Regional disparities in child mortality within China 1996–2004: epidemiological profile and health care coverage

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Abstract

Objective China was one of the 68 "countdown" countries prioritized to attain Millennium Development Goals (MDG 4). The aim of this study was to analyze data on child survival and health care coverage of proven cost-effective interventions in China, with a focus on national disparities.

Methods National maternal and child mortality surveillance data were used to estimate child mortality. Coverage for proven interventions was analyzed based on data from the National Health Services Survey, National Nutrition and Health Survey, and National Immunization Survey.

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Consultations and qualitative field observations by experts were used to complement the Survey data.

Results Analysis of the data revealed a significant reduction in the overall under-5 (U5) child mortality rate in China from 1996 to 2007, but also great regional disparities, with the risk of child mortality in rural areas II–IV being two- to sixfold higher than that in urban areas. Rural areas II–IV also accounted for approximately 80% of the mortality burden. More than 60% of child mortality occurred during the neonatal period, with 70% of this occurring during the first week of life. The leading causes of neonatal mortality were asphyxia at birth and premature birth; during the post-neonatal period, these were diarrhea and pneumonia, especially in less developed rural areas. Utilization of health care services in terms of both quantity and quality was positively correlated with the region's development level. A large proportion of children were affected by inadequate feeding, and the lack of safe water and essential sanitary facilities are vital indirect factors contributing to the increase in child mortality. The simulation analysis revealed that increasing access to and the quality of the most effective interventions combined with relatively low costs in the context of a comprehensive approach has the potential to reduce U5 deaths by 34%.

Conclusions China is on track to meet MDG 4; however, great disparities in health care do exist within the country. It is therefore necessary to specifically target rural areas II–IV. Many causes of child mortality can be prevented or averted through the provision of basic health care. However, the leading predisposing factor contributing to child mortality in China is the insufficient coverage and poor quality of maternal and child health care services. Based on these data, we recommend that the government put more effort to ensure the health of the Chinese people, particularly in terms of providing the most vulnerable populations,

i.e. children from the poorest areas and households, with access to good quality essential health care services.

Keywords Child mortality · Millennium Development Goals · Coverage · Socio-economic disparities · China

Introduction

The World Summit for Children held in 1990 called for a worldwide investment in health care systems and interventions to reduce child mortality to below 70 deaths per 1,000 live births by the year 2000 [1]. Just before the failure of achieving this objective as announced, the 2000 Millennium Summit was held, which included the reduction in child mortality as the fourth of the Millennium Development Goals (MDG 4) [2]. The target of MDG 4 requires a two-thirds reduction of under-5 child mortality rate (U5MR) between 1990 and 2015. However, in two independent *Lancet* series, each group of authors concluded that child mortality issues were still off the world agenda [3, 4]. They also suggested that a large proportion of child deaths could be prevented with simple, low-cost interventions that are currently feasible but which are not reaching children in the poorer parts of the world and, therefore, that massive increases in health care coverage are required to reach MDG 4 [5, 6].

To monitor and accelerate the progress, a global movement of scientists, policymakers, health care activists, and health care program managers, called Child Survival Countdown, was founded in 2005. The primary focus of this movement is health care coverage, defined as the proportion of individuals who need an intervention and actually receive it [7]. Countdown selected 60 countries (expanded to 68 in 2008) for prioritization, tracking the coverage of proven interventions and measures of mortality in these countries, where the highest burden of mortality is among mothers and children [8].

As the largest developing country in the world, China bears a large burden of global child mortality and was therefore categorized into these prioritized countries by Countdown to attain MDG 4 [9, 10]. However, despite global attention being directed toward China in this area, there is still lack of systematic research and data on the actual situation of child survival in China. Is China on track to achieving MDG 4? What are the main causes of child mortality in China? Given the size of a large country, are there any disparities of child mortality burden among different socio-economic groups? Moreover, is it possible for children in China to obtain high-quality, sustainable, and equitable health care coverage with interventions proven to reduce their risk to die? The aim of this paper was to synthesize evidence with the aim of answering these questions.

Materials and methods

The authors are members of the academic groups participating in the Joint Review of Maternal and Child Survival Strategies in China in 2005.[1] This paper contributes to part of the technical report of this Joint Review. Maternal and Child Mortality Surveillance (MCMS) data are used to depict the situation of child mortality in China. Health care coverage is analyzed based on the 3rd National Health Services Survey (NHSS), the 2002 National Nutrition and Health Survey (NNHS), and the 2004 Comprehensive National Immunization Survey. Qualitative data were collected, and expert consultations and observations were used to complement the coverage analyses.

