Prevalence of Diarrhea among Children Less Than 36 Months of Age in Rural Western China in 2001 and 2005

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Abstract. We collected for rural western China data for 14,658 children less than 36 months of age in 2001 and for 14,112 children in 2005. A generalized estimated equation log-binomial model was used to identify the determinants of childhood diarrhea. In 2005, prevalence of diarrhea was approximately 7.4%, which compared with that for 2001, had decreased by 8.7%. The generalized estimated equation analysis showed that region affected the prevalence of childhood diarrhea significantly. Age was negatively associated with childhood diarrhea. Although childhood upper respiratory infections increased the risk of diarrhea, the risk could be decreased by use of vitamin A in the previous year. In addition, children of Han ethnicity or those living in one-child families had a lower risk of diarrhea in 2001, but underweight children had a higher risk in 2005. These findings may have some implications for formulating policies of childhood diarrhea prevention and control in rural western China.

INTRODUCTION

Since the 1970s, child mortality from diarrhea has decreased substantially worldwide as a result of social and economic development and implementation of child survival interventions.¹ However, diarrhea continues to be one of the most important causes of child morbidity and mortality in developing countries.^{1,2} It is estimated that globally approximately 0.7 million children less than five years of age die of diarrhea annually,³ but most of these deaths occur only in 15 developing countries, including China, and mainly in the first two years of life.³ In China, approximately 40,000 children less than five years of age die of diarrhea annually.² Tendency data of diarrhea mortality showed that the death rate decreased only by 2% during 2000–2008.⁴ In postneonatal infants (1–11 months of age), the proportion of deaths caused by diarrhea was relatively higher.⁴

The fact that a great number of children die of diarrhea annually in developing countries suggests that the prevalence of childhood diarrhea in these areas is high. A recent study of childhood diarrhea from India showed that the prevalence of diarrhea among children still surpassed 30%,⁵ but a research report from Mirzapur in rural Bangladesh showed that approximately 7% of children less than five years of age had had at least one attack of diarrhea in a two-week reference period.⁶ The variation of the prevalence from country to country demonstrates that geographic factors might make significant contributions to the prevalence of childhood diarrhea. Many factors influencing the prevalence of diarrhea had been documented. Apart from unimproved hygiene, inadequate sanitation, and unsafe drinking water, the social, economic, demographic, and environmental factors of households and immunization status of a child had some significant association with the prevalence of childhood diarrhea.^{7,8} In addition, childhood factors, such as age and birth interval, have also been identified as risk factors for childhood diarrhea.⁸

In China, few studies have determined the prevalence of diarrhea among children less than 36 months of age in rural

western China. In this study, we describe the prevalence of diarrhea among children less than 36 months of age and explore its influencing factors, aiming to lead policymakers to direct their target at vulnerable populations through investments in health care and infrastructural development. We also intended to identify the information necessary for designing appropriate strategies for prevention program for childhood diarrhea. In addition, we obtained data necessary for policymakers to use and advocate so that adequate resources can be allocated for the programs and issues of childhood diarrhea.

MATERIALS AND METHODS

Setting and study population. Two cross-section surveys were conducted. One was conducted in 2001 and the other in 2005. Both surveys were conducted during June–August. The survey in 2001 included 46 counties in 9 provinces (Gansu, Guangxi, Jiangxi, Inner Mongolia, Ningxia, Qinghai, Sichuan, Xinjiang and Chongqing), and the one in 2005 included 45 counties in 10 provinces (Guizhou was included in addition to the 9 provinces just mentioned). All surveyed counties were not sampled randomly but determined directly by the Chinese Ministry of Health and the United Nations Children's Fund.

A multi-stage probability-proportional-to-size sampling method was adopted to obtain samples from townships and villages. Five townships were sampled from each county and then four villages were selected in each sampled township. Of the sampled villages, 16 households with children less than 36 months of age were selected randomly. If there were more than 16 households in a village, 16 households were selected randomly; if the households in a village did not amount to 16, all of them were selected and the rest were selected from a neighboring village. Of each selected household, only one child was selected randomly and his or her caretaker was investigated. Among the selected 16 children in one selected village, only 8 children were selected randomly. Hemoglobin was measured in the field by using a portable HemoCue System (HemoCue, Inc., Angelholm, Sweden).

