

LONDON
SCHOOL of
HYGIENE
& TROPICAL
MEDICINE



LSHTM Research Online

Gao, YQ; Ronsmans, C; Lin, A; (2009) Time trends and regional differences in maternal mortality in China from 2000 to 2005. Bulletin of the World Health Organization, 87 (12). pp. 913-920. ISSN 0042-9686 DOI: <https://doi.org/10.2471/blt.08.060426>

Downloaded from: <http://researchonline.lshtm.ac.uk/4320/>

DOI: <https://doi.org/10.2471/blt.08.060426>

Usage Guidelines:

Please refer to usage guidelines at <https://researchonline.lshtm.ac.uk/policies.html> or alternatively contact researchonline@lshtm.ac.uk.

Available under license: <http://creativecommons.org/licenses/by-nc-nd/2.5/>

<https://researchonline.lshtm.ac.uk>

Time trends and regional differences in maternal mortality in China from 2000 to 2005

Gao Yanqiu,^a Carine Ronsmans^b & An Lin^a

Objective To examine trends and variations in maternal mortality in China between 2000 and 2005.

Methods We used Poisson regression analysis of data from the Chinese National Maternal and Child Health Routine Reporting System between 2000 and 2005 to identify time trends in the maternal mortality ratio (MMR) by province and region.

Findings The MMR declined by an average of 5% per year (crude relative risk, RR: 0.95; 95% confidence interval, CI: 0.94–0.97). There was no interaction between region and year ($P = 0.2311$). Mortality declined by 5% per year in the eastern region (crude RR: 0.95; 95% CI: 0.92–0.97), by 5% per year in the central region (crude RR: 0.95; 95% CI: 0.94–0.96), and by 4% per year in the western region (crude RR: 0.96; 95% CI: 0.94–0.98). The absolute difference in MMR between the western and eastern regions declined from 65.4 deaths per 100 000 live births in 2000 to 49.4 per 100 000 live births in 2005.

Conclusion China is making good progress towards achieving the fifth Millennium Development Goal, and there is no evidence of a widening gap between better-off and economically more deprived provinces.

Une traduction en français de ce résumé figure à la fin de l'article. Al final del artículo se facilita una traducción al español. الترجمة العربية لهذه الخلاصة في نهاية النص الكامل لهذه المقالة.

Introduction

Twenty years into the Safe Motherhood Initiative, countries continue to struggle to reduce the high burden of maternal death. The fifth Millennium Development Goal (MDG-5) has set a target of reducing maternal mortality by 75% between 1990 and 2015, but progress has been slow.^{1,2} Effective technical interventions exist, but their application requires considerable skill. The training, deployment and retention of skilled health personnel remain huge challenges, and inequities, insufficient financial resources and lack of political will continue to limit progress.^{3,4}

China represents one of the few success stories in maternal health. The maternal mortality ratio (MMR), estimated at 1500 deaths per 100 000 live births in the 1950s,^{3,5} decreased to an estimated 88 deaths per 100 000 live births in 1990.^{6–8} The factors explaining this decline are complex, but the successful expansion of rural health services, with an effective referral system from villages to township and county hospitals, is thought to have been a major factor.^{9–11} During the past 25 years China has undergone unprecedented economic growth, and the health reforms introduced concurrently have raised concerns over rising inequalities.^{12,13} There is ample evidence of inequalities between regions in access to obstetric care and maternal survival, but whether gaps increase over time is unknown.^{7,13–15}

As in other countries, in China the accuracy of maternal mortality estimates is uncertain. The recent Countdown, which tracks coverage of child and maternal health indicators in 68 countries, including China, was unable to track progress towards MDG-5 because of the huge margin of uncertainty in maternal mortality estimates.¹⁶ China's maternal mortality estimates are typically obtained from a sentinel surveillance system covering a sample of 37 urban

and 79 rural sites.¹⁷ The generalizability of these data has been called into question, and discrepancies have been noted in the classification of the causes of death.⁷

In this study we used a different source of data to examine trends and variations in the MMR in China between 2000 and 2005. The National Maternal and Child Health Routine Reporting System, established in the 1980s, covers the entire population of China.¹⁸ We report trends in maternal mortality by province and region, and explore the extent to which the observed trends are explained by changes in the proportion of institutional births, the crude birth rate and economic growth over time.

Methods

Data

We obtained data on live births and maternal deaths in each province between 2000 and 2005 from the National Maternal and Child Health Routine Reporting System, which falls under the responsibility of the Ministry of Health.^{13,18} The system differs somewhat in urban and rural areas. In urban areas, all pregnancies are registered and community doctors keep a log of all pregnancy outcomes. When the pregnancy outcome is not known, they call the woman's home to update the information. Once a month they also visit obstetric and emergency departments in their catchment area and check death certificates at the police departments to further identify maternal deaths. Community doctors send monthly reports to sub-district health managers, who forward summary reports to district health managers twice a year. In rural areas, village doctors use their extensive community networks to identify births and deaths within their catchment area. Data are forwarded monthly to township hospitals and twice a

^a Peking University Health Science Center, 38 Xueyuan Road, Haidian District, 100083 Beijing, China.

^b London School of Hygiene and Tropical Medicine, London, England.

Correspondence to An Lin (e-mail: anlin@bjmu.edu.cn).