Data

The Information and Statistics Center of MOH classified 2,377 units (cities and counties) of China into six main stratifications according to their socio-economic development status based on a cluster analysis with ten social variables [11]. These indicators included the rate of employment, the percentage of the population <14 years and >65 years, educational achievements and illiteracy rate, crude birth rate, crude death rate, infant mortality rate, and gross domestic product (GDP) per capita. Urban units were categorized into two strata: large cities as one group, and medium and small cities as the other. In contrast, rural counties were categorized into four types (I, II, III, IV), with type I being the most developed rural county and type IV the least developed one. All data used in this analysis during the sampling process were based on this stratification.

The MCMS units were fragmented right from the very beginning. In 1996, a united national MCMS system was established, and 116 sites (37 urban districts and 79 rural counties) from 31 provinces (autonomous regions and municipal cities) were selected as representative samples of China, for which child mortality data were routinely collected at the individual township level. A Maternal and Child health care (MCH) organization at each surveillance site was responsible for filling in a death report card in the field after receiving notification of deaths from infrastructural MCH doctors. The information collected included basic demographic variables, place of death, causes of death, and much more. The number of live births in each year was recorded for each county. In addition to this passive process, there was the requirement of an active

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searching for 6 months to identify any unreported cases, i.e., under-reporting. A national office was established which was responsible for collecting and organizing all of the data collected, as well as supervising and evaluating unreported cases. Within the framework of this study, individual MCMS death reports were organized into a database for the years 1996–2004.

The NHSS was conducted by the Ministry of Health (MOH) China. The Survey selected 95 units (urban districts and rural counties) by multistage stratified cluster random sampling, where county units as clusters were randomly selected from the six stratifications mentioned above and households were randomly selected from each cluster. The third-round survey covered 57,023 households. The sample size was 193,689, including 39,437 married women of childbearing age (i.e. 15–49 years old) and 9,297 children <5 years. A set of questionnaires were completed by trained local health care staff during interviews with members of the sampled households.

The aim of the 2002 NNHS was to assess the impact of the rapid social and economic developments of the last decade on nutrition and health. The survey covered 132 counties/districts selected by multistage stratified cluster random sampling method and classified according to the six stratifications. The sample included 71,971 households (24,034 urban households and 47,937 rural) with a population of 243,479 (68,656 urban and 174,823 rural dwellers), of whom about 30,000 were children (<12 years) and pregnant women.

The 2004 Comprehensive National Immunization Survey was a nationwide survey carried out by the MOH to evaluate the Expanded Program on Immunization (EPI). The probability proportional to size (PPS) method was used as the sampling technique in this survey, and 10% (273 counties) of all counties were selected. In total, about 2.5 million households were visited during the survey and 171,521 children <5 years were interviewed.

Estimation of child mortality

MCMS data were used to estimate under-5 mortality rate (U5MR). U5MR is defined as number of child deaths during a given time period per 1,000 live births during that same time period [4, 12]. Cause-specific mortality rates were calculated in the same way. The office/organization established by MOH for supervising under-reporting randomly selected sample sites and carried out active searches for under-reporting and unreported mortality cases each year. The under-reporting aspect was taken into account by weighting the data with a 3-year average under-reporting rate for each of the six stratifications. The inverse of the population proportion in each stratum was used as probability weights to represent the national population distribution.

Estimation of health care coverage and simulation of impact

Health care coverage for different socio-economic scenarios was attained by calculating percentages. The Joint Review also assessed the health care coverage of the 25 most cost-effective interventions recommended by the 2003 *Lancet* child survival series published [5, 6] and the article of Adam et al. in the *British Medical Journal* [13]. In order to more closely align China's situation, these interventions were classified into six groups (Table 1). However, available data could provide only part of the information directly. Therefore, experts from each provincial MCH department were asked to complete a questionnaire aimed at providing an estimate of some of the coverage indicators when data were not available.

