

## Letter to the Editor



## Determining Optimal Strategies to Reduce Maternal and Child Mortality in Rural Areas in Western China: an Assessment Using the Lives Saved Tool\*

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China, as a whole, is about to meet the Millennium Development Goals for reducing the maternal mortality ratio (MMR) and infant mortality rate (IMR), but the disparities between rural area and urban area still exists. This study estimated the potential effectiveness of expanding coverage with high impact interventions using the Lives Saved Tool (LiST). It was found that gestational hypertension, antepartum and postpartum hemorrhage, preterm birth, neonatal asphyxia, and neonatal childhood pneumonia and diarrhea are still the major killers of mothers and children in rural area in China. It was estimated that 30% of deaths among 0-59 month old children and 25% of maternal deaths in 2008 could be prevented in 2015 if primary health care intervention coverage expanded to a feasible level. The LiST death cause framework, compared to data from the Maternal and Child Mortality Surveillance System, represents 60%-80% of neonatal deaths, 40%-50% of deaths in 1-59 month old children and 40%-60% of maternal deaths in rural areas of western China.

It is well documented that China has made impressive progress towards achieving the Millennium Development Goals (MDGs), especially the MDG 4 & 5. The maternal mortality ratio (MMR) was reduced from 94.7/100,000 in 1990 to 24.5/100,000 in 2012. The infant mortality rate (IMR) and under-five mortality rate (U5MR) were reduced from 50.2 per thousand live births and 61 per thousand live births in 1990 to 10.3 per thousand live births and 13.2 per thousand live births in 2012, respectively<sup>[1-2]</sup>. The newborn mortality rate was reduced from 22.8 per thousand live births in 2000 to 6.9 per thousand live births in 2012. In 2007, China has already achieved the MDG 4 of reducing

U5MR by two-thirds between 1990 and 2015<sup>[1,3]</sup>. However, great disparities in maternal and child mortality rates still exist among different areas in China. The ratio of U5MR in urban areas to that in rural areas reached 2.75 in 2012, which was considerably higher than the average level of 1.4 in 80 developing countries in 2011<sup>[2,4]</sup>.

International organizations, pay much attention to the development of evidence-based strategies for the selection of cost-effective maternal and child health (MCH) intervention in disadvantaged regions. In December 2011, the World Health Organization (WHO) published 'Essential Interventions, Commodities and Guidelines for Reproductive, Maternal, Newborn and Child Health', which identified 60 cost-effective interventions<sup>[5]</sup>. With the WHO's framework as guidance, each developing country still needs to determine the priority interventions by taking the local context into account. The Lives Saved Tool (LiST) is used for policy modeling based on *The Lancet's* Series on Child Survival, Neonatal Survival, and Maternal and Child Under-Five. It is designed to encourage a strategic approach to a select priority intervention package and provide a unified framework in integrated MCH planning in low-middle income regions; it has been applied widely in these regions in recent years<sup>[6-7]</sup>.

The aim of this study was to explore optimal strategies in reducing maternal and child mortality in rural areas in western China by using LiST. In selecting the survey areas, we found that Tibet, Xinjiang, Qinghai, Yunnan ranked as the top four provinces in China regarding level of MMR, IMR, U5MR. However, the geography and ethnic structure of these provinces are quite different from the other provinces in China, and a broader selection that

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would better represent the country was sought. Expert consultation recommended Guizhou province in southwest China to be included in the survey area due to its high IMR, MMR, and U5MR (all ranking within the top ten in China) and its lower economic level. Shaanxi province in northwest China was selected to represent the relatively developed region in western China.

Based on the provincial surveillance data, the causes of maternal and child deaths were classified by using LiST : 1) causes of neonate death: diarrhea, sepsis, pneumonia, tetanus, asphyxia, premature birth complication, congenital anomaly; 2) causes of death for children aged 1-59 months: diarrhea, pneumonia, meningitis, measles, malaria, pertussis, AIDS, injury; 3) causes of maternal death: prenatal bleeding, postpartum hemorrhage, gestational hypertension, puerperal infection, abortion, childbirth, ectopic pregnancy and other causes of death.

