Original Article

The nutritional status of young children and feeding practices two years after the Wenchuan Earthquake in the worst-affected areas in China

Jing Sun BD[1], Junsheng Huo PhD[1], Liyun Zhao MD[1], Ping Fu BD[1], Jie Wang PhD[1], Jian Huang BD[1], Lijuan Wang PhD[1], Pengkun Song MD[1], Zheng Fang MD[2], Suying Chang PhD[3], Shian Yin PhD[1], Jian Zhang MD[1], Guansheng Ma PhD[1]

[1]*Institute for Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, Beijing, China*
[2]*Food Fortification Office, China CDC, Beijing, China*
[3]*UNICEF, Beijing, China*

This study was carried out to investigate the nutritional status and feeding practices of young children in the worst-affected areas of China two years after the Wenchuan Earthquake. The sample consisted of 1,254 children 6-23 months of age living in four selected counties from the disaster-affected provinces of Sichuan, Shaanxi and Gansu. Length-for-age, weight-for-age, weight-for-length, and hemoglobin concentration were used to evaluate nutritional status. Interviews with selected children's caretakers collected basic demographic information, children's medical history, and child feeding practices. Stunting, underweight, and wasting prevalence rates in children 6-23 months of age were 10.8%, 4.9% and 2.8% respectively, and anemia prevalence was 52.2%. Only 12.3% of children had initiated breastfeeding within the first hour after birth. Overall, 90.9% of children had ever been breastfed, and 87% children 6-8 months of age had received solid, semi-solid or soft foods the day before the interview. The diets of 45% of children 6-23 months of age met the definition of minimum dietary diversity, and the diets of 39% of breastfed and 7.6% non- breastfed children 6-23 months of age met the criteria for minimum meal frequency. The results highlight that a substantial proportion of young children in the earthquake affected disaster areas continue to have various forms of malnutrition, with an especially high prevalence of anemia, and that most feeding practices are suboptimal. Further efforts should be made to enhance the nutritional status of these children. As part of this intervention, it may be necessary to improve child feeding practices.

Key Words: young children, child growth, anemia, complementary feeding, earthquake disaster

INTRODUCTION

Malnutrition in infants and young children is one of the most serious public health problems in developing countries. The majority of growth retardation has its origins in the first 2 or 3 years of life.[1] Such growth retardation is generally not recovered and has profound health implications for the rest of a child's life.[2-4] After an optimum of six months of exclusive breast feeding, there is often a sudden decline in weight-for-age, height-for-age, and weight-for-age z scores which persists until 24 months of age, especially in poor populations.[1] This period coincides with the introduction of complementary foods, implying that complementary feeding practices and/or complementary foods provide insufficient nutrient intake.

A powerful earthquake centered in Wenchuan County in Sichuan Province, China occurred in May 2008 and affected parts of eight provinces with a total population of 348 million people. Sichuan, Gansu, and Shaanxi provinces were the three worst-affected areas, as reported by State Council Information Office of the People's Republic of China. More than 5 million buildings collapsed, resulting in massive population displacement. Transportation infrastructure was damaged or blocked, and large areas of farmland and crops were destroyed or unusable.[5] Food, water, and other supplies rapidly reached displaced families; however, studies conducted by Chinese Center for Disease Control and Prevention (CDC) a few months after the earthquake demonstrated inadequate intake of animal-source foods, fruits, vegetables, and appropriate complementary foods for young children.

Surveys have demonstrated a rapid change in child nutritional status since the earthquake. In 2002, the prevalence of anemia in children 0-23 months of age in Sichuan province was 28.8%.[6] In 2001, children less than 36 months of age in poor areas of Gansu province had a anemia prevalence of 27.4%.[7] A nutrition assessment survey done one year after the earthquake in three affected

counties showed substantially higher prevalence rates of anemia of 52.4% and 42.5% in children 0-11 months of age and 12-23 months of age, respectively.[8]

Several studies have demonstrated exacerbation of different forms of malnutrition during and after disasters and emergencies.[9] This study was conducted by China CDC between April and May 2010 to provide an assessment of the nutritional status of young children and child feeding practices two years after the earthquake to further plan and implement specific nutritional interventions for young children in this disaster-affected area.