The simulations undertaken to assess the effectiveness of the coverage of the essential package of interventions is based on a model outlined in the above-mentioned *Lancet* child survival series [5, 6]. This model integrates

Table 1 Current coverage of main cost-effective mother and child health care (MCH) interventions to reduce under-five mortality in China

Intervention[a]	Coverage (%)					
	Large cities	M&S cities	Rural I	Rural II	Rural III	Rural IV
6-month exclusive breast feeding	31.6	32.6	56.7	61.3	40.4	73.6
Use of antenatal steroid (preterm)	76	69	23	17	13	7
Emergency obstetrical care	95	86	68	54	42	21
Care for preterm/LBW babies	90	82	60	43	34	27
Emergency paediatric care	85	78	53	39	30	15
Antibiotics (for pneumonia)	44	50	67	67	76	64

Data sources: the 2002 National Nutrition and Health Survey (NNHS) and where data were unavailable, the Delphi technique was used

LBW low birth weight, *M&S* middle-sized and small-sized cities

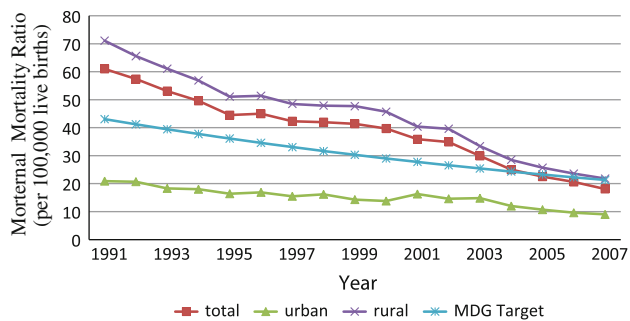[a] The 25 interventions were clustered in six groups

Fig. 1 Trends in the under-5 mortality rate (U5MR) in China, 1990–2007. *MDG* Millennium Development Goal. Source: Maternal and Child Mortality Surveillance (MCMS)

Fig. 2 U5MR by stratifications in China, 1996–2004. *S&M* Small-sized and middle-sized cities. Source: Weighted MCMS data

qualitative and quantitative assessments in the definition of the essential package of interventions. Average weighted data for 2000–2004 were used for the simulation analysis.

Results

Trends and burden of child mortality in China

Figure 1 illustrates the time trends of U5MR in China, the breakdown of data by urban and rural areas, and the corresponding MDG 4 target. Since the MCMS does not provide child mortality data for the year 1990, we adopted the World Health Organization (WHO) estimates in 1990 as the baseline. Figure 1 shows that U5MR has decreased greatly according to the MCMS estimates, although China was off track to achieving MDG 4 before 2005 due to the baseline 45 per 1,000 U5MR estimates by the WHO. Recent years has seen a return to track. Large disparities are apparent between rural and urban areas, although these too have been converging in recent years. The figures suggest that even in 2007, children <5 years in rural China still had a 2.42-fold higher risk of mortality than those living in urban areas.

Even though there has been a significant decrease in child mortality rates, Fig. 2 shows that great disparities remain both with regard to the level and the rate of decline amongst different socio-economic scenarios within and between urban and rural areas. Rural types II III, and IV show large regional disparities that are closely correlated to economic development. Amongst the rural areas, U5MR is highest in rural type IV areas and lowest in rural type I areas; however, the U5MR in the latter is still 23.8% higher than that in urban areas. The U5MR in rural areas is almost twofold higher than than in urban areas, but the gap between urban and rural areas is decreasing: in 1996, U5MR in rural areas was 2.8-hold higher than that in urban areas; by 2004, this had decreased to 1.9-fold. The disparities within rural areas increased during the period
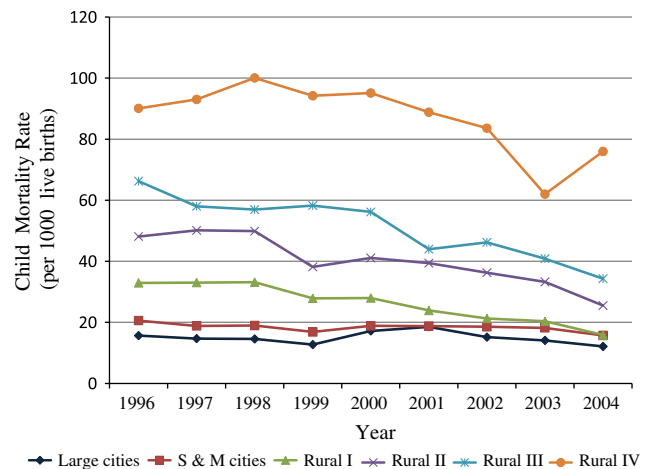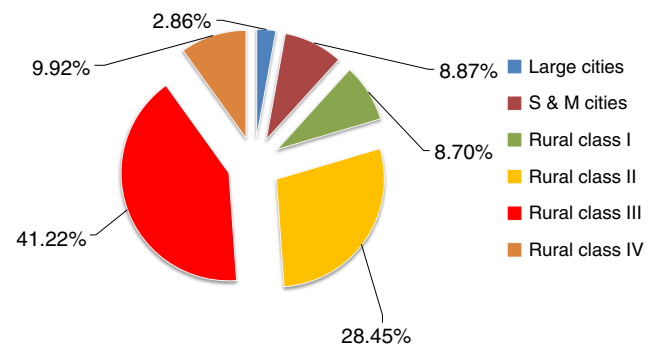

