Original Article

Growth and anaemia among infants and young children for two years after the Wenchuan Earthquake

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Background: In order to monitor malnutrition morbidity and anaemic prevalence of infants and young children in rural disaster areas affected by Wenchuan earthquake. Methods: About three months, one year and two years after earthquake (including 77, 102 and 307 children, respectively), by using the questionnaires, information on nutritional and health status of infants and young children aged 6-23 months was collected and evaluated, and anthropometry and haemoglobin concentration were measured. Results: Most of families could not prepare complementary foods for their children so that the children only ate the same meals as adults which resulted in very poor situation in the quantity and quality of complementary food for infants and young children. The main nutritional problems in children included the lack of feeding knowledge in parents; only 10% children could have breast feeding within one hour after delivery, and the basic exclusive breastfeeding was lower. More than 90% children never received nutrient supplements. The malnutrition prevalence was significantly increased two years after the earthquake. The decrease of body weight was rapid (underweight prevalence from 0 at three months to 5.9% after two years), and then a lasting effect resulted in decrease of length shown by stunting prevalence from 6.6% at three months to 10.8% after two years and wasting prevalence from 1.3% at three months to 4.0% after two years. From three months to two years after earthquake, anaemic prevalence markedly increased from 36.5% to 67.5% and the increasing percentage of anaemia was more obvious in girls than boys. Conclusion: The child's nutritional status continuously worsened and anaemic prevalence was high in areas affected by the earthquake. It is recommended that in the future nutrition interventions should begin immediately.

Key Words: emergency, infants and young children, malnutrition, anaemia, earthquake

INTRODUCTION

During emergency situations, such as earthquakes, volcanic eruptions, mud rock flow, drought, and floods, the food supply system could be severely damaged or even completely stopped, major food shortages can be a primary feature, which would result in serious protein-energy malnutrition and micronutrient deficiencies that inevitably follow such shortages and add greatly to the burden of diseases and mortality.[1-4] Experience has shown that even in previously healthy populations, infant and young child morbidity and mortality often dramatically increase in a very short period because infants and young children have been identified as the most nutritionally vulnerable group.[4-8] Malnutrition and suboptimal nutrition and poor feeding practices during the early years of life could adversely affect child's growth and development, and would have a long-term negative impact on cognitive, motor-skill, physical, social and emotional development, which all could influence the health and risk suffered from chronic diseases at adulthood.[9-11]

Affected by the emergency, endemic micronutrient deficiencies were reported to be very common in infants and young children, and often exacerbated by a general deterioration in nutritional status.[7] The adverse effects of micronutrient deficiencies on growth and development are very profound.[3,6-8] Micronutrient deficiencies may lead to increase risk of death, morbidity and susceptibility to infection, blindness, adverse birth outcomes, growth stunting, low work capacity, decreased cognitive capacity and mental retardation.

The period from 6 to 23 months is the most critical for a young child because of their rapid growth and an increasing reliance on complementary food. This paper will follow-up surveys to evaluate the growth and anaemic status of infants and young children living in rural disaster areas affected by the Wenchuan Earthquake.

METHODS

Rural disaster areas, Kang County located in the high

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Manuscript received 13 July 2013. Initial review completed 30 July 2013. Revision accepted 02 August 2013.
doi: 10.6133/apjcn.2014.23.3.03

mountain and inaccessible area, were near the seismic centre of Wenchuan earthquake on May 12, 2008. The county belongs to the hardest hit area destroyed by the earthquake, life and property losses of local residents were very severe. Using cluster sample design, the follow-up surveys on growth and development status and anaemic prevalence of infants and young children from 6 to 23 months living in this county were carried out three months, one year and two years after the earthquake. The present surveys were approved by the Ethics Committee of National Institute of Nutrition and Food Safety, Chinese Centre for Disease Control and Prevention, and written informed consent was obtained from all parents or guardians.