MATERIALS AND METHODS
Study design and sampling methods
This baseline survey was conducted in four counties in Sichuan, Shaanxi and Gansu provinces. Sampling consisted of three stages. In the first stage, 30 townships were randomly selected within these four counties with probability proportional to size. In the second stage, five villages were randomly selected in each selected township with probability proportional to size. In the final sampling stage, local village doctors in each township's five selected villages were asked to collectively recruit 36 children from all five villages in each selected township.

Four indicators were used to evaluate child nutritional status: the anthropometric indices, including length-for-age, weight-for-age and weight-for-length z scores, were used to evaluate the prevalence of protein-energy malnutrition; and hemoglobin concentration was used to detect the presence of anemia. In addition, interviews collected general information on participating children and feeding practices during the previous day. All measurements and interviews were carried out by trained staff from China CDC, and a team of supervisors monitored data quality.

Anthropometry
The weight of each child was determined using a TZ-530 portable child electronic weighting scale (Double-Jie Test Instrument, Changshu, Jiangsu, China) which has a precision of 10 g. Undressed children were weighed in a warm room. The average of three measurements was recorded as the child's weight. The weighing scale was calibrated daily using standard weights. The lengths of children were measured using a YSC-2 measuring board (Zhong Xing Co, Beijing, China), and an average of two readings were taken and recorded to the nearest 0.1 cm. Z-scores equal to the measured weight or length/height value minus the mean weight or length/height value divided by the standard deviation, were calculated based on the WHO standards for weight-for-age, length/height-for-age and weight-for-length/height. Stunting, underweight, and wasting were defined as having a z score < −2.0 for length-for-age, weight-for-age, and weight-for-length, respectively.[10]

Anemia
Blood specimens were obtained by finger prick and tested according to the recommendations of the portable hemoglobinmeter's manufacturer (HemoCue AB, Ängelholm, Sweden). Anemia was defined according to recommendations from WHO.[11] In children 6-59 months of age, a hemoglobin concentration below 110 g/L de-

fines anemia. A hemoglobin concentration of 90-110 g/L defines mild anemia, a hemoglobin concentration of 60-90 g/L defines moderate anemia, and a hemoglobin concentration of less than 60 g/L defines severe anemia.[12] Since the target area is mountainous, these cut-off points were adjusted according to altitude of residence at the time of data collection according to standard recommendations.[13]

Interview
An interview with the selected child's caretaker collected basic demographic information, the child's medical history, and child feeding practices, including breastfeeding practices and a targeted 24-hour dietary recall. The child's medical history included questions on respiratory diseases and diarrhea. Local township physicians examined each child for glossitis, angular stomatitis, and rickets. Each child's birthweight was recorded from the child's birth card. Low birthweight was defined as less than 2,500 g.[14]

A subset of breastfeeding and infant feeding indicators recommended by WHO were measured by interview questions about dietary history and feeding practices.[15] These indicators include the proportion of children less than 24 months of age with early initiation of breastfeeding; the proportion of children less than 24 months of age who were ever breastfed; the proportion of children 6-23 months of age with minimum dietary diversity; the proportion of children 6-8 months of age who have been introduced to solid, semi-solid or soft foods; and the proportion of children 6-23 months of age consuming iron-rich foods.