Fig. 3 Burden of U5 mortality in China. Source: Weighted MCMS data, 2000–2004

1996–2004, with the U5MR decreasing from 32.9 to 15.9 per 1,000 in rural type I, a drop of 51.8%; similar decreases occurred in rural areas II and III, but there was only a 15.7% increase in rural type IV areas (from 90.1 to 76.0 per 100,000). These results again indicate that U5MR is closely related to the level of economic and social development.

The regional distribution of child mortality burden, calculated on the basis of the 2000–2004 averages, suggests that rural type II and III areas experienced the largest number of child deaths during the study period, together accounting for 69.7% of total child deaths. In comparison, rural type IV areas accounted for 9.9% of the total during the same period. Figure 3 shows that large cities accounted for only 2.9% of total child deaths. The higher proportion of live births in rural areas partly explains this skewed distribution. Rural type II, III, and IV areas account for about 69% of total live births in China (31.4, 31.7 and 5.9%, respectively), and also for 79.6% of the total number

of deaths. In contrast, large cities account for 4.4% of total live births but only for 2.9% of total burden of deaths.

Causes of child mortality in China

In 2004, 63.9% of all child deaths in China occurred during the neonatal period; as such, neonate death accounts for the largest proportion of child death in both urban (67%) and rural (63.7%) areas of China. In Fig. 4, the four leading causes of neonatal death, namely, asphyxia and trauma (4.9 per 1,000 live births), preterm delivery, low birth weight (LBW), and hypothermia (5.4 per 1,000 live births), severe infection (2.3 per 1,000 live births), and congenital malformation (2.5 per 1,000 live births), explain 89% of all neonatal deaths. Amongst these factors, asphyxia and trauma, preterm delivery, LBW, and hypothermia is the leading causes of neonatal deaths in all areas, explaining up to 38.7% of U5 deaths, while severe infection is the third leading cause of neonatal mortality in rural type II, III and IV areas, explaining 16.7% of all deaths. The third cause of

neonatal death in urban and rural type I counties is congenital malformation, accounting for around 10% of all deaths in these areas. Finally, most neonatal deaths (79% of total neonatal mortality) can be seen to have occurred within 7 days of delivery (Fig. 5), indicating that most interventions targeting neonatal and U5 mortality should be closely linked with strategies to reduce maternal mortality, including improving the competency of the medical staff providing health care during the pregnancy, delivery, and postnatal period.

Figure 6 shows the causes of child mortality during the post-neonatal period, with pneumonia the leading cause of post-neonatal mortality in rural type III and IV areas and injury the leading cause of post-neonatal deaths in all other areas. Diarrhea, which has historically been a leading cause of child death, has become less important across China, currently accounting for very low proportion of child death in wealthier regions (i.e. urban and rural type I areas). However, it can still be seen to be the third leading cause of death for children aged 1 month to 5 years in poorer areas
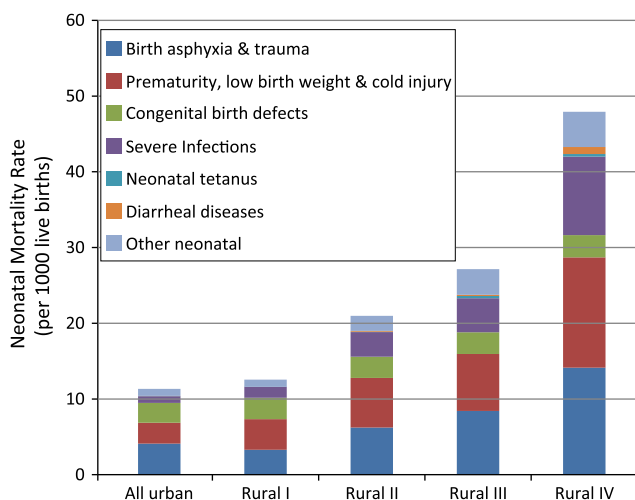