Asphyxia, preterm birth and pneumonia were

found to be the leading causes of neonatal death while pneumonia and diarrhea were identified as leading causes of death for children aged 1-59 months in the rural areas of Guizhou and Shaanxi. It is important to note that more than 60% of all death in this age group in the two provinces belonged to the 'other' category in LiST. Postpartum hemorrhage, antepartum hemorrhage, and gestational hypertension were the leading causes of maternal death, while other death causes increased.

By using LiST, 21 key intervention measures, which will improve the survival of women and children in surveyed areas, were developed and listed in Table 1. The coverage levels used in the analysis represents the feasible and universal scale-up scenarios. In Table 1, the feasible coverage rates were set according to central government policy targets and, in the absence of these, expert consultation, while the universal coverage rates reflects the ideal intervention level.

**Table 1.** Modeled Target Intervention Coverage Rates in Two Scale-up Plans for Two Provinces Surveyed

Intervention	Current Coverage Rate	Feasible Coverage	Universal Coverage
Folic acid supplementation/fortification	41.2%-49.1% <sup>a</sup>	90% <sup>c</sup>	99.9%
Systematic management in pregnancy (ANC visit >4)	69.4%-89.6% <sup>a</sup>	85% <sup>d</sup>	99.9%
Multiple micro-nutrient supplementation	7.7%-12.9% <sup>a</sup>	90% <sup>e</sup>	99.9%
Hospital delivery	96.6%-99.7% <sup>a</sup>	96% <sup>d</sup>	99.9%
National plan vaccination	77.4%-99.3% <sup>a</sup>	95% <sup>d</sup>	99.9%
Hib	3.0%-8.9% <sup>a</sup>	90% <sup>e</sup>	99.9%
Pneumococcal	0-23.4% <sup>a</sup>	90% <sup>e</sup>	99.9%
Rotavirus	0.7%-9.7% <sup>a</sup>	90% <sup>e</sup>	99.9%
Exclusive breastfeeding 0-6 months	14.7%-32.6% <sup>a</sup>	50% <sup>c</sup>	90.0%
Thermal care	89.4%-98.7% <sup>a</sup>	90% <sup>e</sup>	99.9%
Clean postnatal practice	89.4%-98.7% <sup>a</sup>	90% <sup>e</sup>	99.9%
Appropriate complementary feeding	87.9%-93.7% <sup>a</sup>	90% <sup>e</sup>	99.9%
Vitamin A supplementation	27.9%-62.6% <sup>a</sup>	90% <sup>e</sup>	99.9%
Zinc supplementation	24%-52.2% <sup>a</sup>	90% <sup>e</sup>	99.9%
Improved water source	20.2%-79.1% <sup>a</sup>	90% <sup>e</sup>	99.9%
Water connection in the home	54.8%-68.0% <sup>a</sup>	90% <sup>e</sup>	99.9%
Utilization of latrines or toilets	23.9%-58.0% <sup>a</sup>	90% <sup>e</sup>	99.9%
Hand washing with soap	19.9%-37.9% <sup>a</sup>	90% <sup>e</sup>	99.9%
Hygienic disposal of children's stools	78.7%-94.9% <sup>a</sup>	90% <sup>e</sup>	99.9%
ORS-oral rehydration solution	11.7%-40% <sup>a</sup>	90% <sup>e</sup>	99.9%
Zinc-for treatment of diarrhea	25%-50% <sup>b</sup>	90% <sup>e</sup>	99.9%

**Note.** <sup>a</sup> indicator calculated based on the household survey in investigated counties; <sup>b</sup> indicator estimated from local expert consultation; <sup>c</sup> represents the goal of Ministry of Health. *The Mechanism and Management for Folic Acid Supplementation in Preventing Neural Tube Defects (2010. <http://www.moh.gov.cn>);* <sup>d</sup> refers to the goal of National Maternal and Child compendium(2011-2020); <sup>e</sup> refers to presents intervention, which have no quantitative goal in government planning, feasible coverage goals were developed according to experts consultation based on the current level and resource accessibility. For specific intervention in investigated province which has already obtained the feasible coverage, we assumed that the achieved coverage was maintained.

