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Study on accidental death of pregnant and lying-in women from 2009 to 2019

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Fanjuan Kong drafted the initial manuscript, and reviewed and revised the manuscript.
Aihua Wang, Jian He, Lili Xiong, Donghua Xie, and Jinping Su designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript.
Zhiyu Liu and Xiaoqi Sheng conceptualized and designed the study, coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.
All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Abstract

Objective: We collected data on the incidence of accidental deaths associated with pregnancy and 42 days after delivery from 2009 to 2019, including the heterogeneity of sociodemographic factors.

Study Design: This population-based retrospective cohort study tracked all pregnant women who became pregnant in Hunan Province between 2009 and 2019 to determine maternal mortality.

Results: A total of 239 accidental deaths occurred in Hunan Province, with an accident mortality rate of 2.8/100,000. The accident mortality rate in rural areas (3.2/100,000) was greater than that in urban areas (2.0/100,000), and the difference was statistically significant. The proportion of accidental deaths among pregnancy-related deaths showed an upward trend. The main types of accidental death were suicide (1.0/100,000); traffic accidents (0.8/100,000); accidental poisoning/overdose, assault/homicide (0.2/100,000); and other accidents (0.6/100,000). The proportions of accidental deaths at home, in medical institutions and on the way to medical institutions were 34.3%, 28.9% and 20.1%, respectively.

Conclusion: In response to the different causes of accidental maternal death, public health programs and policy interventions should pay special attention to maternal suicide and traffic injuries.

Key words: accidental death; maternal mortality; injury

Strengths and limitations of this study

1. In China, there are few reports about accidental maternal death, and this study fills this gap.
2. The number of accidental deaths among pregnant women is on the rise. In this study, the death situation and the changing trend of death causes of this population were investigated and analyzed.
3. The sample of the study includes all cases of accidental maternal deaths from 2009 to 2019, which is representative and persuasive.
4. However, this study does not further analyze what causes the accident.
Maternal mortality rates (MMRS) are an important index of not only the social, economic and cultural development of a country or region but also maternal and infant safety[1]. Maternal mortality in some developed countries showed decreases in 2015 [2]: 4/100,000 in Italy, 5/100,000 in Japan, 8/100,000 in France, 9/100,000 in the United Kingdom and 14/100,000 in the United States. With the implementation of the maternal and infant safety plan, the advocacy of eugenics, the continued implementation of the hospital delivery subsidy system, and the provision of free basic medical and health care services for pregnant and lying-in women during the whole childbearing process, the maternal mortality rate in China[3] has dropped from 88.8/100,000 in 1990 to 17.8/100,000 in 2019, a decrease of 80.0%.

According to the requirements of the World Health Organization [4] and the China Maternal Mortality Monitoring Program [5], maternal mortality monitoring refers to women during pregnancy or within 42 days after pregnancy termination, excluding deaths caused by accidental or accidental causes (such as car accidents, poisoning, etc.). In China, there are almost no reports of injury maternal deaths in the literature. Maternal mortality, whether due to homicide, suicide or pregnancy-related causes, is equally tragic, may be preventable and deserves national attention [6]. The outline of the Healthy China 2030 Plan issued by the CPC Central Committee and the State Council [7] calls for the establishment of a comprehensive injury monitoring system, the development of technical guidelines and standards for key injury intervention, and the prevention and reduction of suicide and accidental poisoning.

An issue of concern in China and the rest of the world is the study of the changing rules governing maternal mortality and causes of death and the proposal of targeted interventions to effectively reduce maternal mortality. Accidental deaths are underestimated or excluded from maternal mortality reports but have a significant impact on the ability of policymakers to understand potential social and family situations. Many countries have carried out targeted research on accidental maternal deaths. In Colorado[8], USA, self-injury (suicide and overdose) is the most common cause of pregnancy-related death, and most deaths occur during the postpartum period. In NSW[9], Australia, trauma, including suicides, accidental injuries, motor traffic accidents, and homicides, accounts for 73% of all maternal deaths (early and late) annually. In Ontario[10], Canada, more than 60% of maternal injury-related deaths were from self-harm, poisoning/overdose, and homicide.
Through the maternal death reporting system in our province it was found that the number of accidental deaths among pregnant women is increasing, which is a group that has not been fully studied. To more fully grasp the current situation of accidental maternal death in our province and to ensure the safety of mothers and infants, it is necessary to investigate and analyze the death situation and the changing trends in causes of death in this segment of the population.

Data and Methods

Data sources

Hunan Province is located in southeastern China, with an area of 21.18 square kilometers and a population of 73 million. Since 1990, it has been included in the maternal and child health surveillance system. The death surveillance data of this study is the maternal and child health surveillance system of Hunan Province, which is based on the national maternal and child health surveillance system and includes all pregnant and lying-in women in 123 counties (cities) of Hunan Province. The project was approved by the Medical Ethics Committee of Hunan Maternal and Child Health Hospital.

The maternal and child health surveillance system follows strict data collection, reporting, audit and quality control procedures and helps to reduce the risk of underreporting. The monitoring data include information on the main cause of death, date, place of death, sex and age. The root causes of death were classified according to the World Health Organization International Classification of Diseases (ICD-10 10th Edition) [11]. Pregnant women who die as a result of accidents are listed by injury subtypes [12]: intentional self-harm; transport accident; accidental poisoning/overdose; assault/homicide; or others.

Data collection method

During the period from January 1, 2009, to December 31, 2019, all pregnant women who died within 42 days from the beginning of pregnancy to the termination of pregnancy were monitored. All pregnancies, live births and maternal deaths were identified by trained certified professionals.

(1) After receiving the report of maternal death, the county-level maternal and child health institutions immediately reported to the local health administrative department and to the municipal and state-level maternal and child health institutions within 24 hours. Within 3 days after the occurrence of maternal death, special personnel, as well as township and village-level maternal and child doctors, midwives or individual practitioners, are organized to investigate the
woman’s medical history related to her death. Investigate and understand the medical history related to death, including pregnancy, delivery, postpartum, morbidity and death, and ask the deceased's past medical history. If the maternal death occurs at home and there is no health care worker present, the relevant informed personnel should enter the home to investigate the death process and medical history. Then fill in the death report card and write a summary of the medical record or a summary of the death investigation. Copy the original medical records of the death.

(2) The district, city and provincial levels respectively organize maternal death evaluation to determine the root cause of death, and one death evaluation occurs. After the provincial evaluation, the evaluation conclusions are filled in the death report card. After the completion of the review work at all levels, the network direct reporting of the respective evaluation results shall be completed.

Data quality control

These data were collected and reported by experienced doctors and were checked for quality and accuracy at the county level by women's health institutions and individuals. The community health service center conducts quality inspections for service stations/neighborhood committees and township health centers in villages using the monthly meeting system. The district, county, city and state organize a comprehensive quality inspection every quarter. The city and state conduct quality inspection and evaluation at least half a year. The provincial level monitors quality inspection and provides two reviews of monitoring districts and counties every year. The districts and counties that do not meet the requirements will undergo a comprehensive leak investigation. Death data must be checked with lists from civil affairs, public security, disease control and other entities to prevent underreporting and misreporting.

Statistical analysis

Statistical data were exported to Microsoft Excel 2010. SPSS 24.0 was used to analyze the ratios and proportions. The chi-square test was used to compare the differences in accident mortality between rural and urban areas. The Cochran-Armitage time trend test of mortality over time was carried out with SAS software. $P < 0.05$ was regarded as the level of statistical significance.

Results

Mortality trends related to accidental maternal deaths

From 2009 to 2019, a total of 8,574,584 live births were monitored in our province, including
1957 pregnancy-related maternal deaths, 1718 maternal deaths and 239 accidental deaths. The pregnancy-related mortality, maternal mortality and accident mortality in our province were 22.6 ±5.5/100,000, 19.8 ±5.3/100,000 and 2.8 ±0.7/100,000, respectively. The proportion of accidental deaths among pregnancy-related deaths is on the rise, accounting for an increase of 75.11% from 2009 to 2019 (see Table 1).

**Classification of causes of accidental death**

Intentional self-harm accounted for 35.6% of accidental deaths (including 25 cases of taking drugs/pesticides, 16 cases of jumping from buildings, 30 cases of drowning, 4 cases of hanging oneself and 10 cases of other causes), with a mortality rate of 1.0/100,000. Transportation accidents accounted for 30.1% (N=72) of accidental deaths, with a mortality rate of 0.8/100,000. Accidental poisoning/overdose accounted for 7.9% (including 17 cases of CO poisoning and 2 other cases), with a mortality rate of 0.2/100,000. Assault/homicide accounted for 5.4% of accidental deaths, with a mortality rate of 0.2 per 100,000, while other accidents accounted for 20.9% (N=50), with a mortality rate of 0.6 per 100,000. See Table 2 for details.

**Classification of accidental deaths and comparison**

The accident mortality rate in rural areas was higher than that in urban areas, and the difference was statistically significant ($P < 0.05$). The types of accidental maternal deaths differed between urban and rural areas. Among them, the mortality rates of intentional self-harm, ingestion of poisons/pesticides and traffic accidents in rural areas were higher than those in urban areas ($P < 0.05$). See Table 3 and 4 for details.

**Epidemiological study on the accidental deaths of pregnant and lying-in women**

(1) Age distribution: the ages of the pregnant women experiencing accidental death in the province were between 16 and 45 years old, with the largest number of deaths (36.8%) occurring among women between 25 and 29 years old, followed by women between 30 and 34 years old (22.6%). The proportion of accidental deaths among pregnant women of advanced age ($\geq$ 35 years old) was more than 10%.