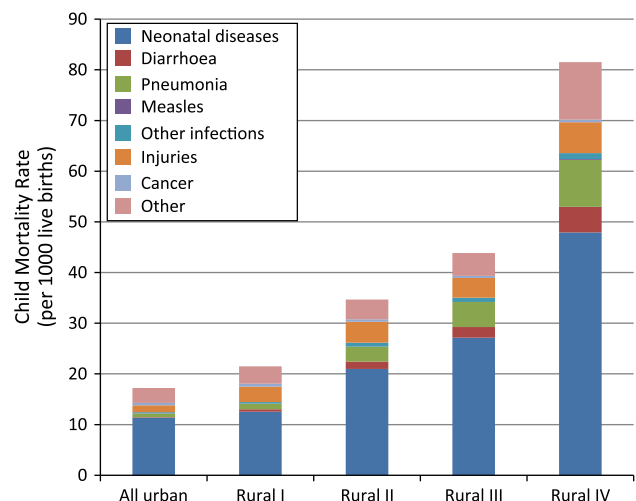Fig. 4 Causes of neonatal mortality in China. Source: Weighted MCMS data, 2000–2004

Fig. 6 Causes of child mortality in China. Source: Weighted MCMS data, 2000–2004
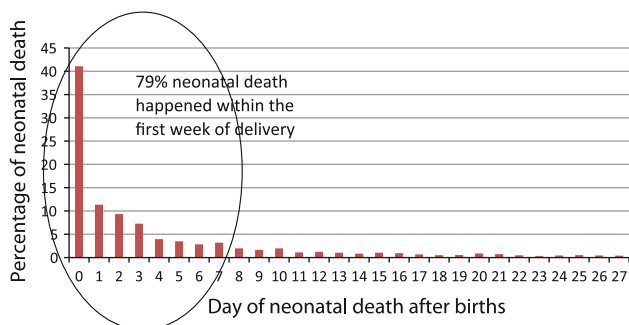

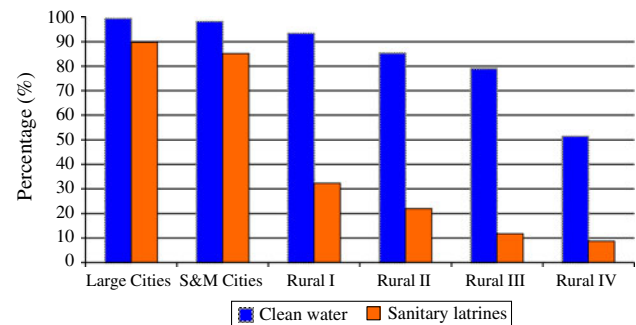Fig. 5 Timing of neonatal death in China, 2000–2004. Source: MCMS

Fig. 7 Coverage of clean water and sanitary latrine. Source: National Health Service Survey, 2003

(i.e. rural type II, III, and IV areas) where there still is lack of sanitation (Fig. 7).

Coverage of health care

Based on the analysis of places of child deaths, a large percentage of child deaths occur at home, with rural type III and type IV areas accounting for the highest proportion of deaths, followed by rural type II areas. Even in rural type I areas, 36% of child deaths can be seen to have occurred outside of health care facilities, indicating that even in this more developed area, public access to health care services are constrained. In addition, a significant proportion of child deaths in rural areas occur on the way to the hospital (accounting for 15–20% of total deaths), possibly due to poor public transportation servies and the lack of health care facilities at the township level (Fig. 8).