Subjects

In August 2008 (about three months after earthquake), information on nutritional and health status of special population was collected and evaluated using the questionnaires, and anthropometry and haemoglobin concentration in infants and young children were measured from two settlements of villages and towns in Kang County in Gansu Province. A total of 77 infants and young children aged 6-23 months were investigated.

In April 2009 (about one year after earthquake), a nutritional survey was conducted in Kang County. This survey recruited 102 infants and young children aged 6-23 months in the same place as that in August 2008, and these children's growth and anaemic status were evaluated.

In May 2010 (two years after the earthquake), a cross-sectional survey and promotional probability methods (PPS) were used to sample the villages to evaluate the children's growth status and anaemic prevalence in the same place as that in August 2008. A total of 307 infants and young children aged 6-23 months were recruited from six villages.

Methods

A questionnaire was answered by the children's mothers or other caregivers. The body weight, length and haemoglobin concentration were measured to evaluate the growth status and anaemic prevalence.

A platform weighing scale (TC100KA, 0-100 kg of capacity and 10 g of accuracy, Huatec Company, China) and length scale (YSC-2, 0.1 cm of accuracy, Beijing Guowangxingda Weight Scale Company, China) were used to measure body weight and length of children wearing only underwear. Before each measurement, the weighing and length scales were checked with the calibrated weight material and the nurses were trained and evaluated.

Haemoglobin (Hb) concentration of whole blood, taken from the tip of left middle finger, was assayed using the hemocue (HB 301, HemoCue AB, Angelholm, Sweden) in the field sites. Anaemia was defined as a haemoglobin level of <110 g/L, and for those sites with altitude over 1000 meters, the anaemic prevalence was corrected using WHO recommended altitude formula.

Bias

Because the surveyed sites located in the rugged mountain areas and the living place was much decentralized and inaccessible areas, the sample size at each selected site and each survey was not consistent by the reasons that some of the children could not catch up with the survey due to the bad weather and raining, or remote and inaccessible transportation from their living areas, which could lead to the potential bias.

Statistical analysis

Epidata software (Windows version 3.1, Epidata, Denmark) was used to enter and manage the raw data. SAS software (version 9.1; SAS Institute Inc, Cary, NC) was used for the statistical analysis. WHO Anthro software was used to calculate the children growth status. Growth status was evaluated by WHO Child Growth Standard (2006). Malnutrition was defined as a Z-score less than -2; underweight, WAZ<-2SD; stunting, LAZ<-2SD; wasting, WLZ<-2SD. Data were expressed as mean±SD.

RESULTS

By the questionnaire survey, the earthquake almost destroyed the living places which meant that most of families did not prepare the complementary foods for older infants and young children so that the children could only eat the same meals as adults.[3] The main nutritional problems for infants and young children aged 6-23 months included the lack of parental feeding knowledge, only 10% could get breast feeding within one hour after delivery, the basic exclusive breastfeeding was lower, and the exclusive breast feeding rate among infants under six months was about 50%. More than 90% children never received any nutrient supplements. Due to the poor available of meats, poultries, dairy and legume products, aquatic products and vegetables, the quantity and quality of complementary food was not ideal.

The growth status of infants and young children

The Z-scores of infants and young children living in rural disaster areas three months, one year and two years after the earthquake, are shown in Table 1. The trends of growth and development status were worse using the Z-scores on weight for length, length for age and weight for age. Two years after the earthquake, the averaged Z-scores, WLZ, LAZ and WAZ, were all less than zero in boys and girls, and the malnutrition extent was more serious in girls than boys.

The malnutrition prevalence and extent

The malnutrition prevalence of infants and young children was evaluated using the Z-score less than -2SD; including underweight with WAZ<2SD, stunting with LAZ <2SD, wasting with WLZ<2SD. The malnutrition prevalence of infants and young children living in rural disaster area three months, one year and two years after the earthquake is shown in Table 2.