(2) Economic level: 28.9% of accidental maternal deaths occurred in families with a per capita income of more than 8000 yuan, and 58.6% of accidental maternal deaths occurred in families with an income of less than 8000 yuan. Accidental maternal deaths were mainly concentrated in low-income families.

(3) Household registration distribution: maternal deaths are mainly concentrated in rural areas, reaching 74.9%.
(4) Pregnancy and childbirth: pregnant women with one pregnancy accounted for 32.6% of maternal deaths, and pregnant women with two pregnancies accounted for 36.4% of maternal deaths. The proportion of maternal deaths among primary parturients is 33.5%, and that among multiparous women is 56.5%.

(5) Education level: the education level of women experiencing accidental death was generally low: 50.2% with a junior high school education, 9.6% with an education level of college and above, and 16.7% with a primary school and illiterate background.

(6) Delivery: 74.5% of pregnant women experiencing accidental death did not give birth, and 25.5% of these women did give birth. Of the pregnant women experiencing accidental death, 37.7% delivered in provincial, prefectural and municipal hospitals; 9.8% delivered in hospitals; 49.2% delivered by cesarean section; and 39.3% gave birth naturally. A total of 9.8% of the pregnant women who had delivered had less than 5 antenatal examinations, and 73.8% of them had more than 5 antenatal examinations.

(7) Place of death: deaths occurring at home, in the hospital and on the way to the hospital accounted for 34.3%, 28.9% and 20.1%, respectively, of all accidental maternal deaths. A total of 51.5% of the deaths were diagnosed on a clinical basis, and 44.4% were inferred.

The sociodemographic characteristics of the women experiencing maternal death from accidents and suicides are summarized in Table 5.

Discussion

Concepts related to maternal mortality

According to the International Classification of Diseases (ICD-10) [13], the relevant definition of maternal mortality involved in this study is as follows: (1) Maternal death refers to the death of a woman during pregnancy or within 42 days after pregnancy termination, regardless of the time and location of pregnancy, due to any cause related to population management or aggravated by pregnancy, but does not include deaths caused by accidents or emergencies; (2) pregnancy-related death refers to the death of a woman during pregnancy or 42 days after pregnancy termination, regardless of the cause of death; and (3) accident refers to the death of a woman during pregnancy or puerperium that is caused by an accident not related to obstetrics.

The trend of accidental deaths of pregnant and lying-in women

By 2019, the maternal mortality rate in Hunan Province continued to decline. According to the narrow definition provided by the World Health Organization (WHO), the maternal mortality rate in 2019 was 9.5/100,000, which is already a low level. Although the accident mortality rate
shows a fluctuating downward trend, the proportion of accidental deaths in pregnancy-related
deaths increased from 10.17% in 2009 to 17.81% in 2019, reflecting an increase of 75.11%. Many
years ago, most women died of complications caused by pregnancy and childbirth, such as
bleeding, infection, and pregnancy-induced hypertension, but maternal mortality is often
associated with factors that are not directly related to pregnancy and childbirth [14]. The
possibility of accidental or intentional injury causing major trauma during pregnancy is
increasingly considered to be a major contributor to maternal and infant morbidity and mortality
[15-16]. Since more than half of all maternal deaths are considered preventable, public health
interventions have the potential to improve maternal health and other pregnancy outcomes [17].
However, there are few articles on accidental deaths in the world, all of which are scattered studies
on poisoning, suicide and other issues. There are no specific data to show the developmental trend
of accidental death and the situation of accidental death throughout pregnancy. Therefore, this
article will be an important supplement to basic information on accidental death.

Differences in accidental maternal mortality between urban and rural areas

In this study, the accident mortality rate in rural areas was higher than that in urban areas (P
<0.05). In particular, maternal self-mutilation mortality, traffic accident mortality and
poison/pesticide mortality in rural areas were higher than those in urban areas (P <0.05). This is
consistent with the trend that the maternal mortality rate in rural areas of China[18] was higher
than that in urban areas in the same period. The possible explanation is that crop drugs, which are
widely used in rural areas, make it easier for people to commit suicide. The educational level of
rural women is generally not high, and they tend to go to extremes after conflicts with their
families and neighbors. The large number of open rivers in rural areas also increase environmental
insecurity. In addition, complex roads and poor infrastructure in rural areas and poor rural health
care systems [19] also increase the risk of death from injuries.

Demographic characteristics

The level of education obtained is an important indicator of early living conditions [20], and
it may play a role in other variables in adulthood as a precausal effect. Some studies[21] have
found that the level of education of a pregnant woman reflects her social status and is inversely
proportional to maternal death; that is, the lower the level of maternal education, the less health
care knowledge a woman has, the deeper the influence of old customs is [22], and the higher the
mortality is. In this study, the education level of pregnant women who had accidental deaths was
generally on the low side, with the highest proportion of women with a junior high school
education (50.2%) and a primary school and illiterate background (16.7%). Economic
characteristics are an important factor affecting maternal mortality. The practice of reducing
maternal mortality in China shows that poverty is an important factor affecting maternal mortality
[23]. In this study, 58.6% of families experiencing accidental death had a per capita annual income
of less than 8000 yuan; thus, accidental deaths were more concentrated in low-income families.

In 2000, more than 67% of women experiencing maternal deaths in China had fewer than
five antenatal check-ups or no antenatal check-ups. By 2013, the proportion had declined but
remained as high as 50% [24]. In this study, 74.48% of the pregnant women who had accidental
deaths underwent antenatal examination in the early stage of pregnancy. Among the parturients
who had given birth, 73.8% had undergone more than five antenatal examinations. Unfortunately,
we have not fully collected data on the 74.5% of pregnant women who died unexpectedly without
giving birth. In the next step, we will continue to improve data collection to provide more
convincing prenatal examination data.

A total of 74.5% of accidental deaths in this study occurred prenatally, but in Colorado [8],
nearly 90% of self-harm deaths occurred during postpartum, with most of these women suffering
from substance abuse and mental disorders. In NSW (2000-2006) [9], 67% of deceased pregnant
women had mental health diagnoses and/or mental health problems related to drug abuse. Among
Australian [25] women who gave birth, the proportion diagnosed with postpartum depression
ranged from 10% to 20%. In this study, we did not collect data on maternal mental and drug abuse,
so the data cannot be compared directly, but it also suggests that we should strengthen the
screening of and interventions for maternal emotional and mental health in a later study.

The major types of accidental deaths

Taking poison, hanging oneself, jumping into a river and electrocution are the main ways for
rural residents to commit suicide [26]. In addition to mental illness and psychological distress, the
causes of suicide are very complex, including the collapse of social order, the disintegration of
families, the misfortune of marriage, financial constraints, domestic violence, despair in serious
illness and other factors [27]. Another risk factor is the universal accessibility of pesticides.
According to the report "Suicide and Suicide Prevention in Asia" [28], the most common suicide
tool used by farmers in China is pesticides, which are used in 62 out of every 100 suicides. In this
study, the top three methods of suicide in rural areas were ingesting poisons, falling from
buildings and drowning oneself in water. Similar to the situation in China, suicide is also a
common cause of death among young people in the community abroad and is related to alcohol
and drug abuse [8, 29-30].

Motor vehicle accidents are the leading cause of maternal mortality related to injury [31-32].
China [33-34] has the largest number of road traffic fatalities in the world (26,367 as of 2013;
World Health Organization (WHO) 2015). In this study, 30.1% of pregnant women died in traffic accidents, which is the second-leading cause of death. China's rural areas have complex topography, a lack of road safety measures, an increasing number of vehicles, and drivers with weak traffic awareness, all of which can easily lead to all kinds of traffic accidents. Abiding by traffic rules has always formed the basis of road safety education in our country. The use of seat belts can reduce the risk of adverse maternal and fetal outcomes [35].

There were 19 cases of accidental poisoning in this study, of which 17 cases were CO poisoning, most by natural gas in the bath; some poisonings occurred in rural areas and were caused by poor ventilation due to carbon heating in winter and the tight closing of doors and windows. Other accidental deaths include house collapses caused by landslides, deaths caused by fires, bee venom, accidental falls, and so on.

**Limitations**

Considering some limitations, our research results should be interpreted carefully. First of all, accident-related causes of death depend on the memories of family members, which may be biased. However, after the data quality control at the provincial, municipal and county levels and the review of the death cases with the public security and civil affairs departments, the data quality and reliability are acceptable. Second, there is no data collected on the details of the family background or the urban and rural environment.

**Conclusion**

From 2009 to 2019, the proportion of accidental deaths in pregnancy-related deaths showed an upward trend, and the differences between urban and rural areas still exist. This proportion in rural areas is higher than that in urban areas, which is related to the underdevelopment of social economy in rural areas. Self-harm and traffic accidents are still the main causes of accidental maternal death, such as pesticides, jumping from buildings and falling into the river are the main ways of maternal self-harm. Therefore, accidental maternal mortality is still a public health problem that has not been deeply studied. Safety education and infrastructure should be strengthened to reduce accident-related deaths, and these policies and programmes should target more vulnerable populations, such as safety education and psychological intervention.
References

[1] Campbell OM, Graham WJ, Lancet Maternal Survival Series steering group. Strategies for reducing maternal mortality: getting on with what works [J]. Lancet 2006;368:1284-99. DOI: 10.1016/S0140-6736(06)69381-1

[2] Ma Xiaowei. China Health Statistics Yearbook (M). 2019.