In addition to the lack of access to health services, the number of good quality clinical MCH services in China's rural areas is deficient. As Fig. 9 shows, only 20–50% of newborns in rural type II, III, and IV areas have access to basic emergency obstetric care (BEOC) (not including surgical delivery and blood transfusion). Moreover, access to comprehensive emergency obstetrical care (CEOC) is available only to 10–30% of newborn in rural type II, III, and IV areas, and to only 40% in type I areas because
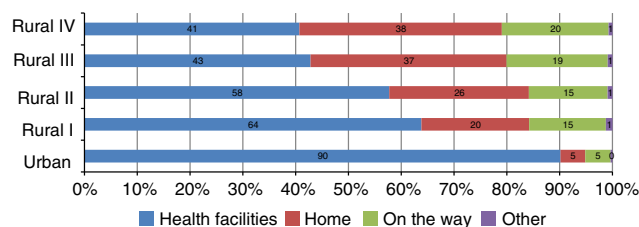

Fig. 8 Place of child death in China (%), 2000–2004. Source: MCMS
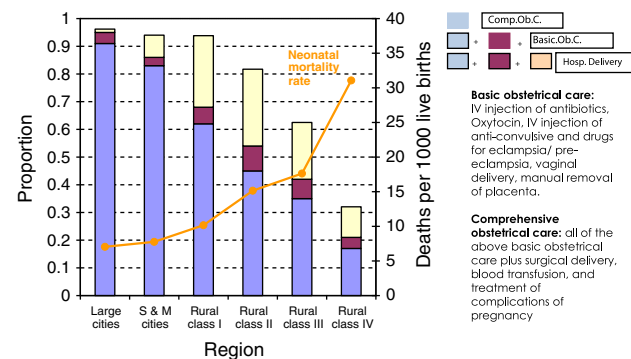

Fig. 9 Emergency obstetric care, hospitals and deaths. Data for quality of care are estimates by national experts. *Comp.Ob.C* Comprehensive emergency obstetrical care, *Basic.Ob.C* basic emergency obstetric care

CEOC is provided mainly at the level of county hospitals and above. This situation implies that neonatal care is also of poor quality in these areas. As shown in Fig. 9, access to EOC is inversely correlated to neonatal mortality, which becomes especially evident in rural type III and type IV areas.

The study also assessed the quality of child health care services in China, revealing a number of deficiencies and/or negative developments. First, even though the rate of postnatal visits is high, there are no quality guidelines for postnatal follow-up visits, and postnatal care appears to be of poor quality. Second, neonatal resuscitation techniques are neither widely nor properly used, and the simple and adequate newborn temperature management technique (i.e., Kangaroo Method) is not widely applied. Third, some simple measures, such as oral rehydration therapy (ORT) have fallen into relative disuse, and antibiotics are inappropriately used in the treatment of acute respiratory infection (ARI). Fourth, the quality of regular child health care needs further improvement. Fifth, insufficient resource allocation to child health care services, the lack of effective monitoring and supervision, and/or poor staff motivation also contribute to the provision of poor quality childcare services.

China has made great progress in improving its child health care services since 1992. The "systematic management" rate (i.e., quality of child health care rate) for children under <3 years has increased from 43% in 1992 to 74% in 2004. The child immunization program has significantly improved during this same period, with the immunization rate of the four routine vaccines reaching 88% in 2004. Despite this remarkable progress, regional differences in the provision of child health care services and imbalanced regional development contribute to the existing disparities in child mortality rates. For example, the 2004 National Immunization Survey found that full immunization rate of the four routine vaccines is 56% in rural type III and IV areas, which is significantly lower than that in rural type I (94.1%) and II (88.8%) areas.

Inappropriate feeding practices are one of the key factors affecting child survival. The NNHS showed that the use of adequate complimentary feeding in infants 6–9 months is low across all regions, ranging from 32.3 to 54.5%. Combined with low rates of exclusive breastfeeding, early and inadequate complementary feeding contributes to increased stunting, decreased disease resistance, and undernutrition (especially for children between 6 and 24 months), all of which are factors contributing to an increase in morbidity and mortality.

A poor caring practice is another factor that affects child mortality. The NHSS showed poor parental care practices for ARI and diarrhea in both urban and rural areas. For example, home care for ARI in urban and rural areas is

Table 2 Under-5 deaths by cause and deaths averted by cause, 2000–2004

Cause	Percent total U5 deaths	Percentage of deaths averted
Diarrhea	4	75.0
Pneumonia	9	56.0
Measles	0	100.0
Malaria	0	
HIV/AIDS	0	
Injuries	8	0
NN-total	61	41.0
NN-asphyxia	18	38.0
NN-prematurity	18	61.0
NN-sepsis	9	66.0
NN-tetanus	0	92.0
NN-congenital	8	5.0
NN-diarrhoea	0	41.0
NN-other	6	0
Other	18	0
Total U5MR		34.0

NN neonatal, *U5MR* under-5 mortality rate, *HIV/AIDS* human immunodeficiency virus/acquired immunodeficiency syndrome

16.7 and 1.7%, respectively. Home treatment care for diarrhea in urban and rural areas is 22.2 and 12.7%.