Data collection. A pre-coded structured household interview questionnaire was used to collect primary information for the families from the caretakers. After they had signed the

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informed consent forms, all participants were interviewed by means of unified face-to-face questionnaires about social and demographic situations of their families and information for their children and maternal care, such as delivery, diarrhea, upper respiratory tract infections (URTIs) in the previous two weeks, breastfeeding, and receiving vitamin A in the previous year. If a children had had diarrhea in the previous two weeks, their caretakers would be further interviewed about the last diarrheal episode in detail. Diarrhea was defined as the passage of three or more loose or watery stools in the preceding 24 hours. Body length and weight of children were measured by using an WBII Horizontal Length Measuring Instrument (Beijing Sixth Tractor Factory, Beijing, China) and a YGZ212 Human Scale (Wuxi Measure Factory, Wuxi, China), respectively. To ensure availability of data, appropriateness of every questionnaire had been carefully verified several times before it was adopted. The current study was reviewed and approved by the Ethics Committee of Medicine College of Xi'an Jiaotong University.

Main study variables. Childhood diarrhea in the previous 14 days was considered a unique outcome variable. Because of lack of the data for income of each household, the family wealth index by year was constructed by using principal analysis involving five variables (type of vehicle, water supply, income resource, texture of pot, and type of used salt) to evaluate the social and economic status of the household. According to the tertiles of the first principal component, social and economic status of the families was classified into three categories: poor, medium, and rich. Because 92% of total population was of Han ethnicity and the remaining 8% were of other ethnicities, ethnicities in China are usually divided into Han ethnicity and ethnic minorities. Ethnicity of the children was considered as dichotomical variable.

Age-specific height Z score (HAZ), age-specific weight Z score (WAZ), and weight-specific height Z score (WHZ) were computed with body length and weight of children by using World Health Organization Anthro software to assess their nutritional status. All extreme values were excluded ($HAZ < -6$ or > 6 , $WAZ < -6$ or > 5 , and $WHZ < -5$ or > 5).⁹ Children with HAZ, WAZ, or WHZ < -2 were identified as stunting, underweight, or wasting respectively. Childhood anemia was diagnosed on the basis of a standard hemoglobin level < 11.0 g/dL when hemoglobin values of the children who were living in townships located $> 1,000$ meters above sea level were corrected by using the Dallman method.^{10–12} Because almost half of the children's hemoglobin level was not measured in the field, childhood anemia was classified into 3 groups: anemia, missing, and non-anemia.

Data analysis. Epidata 3.1 (<http://www.epidata.dk/>) was used for dual data entry and SPSS version17 (SPSS Inc, Chicago, IL) software was adopted for additional analysis. The level of the statistical significance was set at 0.05. A generalized estimated equation (GEE) log-binomial model was adopted to identify predictors of diarrhea by year while the possible correlation in prevalence of childhood diarrhea in the same village was controlled. Prevalence ratios for all variables were estimated.¹³ A generalized linear model with linear scale was used to estimate the absolute change in prevalence of childhood diarrhea between 2001 and 2005 while factors that had possibly influenced the prevalence of childhood diarrhea were adjusted. A partial correlation analysis was performed to further analyze the pairwise correlation between multiple factors.

RESULTS

Sample characteristics. In 2001, an investigation was made of 14,816 households; in 2005, another investigation was made of 14,112 households. In 2001, 158 children were more than 36 months of age. Thus, data for their households was excluded from the study. Sample characteristics of households that participated in the study by year are shown in Table 1. Except for educational status of mothers and sexes of children, all factors involved in the investigation during in 2001 were significantly different from those in 2005.

Prevalence of childhood diarrhea. The prevalence of diarrhea among children less than 36 months of age in different provinces in rural western China in 2001 and 2005 is shown in Table 2. The overall prevalence of childhood diarrhea was 18.0% (95% confidence interval = 17.4–18.6%) in 2001 and 7.4% (95% CI = 6.9–7.8%) in 2005. In 2001, of the 9 investigated provinces, Gansu had the highest prevalence of childhood diarrhea, followed by Ningxia; Chongqing had the lowest prevalence. In 2005, among the 10 investigated provinces, Xinjiang had the highest prevalence of childhood diarrhea, followed by Sichuan; Chongqing continued to have the lowest prevalence. The age-specific prevalence of childhood diarrhea in 2001 and 2005 is shown in Figure 1. In 2001 and 2005 children 6–11 months of age had the highest prevalence of diarrhea. However, in older children, prevalence of diarrhea gradually decreased with age.