[3] Statistical Bulletin on the Development of Health and Health in China in 2019. http://www.nhc.gov.cn/guihuaxxs/s10748/202006/ebfe31f24cc145b198dd730603ec4442.shtml.

[4] Organization wH (1993) International statistical classification of disease and related health problem (ICD-10). 10th revision Vol 2. Geneva.

[5] Division of Maternal and Child Health Services, National Health and Family Planning Commission. National office of maternal and child health monitoring. Handbook of maternal and child health monitoring in China (2013 Edition) [M]. Beijing: Monitoring Program of Maternal Mortality in China, 2013: 26. (in Chinese)

[6] Perlow JH, Lesmes H. Maternal mortality: time for national action [J]. Obstet Gynecol 2014;123:362. DOI: 10.1097/AOG.0000000000000112.

[7] The CPC Central Committee and the State Council issued the outline of the healthy China 2030 Plan. http://www.gov.cn/zhengce/2016-10/25/content_5124174.htm

[8] Metz TD, Rovner P, Hoffman MC, Allshouse AA, et al. Maternal Deaths From Suicide and Overdose in Colorado, 2004-2012 [J]. Obstet Gynecol 2016;128(6):1233-1240. DOI: 10.1097/AOG.0000000000001695

[9] Thornton C, Schmied V, Dennis CL, et al. Maternal deaths in NSW (2000-2006) from nonmedical causes (suicide and trauma) in the first year following birth [J]. Biomed Res Int. 2013;2013:1-6. DOI: 10.1155/2013/623743.

[10] Ray Joel G., Zipursky Jonathan, Park Alison L. Injury-related maternal mortality [J]. Am. J. Obstet. Gynecol. 2018;219(3):307-308. DOI: 10.1016/j.ajog.2018.05.025

[11] World Health Organization. International statistics classification of diseases and related health problem (ICD-10), 10th rev. Geneva: World Health Organization, 1993.

[12] Ray JG, Zipursky J, Park AL. Injury-related maternal mortality [J]. Am. J. Obstet. Gynecol. 2018;219(3).DOI: 10.1016/j.ajog.2018.05.025

[13] World health organization. BEYOND THE NUMBERS-Reviewing maternal deaths and complications to make pregnancy safer[M]. China Union Medical University Press. 2006.

[14] The United Nations reports that steady progress has been made in reducing maternal mortality worldwide. https://news.un.org/zh/story/2014/05/214142

[15] Chang J, Berg C, Saltzman L, Herndon J. Homicide: a leading cause of injury deaths among pregnant and postpartum women in the United States, 1991–1999 [J]. Am J Public Health 2005;95: 471–7. DOI: 10.2105/AJPH.2003.029868

[16] Deshpande NA, Kucirka LM, Smith RN, et al. Pregnant trauma victims experience nearly 2-fold higher mortality compared to their nonpregnant counterparts [J]. Am. J. Obstet. Gynecol. 2017 11;217(5). doi: 10.1016/j.ajog.2017.08.004.
[17] Bernet P, Gumus G, Vishwasrao S. Maternal Mortality and Public Health Programs: Evidence from Florida[J]. Milbank Q. 2020;98(1):21. DOI: 10.1111/1468-0009.12442

[18] Zhou Hong-ying, Deng Feng, LV Ju-hong. Analysis on the changes of maternal mortality in China from 1991 to 2016. Chinese Journal of family planning & gynecology. 2019;11(6):34-37. DOI: 10.3969/j.issn.1674-4020.2019.06.10

[19] Xiang L, Wang K, Miao L, et al. Injury-related mortality among children younger than 5 years in China during 2009-2016: an analysis from national surveillance system[J]. Injury Prev. 2019;25(1):60-66. DOI: 10.1136/injuryprev-2018-042853

[20] Koch E, Romero T, Romero C, et al. Impact of education, income and chronic disease risk factors on mortality of adults: does ‘a pauper-rich paradox’ exist in Latin American societies? [J] Public Health, 2010;124(1):39-48. DOI: 10.1016/j.puhe.2009.11.008

[21] You F, Hou K, Wang R, et al. Maternal mortality in Henan Province, China: changes between 1996 and 2009 [J]. Plos One. 2012;7(10):e47153. DOI: 10.1371/journal.pone.0047153

[22] Xu Zhibing, Liang Yanling. Analysis of Maternal Mortality in Yunfu City from 2000 to 2010 [J]. Chinese medical science. 2012,2(12) : 122-123,144.

[23] Zhu Jun, Liang Juan. Reduce maternal mortality to achieve the development goal of the year before last [J]. Chinese Journal of Preventive Medicine. 2011;3(7):8.

[24] National Maternal and Child Health Surveillance Office. Analysis report on the main results of the National Maternal and Child Health Surveillance Network in 2013(2013) [C]. 2013.

[25] V. Schmied, M. Johnson, N. Naidoo et al. Maternal mental health in Australia and New Zealand: a review of longitudinal studies [J]. Women Birth 2013 ;26(3)167-178. DOI: 10.1016/j.wombi.2013.02.006

[26] JingJun, WuXueya, ZhangJie. Research on the Migration of Rural Women and the Decline of Chinese Suicide Rate [J]. China Agricultural University Journal of Social Sciences Edition. 2010;27(4):20-31.

[27] World Health Organization. Suicide Prevention. (2010-07-31). http://www.who.int/mental-health

[28] Hendin H, et al. Suicide and Suicide Prevention in Asia. Geneva: World Health Organization, 2008

[29] Birgisdottir H, Bjarnadottir RI, Kristjansdottir K, et al. Maternal deaths in Iceland over 25 years [J]. Acta Obstet Gynecol Scand. 2016;95(1):74-78.DOI: 10.1111/aogs.12797

[30] Goldman-Mellor S, Margerison CE. Maternal drug-related death and suicide are leading causes of postpartum death in California [J]. Am. J. Obstet. Gynecol. 2019;221(5):489e1-9. DOI: 10.1016/j.ajog.2019.05.045

[31] Sirin H, Weiss HB, Sauber-Schatz EK, Dunning K. Seat belt use, counseling and motor-vehicle injury during pregnancy: results from a multi-state population-based survey[J]. Matern Child Health J. 2007; 11:505–10.

[32] Sakamoto J, Michels C, Eifelder B, et al. Trauma in Pregnancy. Emerg J. Med. Clin. North Am. 2019 May;37(2):147-160.DOI: 10.1016/j.emc.2019.01.009

[33] Gao Tianzhu. Research on Traffic Accident Regulation Analysis and Preventive Measures of China[D]. Chang’an University, Xi’an, China. 2014.

[34] Chu W, Wu C, Atombo C, et al. Traffic climate, driver behaviour, and accidents involvement in China [J]. Accid Anal Prev. 2019;122:119-126. DOI: 10.1016/j.aap.2018.09.007
[35] Vladutiu CJ, Marshall SW, Poole C, et al. Adverse pregnancy outcomes following motor vehicle crashes [J]. Am J Prev Med. 2013;45(5):1-12.
DOI: 10.1016/j.amepre.2013.06.018
### Table 1  Maternal Mortality in Hunan Province from 2009 to 2019

| Year | Pregnancy-related mortality (/100000) | Maternal mortality (/100000) | Number of accidental deaths | Accident death rate (/100000) | Accidental death / pregnancy-related death (%) |
|------|--------------------------------------|-----------------------------|----------------------------|-----------------------------|-----------------------------------------------|
| 2009 | 30.2                                 | 27.1                        | 24                         | 3.1                         | 10.2                                          |
| 2010 | 33.0                                 | 30.2                        | 22                         | 2.8                         | 8.4                                           |
| 2011 | 23.6                                 | 21.5                        | 17                         | 2.1                         | 9.0                                           |
| 2012 | 24.1                                 | 21.8                        | 19                         | 2.3                         | 9.4                                           |
| 2013 | 20.1                                 | 18.4                        | 14                         | 1.7                         | 8.5                                           |
| 2014 | 24.1                                 | 20.4                        | 29                         | 3.7                         | 15.4                                          |
| 2015 | 21.0                                 | 17.5                        | 27                         | 3.5                         | 16.5                                          |
| 2016 | 22.6                                 | 18.9                        | 30                         | 3.8                         | 16.7                                          |
| 2017 | 20.4                                 | 17.5                        | 24                         | 2.9                         | 14.1                                          |
| 2018 | 17.9                                 | 15.0                        | 20                         | 2.8                         | 15.9                                          |
| 2019 | 11.5                                 | 9.5                         | 13                         | 2.1                         | 17.8                                          |
| **Total** | **22.8** | **20.0** | **239** | **2.8** | **12.2** |

Mean ± standard deviation

- Pregnancy-related mortality: 22.6 ± 5.5
- Maternal mortality: 19.8 ± 5.3
- Accident death rate: 2.8 ± 0.7

