

# Maternal mortality rate in Bao'an district, Shenzhen, China, 1999-2018

yuanfang zhu (✉ [YuanFang\\_Zhu@126.com](mailto:YuanFang_Zhu@126.com))

Bao'an Women's and Children's Hospital <https://orcid.org/0000-0002-4971-005X>

Yali Luo

Bao'an Women's and Children's Hospital

Wei Wang

Bao'an Women's and Children's Hospital

Liling Wang

Bao'an Women's and Children's Hospital

Yuli Cheng

Bao'an Women's and Children's Hospital

Jianmei Li

Bao'an Women's and Children's Hospital

Xu Chen

Bao'an Women's and Children's Hospital

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## Research article

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# Abstract

## Background

China had achieved impressive success in reducing maternal mortality rate (MMR), while substantial heterogeneity still existed, and reports from Shenzhen region remained a blank. This study aiming to use all available data sources to evaluate the MMR from 1999 to 2018 in Bao'an district, Shenzhen, China.

## Methods

Data on maternal deaths and key health-service-related indicators were obtained from registration forms and Shenzhen Maternal and Child Health Management System. The levels and trends of MMR, profiles and leading causes of death, as well as results from the maternal mortality review committee were analyzed.

## Results

The MMR in Bao'an district declined from 95.31 per 100,000 live births in 1999 to zero in 2018, with an annualized rate of decline of 12.03% per year. A significant declining trend of MMR was observed over 5-year intervals (from 82.61 to 5.22 per 100,000 live births). MMR was higher among migrant population, women aged  $\geq 35$  years or those who given birth outside the hospital. The first three causes of maternal death included hemorrhage (27.69%), amniotic fluid embolism (22.31%) and internal medical disease complications (15.38%). Nearly ninety percent (86.78%) of maternal deaths were determined to be preventable.

## Conclusions

Bao'an district had experienced a fast decline in MMR for a two-decade period, its experience in lowering MMR could provide a guideline for other regions to focus on those who needed particular attention and take targeted interventions to reduce maternal deaths.

## Background

Maternal mortality rate (MMR) is an important indicator that reflects a nation's or region's economic development level and maternal and child health care status. Over the past two decades, China has made remarkable progress in reducing MMR. According to Global Burden of Disease (GBD) 2016 Causes of Death Collaborators' report, the national MMR has declined from 111.0 per 100,000 live births in 1990 to 21.8 per 100,000 live births in 2015 [1], and continues to fell to 18.3 per 100,000 live births in 2018 [2]. However, there still exists substantial heterogeneity among different regions because of the great socioeconomic imbalance [3, 4].

Bao'an is accounted for the largest area (396.61 km<sup>2</sup>, 19.86%) among the ten districts in Shenzhen, and presents in the biggest proportion (3.14 million, 25.08%) of Shenzhen's total permanent population at the end of 2017 [5]. Moreover, it is worth mentioning that the overall population in Bao'an are approximately 5.80 million when migrant people are included. It is quite important to estimate precise MMR as public health policymaking should be based on baseline data in local district. Liang *et al* [6] also pointed out that analyses of levels and trends in MMR at the local level would be helpful to summarize the successful experiences and find out what needed to be improved. However, epidemiological studies on maternal deaths from Shenzhen region remains a blank up to now.

In light of the above, the aim of this paper was to use all available data sources to evaluate the MMR from 1999 to 2018 in Bao'an district, Shenzhen, China.

## Methods

### Source of records

Data on maternal deaths and key health-service-related indicators between 1999–2002 were collected manually from original registration forms since regional electronic database had not been established before 2003. Data since 2003 were derived from Shenzhen Maternal and Child Health Management System (SZMCHS), which is a continuously updated maternal and child health care electronic database with an approximate 99.50% geographic coverage.

### Ascertainment of maternal deaths

Maternal deaths were defined as those deaths that occurred during pregnancy or within 42 days of the end of pregnancy and caused by any related complications of pregnancy, childbirth or puerperium (deaths attributable to accident, drug overdose, suicide or homicide were excluded).