After possible factors had been adjusted, the prevalence of diarrhea among children less than 36 months of age in rural

TABLE 1
Sample characteristics of two surveys in rural western China, 2001–2005*

Characteristic	2001	2005	P
SES			
Poor	4,222 (28.80)	4,458 (31.64)	< 0.001
Medium	4,974 (33.93)	3,928 (27.88)	
Rich	5,462 (37.26)	5,704 (40.48)	
Family size ≥ 5 members	7,162 (48.86)	7,272 (51.53)	< 0.001
One child	8,876 (60.55)	8,207 (58.17)	< 0.001
Drinking boiled water	11,218 (76.53)	12,199 (86.44)	< 0.001
Age of mothers, years, mean (SD)	26.64 (7.98)	27.20 (4.72)	< 0.001
Education of mothers > 9 years	1,114 (7.6)	1,050 (7.44)	0.608
Han ethnicity	9,990 (68.15)	8,997 (63.75)	< 0.001
Age of child, months			
0–11	4,896 (33.40)	5,083 (36.02)	< 0.001
12–23	5,441 (37.12)	5,164 (36.59)	
24–36	4,321 (29.48)	3,865 (27.39)	
Male sex	8,423 (57.46)	8,112 (57.48)	0.973
Being breastfed	6,260 (42.71)	5,428 (38.46)	< 0.001
URTI	4,109 (28.03)	2,691 (19.07)	< 0.001
Childhood anemia			
Yes	4,044 (27.59)	3,875 (27.46)	< 0.001
Unknown	7,279 (49.66)	6,603 (46.79)	
No	3,335 (22.75)	3,634 (25.75)	
Nutritional status			
Stunting	2,886 (20.29)	1,824 (13.51)	< 0.001
Underweight	2,407 (16.92)	1,084 (7.89)	< 0.001
Wasting	605 (4.25)	784 (5.83)	< 0.001
Vitamin A in past year	3,684 (25.13)	9,313 (65.99)	< 0.001
Delivery in township and above-level hospital	6,758 (46.10)	11,793 (83.57)	< 0.001
Natural delivery	13,238 (90.31)	11,726 (83.09)	< 0.001

*Values are no. (%) unless otherwise indicated.

SES = socioeconomic status; URTI = upper respiratory tract infection.

TABLE 2
Prevalence of diarrhea among children under 36 months old in rural western China in 2001 and 2005

Region	2001		2005		Change of prevalence of childhood diarrhea, % (95% CI)*
	No. investigated households	Two-week prevalence of childhood diarrhea, %	No. investigated households	Two-week prevalence of childhood diarrhea, %	
Gansu	1,270	30.08	634	4.26	-16.54 (-23.28 to -9.80)
Guangxi	1,957	12.26	1,586	3.66	-7.84 (-10.38 to -5.30)
Guizhou†	—	—	1,265	9.17	-8.55 (-10.91 to -6.18)
Jiangxi	1,665	21.26	1,567	4.72	-14.43 (-17.40 to -11.45)
Inner Mongolia	1,578	14.58	1,217	5.34	-10.31 (-13.92 to -6.70)
Ningxia	1,935	22.69	1,264	6.25	-13.63 (-16.62 to -10.63)
Qinghai	1,860	16.83	1,589	7.49	-4.47 (-7.44 to -1.70)
Sichuan	1,551	19.99	1,577	10.02	-11.96 (-16.29 to -7.63)
Xinjiang	1,266	16.43	2,168	14.53	-0.25 (-2.90 to 2.40)
Chongqing	1,576	10.15	1,245	2.33	-6.85 (-10.28 to -3.42)
Total	14,658	17.98	14,112	7.37	-8.69 (-9.64 to -7.74)

*Overall change of prevalence of childhood diarrhea was adjusted with 19 variables (province, family socioeconomic status, family size, child size, drinking boiled water, age and education of mothers, ethnicity, age and sex of children, being breastfed, stunting, underweight, wasting, upper respiratory tract infections, childhood anemia, receiving vitamin A in the previous year, delivery site, and natural delivery) in these areas, and the change of this prevalence in each province-level area was adjusted with 18 variables (province not included).

†Prevalence of childhood diarrhea in Guizhou in 2001 was estimated with the overall prevalence in this area in 2001.

CI = confidence interval.

western China in 2005 decreased by 8.7%. Of the 10 investigated provinces, only Xinjiang did not show a significant decrease in prevalence of childhood diarrhea. Gansu showed a large decrease in prevalence, followed by Jiangxi and Ningxia. The decrease in age-specific prevalence of childhood diarrhea in 2001 and 2005 is shown in Figure 2. All six-month age groups showed a significant decrease in prevalence of diarrhea ($P < 0.01$), but children 6–11 months of age showed the largest decrease in prevalence (–11.9%), followed by children < 1 to 5 months of age. Children 30–36 months of age showed a decrease of less than 4%. In addition, in children > 6–11 months of age, the decrease was smaller.