Minimum dietary diversity (MDD): The MDD was 4 of 7 food groups per day. The proportion of children 6-23 months of age who receive foods from 4 or more food groups was estimated. The food groups were:
a) Grains, roots and tubers
b) Legumes and nuts
c) Dairy products (milk, yogurt, cheese)
d) Flesh foods (meat, fish, poultry and liver/organ meats)
e) Eggs
f) Vitamin-A rich fruits and vegetables
g) Other fruits and vegetables

Minimum meal frequency: Proportion of breastfed and non-breastfed children 6-23 months of age who receive solid, semi-solid, or soft foods (but also including milk feeds for non-breastfed children) the minimum number of times or more. Breastfed children 6-23 months of age who received solid, semi-solid or soft foods the minimum number of times or more during the previous day.
and
Non-breastfed children 6-23 months of age who received solid, semi-solid or soft foods or milk feeds the minimum number of times or more during the previous day.

Consumption of iron rich foods: Proportion of children 6-23 months of age who receive an iron-rich food or iron-fortified food that is specially designed for infants and young children, or that is fortified in the home.

Children 6-23 months of age who received an iron-rich food or a food that was specially designed for infants and young children and was fortified with iron, or a food that was fortified in the home with a product that included iron during the previous day.

Data management and statistical analysis
EpiData software (Windows version 3.1, EpiData, Denmark) was used to enter and manage the raw data. SPSS software (Windows version 16.0, SPSS, Chicago, IL, USA) was used for all data analysis. Z scores were calculated using the WHO Child Growth Standard using Anthro software (Version 3.2, WHO).

Ethical considerations
Written consent was obtained from caretakers before enrolling children in the survey sample.

RESULTS
Characteristic of the sample
Table 1 presents the characteristic of the surveyed children. Table 2 lists the educational level of the surveyed children's mothers, fathers, and the grandparents as the primary caretakers. The majority of parents had education beyond elementary school. A small proportion of parents and about one fourth of grandparents had no formal education at all.

Child growth
The prevalence rates of underweight, stunting and wasting of children aged 6-23 months are shown in Table 3. The prevalence of all three forms of malnutrition increases with age.

Figure 1 shows the mean average z scores of the 3-month age groups. The average z-score for both weight-for-age and length-for-age decline up to age 18-20 months, and then increase slightly. In contrast, the average z-score for weight-for-length declines earlier in life, albeit not as much, then stabilizes at 12-14 months of age.

The distributions of weight-for-age, length-for-age, and weight-for-length z-scores for survey children and for the WHO Child Growth Standard are displayed in Figure 2. Compared with the standard population, the weight-for-age and length-for-age z-scores for survey children are shifted to the left. There is very little wasting, as indicated by the distribution of weight-for-length z-scores.

Child anemia

Table 1. Characteristic of the surveyed children

Characteristic	Number of children	% of children
Gender		
Male	642	51.2
Female	612	48.8
Age of child, months		
6-11	467	37.2
12-17	480	38.3
18-23	307	24.5
Medical history		
Respiratory disease in previous 2 weeks†	508	40.5
Diarrhea in previous 2 weeks‡	176	14.0
Angular stomatitis§	11	0.9
Glossitis¶	15	1.2
Rickets††	230	18.3
Birth order		
1	813	65.8
2	415	33.6
>=3	8	0.6
Low birthweight	29	4.9
Child's relationship to caretaker		
Father	12	1.0
Mother	980	78.7
Grandparent	244	19.6
Babysitter	2	0.2
Other	7	0.6

† Includes upper respiratory tract infection, tracheitis, bronchitis, pneumonia and other infectious diseases.
‡ Defined as three or more loose stools per day.
§ Defined as inflammation at the corners of the mouth, associated with a wrinkled or fissured epithelium that does not involve the mucosa.
¶ Defined as inflammation of the tongue.
†† Defined as bending and distortion of the bones, nodular enlargements on the ends and sides of the bones, delayed closure of the fontanelles.

Anemia prevalence rates by age and sex are shown in Table 4. Overall, 643 (52.2%) of the 1231 children tested were anemic. The prevalence of anemia in both sexes drops with the increase in age; however, this decline is much more marked in boys than in girls.