In this study, those who met the above criteria and died between 1st January 1999 and 31st December 2018 in Bao'an district were included and their information were processed into tabulated data.

### Definition of relevant term

**Household registry:** According to the Chinese current demographic system and Shenzhen demographic monitoring methods,<sup>5</sup> the household registry had been classified into two types: permanent population for those who 1) achieved permanent residence certificate and 2) lived in Shenzhen for more than one year without permanent residence certificate. Migrant population for those who lived in Shenzhen for less than one year without permanent residence certificate.

### Statistical analysis

MMR was calculated as the number of maternal deaths per 100,000 live births. The levels and trends of MMR, profiles and leading causes of death, as well as results from the maternal mortality review

committee were analyzed. Independent sample  $\chi^2$  tests were performed to compare the status of different subgroups, and the time trends were evaluated by the Cochran-Armitage trend tests.

Epidata 3.0 was applied to set up the database. All statistical analyses were carried out by the SPSS, version 13.0 (Chicago, IL, USA). *P* value < 0.05 was considered as statistically significant.

## Results

### Overall MMR

During 1999–2018, a total of 130 maternal deaths occurred among 689,121 live births in Bao'an district, yielding an overall MMR of 18.86 per 100,000 live births (Table 1). The annual MMR fluctuated from the highest of 123.39 per 100,000 live births in 2000 to the lowest of zero in 2018, with an annualized rate of decline of 12.03% per year (Fig. 1).

Table 1

Maternal mortality rate by sociodemographic characteristics in Bao'an district, Shenzhen, China, 1999–2018

Characteristic	Live births (n)	Maternal deaths (n)	* MMR
<b>Total</b>	689,121	130	18.86
<b>Year (n = 130)</b>			
1999–2003	62,945	52	82.61
2004–2008	147,888	40	27.05
2009–2013	229,298	25	10.90
2014–2018	248,990	13	5.22
<b>† Household registry (n = 130)</b>			
Permanent Population	378,731	32	8.45
Migrant Population	310,390	98	31.57
<b>† Women's age (n = 84)</b>			
< 25	186,496	14	7.51
25-	253,822	15	5.91
30-	147,401	29	19.67
35-	54,597	26	47.62
<b>† Place of delivery (n = 58)</b>			
In hospital	639,473	34	5.32
§ Outside the hospital	3,291	24	729.26
* MMR: Maternal Mortality Rate.			
† Only data between 2003–2018 were included because data of women's age and place of delivery were not available during 1999–2002. Among 84 maternal deaths, 58 had given birth.			
§ Including at home (15 cases), in illegal clinic (eight cases) and on the way to hospital (one case).			

## Time Trends of MMR

The MMR in Bao'an district had remained stubbornly high before 2003, declined substantially between 2003–2008 (though with bounced back in some years), and declined continuously until 2018. A significant declining trend of MMR was shown when 5-year intervals were used as a cut-off, with 5.22 per

100,000 live births during 2014–2018 being 93.68% lower than 82.61 per 100,000 live births during 1999–2003, with significant difference ( $\chi^2=173.15$ ,  $P < 0.01$ ).

By contrast, one key indicator that reflected the maternal health care quality-maternal systematic management rate had stalled during 2002–2008, but began to rise rapidly from 24.63% in 2009 to 91.68% in 2018 (Fig. 1).

## **Subgroup analysis of MMR**

The MMR for migrant population (31.57 per 100,000 live births) was 3.74 times as high as of the permanent population (8.45 per 100,000 live births). Also of particular note was that the MMR was highest among women aged  $\geq 35$  years (47.62 per 100,000 live births) and those who given birth outside the hospital (729.26 per 100,000 live births) when compared to other subgroups.

## **Profile of maternal death**

As listed in Table 2, more migrant population (75.51%) were reported to be unintended pregnancy as compared to permanent population (53.13%,  $P = 0.03$ ). Place of delivery (51.52% vs. 20.00%,  $P = 0.01$ ) and death (28.57% vs. 9.37%,  $P = 0.03$ ) were also more occurred outside the hospital among migrant population.