(Submitted: 17 October 2008 – Revised version received: 23 March 2009 – Accepted: 7 April 2009 – Published online: 25 August 2009)

Table 1. Association between year, region, percentage of institutional births, GDP, crude birth rate and MMR in China, 2000–2005

	MMR	No. of deaths	No. of provinces ^a	Crude RR (95% CI) ^b	Adjusted RR (95% CI) ^b			
					Adjusted for region and % of institutional births	Adjusted for region, % of institutional births and GDP	Adjusted for region, % of institutional births, GDP and year	Adjusted for region, % of institutional births, GDP, year and crude birth rate
Trend by year^c	–	–	–	0.95 (0.94–0.97)	1.01 (0.98–1.04)	1.01 (0.98–1.04)	1.00 (0.99–1.03)	1.01 (0.99–1.03)
Region								
Eastern	21.3	4 164	54	1.00	1.00	1.00	1.00	1.00
Central	39.9	9 811	60	1.87 (1.54–2.28)	1.87 (1.54–2.28)	1.58 (1.30–1.91)	1.37 (1.08–1.75)	1.33 (1.06–1.67)
Western	81.0	16 667	72	3.81 (3.00–4.83)	3.79 (2.99–4.81)	2.28 (1.75–2.98)	2.03 (1.48–2.78)	1.92 (1.40–2.63)
Institutional births, percentage					NA			
≥ 90	23.0	3 930	52	1.00		1.00	1.00	1.00
80–89	34.6	7 115	50	1.50 (1.15–1.96)		1.14 (0.97–1.34)	1.13 (0.97–1.32)	1.13 (0.99–1.30)
70–79	54.5	6 609	32	2.36 (1.94–2.87)		1.46 (1.20–1.77)	1.47 (1.22–1.78)	1.46 (1.20–1.78)
60–69	69.8	5 268	24	3.03 (2.35–3.90)		1.58 (1.22–2.03)	1.57 (1.17–2.10)	1.52 (1.19–1.95)
< 60	103.8	7 750	28	4.51 (3.60–5.63)		2.29 (1.71–3.06)	2.73 (1.84–4.06)	2.16 (1.52–3.07)
GDP per capita, US\$					NA	NA		
≥ 2196	18.9	1 976	36	1.00			1.00	1.00
1464–2195	30.8	4 320	35	1.63 (1.25–2.13)			1.33 (1.19–1.49)	1.30 (1.15–1.47)
732–1463	55.5	18 111	94	2.94 (2.36–3.67)			1.34 (1.03–1.75)	1.37 (1.11–1.69)
< 732	82.4	6 139	21	4.31 (3.24–5.73)			0.99 (0.67–1.48)	1.07 (0.81–1.43)
Crude birth rate, per 1000					NA	NA	NA	
< 8	20.0	834	31	1.00				1.00
8–11	39.9	12 702	74	1.40 (0.93–2.12)				0.95 (0.83–1.08)
12–15	45.1	10 554	54	1.31 (0.97–1.77)				0.92 (0.79–1.06)
> 15	126.7	6 582	27	3.24 (2.36–4.45)				1.31 (0.99–1.73)

CI, confidence interval; GDP, gross domestic product; MMR, maternal mortality ratio; NA, not applicable; RR, relative risk; US\$, United States dollars.

^a Each province is represented six times between 2000 and 2005.

^b Adjusted for clustering within province.

^c Crude and adjusted relative risks for yearly trends represent the relative change in the MMR from one year to the next, assuming a linear trend over time.

year to the county health department. Maternal deaths are defined as the death of a woman while pregnant or within 42 days of pregnancy termination, irrespective of pregnancy duration or termination method, excluding deaths from intentional and unintentional injuries.¹⁹

We also obtained data, by year and province, on the percentage of live births in institutions¹⁸ and on per capita gross domestic product (GDP) and crude birth rate from the National Statistical Yearbooks. The per capita GDP product was converted to United States dollars (US\$) at the exchange rate of 6.83 yuan to 1 US\$ (14 August 2009). Institutional births are defined as births in township, county, provin-

cial or national hospitals. Nominal GDP values were converted to constant currency units using the year 2000 as a base.

Statistical analysis

We assigned each of the 31 provinces, autonomous regions and municipalities to one of three economic regions, using the Chinese government's definition of the eastern (Beijing, Tianjin, Liaoning, Shanghai, Shandong, Jiangsu, Zhejiang, Fujian and Guangdong), central (Hebei, Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan and Hainan) and western region (Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and

Xinjiang). We used box plots²⁰ to model the MMRs, the percentage of live births in institutions, the per capita GDP and the crude birth rate in each province by year and region. Boxes represented the interquartile range (IQR) (from the 25th to the 75th percentile), and any data which lay more than 1.5-fold the IQR below the first quartile or 1.5-fold the IQR above the third quartile were considered outliers.

We examined time trends in maternal mortality with Poisson regression. We first computed crude annual relative risks (RRs) with 95% confidence intervals (CI), using year as a continuous variable and adjusting for clustering at the province level, and tested whether time trends were similar across the three

