference*		
	Mean	SD	Mean	SD	Mean	95% CI	P	Mean	95% CI	P
At age 2–4 months†										
Weight (kg)	6.51	1.09	6.66	1.05	-0.15	-0.32, 0.02	0.09	-0.14	-0.31, 0.04	0.13
Length (cm)	60.75	3.15	61.10	2.89	-0.35	-0.83, 0.14	0.17	-0.31	-0.81, 0.18	0.22
At age 6 months‡										
Weight (kg)	8.21	1.04	8.24	1.05	-0.03	-0.22, 0.14	0.69	-0.01	-0.19, 0.17	0.92
Length (cm)	67.12	2.62	67.22	2.61	-0.10	-0.55, 0.35	0.65	-0.05	-0.49, 0.39	0.82
At age 9 months§										
Weight (kg)	9.15	1.07	9.06	1.12	0.09	-0.11, 0.30	0.38	0.15	-0.05, 0.36	0.14
Length (cm)	70.66	2.49	71.28	2.92	-0.62	-1.13, -0.11	0.02	-0.50	-1.01, 0.01	0.05
At age 12 months										
Weight (kg)	9.70	1.25	9.64	1.16	0.06	-0.15, 0.28	0.56	0.03	-0.19, 0.24	0.81
Length (cm)	74.70	2.84	74.49	2.76	0.21	-0.29, 0.71	0.40	0.19	-0.32, 0.69	0.46
Increment between baseline and 12 months¶										
Weight (kg)	3.26	1.26	3.02	1.01	0.24	0.02, 0.46	0.03	0.22	0.003, 0.45	0.047
Length (cm)	14.16	3.48	13.47	2.69	0.69	0.10, 1.28	0.02	0.66	0.03, 1.29	0.04

*Adjusted for infant's gender and number of siblings, and parents' age, ethnicity, education, employment and household possessions.

†Intervention group *n* 287, control group *n* 302.

‡Intervention group *n* 258, control group *n* 254.

§Intervention group *n* 214, control group *n* 227.

||Intervention group *n* 256, control group *n* 234.

¶Intervention group *n* 234, control group *n* 203.

(although the difference was not statistically significant) and became heavier and longer by the age of 12 months (again the difference was not statistically significant). Given a longer follow-up period, perhaps we would have been able to observe improvements in attained weight and length in the intervention compared with the control group. The results from this study confirmed the finding by Bhutta *et al.* that nutritional education alone can increase linear growth in food-secure populations, which was defined by an average income of at least \$US 1 per person per day⁽²¹⁾.

The study indicated that more infants in the intervention group were fed diverse food groups, including meats or organ meats, eggs, fruits, vegetables, beans, roots, tubers and cooking oil. One of the key messages delivered to caregivers was that young children should be given animal-source protein such as meats, fish and eggs. We found that families with infants were resistant at first to the recommended recipe made from flour, egg, meat, green leafy vegetables, potato and cooking oil because they believed that 'the baby doesn't like egg or vegetables' and that 'egg, meat and cooking oil cannot be digested by the baby'. But after seeing how the recipe was prepared and how well their children accepted it during the recipe preparation demonstration, many of them agreed to try the recipe at home. By explicitly explaining the benefits of specific foods on child growth and addressing their concerns about feasibility, time and cost of preparing the recipes, the intervention changed caregivers' food selection behaviours. The results showed that 96.9% of infants in the intervention group were fed meats or organ meats at age 12 months, nearly double that reported by the control group (58.2%). Findings

from previous observational and randomised controlled studies have shown positive effects of animal-source foods on child growth and cognitive development^(22–25), and therefore researchers have advocated the use of animal-source food to address maternal and child malnutrition problems in developing countries⁽²⁶⁾. In October 2008, the WHO re-emphasised the role of the animal-source foods as 'the first and most effective choice to treat moderately malnourished children'⁽²⁷⁾. In our study, improvements in linear growth were achieved by educating and motivating families to regularly incorporate animal-source foods that were available and affordable, but were not usually fed to infants. Although this strategy is dependent on adequate family resources to acquire such foods, the findings here suggest that interventions to incorporate more animal-source foods in the diets of older infants can be an important component of policies to improve growth in the first year of life.