Figure 3 shows the weighted distribution of hemoglobin concentrations in children 6-23 months of age in the survey data. More than half of children 6-23 months of age were anemic, and among the anemic children, more than four-fifths (85.6%) had mild anemia.

Table 2. Educational level of caretakers of the surveyed children

Education level	Father		Mother		Grandparents	
	Number of children	% of children	Number of children	% of children	Number of children	% of children
No education	15	1.2	37	2.9	63	25.7
Some or completed elementary school	253	19.8	346	27.0	113	46.1
Some or completed junior middle school	717	56.0	670	52.3	60	24.5
Some or completed senior middle school	238	18.6	181	14.1	9	3.7
Some or completed junior college	42	3.3	42	3.3	0	0.0
Some or completed college or university and above	16	1.3	6	0.5	0	0.0

Table 3. Prevalence of underweight, stunting and wasting of the children aged 6-23 months

Age (in months)	Underweight		Stunting		Wasting	
	Number of children	% of children	Number of children	% of children	Number of children	% of children
6-11 (n=464)	14	3.0	34	7.3[***]	9	1.9
12-17 (n=478)	26	5.4	51	10.7[***]	14	2.9
18-23 (n=295)	20	6.8	48	16.3[***]	12	4.1
Total	60	4.9	133	10.8	35	2.8