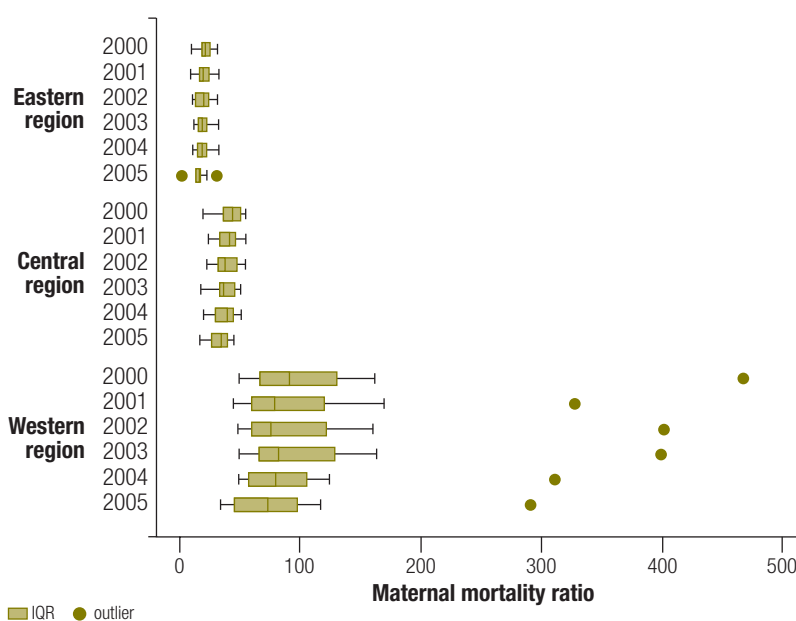
regions by introducing an interaction between year and region. Second, we reported the relative and absolute difference in MMR between regions in 2000 and 2005, using Poisson confidence intervals. Third, we calculated crude annual trends in mortality within each province. Finally, we performed multivariate analysis by progressively adding region, the percentage of births in institutions, the GDP per capita and the crude birth rate to the model in order to predict annual trends (adjusting for clustering within province). Stata version 10.0 software (Stata Corp., College Station, TX, United States of America) was used for statistical analyses.

Results

Between 2000 and 2005, the registration system recorded 30 672 maternal deaths and 64 780 153 live births, resulting in an overall MMR of 47.3 deaths per 100 000 live births. As shown in Table 1 and Fig. 1, MMRs in the western region were on average four-fold higher than in the eastern region (crude RR: 3.81; 95% CI: 3.00–4.83). Similarly, MMRs in the central region were twice as high as in the eastern region (crude RR: 1.87; 95% CI: 1.54–2.28). There was little variation in mortality across provinces in the central and eastern regions, but mortality varied substantially within the western region. The six outliers in the western region were all in Tibet.

Maternal mortality declined by an average of 5% per year (crude RR: 0.95; 95% CI: 0.94–0.97). There was no in-

Fig. 1. Box plot^a of MMR by region and year, China, 2000–2005



IQR, interquartile range; MMR, maternal mortality ratio.

^a Any data which lie more than 1.5-fold the IQR below the first quartile or more than 1.5-fold the IQR above the third quartile are considered outliers.

teraction between region and year ($P = 0.2311$). Mortality declined by 5% per year in the eastern region (crude RR: 0.95; 95% CI: 0.92–0.97), by 5% per year in the central region (crude RR: 0.95; 95% CI: 0.94–0.96), and by 4% per year in the western region (crude RR: 0.96; 95% CI: 0.94–0.98). There was no evidence of a widening gap in maternal mortality between regions between 2000 and 2005 (Table 2). Impressively, the absolute difference in MMR between the western and eastern regions declined from 65.4 deaths per

100 000 live births in 2000 to 49.4 per 100 000 live births in 2005.

The MMR declined significantly in four of nine eastern provinces, in six of 10 central provinces and in eight of 12 western provinces (Table 3). Mortality decreased significantly in all five provinces with an MMR greater than 100 per 100 000 in 2000. In Tibet, mortality declined from 466.9 deaths per 100 000 live births in 2000 to 290.3 deaths per 100 000 live births in 2005 (crude RR: 0.93; 95% CI: 0.89–0.98).

The percentage of births in institutions ranged from 20.1% in Tibet in 2000 to 99.7% in Tianjin in 2004, with a median of 81.9% (Fig. 2). In the eastern region, 98.5% (range: 78.1–99.7%) of women gave birth in health institutions, compared with 83.3% (range: 57.3–94.7%) in the central region and 66.6% (range 20.1–90.9%) in the western region. The extremes at the low end of the distribution were in Tibet (increasing from 20.1% in 2000 to 34.1% in 2005) and Guizhou (increasing from 25.8% in 2000 to 48.7% in 2005). The crude association between institutional births and maternal mortality was strong: maternal mortality was four times higher in provinces where fewer than 60% of births took place in institutions compared with provinces

Table 2. Absolute and relative differences in MMR between regions in China in 2000 and 2005

	Year	
	2000	2005
MMR (no. of deaths)		
Central region	45.10 (1858)	34.06 (1527)
Eastern region	24.36 (803)	17.71 (625)
Western region	89.79 (3206)	67.65 (2302)
Absolute difference in MMR (95% CI)		
Central minus eastern region	20.74 (18.09–23.39)	16.35 (14.15–18.55)
Western minus eastern region	65.44 (61.90–68.97)	49.94 (46.85–53.04)
Ratio of MMRs (95% CI)		
Central to eastern region	1.85 (1.70–2.01)	1.92 (1.75–2.11)
Western to eastern region	3.69 (3.41–3.99)	3.82 (3.49–4.18)

CI, confidence interval; MMR, maternal mortality ratio.

where more than 90% of women gave birth in an institution (crude RR: 4.51; 95% CI: 3.60–5.63) (Table 1).

Per capita GDP in 2005 increased dramatically, from a median of US\$ 860 in 2000 to US\$ 1564 (Fig. 3). Per capita GDP was much higher in the eastern region (median: US\$ 2575; range: 1399–7707) than in the central (median: US\$ 1165; range 710–2023) or western regions (median: US\$ 911; range: 390–2235). There was a strong association between per capita GDP and maternal mortality (Table 1).

