Evaluation of the Rural Primary Health Care project on undernutrition equity among children in rural Western China

Leilei Pei,1 Duolao Wang,2 Lin Ren1 and Hong Yan1*

1Department of Epidemiology and Health Statistics, School of Public Health, Xi’an Jiaotong University College of Medicine, Xi’an, P.R. China and 2Department of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, UK

*Corresponding author. P.O. Box 46, Xi’an Jiaotong University College of Medicine, No.76 West Yanta Road, Xi’an, Shaanxi 710061, P.R. China. Tel: +86-29-8265 5001. Fax: +86-29-8265 5387 Email: xjtu_yh.paper@yahoo.com.cn.

Accepted 4 May 2012

Background The Chinese Ministry of Health (MOH) and the United Nations Children’s Fund (UNICEF) carried out the Rural Primary Health Care Project (RPHC) with a government-led, province-level, integrated intervention that targeted children under 3 years old in rural areas of western China from 2001 to 2005. The objective of this study was to measure the effectiveness of the intervention on childhood nutrition.

Methods 10,415 and 9,916 children under 3 years old in 2001 and 2005, respectively, were selected in rural areas of western China. Stunting was used as the sole outcome variable to assess the child undernutrition change over time. The concentration index was used to assess the extent of the inequality of child undernutrition. Difference-in-difference estimation was used to evaluate the effects of the intervention on child undernutrition.

Results After the intervention, the proportion of child stunting decreased from 20.8% to 10.2%. The results from the difference-in-difference estimation with stunting adjusting for socio-demographic characteristics showed that the intervention had significantly improved the child stunting rate by 0.4%. Despite the decline in the undernutrition rate, the concentration indices for stunting in the intervention group decreased from 0.139 to 0.223 between 2001 and 2005.

Conclusion This intervention project was effective in reducing childhood undernutrition rates to some extent in rural areas of western China. However, it seems that the project had a negative effect on the equity of undernutrition.

Keywords Nutrition, equity, assessment, child health, rural, China

KEY MESSAGES
- The Rural Primary Health Care (RPHC) intervention project was effective in reducing childhood undernutrition rates to some extent in rural areas of western China.
- The findings suggest that socio-economic status disparities in child undernutrition became greater after the intervention.
- These results have important policy implications for the Chinese government regarding the need to promote health care for the low-income population in rural China.
Introduction

There is a strong link between childhood undernutrition and health risks in adult life. Epidemiological evidence indicates that childhood undernutrition is one of the most important causes of infant and child mortality around the world (Bryce et al. 2005; Ellen et al. 2007). Particularly for children under 3 years, undernutrition can adversely affect their intellectual development, and consequently, their health and productivity in adult life (Cravioto et al. 1986; WHO 1995).

Many studies suggest that child undernutrition is tightly associated with household socio-economic status (Larrea and Freire 2002; Chen et al. 2007; Ellen et al. 2008). Typically, the relationship between socio-economic status and health outcomes is inversely correlated, with poor health concentrated in lower socio-economic levels. Socio-economic inequality in undernutrition refers to the degree to which childhood undernutrition rates differ among socially- and economically-advantaged groups. The available literature of socio-economic inequality in undernutrition has focused mainly on the developing countries (Zere and McIntyre 2003; Wagstaff et al. 2003; Hong 2007). Globally, there is higher socio-economic inequality in childhood undernutrition in Latin America compared with other areas (Ellen et al. 2008).

Despite the recent economic development in China, the undernutrition of children remains a critical issue. In the rural areas of western China in particular, socio-economic levels, living conditions and health care services are much poorer compared with central and eastern China. Based on a 1999 national survey conducted in rural western areas, Dang et al. indicated that about 23% of children under 3 years were moderately to severely stunted, 22.6% were moderately to severely wasted and approximately 7.55% were moderately to severely underweight (Dang et al. 2005). A survey in Tibet indicated that the prevalence of undernutrition in children was 39.0% for stunting, 23.7% for underweight and 5.6% for wasting (Dang et al. 2004). Moreover, evidence suggests that the gap in the prevalence of undernutrition in children between affluent and poor households has been increasing over the years, with wide regional differences in China (Chen et al. 2007). It is therefore important to conduct interventions on child undernutrition in rural western China.