Cochran-Armitage trend test Z value

-8.804, -9.5919, 0.5242

P < 0.001, < 0.001, 0.6001

### Table 2 Classification of causes of accidental death of pregnant and lying-in women

| Classification                              | N   | Percentage (%) | Mortality rate (/100000) |
|---------------------------------------------|-----|----------------|--------------------------|
| 1. Intentional self-harm                    | 85  | 35.6           | 1.0                      |
| Among them: taking poison / pesticide       | 25  | 10.5           | 0.3                      |
| Jump off a building                         | 16  | 6.7            | 0.2                      |
| Jump into the river                         | 30  | 12.6           | 0.3                      |
| Hang oneself                                | 4   | 1.7            | 0.0                      |
| Others                                      | 10  | 4.2            | 0.1                      |
| 2. Transport accident                       | 72  | 30.1           | 0.8                      |
| 3. Accidental poisoning / overdose          | 19  | 7.9            | 0.2                      |
| Among them: CO moderate                     | 17  | 7.1            | 0.2                      |
| Food poisoning                              | 1   | 0.4            | 0.0                      |
| Accidental use of pesticides                | 1   | 0.4            | 0.0                      |
Table 3  Accident occurrence of pregnant and lying-in women in urban and rural areas

| Year | Urban live birth | Rural live birth | Urban Number of accidental deaths | Rural Number of accidental deaths | Accident death rate (/ 100000) | Accident death rate (/ 100000) |
|------|------------------|------------------|----------------------------------|----------------------------------|-------------------------------|-------------------------------|
| 2009 | 255649           | 525377           | 5                                | 19                               | 2.0                           | 3.6                           |
| 2010 | 263350           | 534552           | 7                                | 15                               | 2.7                           | 2.8                           |
| 2011 | 267356           | 538004           | 2                                | 15                               | 0.7                           | 2.8                           |
| 2012 | 279088           | 559886           | 5                                | 14                               | 1.8                           | 2.5                           |
| 2013 | 272312           | 549043           | 4                                | 10                               | 1.5                           | 1.8                           |
| 2014 | 266739           | 513835           | 5                                | 24                               | 1.9                           | 4.7                           |
| 2015 | 274312           | 506754           | 6                                | 21                               | 2.2                           | 4.1                           |
| 2016 | 280271           | 515128           | 7                                | 23                               | 2.5                           | 4.5                           |
| 2017 | 304202           | 530753           | 8                                | 16                               | 2.6                           | 3.0                           |
| 2018 | 258183           | 447341           | 7                                | 13                               | 2.7                           | 2.9                           |
| 2019 | 248782           | 383679           | 2                                | 11                               | 0.8                           | 2.9                           |
| Total| 2970244          | 5604352          | 58                               | 181                              | 2.0                           | 3.2                           |
| Chi-square value |                  |                  | 153.606                          | P                                | < 0.001                       |

Table 4 Composition of causes of accidental death of pregnant and lying-in women in Hunan Province from 2009 to 2019

| Classification                  | Urban          | Rural          | Chi-square value | P     |
|---------------------------------|----------------|----------------|------------------|-------|
|                                 | Number of accidental deaths | Accident death rate (/ 100000) | Number of accidental deaths | Accident death rate (/ 100000) |                   |
| 1. Intentional self-harm        | 21             | 0.7            | 64               | 1.1   | 9.160 | 0.002 |
| Among them: taking poison / pesticide | 2             | 0.1            | 23               | 0.4   | 6.704 | 0.010 |
| Jump off a building             | 7              | 0.2            | 9                | 0.2   | 0.586 | 0.444 |
| Jump into the river             | 8              | 0.3            | 22               | 0.4   | 0.842 | 0.359 |
| Hang oneself                    | 0              | 0.0            | 4                | 0.1   |       |       |
| Others                          | 4              | 0.1            | 6                | 0.1   | 0.001 | 0.981 |
| Project                                      | N  | Percent age (%) | Project                                      | N  | Percent age (%) |
|----------------------------------------------|----|-----------------|----------------------------------------------|----|-----------------|
| 1. Transport accident                       | 14 | 0.5             | 3. Accidental poisoning / overdose           | 78 | 3.2             |
| Among them: CO                               | 2  | 0.1             |                                              |    |                 |
| moderate                                     | 2  | 0.1             |                                              |    |                 |
| Food poisoning                               | 0  | 0.0             |                                              |    |                 |
| Accidental use of pesticides                | 0  | 0.0             |                                              |    |                 |
| 4. Assault/homicide                         | 3  | 0.1             |                                              |    |                 |
| 5. Others                                    | 18 | 0.6             |                                              |    |                 |
| Total                                        | 58 | 2.0             |                                              | 179| 3.2             |

Table 5 Demographic characteristics of accidental deaths of pregnant women in Hunan Province from 2009 to 2019

Year

| Project              | N  | Percent age (%) | Project              | N  | Percent age (%) |
|----------------------|----|-----------------|----------------------|----|-----------------|
| 1. ≤19               | 8  | 3.4             | 1. <1000             | 9  | 3.8             |
| 2. 20-24             | 60 | 25.1            | 2. 1000~             | 14 | 5.9             |
| 3. 25-29             | 88 | 36.8            | 3. 2000~             | 46 | 19.3            |
| 4. 30-34             | 54 | 22.6            | 4. 4000~             | 71 | 29.7            |
| 5. 35-39             | 22 | 9.2             | 5. 8000~             | 69 | 28.9            |
| 6. > 40              | 6  | 2.5             | 6. Unknown           | 30 | 12.6            |
| 7. Unknown           | 1  | 0.4             | Pregnancy times     |    |                 |

Urban and rural areas

| Project              | N  | Percent age (%) | Project              | N  | Percent age (%) |
|----------------------|----|-----------------|----------------------|----|-----------------|
| 1. Urban             | 58 | 24.3            | 2. 2                 | 87 | 36.4            |
| 2. Rural             | 179| 74.9            | 3. 3                 | 34 | 14.2            |
| 3. Unknown           | 2  | 0.8             | 4. ≥4                | 17 | 7.1             |

Degree of education

| Project              | N  | Percent age (%) | Project              | N  | Percent age (%) |
|----------------------|----|-----------------|----------------------|----|-----------------|
| 1. College or above  | 23 | 9.6             | Parity               |    |                 |
| 2. High school or technical secondary school | 49 | 20.5 | 1. 0 | 80 | 33.5 |
| 3. Junior middle school | 120 | 50.2 | 2. 1 | 95 | 39.8 |
| 4. Primary school    | 21 | 8.8             | 3. ≥2                | 40 | 16.7            |
| 5. Illiterate        | 19 | 8.0             | 4. Unknown           | 24 | 10.0            |
| 6. Unknown           | 7  | 2.9             | Delivery mode        |    |                 |

Whether or not to give birth

| Project              | N  | Percent age (%) | Project              | N  | Percent age (%) |
|----------------------|----|-----------------|----------------------|----|-----------------|
| 1. Natural birth     | 24 | 39.3            | 1. Undelivered       | 178| 74.5            |
| 2. Cesarean section  | 30 | 49.2            | 2. Delivery          | 61 | 25.5            |
| 3. Unknown           | 7  | 11.5            | Place of delivery    |    |                 |

Gestational week for first examination

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| Place of examination                      | Count | Percentage |
|------------------------------------------|-------|------------|
| 1. Provincial and municipal hospitals    | 23    | 37.7       |
| 2. District and county hospitals         | 20    | 32.8       |
| 3. Street township health center         | 7     | 11.5       |
| 5. Home                                  | 3     | 4.9        |
| 6. On the way                            | 1     | 1.6        |
| 7. Others                                | 2     | 3.3        |
| 9. Unknown                               | 5     | 8.2        |

| Place of death                           | Count | Percentage |
|------------------------------------------|-------|------------|
| 1. Home                                  | 82    | 34.3       |
| 2. On the way                            | 48    | 20.1       |

**The number of antenatal examinations of parturients who have given birth**

| Category                                  | Count | Percentage |
|-------------------------------------------|-------|------------|
| 1. Within 12 weeks                        | 178   | 74.5       |
| 2. 13-27 weeks                            | 17    | 7.1        |
| 3. No antenatal examination               | 4     | 1.7        |
| 4. Unknown                                | 40    | 16.7       |

**Diagnostic basis of cause of death**

| Category                                  | Count | Percentage |
|-------------------------------------------|-------|------------|
| 1. Clinical                               | 123   | 51.5       |
| 2. Infer                                  | 106   | 44.4       |
| 3. Case autopsy                           | 7     | 2.9        |
| 4. Unknown                                | 3     | 1.3        |
| 5. No antenatal examination               | 1     | 1.6        |
| 6. Others                                 | 17    | 7.1        |
| 7. Unknown                                | 40    | 16.7       |
# Study on accidental death of pregnant and lying-in women from 2009 to 2019 in Hunan, China: a cross-sectional study

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Study on accidental death of pregnant and lying-in women from 2009 to 2019 in Hunan, China: a cross-sectional study

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Contributors:
Fanjuan Kong drafted the initial manuscript, and reviewed and revised the manuscript.
Aihua Wang, Jian He, Lili Xiong, Donghua Xie, and Jinping Su designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript.
Zhiyu Liu and Xiaoqi Sheng conceptualized and designed the study, coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.
All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Abstract

Objective Few studies have analyzed accidental maternal deaths. This study is to evaluate the maternal mortality rate and the types of accidental deaths, differences in different regions.

Design A cross-sectional study on accidental death of pregnant and lying-in women from 2009 to 2019 in Hunan Province.

Setting Hunan Province, with a population of 74 million, has an area of 210,000 square kilometres and 123 counties/districts.

Participants A collection of 239 accidental death cases of pregnant and lying-in women in Hunan Province from 2009 to 2019, including 181 cases of rural pregnant and lying-in women and 58 cases of urban pregnant and lying-in women.