[***] $p<0.0001$ Pearson chi-square test.
Stunting is defined as having a z score <-2.0 for length-for-age; underweight is defined as having a z score <-2.0 for weight-for-age; wasting is defined as having a z score <-2.0 for weight-for-length.
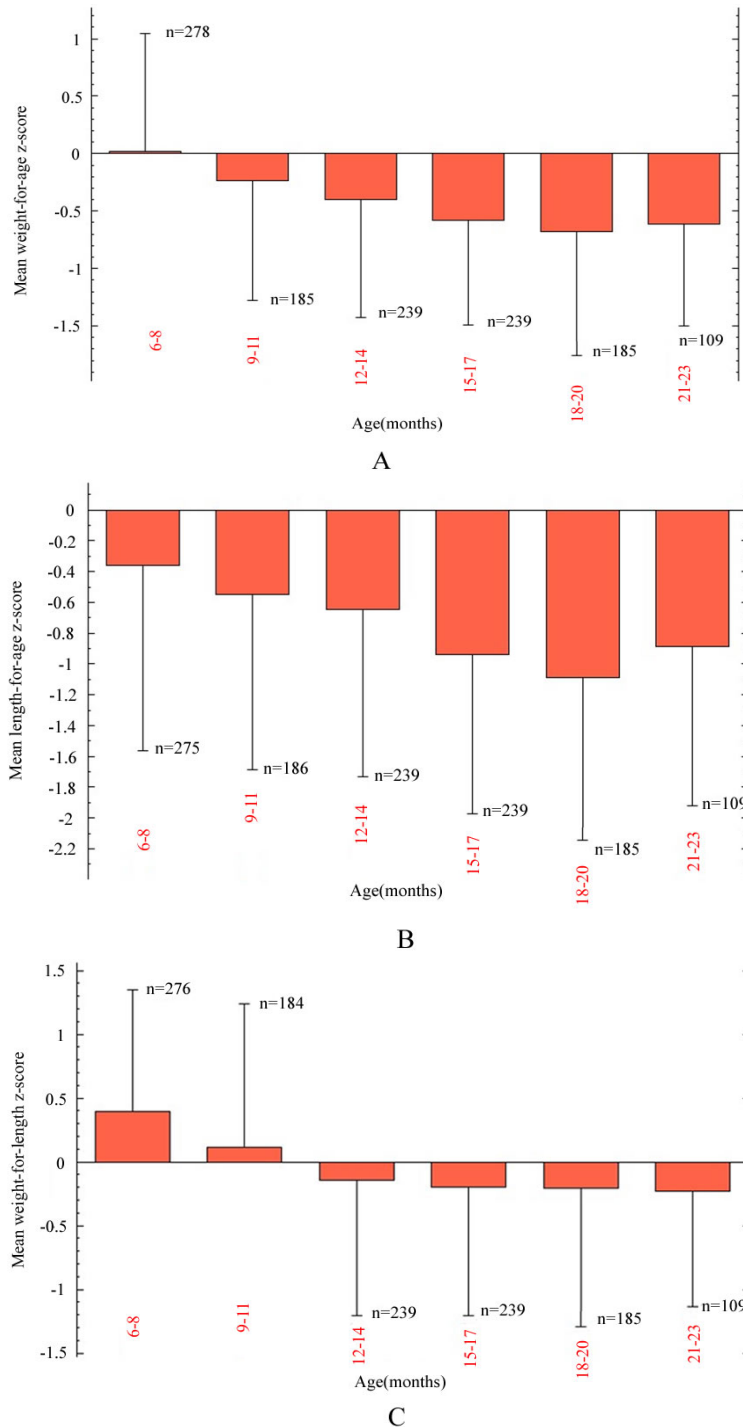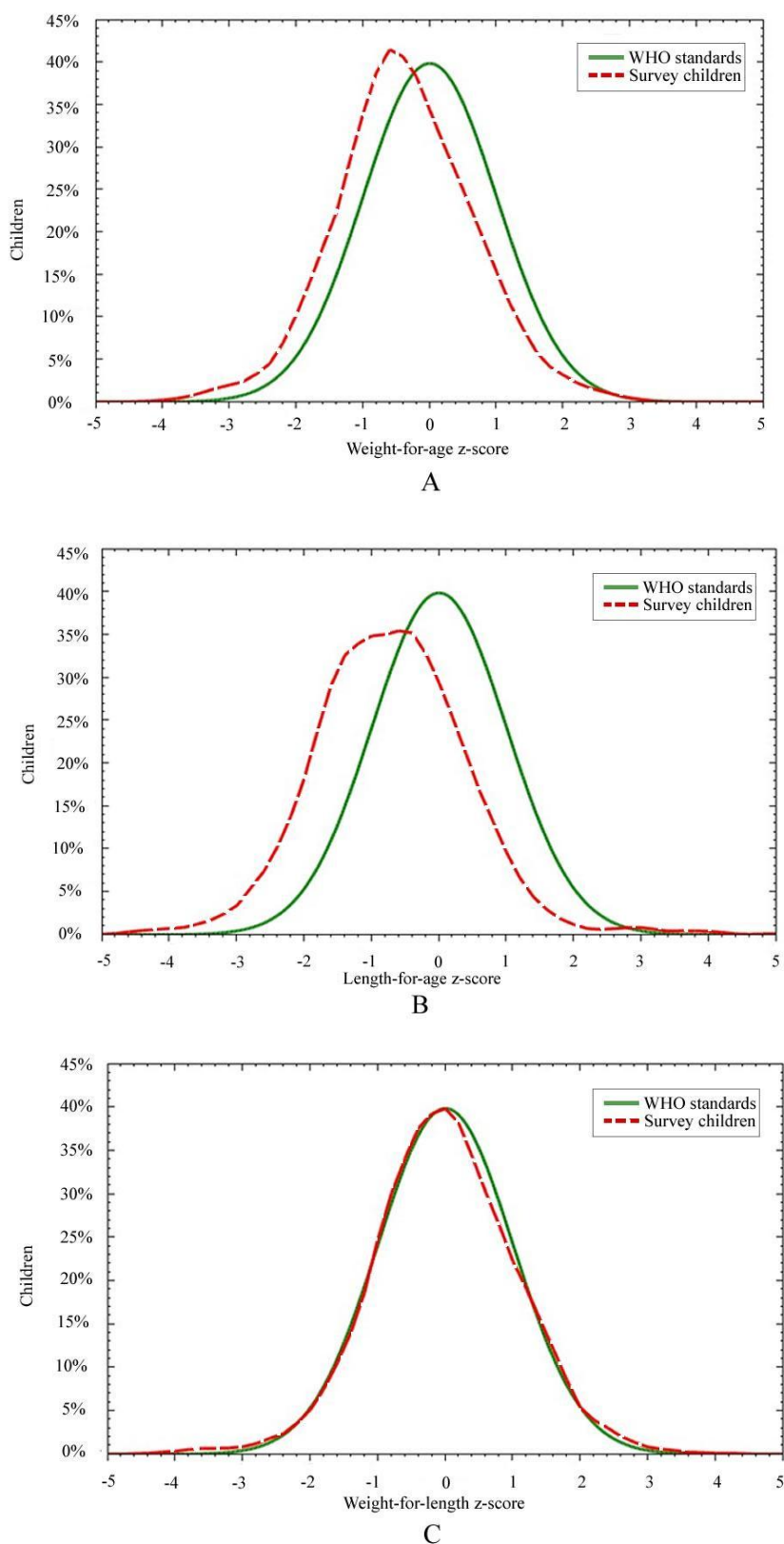