The malnutrition prevalence, including underweight, stunting and wasting, was significantly increased two years after the earthquake. The decrease of body weight gain was very quick based on underweight prevalence (from 0 at three months to 5.9% after two years), which could reflect the lack of food and the occurrence of acute malnutrition after the earthquake, and then the lasting

Table 1. The Z-score change of infants and young children living in rural disaster areas after the earthquake[†]

Age	Total				Boys				Girls			
(month)	n	WLZ	LAZ	WAZ	n	WLZ	LAZ	WAZ	n	WLZ	LAZ	WAZ
Three months after the earthquake												
0~	17	0.74±1.13	0.16±1.81	0.75±0.93	12	0.64±1.12	0.50±1.47	0.76±1.09	5	1.04±1.28	-0.65±2.44	0.71±0.47
6~	26	0.86±1.29	-0.23±1.01	0.61±1.08	18	0.79±1.30	-0.24±1.13	0.61±1.13	8	1.01±1.33	-0.20±0.76	0.59±1.04
12~23	34	0.03±0.84	-0.27±1.17	-0.10±0.89	19	-0.20±0.97	-0.32±1.27	-0.28±1.01	15	0.29±0.58	-0.20±1.07	0.13±0.67
Total	77	0.46±1.13	-0.16±1.29	0.33±1.03	49	0.38±1.20	-0.09±1.30	0.30±1.15	28	0.61±0.99	-0.28±1.29	0.37±0.78
One year after the earthquake												
0~	36	0.49±1.71	0.32±0.87	0.65±1.46	15	0.60±1.72	0.46±0.91	0.75±1.43	21	0.40±1.75	0.21±0.85	0.58±1.51
6~	14	0.44±0.90	-0.14±0.94	0.41±1.04	5	-0.03±0.89	0.01±0.78	0.49±1.09	9	0.70±0.85	-0.20±1.04	0.37±1.08
12~23	52	0.59±0.81	-0.70±1.12	0.10±0.82	27	0.61±0.84	-1.09±1.22	-0.07±0.80	25	0.57±0.80	-0.29±0.85	0.29±0.81
Total	102	0.53±1.21	-0.27±1.11	0.34±1.13	47	0.54±1.19	-0.49±1.30	0.25±1.11	55	0.53±1.24	-0.09±0.89	0.41±1.15
Two years after the earthquake												
0~	10	0.09±1.13	-0.69±1.10	-0.43±0.90	2	-0.82±0.04	-1.06±0.40	-1.30±0.23	8	0.32±1.16	-0.60±1.10	-0.22±0.87
6~	103	0.25±1.15	-0.45±0.93	-0.09±1.09	57	0.26±1.25	-0.48±0.99	-0.08±1.21	46	0.24±1.01	-0.41±0.86	-0.09±0.95
12~23	194	-0.18±0.98	-0.65±1.19	-0.45±0.97	93	-0.15±0.99	-0.49±1.18	-0.35±0.92	101	-0.20±0.98	-0.80±1.20	-0.53±1.01
Total	307	-0.03±1.06	-0.59±1.11	-0.33±1.02	152	-0.01±1.11	-0.50±1.10	-0.27±1.04	155	-0.04±1.01	-0.68±1.11	-0.39±1.00

[†]The results were expressed as mean±SD; WLZ: Z-score of weight for length; LAZ: Z-score of length for age; WAZ: Z-score of weight for age.

effect resulted in the decrease of length shown by stunting prevalence from 6.6% at three months to 10.8% after two years and wasting prevalence from 1.3% at three months to 4.0% after two years. Compared with the percentage of wasting after one year, the data after two years seemed to be slightly lower (4.9% vs. 4.0%), however, this could result from the significant decrease in length (stunting >10%). Compared with the data one year after earthquake, the trend on wasting prevalence after two years of earthquake was somewhat decreased which could contribute to the significant increase in stunting prevalence. In general, the nutrition status of infants and young children was continuously becoming worse in these areas affected by the earthquake.