The current study is the first randomised controlled trial of an education intervention on complementary feeding practices in China. Although problematic complementary feeding is universal in rural areas due to socio-economic constraints and traditional beliefs, there is a severe paucity of studies on complementary feeding in China. Only two educational intervention studies in China have been published. One study was conducted in Sichuan, a southern province in China, which disseminated nutrition education messages and enhanced recipes to families with infants aged 4 to 12 months⁽⁶⁾. The intervention group was heavier and longer than the control group after implementation of the intervention. However, the study was not a randomised controlled design and did not collect baseline information, which prohibited examination

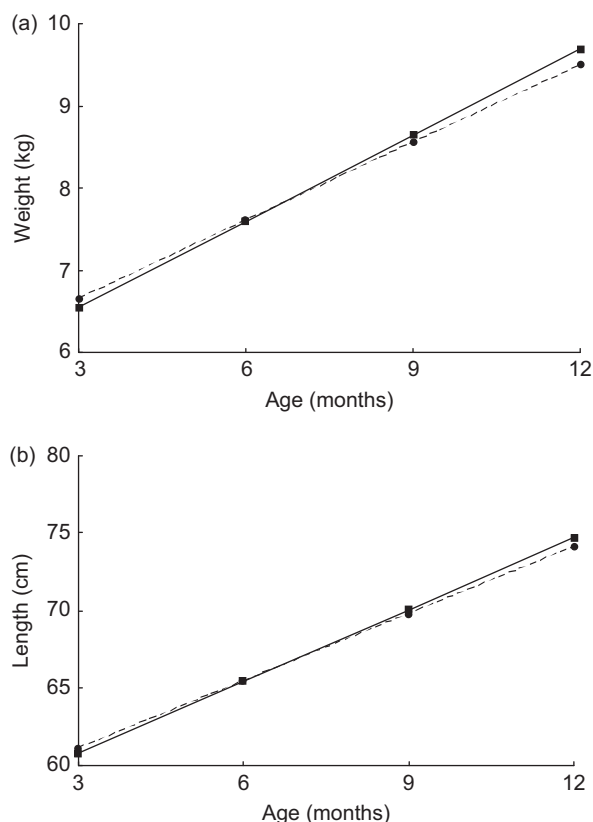


Fig. 2 Infant growth in (a) weight (kg) and (b) length (cm) from baseline to 12 months of age in the intervention (—■—) and control (---●---) groups: healthy infants (n 599), aged 2–4 months at baseline (April–September 2006), from eight townships in Laishui County of Hebei Province, rural north-west China

of the causal effects of the intervention on child growth⁽⁶⁾. The other study was conducted among infants of Dai minority in Yunnan Province⁽¹⁷⁾. That study employed nutrition education, growth monitoring, cooking demonstration and integrated management of childhood diseases as intervention approaches and found improved weights among male infants. However, the study had a cross-sectional design and the weights were compared among two different groups of children at pre- and post-intervention time periods⁽¹⁷⁾. These methodological problems limited the validity of the study results. Our study avoided these potential pitfalls. The strengths of our study are the randomised controlled design, well-trained and supervised field workers, standardised evaluation procedures, and a carefully designed data analysis plan to take into account the clustering nature of the data.

Our study also has some limitations. First, about 20% of participants dropped out during the study period. Many rural labourers poured into cities for jobs because of the huge inequality in social and economic development between the rural and urban areas in China. It is difficult to avoid drop-outs although the field workers made great efforts to maintain the participants in the study. However, the families lost to follow-up were not significantly different

from those who remained in the study with respect to baseline sociodemographic characteristics. Therefore we do not think that the loss to follow-up caused significant selection bias in our study. Second, dietary data in the study such as breast-feeding frequency, meal frequency and consumption of different food groups were obtained from a 24 h dietary recall. According to findings from previous studies, parents of infants report their infant's in-home dietary intakes accurately, and data obtained by the dietary recall can be highly consistent with weighed food intakes⁽²⁸⁾. Researchers in China compared children's daily energy intake obtained from the 24 h dietary recall with data from a 3 d household inventory, the standard approach, and found only a 1% difference between the two methods⁽²⁹⁾. We have no data on accuracy and reliability of our dietary measures, but the body of research supports its use as an adequate method for assessing food consumption in populations, including infants.