Main outcome measure Classification of accidental mortality and accidental mortality of pregnant women

Results A total of 239 accidental deaths occurred in Hunan Province, with an accident mortality rate of 2.8/100,000 live births. The accident mortality rate in rural areas (3.2/100,000 live births) was greater than that in urban areas (2.0/100,000 live births). The proportion of accidental deaths among pregnancy-related deaths showed an upward trend. The main types of accidental death were suicide (1.0/100,000 live births); traffic accidents (0.8/100,000 live births); accidental poisoning/overdose, assault/homicide (0.2/100,000 live births); and other accidents (0.6/100,000 live births). Maternal accidental deaths were mainly concentrated in low-income families, rural areas and low level of education. 74.5% of accidental deaths occurred before childbirth. 49.2% of pregnant women gave birth by cesarean section.

Conclusion In response to the different causes of accidental maternal death, public health programs and policy interventions should pay special attention to maternal suicide and traffic injuries.

Key words: accidental death; maternal mortality; injury

Strengths and limitations of this study

1. In China, there are few reports about accidental maternal death, and this study fills this gap.

2. The sample of the study includes all cases of accidental maternal deaths from 2009

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to 2019, which is representative and persuasive.

3. The diagnostic criteria of accidental maternal death did not change, and the changing trend of accidental maternal death was seen more clearly.

4. However, this study does not further analyze what causes the accident.

Maternal mortality rates (MMRS) are an important index of not only the social, economic and cultural development of a country or region but also maternal and infant safety[1]. Maternal mortality in some developed countries showed decreases in 2015 [2]: 4/100,000 in Italy, 5/100,000 in Japan, 8/100,000 in France, 9/100,000 in the United Kingdom and 14/100,000 in the United States. With the implementation of the maternal and infant safety plan, the advocacy of eugenics, the continued implementation of the hospital delivery subsidy system, and the provision of free basic medical and health care services for pregnant and lying-in women during the whole childbearing process, the maternal mortality rate in China[3] has dropped from 88.8/100,000 in 1990 to 17.8/100,000 in 2019, a decrease of 80.0%.

According to the requirements of the World Health Organization [4] and the China Maternal Mortality Monitoring Program [5], maternal mortality monitoring refers to women during pregnancy or within 42 days after pregnancy termination, excluding deaths caused by accidental or accidental causes (such as car accidents, poisoning, etc.). In China, there are almost no reports of injury maternal deaths in the literature. Maternal mortality, whether due to homicide, suicide or pregnancy-related causes, is equally tragic, may be preventable and deserves national attention [6]. The outline of the Healthy China 2030 Plan issued by the CPC Central Committee and the State Council[7] calls for the establishment of a comprehensive injury monitoring system, the development of technical guidelines and standards for key injury intervention, and the prevention and reduction of suicide and accidental poisoning. An issue of concern in China and the rest of the world is the study of the changing rules governing maternal mortality and causes of death and the proposal of targeted interventions to effectively reduce maternal mortality.

The possibility of accidental or intentional injury causing major trauma during pregnancy is increasingly considered to be a major contributor to maternal and infant morbidity and mortality [8-9]. Since more than half of all maternal deaths are considered preventable, public health interventions have the potential to improve maternal health and other pregnancy outcomes [10].
Accidental deaths are underestimated or excluded from maternal mortality reports but have a significant impact on the ability of policymakers to understand potential social and family situations. Many countries have carried out targeted research on accidental maternal deaths. In Colorado[11], USA, self-injury (suicide and overdose) is the most common cause of pregnancy-related death, and most deaths occur during the postpartum period. In NSW[12], Australia, trauma, including suicides, accidental injuries, motor traffic accidents, and homicides, accounts for 73% of all maternal deaths (early and late) annually. In Ontario[13], Canada, more than 60% of maternal injury-related deaths were from self-harm, poisoning/overdose, and homicide. There are no specific data to show the developmental trend of accidental death and the situation of accidental death throughout pregnancy.

Through the maternal death reporting system in our province it was found that the number of accidental deaths among pregnant women is increasing, which is a group that has not been fully studied. To more fully grasp the current situation of accidental maternal death in our province and to ensure the safety of mothers, this study included 239 cases and analyzed the distribution of urban and rural areas, and the classification of causes of death. It is the first time to analyze accidental deaths of pregnant women in China. This is an important supplement to the study of accidental deaths of pregnant women in China.

Data and Methods

Data sources

Hunan Province is located in southeastern China, with an area of 21.18 square kilometers and a population of 73 million. Since 1990, it has been included in the maternal and child health surveillance system. The death surveillance data of this study is the maternal and child health surveillance system of Hunan Province, which is based on the national maternal and child health surveillance system and includes all pregnant and lying-in women in 123 counties (cities) of Hunan Province. The project was approved by the Medical Ethics Committee of Hunan Maternal and Child Health Hospital (No: EC20180319).

The maternal and child health surveillance system follows strict data collection, reporting, audit and quality control procedures and helps to reduce the risk of underreporting. The monitoring data include information on the main cause of death, date, place of death, sex and age. The root causes of death were classified according to the World Health Organization International Classification of Diseases (ICD-10 10th Edition) [14-15].
According to the International Classification of Diseases (ICD-10) [14-15], maternal death refers to the death of a woman during pregnancy or within 42 days after pregnancy termination, regardless of the length of pregnancy and the location of pregnancy, due to any cause related to or aggravated by pregnancy or pregnancy management, but does not include deaths caused by accidents or accidental causes (such as car accidents, poisoning, etc.). The following conditions should also be reported as maternal deaths: maternal deaths caused by anesthetic accidents or drug allergies and maternal suicides caused by confirmed mental illness; hydatidiform mole women, including complete and partial hydatidiform mole, complications caused by hydatidiform mole dying within 42 days after the last curettage. Or hydatidiform mole is transformed into trophoblastic tumor and causes death within 42 days after the last uterine curettage, all maternal deaths should be reported; (2) pregnancy-related death refers to the death of a woman during pregnancy or 42 days after pregnancy termination, regardless of the cause of death; and (3) accident refers to the death of a woman during pregnancy or puerperium that is caused by an accident not related to obstetrics. Pregnant women who die as a result of accidents are listed by injury subtypes [16]: intentional self-harm; transport accident; accidental poisoning/overdose; assault/homicide; or others. In this paper, the accidental death of pregnant women refers to the death determined by experts, which is not caused by pregnancy or pregnancy management, nor is it suicide caused by mental illness.

Data collection method

During the period from January 1, 2009, to December 31, 2019, all pregnant women who died within 42 days from the beginning of pregnancy to the termination of pregnancy were monitored. All pregnancies, live births and maternal deaths were identified by trained certified professionals.

(1) After receiving the report of maternal death, the county-level maternal and child health institutions immediately reported to the local health administrative department and to the municipal and state-level maternal and child health institutions within 24 hours. Within 3 days after the occurrence of maternal death, special personnel, as well as township and village-level maternal and child doctors, midwives or individual practitioners, are organized to investigate the woman’s medical history related to her death. Investigate and understand the medical history related to death, including pregnancy, delivery, postpartum conditions, the course of onset and death, and past medical history. If the maternal death occurs at home and there is no health care worker present, the relevant informed personnel should enter the home to investigate the death process and medical history. Fill out the death report card and write down the summary of the medical record or the summary of the death investigation.
(2) The district, city and provincial levels respectively organize maternal death evaluation to determine the root cause of death, and one death evaluation occurs. After the provincial evaluation, the evaluation conclusions are filled in the death report card. After the completion of the review work at all levels, the network direct reporting of the respective evaluation results shall be completed.

Data quality control

These data were collected and reported by experienced doctors and were checked for quality and accuracy at the county level by women's health institutions and individuals. The community health service center conducts quality inspections for service stations/neighborhood committees and township health centers in villages using the monthly meeting system. The district, county, city and state organize a comprehensive quality inspection every quarter. The city and state conduct quality inspection and evaluation at least half a year. The provincial level monitors quality inspection and provides two reviews of monitoring districts and counties every year. The districts and counties that do not meet the requirements will undergo a comprehensive leak investigation. Death data must be checked with lists from civil affairs, public security, disease control and other entities to prevent underreporting and misreporting.

Statistical analysis

Statistical data were exported to Microsoft Excel 2010. SPSS 24.0 was used to analyze the ratios and proportions. The chi-square test was used to compare the differences in accident mortality between rural and urban areas. The Cochran-Armitage time trend test of mortality over time was carried out with SAS software. $P <0.05$ was regarded as the level of statistical significance.

Results

Mortality trends related to accidental maternal deaths

From 2009 to 2019, a total of 8,574,584 live births were monitored in our province, including 1957 pregnancy-related maternal deaths, 1718 maternal deaths and 239 accidental deaths. The pregnancy-related mortality, maternal mortality and accident mortality in our province were 22.6 $±5.5/100,000$, 19.8 $±5.3/100,000$ and 2.8 $±0.7/100,000$, respectively. The proportion of accidental deaths among pregnancy-related deaths is on the rise, accounting for an increase of 75.11% from 2009 to 2019 (see Table 1).
Classification of causes of accidental death

Intentional self-harm accounted for 35.6% of accidental deaths (including 25 cases of taking drugs/pesticides, 16 cases of jumping from buildings, 30 cases of drowning, 4 cases of hanging oneself and 10 cases of other causes), with a mortality rate of 1.0/100,000. Transportation accidents accounted for 30.1% (N=72) of accidental deaths, with a mortality rate of 0.8/100,000. Accidental poisoning/overdose accounted for 7.9% (including 17 cases of CO poisoning and 2 other cases), with a mortality rate of 0.2/100,000. Assault/homicide accounted for 5.4% of accidental deaths, with a mortality rate of 0.2 per 100,000, while other accidents accounted for 20.9% (N=50), with a mortality rate of 0.6 per 100,000. See Table 2 for details.