Figure 1. Mean weight-for-age z-scores (A), mean length-for-age z-scores (B), mean weight-for-length z-scores (C) of children 6-23 months of age. Stunting is defined as having a z score <-2.0 for length-for-age; underweight is defined as having a z score <-2.0 for weight-for-age; wasting is defined as having a z score <-2.0 for weight-for-length.

Figure 2. Weight-for-age z-scores (A), length-for-age z-scores (B), weight-for-length z-scores (C) distributions for children 6-23 months of age in the survey data and the WHO Child Growth Standard. Stunting is defined as having a z score < –2.0 for length-for-age; underweight is defined as having a z score < –2.0 for weight-for-age; wasting is defined as having a z score < –2.0 for weight-for-length.

Infant and young child feeding

Indicators of breastfeeding are shown in Table 5. A high proportion of children had ever been breastfed; however, few had initiated breastfeeding within the first hour after birth and almost two-thirds initiated breastfeeding only on the second day after birth or later.

The four complementary feeding indicators are shown in Table 6. The vast majority of children 6-8 months of age had received solid, semi-solid or soft foods the day before the interview. The diet of less than one-half of children 6-23 months of age met the definition of minimum dietary diversity. Although this proportion rises with

Table 4. Number (%) of children with anemia, by age and sex

Age, months	Number (%) of children			
	Male	Female	*p* value for difference between sexes	Total
6-11	156 (63.1)	116 (54.2)	0.051	272 (69.0)***
12-17	115 (48.7)	128 (53.1)	0.363	243 (50.9)***
18-23	56 (38.4)	72 (49.0)	0.067	128 (43.7)***
Total	327 (52.0)	316 (52.5)	0.859	643 (52.2)

*** *p*<0.0001 Pearson chi-square test.
hemoglobin concentration below 110 g/L defines anemia
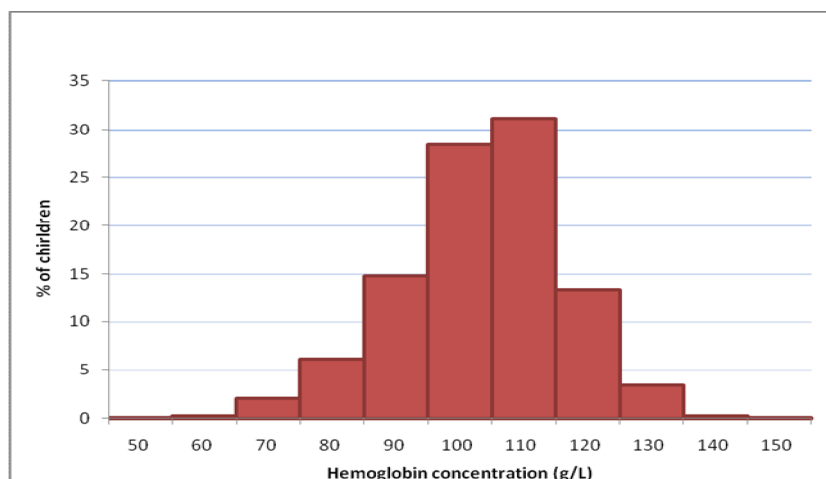
Figure 3. Distribution of hemoglobin concentrations in children 6-23 months of age in the survey data. Hemoglobin concentration below 110 g/L defines anemia; hemoglobin concentration of 90-110 g/L defines mild anemia; hemoglobin concentration of 60-90 g/L defines moderate anemia; hemoglobin concentration of less than 60 g/L defines severe anemia.