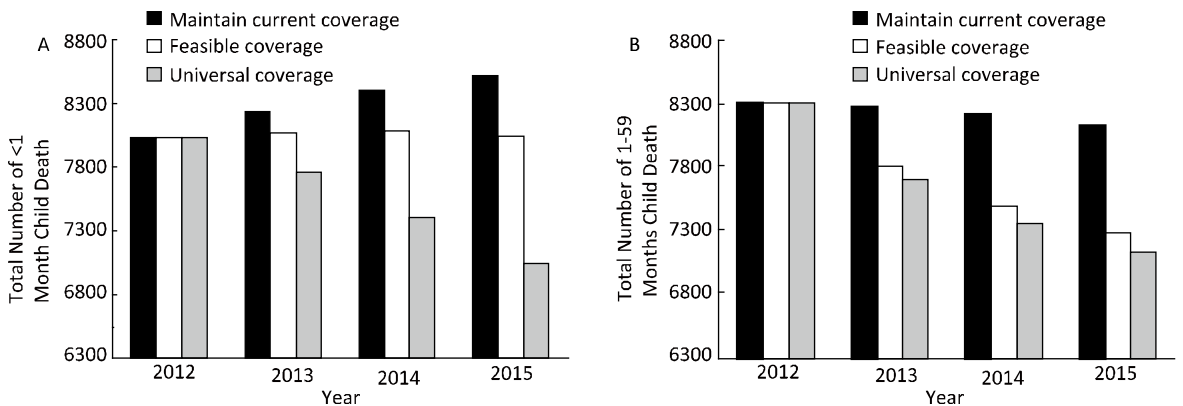
Table 2 presents the number of deaths in mothers and children aged 0-59 months that could be prevented by the interventions with current coverage, feasible coverage, and universal coverage. Figure 1 presents the difference in health effects in reducing child deaths from 0-59 months among the interventions with current coverage, feasible coverage and universal coverage. Expanding intervention coverage will bring the most effects to

children aged 1-59 months (Figure 1B). In Guizhou, expanding intervention to universal coverage could prevent more maternal deaths. In Shaanxi, expanding intervention coverage had no influence on the predicted number of maternal deaths, indicating that current maternal health interventions, especially the high coverage of institutional delivery, already contributed optimally to the prevention of maternal deaths.

**Table 2.** Estimated Number of Maternal and Child Deaths in Shaanxi and Guizhou Prevented by 'evidence-based intervention' with Different Coverage

Indicators	Shaanxi	Guizhou
Neonatal death estimation		
NMR in 2008 (per 1000 live births)	7.15	13.55
Estimated number of deaths in 2008	1826	6115
Predicted number of neonatal deaths prevented by intervention (% reduction)		
Current coverage 2015	82 (4.5%)	454 (7.4%)
Feasible coverage in 2015	221 (12.1%)	704 (11.5%)
Universal coverage in 2015	287 (15.7%)	1432(23.4%)
Estimation of deaths in children aged <5 years		
U5MR in 2008 (per 1000 live births)	11.18	28.73
Estimated number of deaths in 2008	2839	12813
Predicted number of deaths in children aged <5 years prevented by intervention (% reduction)		
Current coverage 2015	79 (2.9%)	398 (3.1%)
Feasible coverage in 2015	343 (12.1%)	2279 (17.8%)
Universal coverage in 2015	427 (15.0%)	3177 (24.8%)
Maternal death estimation		
MMR in 2008 (per 1000 live births)	21.23	67.99
Estimated number of deaths in 2008	54	307
Predicted number of maternal deaths prevented by intervention (% reduction)		
Current coverage 2015	9 (16.7%)	68 (22.15%)
Feasible coverage in 2015	9 (16.7%)	68 (22.15%)
Universal coverage in 2015	9 (16.7%)	96 (31.27%)

**Note.** The NMR was adjusted based on the surveillance data according to the urban/rural proportion in year report. The U5MR was adjusted based on the surveillance data according to the urban/rural proportion in year report. The MMR was adjusted based on the surveillance data according to the urban/rural proportion in year report.