Classification of accidental deaths and comparison

The accident mortality rate in rural areas was higher than that in urban areas. The types of accidental maternal deaths differed between urban and rural areas. Among them, the mortality rates of intentional self-harm, ingestion of poisons/pesticides and traffic accidents in rural areas were higher than those in urban areas. See Table 3 and 4 for details.

Epidemiological study on the accidental deaths of pregnant and lying-in women

The sociodemographic characteristics and obstetric characteristics of the women experiencing maternal death from accidents and suicides are summarized in Table 5.

(1) Age distribution: the ages of the pregnant women experiencing accidental death in the province were between 16 and 45 years old, with the largest number of deaths (36.8%) occurring among women between 25 and 29 years old, followed by women between 30 and 34 years old (22.6%). The proportion of accidental deaths among pregnant women of advanced age (≥ 35 years old) was more than 10%.

(2) Economic level: 28.9% of accidental maternal deaths occurred in families with a per capita income of more than RMB 8000 (approximately USD 1,200), and 58.6% of accidental maternal deaths occurred in families with an income of less than RMB 8000 (approximately USD 1,200). Accidental maternal deaths were mainly concentrated in low-income families.

(3) Household registration distribution: maternal deaths are mainly concentrated in rural areas, reaching 74.9%.

(4) Education level: the education level of women experiencing accidental death was generally low: 50.2% with a junior high school education, 9.6% with an education level of college and above, and 16.7% with a primary school and illiterate background.

(5) Delivery: 74.5% of pregnant women experiencing accidental death did not give birth, and 25.5% of these women did give birth. 49.2% of pregnant women delivered by cesarean section.
and 39.3% by natural delivery. A total of 9.8% of the pregnant women who had delivered had less than 5 antenatal examinations, and 73.8% of them had more than 5 antenatal examinations.

(6) Diagnostic basis of cause of death: a total of 51.5% of the deaths were diagnosed on a clinical basis, and 44.4% were inferred.

**Discussion**

To the best of our knowledge, this was the first study to analyze the characteristics of accidental maternal death in China. The main findings of our research are as follows: (1) the proportion of accidental death in pregnancy-related deaths is on the rise; (2) the main types of accidental deaths are suicide, traffic accidents, accidental poisoning / overdose, injury / homicide and other accidents; (3) maternal accidental deaths are mainly concentrated in low-income families, rural areas and low education level; (4) 74.5% of accidental deaths occur before childbirth.

**The trend of accidental deaths of pregnant and lying-in women**

Many years ago, most women died of complications caused by pregnancy and childbirth, such as bleeding, infection, and pregnancy-induced hypertension, but maternal mortality is often associated with factors that are directly related to pregnancy and childbirth [17]. With the improvement of medical standards and the increase of people's health awareness, the death of pregnant women in many countries has been controlled at a relatively low level. By 2019, the maternal mortality rate in Hunan Province continued to decline. According to the narrow definition provided by the World Health Organization (WHO), the maternal mortality rate in 2019 was 9.5/100,000, which is already a low level. Although the accident mortality rate shows a fluctuating downward trend, the proportion of accidental deaths in pregnancy-related deaths increased from 10.17% in 2009 to 17.81% in 2019, reflecting an increase of 75.11%. Because the number of deaths of pregnant women in our province is declining, but the number of accidental deaths has not been well controlled in the fluctuations, resulting in an increase in the proportion.

At present, there are few studies on accidental deaths of pregnant and lying-in women in the world, and we do not have relevant data from other countries. However, attention to the accidental death of pregnant and lying-in women requires more care from the society.

**Differences in accidental maternal mortality between urban and rural areas**

In this study, the self-harm rate of urban pregnant and lying-in women is higher than other categories of accidental death.

The accident mortality rate in rural areas was higher than that in urban areas. In particular, maternal self-mutilation mortality, traffic accident mortality and poison/pesticide mortality in rural
areas were higher than those in urban areas. This is consistent with the trend that the maternal mortality rate in rural areas of China[18] was higher than that in urban areas in the same period. The possible explanation is that crop drugs, which are widely used in rural areas, make it easier for people to commit suicide. The educational level of rural women is generally not high, and they tend to go to extremes after conflicts with their families and neighbors. The large number of open rivers in rural areas also increase environmental insecurity. In addition, complex roads and poor infrastructure in rural areas and poor rural health care systems [19] also increase the risk of death from injuries.

**Demographic characteristics**

The level of education obtained is an important indicator of early living conditions [20], and it may play a role in other variables in adulthood as a precausal effect. Some studies[21] have found that the level of education of a pregnant woman reflects her social status and is inversely proportional to maternal death; that is, the lower the level of maternal education, the less health care knowledge a woman has, the deeper the influence of old customs is [22], and the higher the mortality is. In this study, the education level of pregnant women who had accidental deaths was generally on the low side, with the highest proportion of women with a junior high school education (50.2%) and a primary school and illiterate background (16.7%). Economic characteristics are an important factor affecting maternal mortality. The practice of reducing maternal mortality in China shows that poverty is an important factor affecting maternal mortality [23]. In this study, 58.6% of families experiencing accidental death had a per capita annual income of less than RBM 8000 (approximately USD 1,200). Accidental deaths were more concentrated in low-income families.

In 2000, more than 67% of women experiencing maternal deaths in China had fewer than five antenatal check-ups or no antenatal check-ups. By 2013, the proportion had declined but remained as high as 50% [24]. In this study, 74.5% of the pregnant women who had accidental deaths underwent antenatal examination in the early stage of pregnancy. Among the parturients who had given birth, 73.8% had undergone more than five antenatal examinations. This also reminds us that in the process of prenatal check-ups, medical staff can pay more attention to the psychology and life of pregnant women, teach more health education knowledge, and society provides more help for women, so as to avoid some accidental deaths. In the next step, we will continue to improve data collection to provide more convincing prenatal examination data.

A total of 74.5% of accidental deaths in this study occurred prenatally, but in Colorado [11], nearly 90% of self-harm deaths occurred during postpartum, with most of these women suffering from substance abuse and mental disorders. In NSW (2000-2006) [12], 67% of deceased pregnant
women had mental health diagnoses and/or mental health problems related to drug abuse. Among Australian [25] women who gave birth, the proportion diagnosed with postpartum depression ranged from 10% to 20%. In this study, we did not collect data on maternal mental and drug abuse, so the data cannot be compared directly, but it also suggests that we should strengthen the screening of and interventions for maternal emotional and mental health in a later study.

The major types of accidental deaths

Taking poison, hanging oneself, jumping into a river and electrocution are the main ways for rural residents to commit suicide [26]. In addition to mental illness and psychological distress, the causes of suicide are very complex, including the collapse of social order, the disintegration of families, the misfortune of marriage, financial constraints, domestic violence, despair in serious illness and other factors [27]. Another risk factor is the universal accessibility of pesticides. According to the report "Suicide and Suicide Prevention in Asia" [28], the most common suicide tool used by farmers in China is pesticides, which are used in 62 out of every 100 suicides. In this study, the top three methods of suicide in rural areas were ingesting poisons, falling from buildings and drowning oneself in water. Similar to the situation in China, suicide is also a common cause of death among young people in the community abroad and is related to alcohol and drug abuse [11, 29-30].

Motor vehicle accidents are the leading cause of maternal mortality related to injury [31-32]. China [33-34] has the largest number of road traffic fatalities in the world (26,367 as of 2013; World Health Organization (WHO) 2015). In this study, 30.1% of pregnant women died in traffic accidents, which is the second-leading cause of death. China's rural areas have complex topography, a lack of road safety measures, an increasing number of vehicles, and drivers with weak traffic awareness, all of which can easily lead to all kinds of traffic accidents. Abiding by traffic rules has always formed the basis of road safety education in our country. The use of seat belts can reduce the risk of adverse maternal and fetal outcomes [35].

There were 19 cases of accidental poisoning in this study, of which 17 cases were CO poisoning, most by natural gas in the bath; some poisonings occurred in rural areas and were caused by poor ventilation due to carbon heating in winter and the tight closing of doors and windows. Other accidental deaths include house collapses caused by landslides, deaths caused by fires, bee venom, accidental falls, and so on.

Limitations

Considering some limitations, our research results should be interpreted carefully. First of all,
accident-related causes of death depend on the memories of family members, which may be biased. However, after the data quality control at the provincial, municipal and county levels and the review of the death cases with the public security and civil affairs departments, the data quality and reliability are acceptable. Second, there is no data collected on the details of the family background or the urban and rural environment.

Conclusion

From 2009 to 2019, the proportion of accidental deaths in pregnancy-related deaths showed an upward trend, and the differences between urban and rural areas still exist. This proportion in rural areas is higher than that in urban areas, which is related to the underdevelopment of social economy in rural areas. Self-harm and traffic accidents are still the main causes of accidental maternal death, such as pesticides, jumping from buildings and falling into the river are the main ways of maternal self-harm. Therefore, accidental maternal mortality is still a public health problem that has not been deeply studied. Safety education and infrastructure should be strengthened to reduce accident-related deaths, and these policies and programmes should target more vulnerable populations, such as safety education and psychological intervention.

References

[1] Campbell OM, Graham WJ, Lancet Maternal Survival Series steering group. Strategies for reducing maternal mortality: getting on with what works[J]. Lancet 2006;368:1284-99. DOI: 10.1016/S0140-6736(06)69381-1

[2] Ma Xiaowei. China Health Statistics Yearbook (M). 2019.