The haemoglobin concentration and anaemic prevalence

The haemoglobin concentration and anaemic prevalence of infants and young children is shown in Table 3. From three months to two years after the earthquake, the average haemoglobin levels decreased gradually and significantly and the anaemic prevalence, based on altitude adjustment, significantly increased from 36.5% to 67.5% and the increasing percentage of anemia was more obvious in girls than boys (25% to 71.5% for girls and 43.6% to 60.9% for boys).

DISCUSSION

In an emergency, such as an earthquake, time is often limited and there is really a need for immediate information on the severity and extent of nutritional problems in the local places, especially in the vulnerable groups such as infants and young children, and pregnant and lactating women. Infants and young children have particularly high nutrient needs for growth and development, how to meet their requirements is challenging in settings

Table 2. The malnutrition prevalence trend of infants and young children living in rural disaster areas after the earthquake (%)[†]

Age	Total				Boys				Girls			
(month)	n	Under weight	Stunting	Wasting	n	Under weight	Stunting	Wasting	n	Under weight	Stunting	Wasting
Three months after the earthquake												
0~	17	0	11.8	0	12	0	0	0	5	0	40.0	0
6~	26	0	0	3.8	18	0	0	5.6	8	0	0	0
12~23	34	0	0	0	19	0	10.5	0	15	0	6.7	0
Total	77	0	6.6	1.3	49	0	4.2	2.0	28	0	10.7	0
One year after the earthquake												
0~	36	5.6	0	13.9	15	6.7	0	13.4	21	4.8	0	14.3
6~	14	0	0	0	5	0	0	0	9	0	0	0
12~23	52	1.9	11.5	0	27	3.7	18.5	0	25	0	4.0	0
Total	102	2.9	6.0	4.9	47	4.3	10.9	4.2	55	1.8	1.9	5.4
Two years after the earthquake												
0~	10	0	10.0	0	2	0	0	0	8	0	12.5	0
6~	103	4.9	3.9	4.9	57	7.1	3.5	7.1	46	2.2	4.3	2.2
12~23	194	6.7	14.4	3.6	93	4.3	11.9	2.2	101	8.9	16.9	5.0
Total	307	5.9	10.8	4.0	152	5.3	8.5	4.0	155	6.4	12.9	3.8

[†]The prevalence of malnutrition was calculated by Z-score less than -2SD; Underweight, WAZ <-2SD; Stunting, LAZ <-2SD; Wasting, WLZ <-2SD.

Table 3. The haemoglobin concentration of infants and young children living in Kang County three months after the earthquake

Age	Hb (g/L) [†]			Anaemia (%)		
(month)	Total	Boys	Girls	Total	Boys	Girls
Three months after the earthquake						
0~	114.5±14.8 (14)	112.9±12.0 (10)	118.5±22.2 (4)	35.7	30.0	50.0
6~	115.5±12.5 (19)	112.6±11.4 (12)	120.4±13.7 (7)	36.8	41.7	28.6
12~23	116.5±13.1 (30)	113.5±13.2 (17)	120.5±12.3 (13)	36.7	52.9	15.4
Total	115.8±13.1 (63)	113.0±12.1 (39)	120.2±13.9 (24)	36.5	43.6	25.0
One year after the earthquake						
0~	109.6±11.8 (35)	111.5±10.4 (15)	108.2±12.9 (20)	71.4	73.3	70.0
6~	110.5±8.4 (15)	107.8±10.9 (5)	111.8±7.2 (10)	73.3	80.0	70.0
12~23	115.0±12.0 (51)	113.8±11.9 (26)	116.2±12.2 (25)	45.1	57.7	32.0
Total	112.4±11.7 (101)	112.4±11.3 (46)	112.5±12.1 (55)	58.4	65.2	52.7
Two years after the earthquake						
0~	109.2±17.1 (10)	118.5±20.5 (2)	106.9±16.9 (8)	50.0	50.0	50.0
6~	103.8±12.0 (103)	102.6±13.1 (57)	105.3±10.4 (46)	74.8	73.7	76.1
12~23	107.3±12.7 (210)	110.3±12.5 (97)	104.4±12.3 (104)	64.7	57.7	71.2
Total	106.2±12.7 (314)	107.6±13.3 (156)	104.8±12.0 (158)	67.5	60.9	71.5

[†]The number in parenthesis was the sample size.

where the ration is limited to a few food commodities, with little access to a diverse diet and bioavailable sources of micronutrients.