increasing age, less than two-thirds of children in the oldest age group met minimum dietary diversity. Few children, either breastfeeding or not breastfeeding, met the criteria for minimum frequency of meals. Overall, less than one-half of children 6-23 months of age had eaten iron-rich foods, such as flesh foods, the day before the interview, but this proportion increased somewhat with age. No children in this survey had received iron-containing micronutrient powder or lipid-based nutrient supplement. Only 13 children in the survey had consumed iron-fortified infant formula, and five had consumed other iron-fortified supplements.

DISCUSSION

Natural disasters, such as earthquakes and population displacement, often produce a sharp rise in the risk of malnutrition in the disaster-affected or displaced population.[16,17] Due to the lack of pre-earthquake data from the same area, data from a 2005 nationwide survey reflecting children's nutritional status were used as the basis for comparison. This 2005 survey showed that in China, anemia is one of the most common nutritional diseases, and children 0-23 months of age are an especially vulnerable group. The results of our survey showed that the prevalence of anemia in children 6-23 months of age in the earthquake-affected areas was twice as high as the national prevalence in rural areas in 2005 (21.9%).[18] In children 6-11 months of age, the prevalence of anemia

was especially high in our survey (69%). In children 6-23 months of age in disaster-affected areas of Sichuan, Shaanxi and Gansu provinces, the nutritional situation improved substantially since three months after the earthquake.[12] The prevalence rates of wasting, stunting, and underweight are less than one-half what they were at that time. The prevalence of anemia decreased somewhat shortly after the earthquake, but has remained stable since then.[8,12] There are similar examples from other emergency-affected and displaced populations in which restriction of the food supply and lack of foods rich in iron and vitamin C exacerbated iron deficiency anemia in young children.[19] Although these examples are from African populations living in enclosed camps for many years, a common factor with the earthquake-affected population included in this survey is the restriction in the variety of foods available.

The results of our survey also indicate that complementary feeding practices were poor in young children in the disaster-affected areas. Among the feeding practices indicators estimated in this survey, only the age when solid, semi-solid or soft food was introduced conformed with international recommendations. Minimum meal frequency was surprisingly low, especially for non-breastfed children. Moreover, the proportions of children with minimum dietary diversity and with consumption of iron-rich foods were lowest in children 6-11 months of age, demonstrating that early complementary feeding is espe-

Table 5. Child breastfeeding indicators of the surveyed children

Indicators	Number of children	% of children
Initiation of breastfeeding		
<1 hour of delivery	158	12.3
within 1-24 hour of delivery	197	15.3
>24 hour after delivery	834	64.8
Ever-breastfed	1171	90.9

Table 6. Complementary feeding indicators among the children 6-23 months of age

Indicator	Number of children	% of children
Introduced to solid, semi-solid or soft foods (children 6-8 months of age)	234	87.0
Minimum dietary diversity		
6-11 months	159	34.9[***]
12-17 months	236	49.9[***]
18-23 months	173	59.5[***]
Total	549	45.0
Minimum meal frequency		
breastfed	224	39.0[***]
non-breastfed	45	7.6[***]
Consumption of iron-rich foods		
6-11 months	119	40.2[*]
12-17 months	177	46.7[*]
18-23 months	126	51.6[*]
Total	422	46.4

[*] $p<0.05$; [***] $p<0.0001$ Pearson chi-square test

cially poor. The most common caretakers of children were mothers, the majority of whom had some junior middle school or less education. The second most common caretakers were grandparents who were somewhat less well educated. Such caretakers may have less awareness of appropriate feeding practices, including the purchase of commercial complementary food.