The crude birth rate varied between 4.85 and 13.95 per 1000 population in the Eastern region, between 7.25 and 15.44 per 1000 population in the Central region and between 9.05 and 19.05 per 1000 population in the western region (Fig. 4).

The trends in time were fully explained by changes in the percentage of institutional births (Table 1). After adjustment for region and variation in institutional births, the RR in maternal mortality for one year relative to the previous year was 1.01 (95% CI: 0.98–1.04). After adjustment for all factors in the multivariate model, there was some residual variation in maternal mortality according to region, the percentage of births in health institutions and per capita GDP (Table 1).

Discussion

China has made great strides in reducing maternal mortality. If the impressive annual decline of 5% persists, maternal mortality will decrease by 70% during the next 25 years. Encouragingly, progress is seen in all regions, even in the most remote and poorest provinces, and there is no evidence of a widening gap between better-off and economically more deprived regions.

What explains China's success? China has made substantial efforts to improve access to hospitals and emergency obstetric care.^{9,10,14} Gains were possible in part because of the hierarchical health system, which provides effective referral for high-risk patients and an extensive supervision system that facilitates training and contact between health facilities, even in remote areas.^{11,15} Within this system, the promotion and provision of safe delivery services continue to be key priorities.^{21–23} The "Decreasing Project" initiated by the government in 12 western rural provinces in 2000

Table 3. Trends in maternal mortality in each province, autonomous region or municipality in China, 2000–2005

Province, autonomous region or municipality	MMR in 2000 (no. of deaths)	Crude annual RR (95% CI)
Eastern region^a		
Shanghai	9.6 (6)	0.88 (0.73–1.08)
Beijing	11.0 (6)	1.07 (0.91–1.26)
Tianjin	18.2 (20)	0.93 (0.79–1.10)
Zhejiang	19.4 (68)	0.93 (0.87–0.99)
Liaoning	20.8 (59)	1.00 (0.95–1.07)
Shandong	24.7 (212)	0.94 (0.91–0.97)
Guangdong	24.9 (220)	0.93 (0.90–0.97)
Jiangsu	28.6 (126)	0.91 (0.87–0.95)
Fujian	31.1 (96)	1.00 (0.95–1.05)
Central region^a		
Heilongjiang	19.1 (45)	0.95 (0.89–1.02)
Jilin	34.1 (56)	0.97 (0.92–1.03)
Anhui	36.3 (207)	0.95 (0.92–0.98)*
Hebei	37.4 (204)	0.93 (0.90–0.96)*
Hainan	38.7 (35)	1.01 (0.93–1.10)
Hubei	47.7 (179)	0.95 (0.91–0.98)*
Shanxi	48.8 (137)	0.98 (0.93–1.02)
Jiangxi	50.0 (190)	0.94 (0.90–0.97)*
Henan	54.1 (443)	0.96 (0.94–0.99)*
Hunan	54.8 (362)	0.96 (0.93–0.99)*
Western region^a		
Guangxi	49.4 (263)	0.98 (0.96–1.01)
Shaanxi	57.2 (150)	0.98 (0.94–1.03)
Inner Mongolia	62.6 (115)	0.91 (0.87–0.96)*
Sichuan	70.4 (486)	1.02 (0.99–1.04)
Chongqing	79.0 (200)	1.00 (0.97–1.03)
Ningxia	85.8 (57)	0.89 (0.83–0.96)*
Yunnan	95.3 (492)	0.96 (0.94–0.98)*
Gansu	104.7 (279)	0.96 (0.93–0.99)*
Guizhou	120.1 (600)	0.94 (0.92–0.96)*
Qinghai	139.2 (93)	0.95 (0.90–1.00)*
Xinjiang	161.4 (322)	0.93 (0.91–0.96)*
Tibet	466.9 (149)	0.93 (0.89–0.98)*

* $P \leq 0.05$.

CI, confidence interval; MMR, maternal mortality ratio; RR, relative risk.

^a Within each region, provinces are ranked from lowest to highest maternal mortality in 2000.

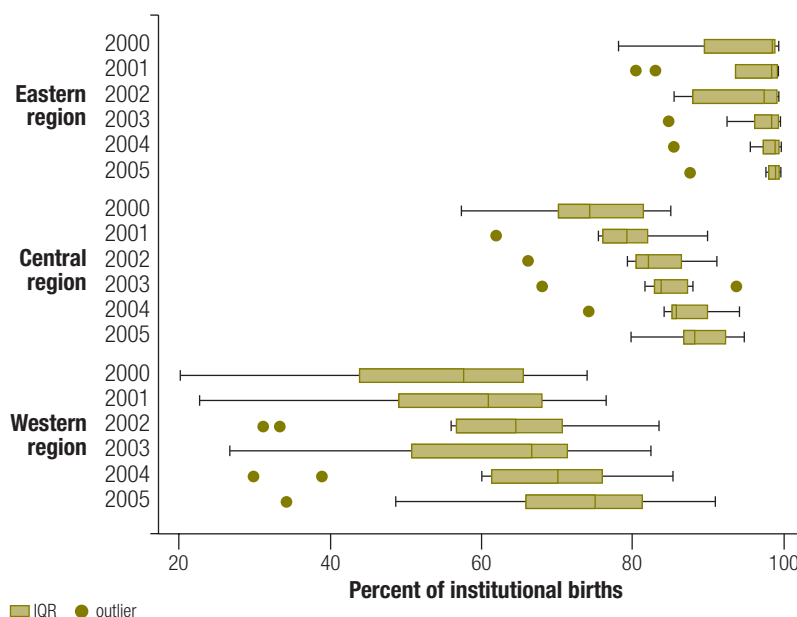
aimed to decrease maternal mortality and eliminate neonatal tetanus.²⁴ Maternal emergency referral systems were strengthened, the quality of services was improved, and targets for increasing institutional birth rates and improving service quality were imposed. Our data show that institutional birth rates have risen substantially, particularly in the western region, where institutional birth rates increased from a median of 58% in 2000 to a median of 74% in 2005. This increase undoubtedly accounts for a large proportion of the observed decrease in mortality. Other factors may also have been important,