[3] Statistical Bulletin on the Development of Health and Health in China in 2019. http://www.nhc.gov.cn/guihuaxxs/s10748/202006/ebfe31f24c145b9dd7306036c4442.shtml.

[4] Organization wH (1993) Internation al statistical classification of disease and related health problem (ICD-10). 10th revision Vol.2. Geneva.

[5] Division of Maternal and Child Health Services, National Health and Family Planning Commission. National office of maternal and child health monitoring. Handbook of maternal and child health monitoring in China (2013 Edition) [M]. Beijing: Monitoring Program of Maternal Mortality in China, 2013: 26. (in Chinese)

[6] Perlow JH, Lesmes H. Maternal mortality: time for national action[J]. Obstet Gynecol. 2014;123:362. DOI: 10.1097/AOG.0000000000001122.

[7] The CPC Central Committee and the State Council issued the outline of the healthy China 2030 Plan. http://www.gov.cn/zhengce/2016-10/25/content_5124174.htm
[8] Chang J, Berg C, Saltzman L, Herndon J. Homicide: a leading cause of injury deaths among pregnant and postpartum women in the United States, 1991–1999 [J]. Am J Public Health 2005;95: 471–7. DOI: 10.2105/AJPH.2003.029868

[9] Deshpande NA, Kucirka LM, Smith RN, et al. Pregnant trauma victims experience nearly 2-fold higher mortality compared to their nonpregnant counterparts [J]. Am. J. Obstet. Gynecol. 2017;11217(5). doi: 10.1016/j.ajog.2017.08.004.

[10] Bernet P, Gumus G, Vishwasrao S. Maternal Mortality and Public Health Programs: Evidence from Florida [J]. Milbank Q. 2020;98(1):21. DOI: 10.1111/1468-0009.12442

[11] Metz TD, Rovner P, Hoffman MC, Allshouse AA, et al. Maternal Deaths From Suicide and Overdose in Colorado, 2004–2012 [J]. Obstet Gynecol. 2016;128(6):1233-1240. DOI: 10.1097/AOG.0000000000001695

[12] Thornton C, Schmied V, Dennis CL, et al. Maternal deaths in NSW (2000-2006) from nonmedical causes (suicide and trauma) in the first year following birth [J]. Biomed Res Int. 2013;2013:1-6. DOI:10.1155/2013/623743.

[13] Ray Joel G., Zipursky Jonathan, Park Alison L. Injury-related maternal mortality [J]. Am. J. Obstet. Gynecol. 2018;219(3):307-308. DOI: 10.1016/j.ajog.2018.05.025

[14] World Health Organization. International statistics classification of diseases and related health problem (ICD-10), 10th rev. Geneva: World Health Organization, 1993.

[15] World health organization. BEYOND THE NUMBERS-Reviewing maternal deaths and complications to make pregnancy safer [M]. China Union Medical University Press, 2006.

[16] Ray JG, Zipursky J, Park AL. Injury-related maternal mortality [J]. Am. J. Obstet. Gynecol. 2018;219(3). DOI: 10.1016/j.ajog.2018.05.025

[17] The United Nations reports that steady progress has been made in reducing maternal mortality worldwide. https://news.un.org/zh/story/2014/05/214142

[18] ZHOU Hong-ying, DENG Feng, LV Ju-hong. Analysis on the changes of maternal mortality in China from 1991 to 2016. Chinese journal of family planning & gynecotology. 2019;11(6):34-37. DOI: 10.3969/j.issn.1674-4020.2019. 06. 10

[19] Xiang L, Wang K, Miao L, et al. Injury-related mortality among children younger than 5 years in China during 2009-2016: an analysis from national surveillance system [J]. Inj. Prev. 2019;25(1):60-66. DOI: 10.1136/injuryprev-2018-042853

[20] Koch E, Romero T, Romero C, et al. Impact of education, income and chronic disease risk factors on mortality of adults: does ‘a pauper-rich paradox’ exist in Latin American societies? [J] Public Health, 2010;124(1):39-48. DOI: 10.1016/j.puhe.2009.11.008

[21] You F, Hou K, Wang R, et al. Maternal mortality in Henan Province, China: changes between 1996 and 2009 [J]. Plos One 2012;7(10):e47153. DOI: 10.1371/journal.pone.0047153

[22] Xu Zhibing, Liang Yanling. Analysis of Maternal Mortality in Yunfu City from 2000 to 2010 [J]. Chinese medical science. 2012;2(12) : 122-123,144.

[23] Zhu Jun, Liang Juan. Reduce maternal mortality to achieve the development goal of the year before last [J]. Chinese Journal of Preventive Medicine. 2011;3(7):8.

[24] National Maternal and Child Health Surveillance Office. Analysis report on the main results of the National Maternal and Child Health Surveillance Network in 2013(2013) [C]. 2013.
[25] V. Schmied, M. Johnson, N. Naidoo et al. Maternal mental health in Australia and New Zealand: a review of longitudinal studies[J]. Women Birth 2013;26(3):167-178. DOI: 10.1016/j.wombi.2013.02.006

[26] Jing Jun, Wu Xueya, Zhang Jie. Research on the Migration of Rural Women and the Decline of Chinese Suicide Rate[J]. China Agricultural University Journal of Social Sciences Edition. 2010;27(4):20-31.

[27] World Health Organization. Suicide Prevention. (2010-07-31). http://www.who.int/mental-health

[28] Hendin H, et al. Suicide and Suicide Prevention in Asia. Geneva: World Health Organization, 2008

[29] Birgisdottir H, Bjarnadottir RI, Kristjansdottir K, et al. Maternal deaths in Iceland over 25 years[J]. Acta Obstet Gynecol Scand. 2016;95(1):74-78. DOI: 10.1111/aogs.12797

[30] Goldman-Mellor S, Margerison CE. Maternal drug-related death and suicide are leading causes of postpartum death in California[J]. Am. J. Obstet. Gynecol. 2019;221(5):489e1-9. DOI: 10.1016/j.ajog.2019.05.045

[31] Sirin H, Weiss HB, Sauber-Schatz EK, Dunning K. Seat belt use, counseling and motor-vehicle injury during pregnancy: results from a multi-state population-based survey[J]. Matern Child Health J. 2007; 11:505–10.

[32] Sakamoto J, Michels C, Eisfelder B, et al. Trauma in Pregnancy. Emerg Med. Clin. North Am. 2019 May;37(2):147-160. DOI: 10.1016/j.emc.2019.01.009

[33] Gao Tianzhu. Research on Traffic Accident Regulation Analysis and Preventive Measures of China[D]. Chang’an University, Xi’an, China. 2014.

[34] Chu W, Wu C, Atombo C, et al. Traffic climate, driver behaviour, and accidents involvement in China[J]. Accid Anal Prev. 2019;122:119-126. DOI: 10.1016/j.aap.2018.09.007

[35] Vladutiu CJ, Marshall SW, Poole C, et al. Adverse pregnancy outcomes following motor vehicle crashes[J]. Am J Prev Med. 2013;45(5):1-12. DOI: 10.1016/j.amepre.2013.06.018
### Table 1  Maternal Mortality in Hunan Province from 2009 to 2019

| Year | Pregnancy-related mortality (/100000) | Maternal mortality (/100000) | Number of accidental deaths | Accident death rate (/100000) | Accidental death / pregnancy-related death (%) |
|------|----------------------------------------|-----------------------------|-----------------------------|-------------------------------|-----------------------------------------------|
| 2009 | 30.2                                   | 27.1                        | 24                          | 3.1                           | 10.2                                          |
| 2010 | 33.0                                   | 30.2                        | 22                          | 2.8                           | 8.4                                           |
| 2011 | 23.6                                   | 21.5                        | 17                          | 2.1                           | 9.0                                           |
| 2012 | 24.1                                   | 21.8                        | 19                          | 2.3                           | 9.4                                           |
| 2013 | 20.1                                   | 18.4                        | 14                          | 1.7                           | 8.5                                           |
| 2014 | 24.1                                   | 20.4                        | 29                          | 3.7                           | 15.4                                          |
| 2015 | 21.0                                   | 17.5                        | 27                          | 3.5                           | 16.5                                          |
| 2016 | 22.6                                   | 18.9                        | 30                          | 3.8                           | 16.7                                          |
| 2017 | 20.4                                   | 17.5                        | 24                          | 2.9                           | 14.1                                          |
| 2018 | 17.9                                   | 15.0                        | 20                          | 2.8                           | 15.9                                          |
| 2019 | 11.5                                   | 9.5                         | 13                          | 2.1                           | 17.8                                          |
| Total| 22.8                                   | 20.0                        | 239                         | 2.8                           | 12.2                                          |