**Figure 1.** Total Number of 0-59 Month Deaths for Key Intervention with Current, Feasible and Universal Coverages. A. The total number of 0-1 month deaths change; B. The total number of 1-59 month deaths change.

Expanding the coverage of the 21 recommended interventions to feasible coverage levels can prevent 20%-30% of 0-59 months child deaths in 2015. According to the LiST estimates, 60%-80% of neonatal deaths, 40%-50% of 1-59 months child deaths and 40%-60% of maternal deaths in rural areas in western and central China could be reduced if effective health interventions reach all the children and women who need them. Breastfeeding, vaccination against pneumonia and oral rehydration therapy (ORS) are the most effective interventions in reducing U5MR. It is more challenging to reduce maternal deaths further as the current coverage rate by institutional delivery is already high in rural areas in China.

The LiST estimates presented here show that, in spite of already impressive reductions in MMR, IMR and U5MR, further improvements in maternal and child mortality can still be made in China. Childhood diarrhea, pneumonia, neonatal asphyxia, neonatal prematurity, postpartum hemorrhage, antepartum hemorrhage, and gestational hypertension still remain important killers of women and children in China's rural areas, and interventions addressing these problems need to be prioritised.

The interventions included in LiST cover many world regions with different epidemiological profiles. Our study found that most of the leading causes of death defined in the model also apply to the Chinese context. While prevalent in some areas in China, malaria and AIDS are not among the major killers for women and children in rural area in China, and the impact of proven interventions will be small relative to the effect of interventions acting against major causes. At the same time, intervention impact against some major causes of death such as congenital anomaly, child injury, internal disease on during pregnancy are not included in LiST, in absence of globally conclusive evidence. As a result the possible impact of interventions could not be factored in in our analyses, which is a limitation of our study.

The study also assessed the degree of confidence needed in the estimates and trends in maternal and child mortality. All the modeled child mortality rates were higher than the measured rates and were out of the 95% confidence interval. There was no statistical significant difference between the modeled MMR and observed MMR in Shaanxi, which might be explained by the high prevalence of institutional delivery.

There are three main factors that may affect the validity of LiST prediction results<sup>[8-10]</sup>: 1) the

reliability of maternal and child mortality rates collected from annual maternal and child health reports or surveillance data; 2) the completeness and quality of coverage data collected through household survey and expert consultation; 3) the relevance of LiST model used in the context of rural area of China as well as its own limitation.

In the rural area of China, old health problems remain, but new challenge have emerged. The observed mortality data from Shaanxi (Guizhou is not included in the mortality reports) showed that the causes of death included in LiST can explain >80% of 0-1 month child death, 40%-50% of 1-59 month child death, 50%-60% of maternal deaths. Nearly 20% of 1-59 month deaths were caused by congenital heart disease and other congenital anomaly. The causes of maternal death showed a stable increase in internal medicine complications which are not included in LiST. The change of death causes indicated that a more comprehensive intervention frameworks are needed to reduce the new emerging death risk.

In summary, our findings should be interpreted with caution due to uncertainties about LiST model and input data. We explored the strategy of maternal and child mortality reduction by using LiST in rural area in western China. Traditional causes of death continue to cause serious health burden in rural China in recent years despite the decline of these causes, while emerging causes of death are increasing. The causes of death in LiST could be further reduced if health interventions reach all the children and women who need them. LiST is useful for complicated decision-making in identifying health priorities in resource-limited regions. Efforts in seeking the cost-effective intervention to address emerging risk need to be made.

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