including an increase in household income leading in turn to increased affordability and demand for hospital delivery. The role of the one-child policy is difficult to ascertain. It is reasonable to assume that families invest more in care for pregnancy and birth when such events occur only once or twice in their lives. However, the family planning policy is unlikely to explain the trends in maternal mortality during the short period studied here. The crude birth rate did not change between 2000 and 2005, and birth rate was not associated with maternal mortality in our adjusted model.

Even after adjustment for the increase in institutional births, variations in maternal mortality persisted across regions and per capita GDP. The regional differences are particularly notable, since the MMR in the western region remained twice as high as in the eastern region. Women in the western region were more likely to give birth in smaller township hospitals, which may not be sufficiently equipped to deal with obstetric emergencies.^{21,22} When access to institutional birth attendance is low, women may also seek professional care too late for a midwife or doctor to be able to save their lives.²⁵

The improved access to hospital care for birth goes hand in hand with more technical interventions in normal births. The use of antenatal ultrasound scans is common, and the rapidly increasing Caesarean delivery rates reflect, in part, women's increasing preference to give birth by this route.^{15,26,27} The population-based Caesarean delivery rate increased from 6.7% in 1993 to 20.6% in 2003.²⁸ However, the shift towards interventionist births may not be economically sustainable,¹⁵ and Caesarean delivery may cause avoidable morbidity and mortality.²⁹ The government is aware of the increased medicalization of childbirth, but efforts to reverse these trends are clearly needed.³⁰

Fig. 2. Box plot^a of the percentage of institutional births by region and year, China, 2000–2005



IQR, interquartile range.

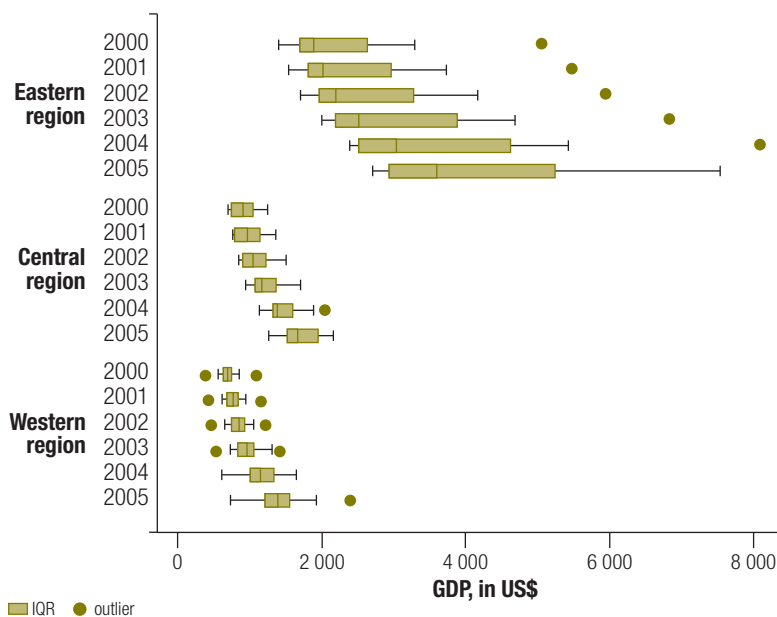
^a Any data which lie more than 1.5-fold the IQR below the first quartile or more than 1.5-fold the IQR above the third quartile are considered outliers.

The consequences of China's health care reform on growing inequities in survival and access to care have received much attention.^{7,13,15} State expenditure as a proportion of total health expenditure has decreased, out-

of-pocket payments have increased, and efforts to revive health insurance programmes have had variable success.^{14,15} Our data do not support the hypothesis that the gap between rich and poor regions has widened. The MMR has declined at a similar rate in all three regions, the absolute difference between regions has become smaller, and provinces with the highest burden of mortality have made the greatest absolute progress. We could not assess mortality in rural and urban areas or for isolated ethnic minorities or migrant populations, but the data from the most remote provinces are certainly encouraging.

A critical assessment of the accuracy of the vital registration data is warranted. Even though the Maternal and Child Routine Reporting System was established in the 1980s, we used data from 2000 onwards because the system was substantially strengthened in 2000 and in later years. The levels of maternal mortality estimated here are remarkably close to those reported by the sample surveillance system.^{6,8,17} This is encouraging, because the latter covers only a small fraction of the Chinese population and the two data sources are unrelated. Our estimate for 2005 falls within the uncertainty limits reported