Predictors of childhood diarrhea. Predictors of childhood diarrhea in rural western China in 2001 and 2005 are shown in Table 3. The GEE model analysis showed that in 2001 and 2005, prevalence of childhood diarrhea was significantly associated with the province in which diarrhea occurred and age of the child was negatively associated with diarrhea. Although a childhood URTI increased the risk of diarrhea, this risk could be decreased significantly by receiving vitamin A in the previous year. In addition, children of Han ethnicity or those living in one-child families had a lower risk for diarrhea than those of other ethnicities or those living in more-than-one-child families in 2001. Underweight children had a greater risk for diarrhea than children with normal weights in 2005. A partial correlation analysis showed a correlation among vitamin A supplementation (VAS), URTI, and diarrhea when all possi-

ble confounders in the current study were controlled. Results showed that VAS had a negatively correlation with diarrhea and URTI (VAS versus diarrhea: partial correlation coefficient = -0.049 , $P < 0.001$ and VAS versus URTI: partial correlation coefficient = -0.048 , $P < 0.001$), but URTI had a positive correlation with diarrhea (URT I versus diarrhea: partial correlation coefficient = 0.162 , $P < 0.001$).

DISCUSSION

In rural western China, childhood diarrhea among children less than 36 months of age had significantly improved: childhood diarrhea in 2005 compared with that in 2001, decreased by almost 9%. There were three possible reasons for this decrease. First, during this period, the primary health care program for rural areas was promoted to help rural areas of western China accelerate the achievement of Millennium Development Goal 4 aiming at reducing childhood mortality. Second, water and sanitation infrastructure in rural areas of China had been greatly improved. Third, the intervention of water, sanitation, and hygiene might have improved access to clean water.¹⁴ However, despite these factors, regional differences still existed. In 2001, the prevalence of childhood diarrhea in Gansu was 30%, but that in Chongqing was only 10%. In 2005, the highest prevalence (in Xinjiang) was nearly six times higher than the lowest prevalence (in Chongqing).

FIGURE 1. Age-specific prevalence of childhood diarrhea in rural western China, 2001–2005.

FIGURE 2. Decrease in the age-specific prevalence of childhood diarrhea in rural western China, 2001–2005.

The GEE model analysis also showed that the prevalence of childhood diarrhea was significantly associated with the province in which it occurred. The difference between provinces in childhood diarrhea in the above-stated two years was the result of only the aforementioned disproportionate decrease. Of the nine provinces in which the prevalence had decreased significantly, Gansu had the fastest decrease, and the decreases in Jiangxi, Ningxia, Sichuan and Inner Mongolia all exceeded 10%. However, Xinjiang did not show any effective decrease. This finding might have been caused by low coverage and acceptability of diarrhea-related population interventions and inefficiency of implementing rural primary health care program in this province. Thus, childhood diarrhea prevention and control programs should address geographic differences in aspects of prevalence and improvement, and national health policies should encourage every province to take concrete and practical measures to control childhood diarrhea according to the local health situation as identified by the regional survey of childhood diarrhea.

Our study found that the age of the child was negatively associated with the prevalence of childhood diarrhea, which can also be observed intuitively from the tendency of the age-specific prevalence. This association can be accounted for by the characteristics of children's physiologic development. In the infantile period, children's immune function is in the rapid

formative stage and their digestive system is still developing; therefore, they are more susceptible to diarrhea. For older children, especially those who are greater than two years of age, the digestive and immune systems function well and can enhance the adaptability and resilience to diarrhea. Thus, younger children should continue to be considered as a priority of national diarrhea prevention and control programs.

However, a previous study showed that the lowest prevalence of diarrhea was in children > 1 to 5 months of age among six-month age groups.¹⁵ This finding was different from our findings: the prevalence of diarrhea in children < 1 to 5 months of age was lower than that in children 6–11 months of age. On the basis of infant development, our findings seem more reasonable. After six months of age, infants ingest less immune substances from breast milk; thus, they are more susceptible to diarrhea. In addition, these infants begin to crawl and were therefore more likely to contact dirt or pollutants than children > 1 to 5 months of age.

Our study also found that children who had been given vitamin A in the previous year were less likely to have diarrhea than those who had not received vitamin A. A recent meta-analysis had showed that VAS could reduce the incidence of diarrhea in children six months to five years of age.¹⁶ Several studies also showed that VAS could reduce the severity of diarrheal episodes and diarrhea-associated mortality.^{17,18} A double-blind and randomized clinical trial of VAS in Mexico showed a modified effect of VAS on childhood diarrhea and a correlation with the cleanliness of the floor in households.¹⁹ These studies confirmed observations in our study to a certain extent. Therefore, more effort should be made to find ways to sustain this important child survival initiative and use it to maximize the number of the children who could survive episodes of diarrhea.