The malnutrition of infants and young children was a serious problem

It is well known that stunting in the first two years of life could lead to irreversible damage across the course of life, which indicates that the short- and long-term effects of acute malnutrition during infants and young children not only affects the growth and development, but is also deeply involved in the further cognitive ability and increases the greater risk susceptible to the chronic non-communicable diseases at adulthood.[9,12]

In displaced and emergency-affected populations, the most common method for assessing the overall nutritional status in a population is to weigh and measure children 6-59 months of age.[13,14] Based on our monitoring results on infant and young child's anthropometry at three months, one year and two years after the earthquake, the growth and development status were gradually worse which indicated the occurrence of acute malnutrition;[6] compared with the basal level at the three month, underweight, stunting and wasting prevalence were significantly increased after two years (Table 2). Our data indicated that body weight of young child was first affected by the food shortage during emergency; the percentage of underweight was increased from 0 at three months to 5.9% after two years. If this adverse effect continued, height gain would be affected (wasting prevalence from 1.3% at three months to 4.0% after two years). However, at this situation, the wasting rate could not show a further reduction due to the decrease in length (stunting prevalence from 6.6% at three months to 10.8% after two years). If these children are living in such areas that they could not be quickly given with an adequate nutrition intervention, it would result in increased wasting, more underweight, and greater levels of stunting which would result in the increase of mortality.

After the earthquake, the government provided food supplies (a general food basket) which could meet the basic energy and nutrient requirements for adults, the mean per capita cereals (including rice or wheat powder) supply was 500 g/day after the earthquake, which could provide about 1730 kcal/day, and if added additional energy from the non-staple food consumption (vegetables and fruits), a general food basket could provide about 2100 kcal energy per person per day that met the needs for the basic energy, protein, but fat and micronutrient requirements could not be met. However, for a special physiological state, such as pregnant women, nursing mothers, and infants and young children, these foods could be difficult to meet the requirements for a variety of micronutrients so that these populations would be at high risk to suffer from nutritional deficiencies.[3,7,15] Our findings suggest that increasing food supplies and improving food quality would be an urgent public health concern, which includes to increase nutritionally balanced, diversified, culturally acceptable diet for infant and young child feeding in such emergencies in order to save lives and decrease infant and young child's morbidity and mortality.

Anaemic prevalence was significantly increased in infants and young children

Iron deficiency anaemia is the most common single nutrient disorder, 90% of all types of anaemia in China are due to iron deficiency.[16] Infants and young children from 6 to 23 months of age appear to be the most vulnerable to iron-deficiency and iron-deficient anemia.[16,17] There is a significant amount of scientific literature which suggests that malnutrition and iron deficiency and iron-deficient anaemia may be associated with an impaired immune system[18,19] which could increase the morbidity and mortality, and delay in cognitive function development[20] or lead to behaviour problems.[21]

The monitoring of results from rural disaster areas showed that the haemoglobin concentration gradually decreased and anaemic prevalence significantly increased in infants and young children, and this negative effect was more significant for girls, for example, increase of anaemic percentage at three months and two years of the earthquake was 25% to 71.5% for girls and 43.6% to 60.9% for boys respectively (Table 3). What are the reasons on the high prevalence of anaemia? The great concerns regarding high iron deficiency anaemia were the inadequacy of iron intake and that most of the iron was from plant foods (non-heme iron), because non-heme iron is relatively unavailable to the absorptive cells, but this kind of iron could constitute a significant amount of iron intake in such areas.[6,16] Increased levels of anaemia were also associated with a reduction in consumption of high quality foods including lack of animal products, dairy and legume products in their daily diets.