In addition to poor dietary diversity, meal frequency, and consumption of iron-rich foods, the earthquake and subsequent displacement and social disruption may have also resulted in worsening complementary feeding practices. Displaced disaster-affected families are often separated from their normal sources of food and income. They often must rely of relief food which requires a substantial change in dietary habits, including a narrowing of food choices if heavily dependent on relief food. As a result, protein-energy malnutrition and micronutrient deficiencies become much more common in such populations. Families may not be able to make or have access to complementary foods tailored to young children. As a result, children may have to eat the same food as adults, and such food may not be as palatable to children and may not contain sufficient quantities of bioavailable micronutrients.

Overall, the findings of this survey demonstrate the presence of nutritional problems, especially anemia, in young children in the earthquake-affected areas. Because of the long-term nature of the effects of many forms of malnutrition on child growth and development, timely public health interventions are needed after emergencies and disasters. In the population affected by the Wenchuan earthquake, complementary feeding interventions are especially needed. Such interventions used elsewhere have included education of mothers, distribution of special complementary food, in-home fortification of complementary foods with micronutrients, or a combination of several strategies. The most appropriate interventions may differ between different populations, and selection of interventions should be based on the actual situation in the target population.[20] An in-home fortification product called Ying Yang Bao has been developed in China. It consists of soybean powder as a substrate and multiple micronutrients as fortificants. Like other in-home fortification products, it is to be added to complementary food by the mother just before consumption by the young child. This product has been shown to be effective in promoting growth and enhancing mental development in children 4-12 months of age.[21,22] As a result of this survey, Ying Yang Bao has been distributed to children 6-23 months of age in the earthquake-affected population. A future follow-up survey will assess the population effect of this intervention.

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[1]*Institute for Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, Beijing, China*
[2]*Food Fortification Office, China CDC, Beijing, China*
[3]*UNICEF, Beijing, China*

中国汶川大地震两年后灾区婴幼儿营养状况和喂养行为研究

本文是中国汶川大地震两年后对受灾严重地区的婴幼儿营养状况和喂养行为进行的调查研究。本研究在四川、陕西和甘肃三个受灾省份抽取四个县中1,254名6-23月龄婴幼儿作为调查对象。以年龄别身长、年龄别体重、身长别体重以及血红蛋白水平作为婴幼儿营养状况的评价指标。调查中还采用问卷向婴幼儿看护人收集了婴幼儿基本信息、婴幼儿父母职业及文化程度、婴幼儿过去两周腹泻和呼吸系统患病情况，以及婴幼儿膳食摄入和喂养行为等相关信息。结果顯示，接受调查的婴幼儿之生长迟缓、低体重、消瘦发生率分别为 10.8%、4.9%和 2.8%，贫血患病率为 52.2%。只有 12.3%的婴幼儿在出生后一小时内开奶，90.9%的婴幼儿为母乳喂养。87%的 6-8 月龄婴幼儿在调查前 24 小时内摄入了固体、半固体、或软质食物。45%的婴幼儿达到了WHO 推荐的最少膳食种类指标，39%的母乳喂养婴幼儿和 7.6%的非母乳喂养的婴幼儿达到了 WHO 推荐的最少食物频率指标。调查结果表明受灾地区婴幼儿存在各种类型的营养不良状况，贫血患病率高，婴幼儿喂养行为状况不理想。需要更多的投入以提高这些婴幼儿的营养状况，并且，将改善婴幼儿喂养行为作为此次营养干预工作内容的一部分是很有必要的。

关键词：婴幼儿、生长发育、贫血、辅食、地震