The United Nations Children’s Fund (UNICEF) and the Chinese Ministry of Health (MOH) jointly carried out ‘The Rural Primary Health Care Project’ (RPHC) with a government-led, province-level integrated intervention in western China from 2001 to 2005, which targeted children under 3 years of age. The project goals were to improve the serviceability of the three-level rural health care network, to monitor child growth and development, promote child healthy growth and reduce the incidence of undernutrition in infants and children. This study was designed to evaluate the effectiveness of such an intervention on undernutrition and socio-economic inequity in these areas from 2001 to 2005.

Methods

Subject and design

The project was carried out in 10 provinces of western China with a total land area of 142,270 km² and a population of 19.1 million from 52 ethnicities. Considering the hierarchical structure of Chinese administrative districts and the imbalanced population distributions among different provinces, a 3-stage probability proportional to size sampling method was used in the study. At the beginning of the intervention in 2001, 46 counties of 10 provinces were chosen; then in 2005, 45 counties of 10 provinces were selected to evaluate the effects of the project. These counties with poor economy and higher willingness to participate in the project were selected by the MOH and UNICEF, not randomly. In each chosen county, five townships were selected with the probability proportional to total population (from the countries’ demographic data). In each of these townships, four villages were randomly selected. Finally, 16 children under 3 years were randomly selected from each village. In this study, 34 counties were included in both surveys in 2001 and 2005. Among these 34 counties, nine were subjected to the intervention and 25 counties were used as controls.

Interventions

The main aspects of the intervention were to: (1) establish and perfect the three-level ‘county-township-village’ rural health care network in target counties with the county hospitals as technology support, township hospitals as hubs and village clinics as service bases; (2) provide nutritional consultation to families through town and village clinics, and carrying out the community nutrition intervention in programme counties; and (3) monitor the trend in child (<3 years old) development via a growth curve and offer feeding and dietary instruction for individuals with low birth weight.

All the interventions were implemented through the three-level county-township-village rural health care network, which is the standard channel through which all national health policies are implemented. County-level staff were responsible for policy supervision across the whole county. Township-level and village-level staff were responsible for providing nutritional consultation to families, including breast-feeding, complementary feeding and child’s growth knowledge, and carrying out the community nutrition intervention, such as health education for parents, vitamin A intake and hepatitis B vaccination, etc. In addition, village-level staff were also responsible for monitoring each child’s growth. Staff at all levels were trained beforehand according to the detailed standard guidelines and training protocols developed in the pilot study.

Data were collected at each village by investigators from Xi’an Jiaotong University College of Medicine in 2001 and 2005. The investigators were trained to standardize questionnaire administration and anthropometric measurements, including lectures and practice in the field at least 1 week before commencement of the survey. During the survey, all fieldworkers were closely monitored by their supervisors and randomly examined.
Subjects were also re-interviewed when errors and/or missing values were detected. Consent was obtained before administration of the survey questionnaire. This study was approved by the ethics committee of Xi’an Jiaotong University.

**Main study variables**

**Measurement of undernutrition**

In this study, anthropometric indices were used to evaluate the undernutrition in children; these were non-invasive, low cost and easily comparable. Body length was measured in children from birth to 36 months using a standard calibrated board (accurate to 1 mm). Weight was measured using portable electronic scales with measurement accuracy to 0.1 kg. All equipment was newly purchased, recommended by UNICEF and calibrated daily. Anthropometric indicators calculated from the age, height and weight were height-for-age, weight-for-height and weight-for-age for children, used to quantify nutritional status. These measures were expressed in the form of Z-score, according to the new World Health Organization (WHO) child growth standards released in April 2006 (WHO 2006). For example, a height-for-age Z-score (HAZ) is the difference between the height of a child and the median height of a child of the same age and sex in a well-nourished reference population, divided by the standard deviation in the reference population. Undernutrition is classified into stunting determined as HAZ<-2, wasting as weight-for-height Z-score (WHZ) <-2 and underweight as weight-for-age Z-score (WAZ) <-2 (WHO 1995). Stunting is regarded as a long-lasting dietary inadequacy but is less sensitive to temporary food shortages. Wasting, on the other hand, is sensitive to temporary food shortages and episodes of illness and indicates a deficit in tissue and fat mass (Wagstaff 2000). Moreover, with weight-for-age it is difficult to discriminate between temporary and permanent undernutrition. Thus, we used solely stunting to evaluate the changes in child undernutrition over time.