Another concern is possible information bias caused by the inability to blind people to the treatment assignment. For a randomised controlled study, ideally the people who evaluate the outcomes should not be the same people who administer the intervention. These people, together with the participants, should be blind to treatment assignment. In the current study, due to the shortage of health-care staff, those people conducting questionnaire survey and anthropometric measurement were the same ones who delivered the intervention, and they were aware of the treatment assignment. The study participants were also aware of their treatment as it was clearly stated in the consent procedure. However, we believe that this should not have introduced information bias because the anthropometric outcomes were objective. In addition, we implemented strict training, supervision and quality control measures. Weight and length scales were centrally purchased and distributed to the township hospitals, and were calibrated by the supervisors from Peking University every month. Before the study was launched, all examiners were gathered at the county hospital and trained on standardised measurement techniques. After the training, the trainees were asked to measure weights and lengths of twelve children, three times for each child. The validity of anthropometric measurements was evaluated by comparing the readings of the trainees with those made by the supervisor. The intra-observer reliability was measured by the coefficient of reliability. After the training session, all observers reached a coefficient of reliability greater than 0.95. During the study, supervisors from Peking University and the county hospital conducted supervision every month on the observers' practice of measuring children's weight and length. The inter-observer reliability was 0.98 for weight and 0.93 for length. If there was more than 0.1 kg difference in weight and more than 1.0 cm in length between two measurements, additional measurement would be taken until the difference was within 0.1 kg for

weight and 1.0 cm for length. The average of the two measurements was used as the final value of measurement. These approaches should have ensured the quality of outcome measurement.

The findings from our study, combined with the positive findings from other studies, provide promising evidence about the effects of educational interventions on complementary feeding practices and infant nutritional status. Further study is needed to determine the sustainability of such intervention effects on child growth and nutrition, and to assess the generalisability of the intervention to similar areas in China and other developing countries.