Fig. 3. Box plot^a of GDP by region and year, China, 2000–2005



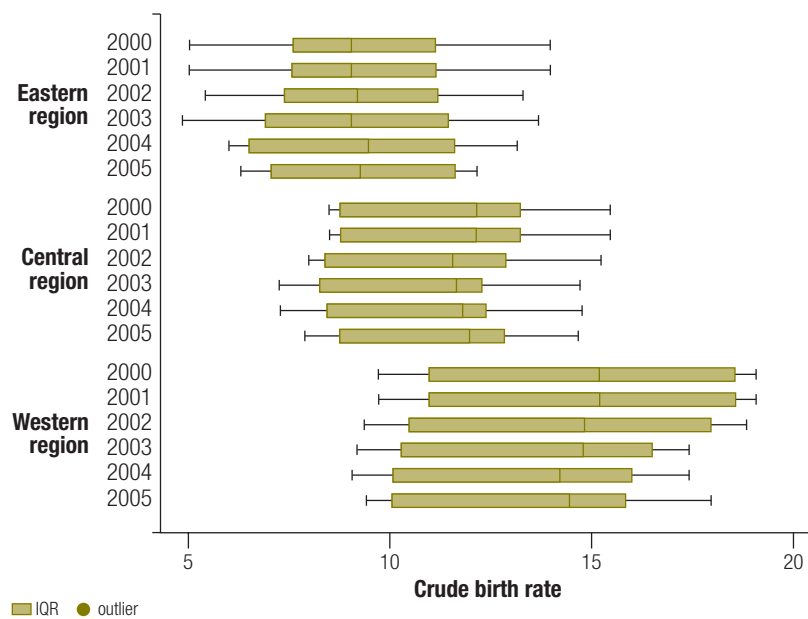
GDP, gross domestic product; IQR, interquartile range; US\$, United States dollars.

^a Any data which lie more than 1.5-fold the IQR below the first quartile or more than 1.5-fold the IQR above the third quartile are considered outliers.

by WHO and others, although our estimate of 4454 deaths is much lower than the 7800 deaths estimated by WHO, the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA) and The World Bank.³¹ The latter estimate is based on data from the sentinel surveillance system, where the reported MMR was accepted as the lower limit of uncertainty, twice the observed value was taken as the upper limit of uncertainty, and the midpoint of the uncertainty range was taken as the point estimate. In other words, estimates by WHO, UNICEF, UNFPA and The World Bank inflated the reported numbers by 50% because of presumed underreporting.

There may be biases in both the denominator (live births) and the numerator (maternal deaths) of the MMR. Many studies have drawn attention to underreporting of births in national vital registration systems and fertility surveys,^{32,33} and the Routine Reporting System used in China is probably no exception. Underreported births tend to be girls or the outcome of pregnancies not approved by the family planning system. For this reason birth rates reported from censuses, routine reports or surveys are generally inflated upwards.^{32–35} The yearly number of births counted through the Routine Reporting System was substantially lower than the number reported by the China Bureau of Statistics.³⁶ This may be partly because the Routine Reporting System records births among women who are officially registered in their locality, so births among migrant women may be underreported. It is also possible that some home births were missed, although the high coverage of births in hospital and the extensive network of community health workers would limit this bias. For maternal deaths the situation is similar: underreporting may occur for deaths in early pregnancy or among migrant women, in areas where institutional birth rates are low, or because of an imperative

Fig. 4. Box plot^a of crude birth rate by region and year, China, 2000–2005



IQR, interquartile range.

^a Any data which lie more than 1.5-fold the IQR below the first quartile or more than 1.5-fold the IQR above the third quartile are considered outliers.

for local officials to perform well and meet targets, although this is impossible to verify.

These potential biases are likely to affect the absolute levels of maternal mortality, but they do not necessarily affect time trends or differences between regions. We did not adjust the birth rates upward because the data for deaths and births were obtained from the same source, and arbitrarily inflating the number of births would have falsely lowered the MMR. The underreporting of births may not vary much with time or by region. However, if maternal deaths are more likely to be missed where institutional birth rates are low, the actual gap between richer and poorer provinces may be greater than what we found, particularly in the earlier years of our study period, when institutional birth rates were lower.

Success stories in maternal health are greatly needed, and the positive lessons learned from China should

give other countries the confidence that progress is possible. The factors that explain this success are multiple, but there is little doubt that a policy of institutional birth within a well-functioning health system has been a major contributor. The main challenge for China's maternal health services is to maintain the gains already made for the majority, while prioritizing resources to the poorest areas. ■

Acknowledgement

We thank Dr Pang Ruyan for helpful comments.

Funding: This study was supported by the Maternal and Child Health Department, Ministry of Health, China. Professor Ronsmans was supported by a Research Fellowships under the 2007/08 United Kingdom/China Fellowships for Excellence programme.

Competing interests: None declared.

Résumé**Tendances au cours du temps et variations régionales de la mortalité maternelle en Chine entre 2000 et 2005**

Objectif Étudier les tendances et les variations de la mortalité maternelle en Chine entre 2000 et 2005.

Méthodes Nous avons fait appel à une régression de Poisson pour analyser les données du système chinois de notification systématique de la santé materno-infantile entre 2000 et 2005 pour déterminer les tendances au cours du temps du taux de mortalité maternelle (TMM) par province et par région.

Résultats Le TMM a baissé en moyenne de 5 % par an (risque relatif brut, RR : 0,95 ; intervalle de confiance à 95 %, IC : 0,94-0,97). Il n'y avait pas d'interaction entre la partie de la Chine et l'année ($p = 0,2311$). La mortalité a diminué de 5 % par an dans

la partie orientale (RR brut : 0,95 ; IC à 95 % : 0,92-0,97), de 5 % par an dans la partie centrale (RR brut : 0,95 ; IC à 95 % : 0,94-0,96) et de 4 % par an dans la partie occidentale de la Chine (RR brut : 0,96 ; IC à 95 % : 0,94-0,98). La différence absolue de mortalité maternelle entre les parties occidentale et orientale est passée de 65,4 décès pour 100 000 naissances vivantes en 2000 à 49,4 décès pour 100 000 naissances vivantes en 2005.