Table 2

Comparisons between different household registry and delivery place among maternal deaths in Bao'an district, Shenzhen, China, 1999–2018

Factors	Household Registry		* Place of Delivery	
	Permanent (n = 32,%)	Migrant (n = 98,%)	In hospital (n = 43,%)	† Outside the Hospital (n = 38,%)
<b>§ Intended pregnancy</b>				
Yes	13 (40.63)	22 (22.45)	16 (37.21)	8 (21.05)
No	17 (53.13)	74 (75.51)	25 (58.14)	30 (78.95)
Unknown	2 (6.24)	2 (2.04)	2 (4.65)	0 (0.00)
<b>Timing of death</b>				
During pregnancy	12 (37.50)	27 (27.55)	1 (2.33)	0 (0.00)
On the day of delivery	11 (34.38)	48 (48.98)	20 (46.51)	32 (84.21)
1–42 days postpartum	9 (28.13)	23 (23.47)	22 (51.16)	6 (15.79)
<b>Place of death</b>				
In hospital	29 (90.63)	70 (71.43)	42 (97.67)	18 (47.37)
Outside the hospital	3 (9.37)	28 (28.57)	1 (2.33)	20 (52.63)
<b>Year</b>				
1999–2008	11 (34.38)	81 (82.65)	20 (46.51)	33 (86.84)
2009–2018	21 (65.62)	17 (17.35)	23 (53.49)	5 (13.16)
<b>Result of the review committee</b>				
Preventable death	19 (59.38)	86 (87.76)	31 (72.09)	38 (100.00)
Inevitable death	11 (34.37)	5 (5.10)	12 (27.91)	0 (0.00)
Unknown	2 (6.25)	7 (7.14)	0 (0.00)	0 (0.00)
<b>Place of delivery</b>				
In hospital	16 (80.00)	27 (40.91)	/	/

\* Among 130 maternal deaths, 86 had given birth, and five were excluded because the delivery place could not be identified.

† Including at home (25 cases), in illegal clinic (11 cases) and on the way to hospital (two cases).

§ Self-reported that this pregnancy was timely arranged and in expectation.

Factors	Household Registry		* Place of Delivery	
	Permanent (n = 32,%)	Migrant (n = 98,%)	In hospital (n = 43,%)	† Outside the Hospital (n = 38,%)
Outside the hospital	4 (20.00)	34 (51.52)	/	/
<b>Household registry</b>				
Permanent	/	/	16 (37.21)	4 (10.53)
Migrant	/	/	27 (62.79)	34 (89.47)
* Among 130 maternal deaths, 86 had given birth, and five were excluded because the delivery place could not be identified.				
† Including at home (25 cases), in illegal clinic (11 cases) and on the way to hospital (two cases).				
§ Self-reported that this pregnancy was timely arranged and in expectation.				

On the other hand, when divided the deaths into two groups based on the delivery place, those who were not in-hospital delivered were more likely to die on the day of delivery (84.21% vs. 46.51%,  $P < 0.01$ ) and outside the hospital (52.63% vs. 2.33%,  $P < 0.01$ ). Besides, a predominance of migrant population (89.47%) was also noted in this subgroup, while this percentage was only 62.79% in the group of in-hospital delivering.

Another noticeable change being seen was the proportion of maternal deaths among those who delivered outside the hospital had been significantly decreased from 86.64% in 1999–2008 to 13.16% in 2009–2018.

## Cause of maternal death

The first three causes of maternal death included hemorrhage (36 cases, 27.69%), amniotic fluid embolism (29 cases, 22.31%) and internal medical disease complications (20 cases, 15.38%), and varied by the timing of death (Table 3).