Lack of access to safe water and sanitation and, consequently, poor hygiene, is another problem leading to an increased incidence of diarrhea. This aspect requires attention, especially in rural type III and IV areas. As shown in Fig. 7, only 51% of people living in rural type IV areas have access to clean water, and only 21.8% has access to sanitary latrines.

We adopted the 25 most effective interventions recommended by the *Lancet* series and selected the six most effective interventions, estimating their coverage by the Delphi technique. Table 1 shows that the overall coverage of the six interventions is low and that there are substantial disparities in the provision of the six interventions: low coverage is especially present in rural type III and IV areas. For example, the use of antenatal steroids to prevent preterm delivery in rural type III and type IV areas is only 13 and 7%, respectively. Coverage of care for preterm/LBW babies and of emergency pediatric care is also low in rural type IV area, namely, 27 and 15%, respectively.

Calculations based on the same methodology as that used in the *Lancet* series indicate that adopting the comprehensive interventions listed in Table 2 and increasing the coverage rate from the current level to 99% may reduce the current U5 mortality rate by 34%, allowing China to reach the MCH targets stipulated in the 11th Five Year Plan and the MDGs. The simulation analysis shows that deaths caused by diarrhea could be reduced by 75%,

pneumonia by 56%, neonatal asphyxia by 38%, preterm delivery/LBW by 61%, and neonatal sepsis by 66% (Table 2).

Discussion

As our study shows, there has been a significant reduction in child mortality in China, although China is off-track of the MDG 4. However, current trends reveal that China is returning to the track of meeting the MDGs in terms of U5MR. However, there are large regional disparities in health care coverage in China, not only between urban and rural areas, but also between and within different regions in China. In our survey, rural type IV and rural type III areas experienced the highest mortality rate, and rural type II and III areas accounted for the majority of the child mortality burden in China. Thus, to ensure a successful and sustainable reduction of maternal mortality, as well as to increase equity in access to services, it is necessary to implement a strategy that specifically targets rural type II and III areas while continuing to focus on rural type IV areas.

Neonatal death is the largest contributor to child mortality in China. Our data shows that most of child mortality throughout China is caused by a small number of preventable or curable causes. More than 60% of child mortality happened during the neonatal period, with 70% occurring during the first week of life. The leading causes of neonatal mortality are asphyxia at birth and premature birth, while during post-neonatal period, diarrhea and phenomena are the leading causes of child mortality, especially in less developed rural areas. These factors can either be prevented or averted successfully through the provision of basic and low-cost health care.

In terms of coverage, our analysis finds that although great progress has been made during the past three decades, it is the insufficient coverage of health care services and poor health care service quality that are the leading predisposing factors contributing to child mortality. The proportion of child health care services usage is positively correlated with the region's level of economic development; thus, the use of health care services remains the lowest in the poorest areas, namely, rural type IV areas. This finding re-emphasizes the fact that improving the health care service capacity and the quality of medical institutions in type II, III, and IV rural areas will have a significant impact on reducing U5MR both in rural areas and nationwide. At the same time, a large proportion of children through the country are affected by inadequate feeding, hygiene and parental care practices, all of which contribute, inter alia, to complications at delivery, LBW, childhood diseases, and the child's intellectual and physical

development. The lack of safe water, essential sanitary facilities, and communicable diseases such as tuberculosis and hepatitis B are all indirect factors contributing to the increase of maternal and child mortality. Increasing both the quality of and access to the most effective interventions with relatively low costs in a comprehensive manner has the potential to reduce U5 deaths by 34%, thereby achieving the MDG targets.

Therefore, it is essential to strengthen MCH interventions, particularly in rural areas, and to back up this initiative with systemic reforms that ensure equal access to good quality MCH services across the whole of China. Such measures should be viewed as key components of a strategy for operationalizing the Government's aim of building a "new socialist countryside" [14] and promoting balanced development among regions in order to build a harmonious society. In paying close attention to solving problems related to the vital interests of the people, we recommend that the government more effort to ensure the health of the people, particularly in terms of providing the most vulnerable populations, i.e. children from the poorest areas and households, with access to good quality essential health care services.

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