How to solve the malnutrition and anaemia in children living in rural disaster areas?

During emergency, a general food basket could meet the basic energy and nutrient requirements for adults.[22] However, this might not be suitable for the older infants and young children. The most important way should be to encourage and promote the exclusive breast feeding for the babies at the first six months of age, and then introduce adequate complementary food in addition to the breastfeeding which might avoid some of the increased malnutrition that occurred during the emergencies.[23] Access to foods rich in micronutrients would be useful for sufficient growth and development and anaemic prevention in infants and young children during emergency. In order to meet the energy and nutrient (especially for micronutrient) requirements to prevent malnutrition and iron deficiency and iron-deficiency anaemia, specific interventions are required during emergencies to protect and promote optimal infant and young child feeding practices. These interventions should routinely include a relief response and should be sustained throughout the period of response, and provide nutritionally balanced, diversified, and culturally acceptable diets to meet the nutritional needs for these target populations. However, this can be a significant challenge during emergencies, since many constraints often exist; environment conditions may hinder safe food preparation and feeding,[3] and traditional ingredients that were normally used to prepare weaning foods may not be available.

Limitations

The current results would have certain limitations due to some constraints from the disaster areas. In these surveyed areas, we could not recruit so many children in much decentralized and inaccessible mountain areas and also it was difficult to find the basic data on growth and nutritional status and food supply or consumption in infants and young children before the earthquake because the national or regional nutrition surveys had not reached or covered these areas in the past. For those reasons, we used the National Data and WHO grow curve standard for the comparison to show the severity of malnutrition and anaemic prevalence in these areas.

In conclusion, since malnutrition is an important determinant of child's mortality, interventions should begin immediately afterwards because food or nutrition interventions might play a key role in saving lives through their impact on the nutrition and health for all target population aged 6 to 23 months. The other ways including encouraging and promoting breast feeding, and introducing high quality complementary foods in addition to breast milk which should be an important intervention measure for the infants from six months of age.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the collaboration of UNICEF, which provided part support. We thank the field team from Kang County Centre for Disease Control and Prevention, which was involved in data collection. We are indebted to the local community health doctors and nurses who assisted with our field work. We thank the study families for participation survey.

AUTHOR DISCLOSURES

All authors read and approved the final manuscript. The authors have no commercial associations or sources of support. None of the authors reported declaration of conflict of interest.

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Original Article

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中国汶川地震后 2 年灾区婴幼儿生长发育和贫血状况

背景：为了监测中国汶川地震灾区婴幼儿营养不良的发病率和贫血的流行情况。方法：在地震后 3 个月、1 年和 2 年分别调查了 77 名、102 名和 307 名 6-23 个月龄婴幼儿的营养和健康状况，使用问卷收集和评估了相关信息，同时测定了人体测量学指标和血红蛋白浓度。结果：大多数家庭不能够为婴幼儿制作辅食，使这些儿童摄入与成人相同的食物，进食的数量和质量都很差。存在的主要营养问题包括儿童看护人缺乏婴幼儿喂养知识，仅有 10%的新生儿出生后 1 小时内能吃到母乳，纯母乳喂养率较低。超过 90%的儿童从来没有吃过营养素补充剂。地震后 2 年，婴幼儿营养不良患病率显著增加。与 3 个月时的结果相比较，2 年后低体重率由未检出增加到 5.9%，生长迟缓率由 6.6%增加到 10.8%，消瘦率由 1.3%增加到 4.0%；贫血患病率也显著增加，由 36.5%增加到 67.5%，女孩的贫血患病率显著高于男孩。结论：地震灾区婴幼儿营养状况不断恶化，贫血患病率较高。建议尽快采取相应的营养干预措施。

关键词：突发事件、婴幼儿、营养不良、贫血、地震