Table 3  
Cause and time of maternal deaths in Bao'an district, Shenzhen, China, 1999–2018

* Cause of death	During pregnancy	Day of delivery	1–42 days postpartum	Total
† Hemorrhage	§ <sup>1</sup> 3 (33.33)	21 (35.60)	2 (6.24)	36 (27.69)
Amniotic fluid embolism	0 (0.00)	<b>25 (42.37)</b>	4 (12.50)	29 (22.31)
Internal medical disease complications	8 (20.51)	5 (8.47)	<b>7 (21.88)</b>	20 (15.38)
Hypertensive disorder of pregnancy	6 (15.38)	5 (8.47)	5 (15.63)	16 (12.31)
Puerperal infection	0 (0.00)	1 (1.69)	5 (15.63)	6 (4.61)
Pneumonia	2 (5.13)	0 (0.00)	3 (9.38)	5 (3.85)
Others	10 (25.65)	2 (3.40)	6 (18.74)	18 (13.85)
<b>Total</b>	39 (100.00)	59 (100.00)	32 (100.00)	<b>130 (100.00)</b>
* Cause of death categories were mutually exclusive.				
† Mainly included postpartum uterine inertia (11 cases, 8.46%), ectopic gestation (seven cases, 5.38%) and hysterorrhexis (six cases, 4.62%).				
§ No. (%) attributed to each cause (column %).				

## Result from the maternal mortality review committee

A number of 121 deaths (92.31%) were assessed by the maternal mortality review committee. Among these, 105 (86.78%) were determined to be preventable deaths. Preventability was of great statistical differences between subgroups (Table 2), it was worth mentioning that all deaths that delivered outside the hospital were determined to be preventable.

## Discussion

The number of maternal deaths in Bao'an district had been pushed down to zero in 2018, and still remained as of today, which had in advance met the Sustainable Development Goals (SDGs) target level of pushing MMR down to 70 per 100,000 live births before 2030 [7]. The mean annual reduction rate of MMR (12.03%) was much faster than the target pace in Millennium Development Goal (MDG) 5 of 5.5% per year.<sup>7</sup> Substantial variation in MMR and profile of maternal death across different subgroups were also found in this paper. Migrant or out-of-hospital delivery people had a higher MMR, but a greater proportion of being determined as preventable death. This report provides the first estimate of the levels and trends of MMR at the district level over a 20-year period, and its breakthrough in reducing maternal deaths might provide a case study for other regions.

The rapid reduction of MMR in Bao'an district might be an excellent reflection of the implementation effects of the quaternary maternal health service network with fully regional coverage, namely: community health service centers as net bottom, primary hospitals with midwifery qualification as foundation, local maternal and child health hospital as core, and higher level of medical institutions as technical support, among which Bao'an Women's and Children's Hospital was in charge of integrated managements for nearly 50,000 parturients within the jurisdiction every year. Health service providers at all levels had devoted substantial efforts to providing systematic and high-quality prenatal, delivery and postpartum care, and the rate of maternal systematic management in this way rapidly increased in the latest decade, as follows:

First prenatal examination was provided and maternal health file was established by all hospitals, those who were graded for high risk (e.g., with severe complications) were referral to subspecialty clinics for specially-assigned management and follow-up. A green channel service was developed for obstetric emergencies at all hospitals and two obstetric emergency centers were set up to ensure critically ill pregnant women were rescued in time. On the other side, consulting services through pregnancy schools or midwife clinics were actively promoted to improve maternal health education. With respect to delivery management, first-aid training was carried out extensively to strengthen support and supervision of obstetric rescue capacity, particularly in private hospitals. For instance, skill competition for the rescue of amniotic fluid embolism was held annually as this was the first cause of death during delivery in Bao'an district. In addition, Bao'an district had taken the lead in implementing labor analgesia since 2008 to lower the rate of cesarean section, which could also partly contribute to the reduction of maternal mortality as cesarean delivery was associated with increased risk of death [8]. After delivery, two free door-to-door postnatal visit services (within two weeks postpartum) were timely arranged by health staff from community health service centers, to provide postpartum rehabilitation guidance as well as depression screening for safeguarding maternal physical and psychological health.

Beyond that, since the reform and opening-up, a large unregistered migrant population had rushed into Shenzhen to take better-paid work away from their rural villages. Generally, they were characterized by low educational level, poorly paid, and unwilling to seek health care knowledge and service [9]. Besides, with the still prevailing traditional concept of "more children, more blessing", many families would rather take risks to give excess births regardless of the national one-child family planning policy. Therefore, many families chose to delivery at home or in the illegal underground clinic in the past years for saving money and avoiding substantial fined. A previous study [10] had pointed out that low percentages of in-hospital delivery rate might contribute to the high maternal mortality rate, which our data was in line with.