Conclusion La Chine réalise de grands progrès en direction de l'Objectif 5 du Millénaire pour le développement et on ne relève pas d'indice d'un élargissement de l'écart entre les provinces prospères et celles plus défavorisées sur le plan économique.

Resumen**Tendencias temporales y diferencias regionales de la mortalidad materna en China de 2000 a 2005**

Objetivo Estudiar las tendencias y diferencias de la mortalidad materna en China entre 2000 y 2005.

Métodos Usamos el modelo de regresión de Poisson para analizar datos registrados en el Sistema Nacional de Notificación Sistemática de la Salud Materno-infantil de China entre 2000 y 2005, al objeto de detectar tendencias temporales de la razón de mortalidad materna (RMM) por provincias y regiones.

Resultados La RMM cayó por término medio un 5% anual (riesgo relativo bruto, RR: 0,95; intervalo de confianza [IC] del 95%: 0,94-0,97). No se detectó ninguna interacción entre región y año ($p = 0,2311$). La mortalidad disminuyó un 5% anual en la región

oriental (RR bruto: 0,95; IC95%: 0,92-0,97), un 5% anual en la región central (RR bruto: 0,95; IC95%: 0,94-0,96), y un 4% al año en la región occidental (RR bruto: 0,96; IC95%: 0,94-0,98). La diferencia absoluta entre las razones de mortalidad materna de la región occidental y la oriental disminuyó de 65,4 defunciones por 100 000 nacidos vivos en 2000 a 49,4 por 100 000 nacidos vivos en 2005.

Conclusión China está logrando progresos significativos con miras a alcanzar el quinto Objetivo de Desarrollo del Milenio, y no hay indicios de que esté aumentando la brecha entre las provincias más prósperas y las más desfavorecidas económicamente.

ملخص**اختلاف الاتجاهات الزمنية والإقليمية لوفيات الأمهات في الصين من عام 2000 حتى 2005**

الغرض: هو فحص تباين الاتجاهات الزمنية لوفيات الأمهات في الصين بين عامي 2000 و 2005. فاصلة الثقة 95%: 0.92 - 0.97)، وتناقصت بمقدار 5% لكل سنة في المنطقة الوسطى (الاختطار النسبي الخام: 0.95؛ فاصلة الثقة 95%: 0.94 - 0.96)، وتناقصت بمقدار 4% لكل سنة في المنطقة الغربية (الاختطار النسبي الخام: 0.96؛ فاصلة الثقة 95%: 0.94 - 0.98). وتناقص الاختلاف المطلق في معدل وفيات الأمهات بين المنطقة الغربية والمنطقة الشرقية من 65.4 وفاة لكل 100 ألف مولود حي إلى 49.4 لكل 100 ألف مولود حي في عام 2005.

الاستنتاج: تحرز الصين تقدماً جيداً نحو تحقيق المرمى الخامس من المرامي الإنمائية للألفية، ولا يوجد دليل على اتساع الفجوة بين المناطق الأفضل حالا من الناحية الاقتصادية وبين المناطق المحرومة.

الطريقة: استخدم الباحثون تحليل التحوّفات لبواسون Poisson regression لتحليل بيانات نظام التبليغ الروتيني الوطني الصيني الخاص بصحة الأمهات والأطفال بين عامي 2000 و 2005 لتحديد الاتجاهات الزمنية لمعدلات وفيات الأمهات حسب المقاطعات والمناطق.

الموجودات: تناقص معدل وفيات الأمهات بوسطيّ مقداره 5% كل سنة (الاختطار النسبي الخام: 0.95، فاصلة الثقة 95%: 0.94 - 0.97). لم يوجد تأثير متبادل بين المنطقة والسنة (قوة الاحتمال $P = 0.2311$). وتناقصت الوفيات بمقدار 5% لكل سنة في المنطقة الشرقية (الاختطار النسبي الخام:

References

- Sachs JD, McArthur JW. The Millennium Project: a plan for meeting the Millennium Development Goals. *Lancet* 2005; 365:347-53. PMID: 15664232
- Ronsmans C, Graham WJ on behalf of the Lancet Maternal Survival Series Steering Group. Maternal mortality: who, when, where and why. *Lancet* 2006;368:1189-200. PMID:17011946 doi:10.1016/S0140-6736(06)69380-X
- Koblinksky M, Matthews Z, Hussein J, Mavalankar D, Mridha MK, Anwar I, et al. on behalf of The Lancet Maternal Survival Series steering group. Going to scale with professional skilled care. *Lancet* 2006;368:1377-86. PMID:17046470 doi:10.1016/S0140-6736(06)69382-3. Correction in: *Lancet*. 2006 Dec 23;368(9554):2210. Marchal, Bruno [added]; De Brouwere, Vincent [added].
- Filippi V, Ronsmans C, Campbell OM, Graham WJ, Mills A, Borghi J, et al. Maternal health in poor countries: broader context and call for action. *Lancet* 2006;368:1542-5.
- China, Ministry of Health. [National health statistical abstract 2005]. Beijing: Ministry of Health; 2005. Chinese.
- China, Ministry of Health, Maternal and Child Health Department. [Research on maternal and child health strategies. Vol. 1]. Beijing: Ministry of Health; 2006. Chinese.
- Joint review of the maternal and child survival strategy in China. Beijing: United Nations Children's Fund/World Health Organization/United Nations Population Fund; 2006.