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References

- Dewey KG (2001) The challenges of promoting optimal infant growth. *J Nutr* **131**, 1879–1880.
- Bhandari N, Mazumder S, Bahl R, Martinez J, Black RE & Bhan MK; Infant Feeding Study Group (2004) An educational intervention to promote appropriate complementary feeding practices and physical growth in infants and young children in rural Haryana, India. *J Nutr* **134**, 2342–2348.
- Chen C (2000) Fat intake and nutritional status of children in China. *Am J Clin Nutr* **72**, 5 Suppl., 1368S–1372S.
- Chinese Ministry of Health (2004) *A Study on Young Children's Nutrition and Health in Eight Provinces in China*. Beijing: Department of Maternal and Child Health, Chinese Ministry of Health.
- Zhai FY & He YN (2001) Complementary feeding practice in Chinese rural children. *Wei Sheng Yan Jiu* **30**, 305–308.
- Guldan GS, Fan HC, Ma X, Ni ZZ, Xiang X & Tang MZ (2000) Culturally appropriate nutrition education improves infant feeding and growth in rural Sichuan, China. *J Nutr* **130**, 1204–1211.
- Wang XL, Wang Y & Shi L (2000) Analysis on breast-feeding and complementary feeding of children under 2 years of age in rural China. *Chin J Child Health Care* **8**, 144–146.
- Asian Development Bank (2008) Micronutrient Malnutrition Situation Analysis in China. Project Report. <http://www.adb.org/Projects/Food-Fortification/cip-prc.pdf> (accessed October 2008).
- Caulfield LE, Huffman SL & Pivovoz EG (1999) Interventions to improve intake of complementary foods by infants 6 to 12 months of age in developing countries: impact on growth and on the prevalence of malnutrition and potential contribution to child survival. *Food Nutr Bull* **20**, 183–200.
- Kilaru A, Griffiths PL, Ganapathy S & Ghosh S (2005) Community-based nutrition education for improving infant growth in rural Karnataka. *Indian Pediatr* **42**, 425–432.
- Penny ME, Creed-Kanashiro HM, Robert RC, Narro MR, Caulfield LE & Black RE (2005) Effectiveness of an educational intervention delivered through the health services to improve nutrition in young children: a cluster-randomised controlled trial. *Lancet* **365**, 1863–1872.
- Santos I, Victora CG, Martinez J, Gonçalves H, Gigante DP, Valle NJ & Pelto G (2001) Nutrition counseling increases weight gain among Brazilian children. *J Nutr* **131**, 2866–2873.
- Salehi M, Kimiagar SM, Shahbazi M, Mehrabi Y & Kolahi AA (2004) Assessing the impact of nutrition education on growth indices of Iranian nomadic children: an application of a modified beliefs, attitudes, subjective-norms and enabling-factors model. *Br J Nutr* **91**, 779–787.
- Bhandari N, Bahl R, Nayyar B, Khokhar P, Rohde JE & Bhan MK (2001) Food supplementation with encouragement to feed it to infants from 4 to 12 months of age has a small impact on weight gain. *J Nutr* **131**, 1946–1951.
- Pachon H, Schroeder DG, Marsh DR, Dearden KA, Ha TT & Lang TT (2002) Effect of an integrated child nutrition intervention on the complementary food intake of young children in rural north Viet Nam. *Food Nutr Bull* **23**, 4 Suppl., 62–69.
- Gartner A, Kameli Y & Traissac P (2007) Has the first implementation phase of the Community Nutrition Project in urban Senegal had an impact? *Nutrition* **23**, 219–228.
- Li Y, Hotta M, Shi A, Li Z, Yin J, Guo G, Kawata K & Ushijima H (2007) Malnutrition improvement for infants under 18 months old of Dai minority in Luxi, China. *Pediatr Int* **49**, 273–279.
- Hotz C & Gibson R (2005) Participatory nutrition education and adoption of new feeding practices are associated with improved adequacy of complementary diets among rural Malawian children: a pilot study. *Eur J Clin Nutr* **59**, 226–237.
- Mackintosh UA, Marsh DR & Schroeder DG (2002) Sustained positive deviant child care practices and their effects on child growth in Viet Nam. *Food Nutr Bull* **23**, 4 Suppl., 18–27.
- Cogill B (2003) *Anthropometric Indicators Measurement Guide*. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.
- Bhutta ZA, Ahmed T, Black RE *et al.*; Maternal and Child Undernutrition Study Group (2008) What works? Interventions for maternal and child undernutrition and survival. *Lancet* **371**, 417–440.
- Sanghvi T, Ameringzen MV, Baker J & Fiedler J (2007) Vitamin and mineral deficiencies technical situation analysis: a report for the Ten Year Strategy for the Reduction of Vitamin and Mineral Deficiencies. *Food Nutr Bull* **28**, 1 Suppl., S157–S219.
- Grillenberger M, Neumann CG, Murphy SP, Bwibo NO, Weiss RE, Jiang L, Hautvast JG & West CE (2006) Intake of micronutrients high in animal-source foods is associated with better growth in rural Kenyan school children. *Br J Nutr* **95**, 379–390.
- Neumann CG, Bwibo NO, Murphy SP, Sigman M, Whaley S, Allen LH, Guthrie D, Weiss RE & Demment MW (2003) Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: background, study design and baseline findings. *J Nutr* **133**, 11 Suppl. 2, 3941S–3949S.
- Siekmann JH, Allen LH, Bwibo NO, Demment MW, Murphy SP & Neumann CG (2003) Kenyan school children have multiple micronutrient deficiencies, but increased plasma vitamin B-12 is the only detectable micronutrient response

- to meat or milk supplementation. *J Nutr* **133**, 11 Suppl. 2, 3972S–3980S.
26. Anon. (2003) Animal source foods to improve micronutrient nutrition and human function in developing countries. Proceedings of a conference. June 24–26, 2002. Washington, DC, USA. *J Nutr* **133**, 11 Suppl. 2, 3875S–4061S.
27. World Health Organization (2008) Consultation on the dietary management of moderate malnutrition. http://www.who.int/nutrition/topics/severemalnutrition_consultation_dietarymanagement/en/index.html (accessed March 2009).
28. Klesges RC, Klesges LM, Brown G & Frank GC (1987) Validation of the 24-hour dietary recall in preschool children. *J Am Diet Assoc* **87**, 1383–1385.
29. Zhai F, Guo X & Popkin B (1996) Evaluation of the 24-hour individual recall method in China. *Food Nutr Bull* **17**, 154–161.