**Measurement of socio-economic status**

Income is commonly used to assess socio-economic status (SES) (Alberts et al. 1997). However, as there was a lack of accurate income data in the survey, a wealth index constructed from an inventory of household assets or facilities, with a principal component analysis method, was used as the indicator of SES, and this index was categorized into tertiles indicating the poorest, middle and the wealthiest households (Filmer and Pritchett 2001; Zeng et al. 2008). Houweling et al. have also shown that with a lack of reliable information on income or expenditure, the use of such an asset index can be considered as a good replacement to distinguish between socio-economic layers within a population (Houweling et al. 2003; Wagstaff and Watanabe 2003).

**Socio-economic inequities of child undernutrition**

Wagstaff et al. argued that the concentration index (CI) can accurately reflect health inequality (Wagstaff et al. 1991). It is calculated from the concentration curve, which plots the cumulative proportions ranked by the SES against the cumulative of undernutrition with twice the area between the concentration curve and the diagonal from −1 to 1. The CI reflects the socio-economic dimension of inequality in health and the experience of the entire population. In addition, it is sensitive to changes in the distribution of population across socio-economic groups. The value of CI measures the severity of socio-economic inequality. CI<0 indicates that undernutrition is more likely to be concentrated among low SES groups, or vice versa. CI equals zero, indicating that undernutrition is distributed equally across SES groups, when the concentration curve overlaps with the diagonal. Consequently, CI was used as the main index for assessing equity in child undernutrition.

**Statistical analysis**

A database was established using Epi Info Version 6.0 (CDC, Atlanta, GA, USA) and data were double-entered to reduce data entry errors. All statistical analyses were performed using SPSS version 13.0 (Statistical Package for Social Science, Inc., Chicago, IL, USA) and SAS/STAT version 9.1 (Statistics Analysis System, Inc. Cary, North Carolina, USA).

Difference in difference (D-in-D) estimation was used to assess the effects of the intervention on stunting while controlling for socio-economic characteristics of children in the framework of a linear mixed model. The D-in-D estimate is actually the coefficient of the interaction between the intervention and time in a regression model with intervention, time and their interaction as covariates (Wooldridge 2007; Liu et al. 2010). This method guarantees the equivalence of intervention and control groups in which everything apart from the variable of interest (or other things that can be controlled for) are assumed to be the same. For stunting in the study, the D-in-D estimate is the difference between 2005 and 2001 in the proportion of children experiencing stunting. In addition, some covariates were included in the regression model, i.e. children’s age, gender, ethnicity, place of birth, women’s age, mother’s education in years and size of family.

The concentration indices (CIs) of child stunting in 2001 and 2005 by treatment groups were calculated. Furthermore, the methods developed by Kakwani et al. (1997) were used to calculate the 95% confidence interval and test whether CIs were different from zero. The bootstrapping method was used to derive the estimate of standard error of an arbitrary estimator.

**Results**

**Data collection**

In the 2001 survey, we examined 2782 children under 3 in the intervention group and 7633 in the control group. In 2005, 2754 children represented the intervention group, with 7162 for the control. There were 93 missing values in the intervention group and 203 in the control group in 2001, because the children or their parents were unavailable for measurement, the children’s birth dates were unknown or they had improbable Z-scores or exceeded the ranges (HAZ: <-6 or >6) (WHO 1995). In 2005, a total of 34 and 616 children in the intervention and control groups, respectively, were excluded. Table 1 shows the
Impact of the intervention on child stunting

In the baseline survey, the percentage of child stunting was 20.8% in the intervention group and 22.9% in the control group. At follow-up, the percentage decreased by 10.6% in the intervention group, but there was also a similar drop of 9.8% in the control group. To assess the modifying effects of household wealth on responses to the intervention, stunting prevalence was analysed across treatment groups by household wealth categories in 2001 and 2005. The analysis showed that the prevalence of stunting was reduced progressively from the poorest to wealthier households (Table 2).

Table 2 also presents the results of the intervention effects from the D-in-D estimation for stunting adjusting for some socio-demographic characteristics. It is clear that the intervention project had some positive impacts on the nutritional status of children under 3 years. It significantly improved the child stunting rate by 0.5% overall. Moreover, it significantly improved child stunting rates in the middle and wealthier households in the intervention group compared with the control group. However, there was no effect on the rate of child stunting in the poorest households in the intervention group in comparison with the control group.