To improve this situation, Bao'an district had taken the lead in implementing delivery assistance mechanism for impoverished pregnancy women in 2000, and two supporting measures from the local Reducing Maternal Mortality and Eliminating Neonatal Tetanus Programme (also known as the "Reducing & Eliminating" Programme) had been carried out since 2005: 1) developed a poverty alleviation channel for impoverished pregnant women to ensure certain fee waiver not only in prenatal examination and in-hospital delivery but also in emergency rescue. And 2) carried out special actions to crack down on illegal

medical practices and birth delivering. Great improvements had been achieved since the in-hospital delivery rate had increased from 98.96% in 2002 to 99.82% in 2018, and the proportion of maternal deaths among out-of-hospital delivery had been significantly decreased in the most recent decade.

In the same period, the maternal health workforce in Bao'an district had been developed rapidly, the numbers of well educated and highly trained obstetrician and midwife per 1000 lying-in women were 7.76 and 5.69 in 2018, with an annualized rate of increase of 6.74% and 3.99% since 2007, respectively (**Supplemental Table**). In short, the quaternary maternal health services network along with the "Reducing & Eliminating" Programme, and the constant improvements in access to maternal health-care resources and services, might all have contributed to the fast decline in MMR in Bao'an district.

More importantly, aiming to identify the most appropriate interventions to reduce maternal death, Bao'an district had established the maternal mortality review committees in 2000. Every death case was reviewed by a multidisciplinary expert team through three links (individual, family and community, health care institutions, other social departments such as transportation, education) and four aspects (knowledge and skill, attitude, resource and management). Nearly ninety percent of maternal deaths were determined to be preventable during the past two decades, and the preventability differed greatly between subgroups, indicating that multiple factors involving maternal death should be concerned, such as improving migrant women's self-health care consciousness and reducing social inequities.

Yet it should not be ignored that, the high maternal mortality rate among women aged  $\geq 35$  years still reminded us the new risk of maternal and child safety in the coming decade and much remains to be done. Since the national family planning policy had been adjusted from January 1st, 2016 [11], the newly "universal two-child" policy and the transition of fertility concept had brought severe challenges to reduce maternal deaths, as the proportion of pregnant women aged  $\geq 35$  years, who were at higher risk of maternal mortality [12], had been continuously increased from 12.13% in 2016 to 17.06% in the first half-year of 2019 in Bao'an district (data from SZMCHS).

Several limitations of this analysis needed to be mentioned. First, due to the large time span and the imperfect data collection mechanism in the early years, information on the maternal deaths were not collected in a consistent form, resulting in some missing indicators which were of great analytical value. Second, descriptions about demographic characteristics of maternal deaths were limited, largely due to the natural deficiency of SZMCHS. As described previously [13], data in SZMCHS were primarily used for administrative reports rather than researches. Last but not least, it was more meaningful to classify the out-of-hospital delivery location instead of using the rough word-"delivering outside the hospital". Nevertheless, with limited sample sizes, it was unable to conduct further grouping considering the stability of statistical efficiency. The aforementioned flaws all pointed out the importance and necessity of enhanced data collection and updated system for recording detailed information on every death case.

In summary, Bao'an district had experienced a fast decline in MMR for a two-decade period, its experience in lowering MMR could provide a guideline for other regions to focus on those who needed particular attention and take targeted interventions to reduce maternal deaths.

# Declarations

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## Authors' contributions

YF Zhu conceived the study and provided overall guidance; YL Luo and W Wang conducted the study, collected the data and wrote the manuscript; LL Wang, YL Cheng and JM Li did the analysis; X Chen reviewed each section of estimation in detail.

## Ethical approval

The study protocol was approved by the Institutional Review Board of Bao'an Women's and Children's Hospital. The data files obtained for this study contained no personal identifiers.

## Consent for publication

Not applicable.

## Availability of data and material

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

## Competing interests

The authors declared no conflict of interest.