8. Zhang LM, Ding H, Chung-Hua Fu Chan Ko Tsa Chih. [Analysis of national maternal death surveillance: 1989-1991]. *[Chin J Obstet Gynecol]* 1994;9:514-7. Chinese.
9. Koblinsky MA, Campbell O, Heichelheim J. Organizing delivery care: what works for Safe Motherhood. *Bull World Health Organ* 1999;77:399-406. PMID:10361757
10. China, Ministry of Health, UNICEF China, National Working Committee of Women and Children. *Safe motherhood in China: progress and prospects of UNICEF supported project*. Beijing: Ministry of Health, UNICEF China, National Working Committee of Women and Children; 2003.
11. Hesketh T, Zhu WX. Health in China: maternal and child health in China. *BMJ* 1997;314:1898-900. PMID:9224139
12. Liu B, Jiang F, Hu SL. [Geographic differences in population health]. *Chin Health Resources* 2006;9:12-4. Chinese.
13. Wang B, Gao YQ. [Socioeconomic inequalities in maternal mortality in China]. *Popul Res* 2007;31:63-74. Chinese.
14. Harris A, Gao Y, Barclay L, Belton S, Yue ZW, Min H, et al. Consequences of birth policies in China. *Reprod Health Matters* 2007;15:114-24. PMID:17938076 doi:10.1016/S0968-8080(07)30315-7
15. Ma S, Sood N. *A comparison of the health systems in China and India* (occasional paper). Pittsburgh, PA : RAND Corporation; 2008.
16. Countdown Coverage Writing Group, on behalf of the Countdown to 2015 core group. Countdown to 2015 for maternal, newborn, and child survival: the 2008 report on tracking coverage of interventions. *Lancet* 2008;371:1247-58. PMID:18406859 doi:10.1016/S0140-6736(08)60559-0
17. Liang J, Li WM, Wang YP, Zhou GX, Wu YQ, Zhu J, Chung-Hua Fu Chan Ko Tsa Chih et al. [Analysis of maternal mortality in China from 1996 to 2000]. *[Chin J Obstet Gynecol]* 2003;38:257-60. Chinese.
18. China, Ministry of Health. *[Manual for the maternal and child health routine reporting system]*. Beijing: Ministry of Health; 2007. Chinese.
19. *International statistical classification of diseases and related health problems, tenth revision*. Geneva: World Health Organization; 1992.
20. StataCorp. Stata Statistical Software, release 10. College Station, TX: StataCorp LP; 2007.
21. National Maternal and Child Health Surveillance Office. *[National maternal and child health surveillance report, 2005]*. Beijing: Ministry of Health; 2006. Chinese.
22. Li XY, Wu ZC, Li CX, Xu L, Gao J, Tang SL. [Structure of delivery place in rural China from 1991 to 2003]. *Primary Health Care* 2005;19:1-3. Chinese.
23. Kaufman J, Fang J. Privatisation of health services and the reproductive health of rural Chinese women. *Reprod Health Matters* 2002;10:108-16. PMID:12557647 doi:10.1016/S0968-8080(02)00090-3
24. Department of Maternal and Child Health and Community Health, Ministry of Health. *[Experience of the programme of decreasing maternal mortality ratios and eliminating newborn tetanus]*. Beijing: Ministry of Health; 2002. Chinese.
25. Ronsmans C, Scott S, Qomariyah SN, Achadi E, Braunholz D, Marshall T, et al. Midwife-led community care and maternal mortality in Indonesia. *Bull World Health Organ* 2009;87:416-23.
26. Sufang G, Padmadas SS, Fengmin Z, Brown JJ, Stones RW. Delivery settings and caesarean section rates in China. *Bull World Health Organ* 2007; 85:755-62. PMID:18038056 doi:10.2471/BLT.06.035808
27. Zhang J, Liu Y, Meikle S, Zheng J, Sun W, Li Z. Caesarean delivery on maternal request in southeast China. *Obstet Gynecol* 2008;111:1077-82. PMID:18448738
28. Li XY, Wu ZC, Wang T, Xu L, Gao J. [Caesarean section rates and their determinants in China]. *Chin J Publ Health* 2006;22:1-2. Chinese.
29. Villar J, Carroli G, Zavaleta N, Donner A, Wojdyla D, Faundes A, et al. World Health Organization 2005 Global Survey on Maternal and Perinatal Health Research Group. Maternal and neonatal individual risks and benefits associated with caesarean delivery: multicentre prospective study. *BMJ* 2007;335:1025-36. PMID:17977819 doi:10.1136/bmj.39363.706956.55
30. Yin CY. [Study on feasibility of decreasing cesarean-section rate in system theory view]. *Chinese Hospitals* 2007;11:28-30. Chinese.
31. *Maternal mortality in 2005: estimates developed by WHO, UNICEF, UNFPA and the World Bank*. Geneva: World Health Organization/United Nations Children's Fund/United Nations Population Fund/The World Bank; 2007.
32. Merli MG, Raftery AE. Are births underreported in rural China? Manipulation of statistical records in response to China's population policies. *Demography* 2000;37:109-26. PMID:10748993 doi:10.2307/2648100
33. Yu XJ. [Estimation of size and structure of the Chinese population in the Fifth National Census]. *Popul Res* 2002;26:9-15. Chinese.
34. Wang JY, He YY, Wang ZC, [Duan CR. Estimation of the total fertility rate in the provinces of China]. *Popul Res* 2004;28:20-8. Chinese.
35. Guo ZG. [Further study on low fertility in China in the 1990s]. *Popul Res* 2004;28:16-24. Chinese.
36. National Bureau of Statistics of China. *China statistical yearbook 2000*. Beijing: China Statistics Press; 2007.