For evaluating inequities in child undernutrition by household wealth categories, concentration indices of child stunting by treatment groups in 2001 and 2005 were calculated. Table 3 shows that CIs for stunting were –0.139 in the intervention group and –0.127 in the control group in 2001. After the intervention, the CI decreased to –0.223 in 2005, while increasing to –0.115 in the control group. The change in stunting CIs between 2001 and 2005 was significantly greater in the intervention areas than in the control areas (–0.084 vs 0.012) based on a 95% confidence interval using the bootstrapping method. The disparities in undernutrition between the poor and the rich in the intervention group were greater than in the control. The rate of stunting was significantly improved in most groups except for the poorest households in the intervention group.

Discussion

The study site was the rural areas of western China, a region where the nutritional status of infants and young children is poor, particularly so in the rural areas (Dang et al. 2004; Dang et al. 2005). The aim of the RPHC was to reduce the incidence of undernutrition in infants and children, to monitor and promote healthy child growth and development from 2001 to 2005.

Table 1 Socio-demographic characteristics of children aged 0–36 months<sup>a</sup>

<table>
<thead>
<tr>
<th>Characteristics&lt;sup&gt;b&lt;/sup&gt;</th>
<th>2001</th>
<th>2005</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 2782)</td>
<td>(n = 7633)</td>
<td>(n = 2754)</td>
</tr>
<tr>
<td>Age of child in months mean (95% CI)</td>
<td>18.1 (17.75, 18.45)</td>
<td>17.7 (17.48, 17.92)</td>
<td>0.050</td>
</tr>
<tr>
<td>Male sex, % (95% CI)</td>
<td>58.5 (56.70, 60.30)</td>
<td>56.8 (55.70, 57.90)</td>
<td>0.112</td>
</tr>
<tr>
<td>Han ethnicity, % (95% CI)</td>
<td>68.3 (66.60, 70.00)</td>
<td>71.9 (70.90, 72.90)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Place of birth, in hospital, % (95% CI)</td>
<td>36.6 (34.84, 38.36)</td>
<td>33.3 (52.20, 54.60)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age of mother in years, mean (95% CI)</td>
<td>26.5 (26.36, 26.64)</td>
<td>26.1 (26.00, 26.20)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mother's education in years, mean (95% CI)</td>
<td>5.8 (5.68, 5.92)</td>
<td>5.7 (5.66, 5.82)</td>
<td>0.433</td>
</tr>
<tr>
<td>Size of family, % (95% CI)</td>
<td>8.5 (56.70, 60.30)</td>
<td>56.8 (55.70, 57.90)</td>
<td>0.112</td>
</tr>
</tbody>
</table>

Table 2 Intervention effects on stunting rates in children aged less than 3 years by household wealth index: difference in difference (D-in-D) estimation<sup>c</sup>

<table>
<thead>
<tr>
<th>Household wealth index</th>
<th>2001</th>
<th>2005</th>
<th>No covariate D-in-D estimate</th>
<th>With covariate D-in-D estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(95% CI)</td>
<td>(95% CI)</td>
<td>(95% CI)</td>
<td>(95% CI)</td>
</tr>
<tr>
<td>Poorest</td>
<td>26.2 (23.5, 28.9)</td>
<td>26.7 (26.3, 28.1)</td>
<td>22.2 (17.77, 26.7)</td>
<td>17.0 (15.3, 18.7)</td>
</tr>
<tr>
<td>Middle</td>
<td>19.9 (17.4, 22.4)</td>
<td>20.5 (18.9, 22.1)</td>
<td>10.0 (5.4, 11.8)</td>
<td>13.2 (11.8, 14.6)</td>
</tr>
<tr>
<td>Wealthier</td>
<td>13.8 (11.4, 16.2)</td>
<td>16.2 (14.4, 18.0)</td>
<td>7.6 (6.2, 9.0)</td>
<td>10.5 (9.4, 11.6)</td>
</tr>
<tr>
<td>Total</td>
<td>20.8 (19.4, 22.2)</td>
<td>22.9 (22.1, 23.8)</td>
<td>10.2 (8.8, 11.6)</td>
<td>13.1 (12.2, 13.9)</td>
</tr>
</tbody>
</table>

Note: *Comparison of baseline characteristics of the children enrolled in the programme by treatment groups in 2001 and 2005.

<sup>a</sup>Values are given as mean or the percentage of the study population and 95% confidence interval (CI).