Our study found associations of VAS and URTI with childhood diarrhea. Previous studies had also shown that vitamin A may affect not only diarrhea but also respiratory tract infections.^{16,20} Thus, further analysis is needed to clarify the complex correlations between VAS, URTI, and diarrhea.

TABLE 3
Predictors of prevalence of diarrhea among children less than 36 months of age in rural western China in 2001 and 2005*

Region or characteristic	2001			2005		
	PR	95% CI	P	PR	95% CI	P
Gansu	2.47	2.02–3.02	< 0.001	1.53	0.74–3.14	0.247
Guangxi	0.84	0.66–1.06	0.141	1.28	0.75–2.19	0.362
Guizhou	—	—	—	3.07	1.85–5.08	< 0.001
Jiangxi	1.90	1.56–2.31	< 0.001	1.51	0.91–2.50	0.109
Inner Mongolia	1.34	1.07–1.66	0.009	2.19	1.29–3.70	0.004
Ningxia	1.89	1.56–2.28	< 0.001	2.22	1.35–3.65	0.002
Qinghai	1.35	1.08–1.68	0.008	2.78	1.71–4.51	< 0.001
Sichuan	1.59	1.29–1.96	< 0.001	3.21	1.98–5.20	< 0.001
Xinjiang	1.36	1.06–1.75	0.014	5.57	3.46–8.96	< 0.001
Chongqing	1	—	—	1	—	—
One child	0.91	0.83–0.99	0.027	0.97	0.85–1.12	0.716
Han ethnicity	0.70	0.63–0.77	< 0.001	0.98	0.83–1.16	0.842
Age of children, months						
0–11	1.60	1.41–1.81	< 0.001	1.63	1.27–2.08	< 0.001
12–23	1.34	1.21–1.49	< 0.001	1.47	1.24–1.75	< 0.001
24–36	1	—	—	1	—	—
Receive vitamin A	0.89	0.80–0.98	0.022	0.84	0.72–0.97	0.020
URTI	1.78	1.65–1.92	< 0.001	2.73	2.39–3.12	< 0.001
Underweight	1.04	0.93–1.17	0.489	1.45	1.13–1.85	0.003

*Only predictors at 5% of a multivariate generalized estimated equation model in 2001 or 2005 are listed.

PR = prevalence ratio; CI = confidence interval.

The partial correlation analysis in our study showed that VAS had an almost equal synchronous negative effect on diarrhea and URTI. A possible reason for this finding might be that VAS improved immunity and affected the inflammatory mechanism.^{21,22} This parallel effect of VAS also suggested that VAS may not damage the inherent association between URTI and diarrhea.

In addition, the finding that childhood URTI can increase the risk of diarrhea seemed to be verified by results of previous studies. A study cohort of children less than three years of age in India and Nepal showed that the effect of prevalence of acute lower respiratory tract infections on the incidence of diarrhea varied with seasons.²³ A study in a rural area of Uganda showed that URTIs were a risk for childhood diarrhea.¹⁵ To our knowledge, children with respiratory tract infections usually had lower immunity, which resulted in their susceptibility to diarrhea. In addition, some viruses that cause respiratory tract infections can also cause intestinal infections. More importantly, children with URTIs may live in crowded conditions and poor sanitation, which can facilitate transmission of diarrhea pathogens.

Underweight also seemed to be a risk of childhood diarrhea in 2005. The association between malnutrition and childhood diarrhea has been documented.^{24,25} This association may be related to impaired immunity in children with malnutrition. Diarrhea could result in a large loss of body fluid and make ill children appear underweight, which could be sensitive in the short term.

Several limitations in our study should be acknowledged. Because all data were collected on the basis of caretakers' recall, estimated results of diarrhea incidence are subject to recall bias. Some potential factors, such as personal hygiene, management of baby stool, and outbreaks of intestinal diseases, which had not been analyzed in this study, may confound its findings. In addition, seasonal factors may have an important effect on prevalence of childhood diarrhea. However, both surveys in our study were conducted during the summer.

In conclusion, childhood diarrhea among children less than 36 months of age has decreased significantly from 2001 through 2005. However, the decrease in diarrhea prevalence in certain provinces was disproportionate. The area in which the child was born and lived, the age of the child, childhood URTIs, and VAS significantly affected the prevalence of childhood diarrhea. These findings may have implications for formulating policies of childhood diarrhea prevention and control in rural western China.

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