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## Figures

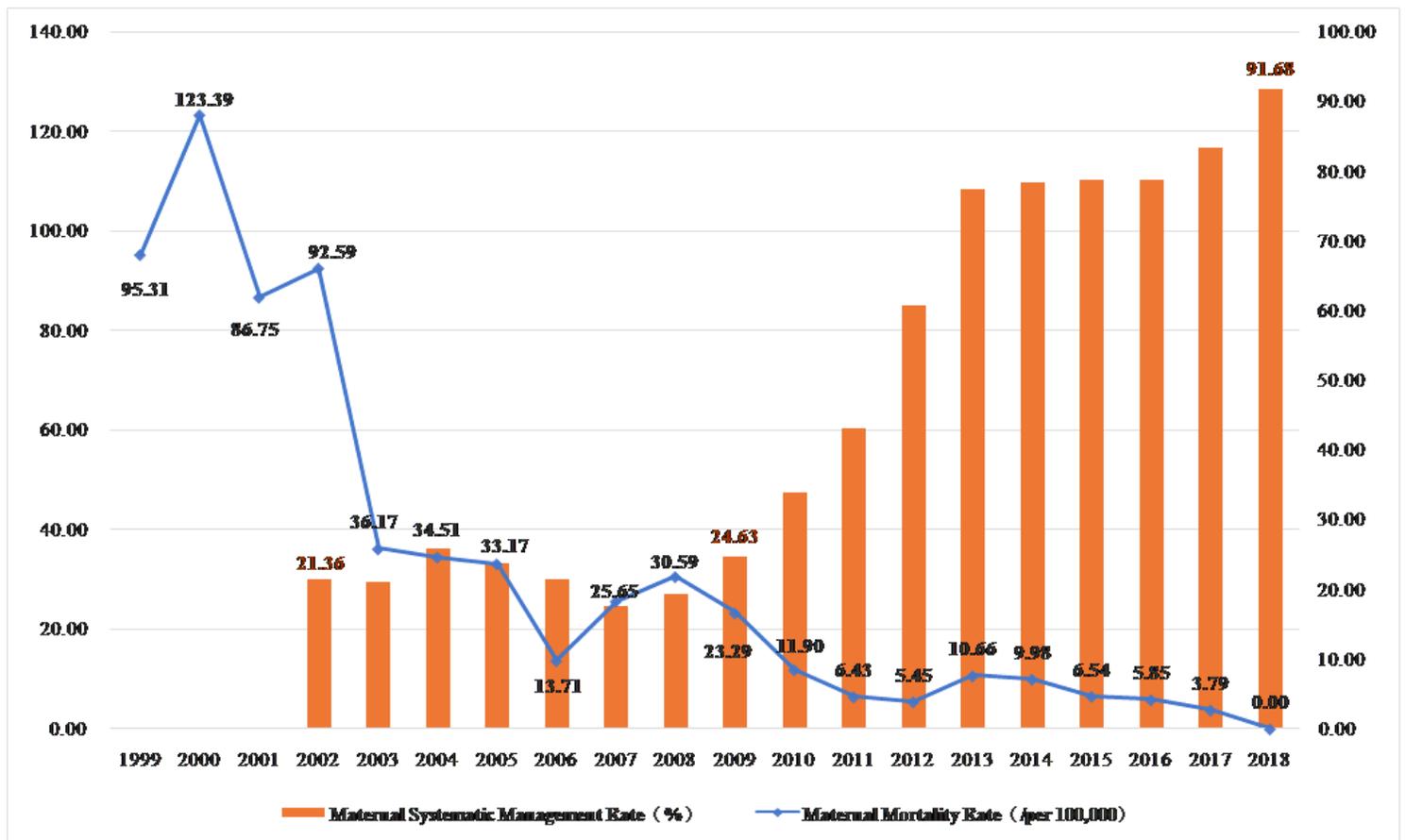


Figure 1

Maternal mortality rate and maternal systematic management rate in Bao'an district, Shenzhen, China, 1999-2018

## Supplementary Files

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- [5.SupplementalTable.doc](#)