<sup>b</sup>The difference in difference estimator was estimated using a linear regression model adjusting for covariates including women's age, women's ethnicity, mother's education in years, size of family, children's age, children's gender. 95% confidence interval (CI).
This four-year child health care intervention had some effect on child undernutrition. In the study the responses to the intervention project were strongly modified by the level of wealth of participants’ households. After using D-in-D estimation adjusting for some socio-demographic characteristics, the intervention was found to produce some improvement on child stunting in wealthier households, but there was no effect on the rate of stunting in the poorest households. Despite the decline of child undernutrition rates, socio-economic gaps in child undernutrition were even greater in the intervention group than in the control. Evidence indicates that this concentration index varies around the world: −0.15 in Sub-Saharan Africa, −0.19 in South and south-east Asia, −0.13 in Eastern Mediterranean and −0.22 in Latin America and the Caribbean (Zere and McIntyre 2003; Ellen et al. 2007). It seems that the extent of childhood undernutrition inequity after the intervention in rural western China was more serious. The results suggest that the RPHC project did not reduce inequities in child undernutrition, and in fact may have exacerbated them.

Previous studies have contributed to our understanding of why poor children are more likely to be malnourished than their better-off peers (Morris et al. 2000; Filmer et al. 2001). In contrast with children born to wealthier families, poor children are more exposed to risks for undernutrition such as poor housing conditions, crowding, inadequate water and sanitation, and deficiency in one or more essential micronutrients (e.g. vitamin A, iron, zinc) (WHO and World Bank 2002). In addition, knowledge has an important role in such things as securing a nutritious diet and making appropriate use of health care services (Schellenberg et al. 2003). Generally speaking, education levels are lower in poor households. In the study areas, moreover, we found that it is difficult for mothers to commit to exclusive breastfeeding, due to time limitations for those from poor households involved in farm work. A synergy of poverty may contribute to the wide inequities in child undernutrition described above.

When the programme was conducted, it was found that poor people mainly lived in underserved areas and therefore were less likely than their wealthier counterparts to be covered by the public or private health care organizations. Due to access barriers including the cost of care, cost of transportation and low awareness on health-promoting routines, lower health care levels always existed amongst the poor. When a new, effective, equitably targeted intervention becomes available, rich people will tend to take advantage of it more rapidly than will poor people, so that inequity ratios could initially widen (Rogers 1995; Victora et al. 2000).

In spite of the positive effects of this programme, it did not deal with a lot of the root causes of undernutrition. Hence, there is still an urgent need to improve the child undernutrition disparities between poorest and wealthiest households. Tackling undernutrition should be viewed and addressed in a broader context, because policies trying to reduce average undernutrition rates can differ from those aiming at lowering socio-economic inequality in undernutrition. Because of the damaging effects of poverty on child health, increasing the income of the poorest is a sound strategy (World Bank 1981; Sahm 1994). On the other hand, poor should be given priority in budget allocations. Finally, policy makers in China designing child health programmes should give serious consideration to both targeting and universal coverage as potentially effective approaches for improving equity in child health.

The strength of the current study is its large number of subjects. Furthermore, this intervention was conducted by professional staff for 4 years, so these conclusions were clearly demonstrated. There are, however, a number of limitations. First, county and province selection was not random, and the intervention and control groups were not randomly allocated. As a result, the observed treatment differences may be subject to unobserved confounding factors. Second, there were some missing values in the survey. However, these missing subjects were randomized and very small compared with the large sample size. Third, as the study was confined to rural western China, the conclusions from this study may not be generalizable to other countries or areas. Fourth, in the poorest group, we found that the decline in stunting prevalence between 2001 and 2005 was significantly lower in the intervention areas than in the control areas. The reason for this may be that the counties in the intervention group had a lower economic level than in the control, and that the compliance of the poor families was not very good. This needs further study to precisely determine the factors involved.

### Conclusion

In general, the Rural Primary Health Care Project (RPHC) conducted in western China had some effect on reducing childhood undernutrition rates in the rural areas involved. However, it was found that SES disparities in child undernutrition became greater after the intervention. The Chinese government should make great efforts to provide health care for those on low-income as a priority target population.

### Acknowledgements

We thank the Ministry of Health, People’s Republic of China, and United Nations Children’s Fund for support and co-operation (No.YH001); Health Department of each project province and local health bureau for co-operation and organization in the field data collection; and staff from Xi’an Jiaotong University for participation in the field data collection.
References