Mean ± standard deviation  
22.6±5.5  19.8±5.3  2.8±0.7

Cochran-Armitage trend test Z value  
-8.804  -9.5919  0.5242

P-values  
< 0.001  < 0.001  0.6001

### Table 2 Classification of causes of accidental death of pregnant and lying-in women

| Classification                  | N  | Percentage (%) | Mortality rate (/100000) |
|---------------------------------|----|----------------|--------------------------|
| 1.Intentional self-harm         | 85 | 35.6           | 1.0                      |
| Among them: taking poison / pesticide | 25 | 10.5           | 0.3                      |
| Jump off a building             | 16 | 6.7            | 0.2                      |
| Jump into the river             | 30 | 12.6           | 0.3                      |
| Hang oneself                    | 4  | 1.7            | 0.0                      |
| Others                          | 10 | 4.2            | 0.1                      |
| 2.Transport accident            | 72 | 30.1           | 0.8                      |
| 3.Accidental poisoning / overdose | 19 | 7.9            | 0.2                      |
| Among them: CO moderate         | 17 | 7.1            | 0.2                      |
| Food poisoning                  | 1  | 0.4            | 0.0                      |
Table 3  Accident occurrence of pregnant and lying-in women in urban and rural areas

| Year | Urban live birth | Rural live birth | Urban Number of accidental deaths | Urban Accident death rate (/ 100000) | Rural Number of accidental deaths | Rural Accident death rate (/ 100000) |
|------|-----------------|-----------------|----------------------------------|--------------------------------------|----------------------------------|--------------------------------------|
| 2009 | 255649          | 525377          | 5                                | 2.0                                  | 19                               | 3.6                                  |
| 2010 | 263350          | 534552          | 7                                | 2.7                                  | 15                               | 2.8                                  |
| 2011 | 267356          | 538004          | 2                                | 0.7                                  | 15                               | 2.8                                  |
| 2012 | 279088          | 559886          | 5                                | 1.8                                  | 14                               | 2.5                                  |
| 2013 | 272312          | 549043          | 4                                | 1.5                                  | 10                               | 1.8                                  |
| 2014 | 266739          | 513835          | 5                                | 1.9                                  | 24                               | 4.7                                  |
| 2015 | 274312          | 506754          | 6                                | 2.2                                  | 21                               | 4.1                                  |
| 2016 | 280271          | 515128          | 7                                | 2.5                                  | 23                               | 4.5                                  |
| 2017 | 304202          | 530753          | 8                                | 2.6                                  | 16                               | 3.0                                  |
| 2018 | 258183          | 447341          | 7                                | 2.7                                  | 13                               | 2.9                                  |
| 2019 | 248782          | 383679          | 2                                | 0.8                                  | 11                               | 2.9                                  |
| Total | 2970244         | 5604352        | 58                               | 2.0                                  | 181                              | 3.2                                  |

Table 4 Composition of causes of accidental death of pregnant and lying-in women in Hunan Province from 2009 to 2019

| Classification                  | Urban Number of accidental deaths | Urban Accident death rate (/ 100000) | Rural Number of accidental deaths | Rural Accident death rate (/ 100000) |
|---------------------------------|----------------------------------|--------------------------------------|----------------------------------|--------------------------------------|
| 1.Intentional self-harm         | 21                              | 0.7                                 | 64                               | 1.1                                 |
| Among them: taking poison / pesticide | 2                              | 0.1                                 | 23                               | 0.4                                 |
| Jump off a building             | 7                               | 0.2                                 | 9                                | 0.2                                 |
| Jump into the river             | 8                               | 0.3                                 | 22                               | 0.4                                 |
| Hang oneself                    | 0                               | 0.0                                 | 4                                | 0.1                                 |
| Others                          | 4                               | 0.1                                 | 6                                | 0.1                                 |
| 2.Transport accident            | 14                              | 0.5                                 | 58                               | 1.0                                 |
| 3.Accidental poisoning /        | 2                               | 0.1                                 | 17                               | 0.3                                 |
| overdose                                                                 | N    | Percent (%) | N    | Percent (%) |
|------------------------------------------------------------------------|------|-------------|------|-------------|
| Among them: CO                                                          | 2    | 0.1         | 15   | 0.3         |
| moderate                                                               |      |             |      |             |
| Food poisoning                                                          | 0    | 0.0         | 1    | 0.0         |
| Accidental use of pesticides                                           | 0    | 0.0         | 1    | 0.0         |
| 4. Assault/homicide                                                    | 3    | 0.1         | 10   | 0.2         |
| 5. Others                                                               | 18   | 0.6         | 32   | 0.6         |
| **Total**                                                               | 58   | 2.0         | 179* | 3.2         |

Note:*There were 3 cases of accidental deaths in rural areas. The classification of accidental deaths is not clear.

Table 5 Demographic characteristics and Obstetric characteristics of accidental deaths of pregnant women in Hunan Province from 2009 to 2019

### Demographic characteristics

| Project                      | N    | Percent (%) | Project                      | N    | Percent (%) |
|------------------------------|------|-------------|------------------------------|------|-------------|
| **Age in years**             |      |             |                              |      |             |
| 1. ≤19                       | 8    | 3.4         | 1. College or above          | 23   | 9.6         |
| 2. 20–24                     | 60   | 25.1        | 2. High school or technical secondary school | 49 | 20.5 |
| 3. 25–29                     | 88   | 36.8        | 3. Junior middle school       | 120  | 50.2 |
| 4. 30–34                     | 54   | 22.6        | 4. Primary school            | 21   | 8.8         |
| 5. 35–39                     | 22   | 9.2         | 5. Illiterate                | 19   | 8           |
| 6. > 40                      | 6    | 2.5         | 6. Unknown                   | 7    | 2.9         |
| 7. Unknown                   | 1    | 0.4         |                              |      |             |

| **Urban and rural areas**    |      |             |                              |      |             |
| 1. Urban                     | 58   | 24.3        | 2. RMB 1000                  | 14   | 5.9         |
| 2. Rural                     | 179  | 74.9        | 3. RMB 2000                  | 46   | 19.2        |
| 3. Unknown                   | 2    | 0.8         | 4. RMB 4000                  | 71   | 29.6        |
| 4. RMB 8000                  | 69   | 28.9        | 5. Unknown                   | 30   | 12.6        |

### Obstetric characteristics

| Project                      | N    | Percent (%) | Project                      | N    | Percent (%) |
|------------------------------|------|-------------|------------------------------|------|-------------|
| **Whether or not to give birth** |      |             | **The number of antenatal examinations of parturients who have given birth** |      |             |
| 1. Undelivered               | 178  | 74.5        | 1. <5                        | 6    | 9.8         |
| 2. Delivery                  | 61   | 25.5        | 2. ≥5                        | 45   | 73.8        |
| **Delivery mode**            |      |             | **3. No antenatal examination** |      |             |
| 1. Natural birth             | 24   | 39.3        | 4. Unknown                   | 9    | 14.8        |
| 2. Unknown                   |      |             |                              |      |             |
| 2. Cesarean section | 30 | 49.2 | 3. Unknown | 7 | 11.5 |
|---------------------|----|------|------------|---|------|
| **Diagnostic basis of cause of death** | 1.Clinical | 123 | 51.5 |
| **Gestational week for first examination** | 2.Infer | 106 | 44.4 |
| 1. Within 12 weeks | 178 | 74.5 |
| 2. 13-27 weeks | 17 | 7.1 |
| 3. No antenatal examination | 4 | 1.7 |
| 4. Unknown | 40 | 16.7 |
### STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

| Item No. | Recommendation | Page No. |
|----------|----------------|----------|
| **Title and abstract** | (a) Indicate the study’s design with a commonly used term in the title or the abstract | P1/P3 |
| | (b) Provide in the abstract an informative and balanced summary of what was done and what was found | P3 |
| **Introduction** | Explain the scientific background and rationale for the investigation being reported | P4-5 |
| **Objectives** | State specific objectives, including any prespecified hypotheses | P3 |
| **Methods** | Present key elements of study design early in the paper | P6 |
| | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | P6-7 |
| | (a) Give the eligibility criteria, and the sources and methods of selection of participants | P6-7 |
| | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | P6-7 |
| | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | P5-7 |
| **Bias** | Describe any efforts to address potential sources of bias | P7 |
| **Study size** | Explain how the study size was arrived at | P6 |
| **Quantitative variables** | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | P6-7 |
| **Statistical methods** | Describe all statistical methods, including those used to control for confounding | P7 |
| | Describe any methods used to examine subgroups and interactions | NA |
| | Explain how missing data were addressed | NA |
| | If applicable, describe analytical methods taking account of sampling strategy | NA |
| | Describe any sensitivity analyses | NA |
| **Results** | Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | P7 |
| | Give reasons for non-participation at each stage | NA |
| | Consider use of a flow diagram | NA |
| **Descriptive data** | Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | P10-11 |
| | Indicate number of participants with missing data for each variable of interest | P17 |
| **Outcome data** | Report numbers of outcome events or summary measures | P7 |
| **Main results** | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | NA |
(b) Report category boundaries when continuous variables were categorized

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |

**Discussion**

| Key results | 18 | Summarise key results with reference to study objectives | P9 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | P12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | P9-11 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | P9-11 |

**Other information**

| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | P1 |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.
# Study on accidental death of pregnant and lying-in women from 2009 to 2019 in Hunan, China: a cross-sectional study

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Study on accidental death of pregnant and lying-in women from 2009 to 2019 in Hunan, China: a cross-sectional study

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Short title: Suicide and Accidents

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Fanjuan Kong drafted the initial manuscript, and reviewed and revised the manuscript. Aihua Wang, Jian He, Lili Xiong, Donghua Xie, and Jinping Su designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript. Zhiyu Liu and Xiaoqi Sheng conceptualized and designed the study, coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Abstract

Objective Few studies have analyzed accidental maternal deaths. This study analyzed the basic situation and classification of maternal accidental death, and compared the differences between urban and rural areas.

Design A cross-sectional study on accidental death of pregnant and lying-in women from 2009 to 2019 in Hunan Province.

Setting Hunan Province, with a population of 74 million, has an area of 210,000 square kilometres and 123 counties/districts.

Participants A collection of 239 accidental death cases of pregnant and lying-in women in Hunan Province from 2009 to 2019, including 181 cases of rural pregnant and lying-in women and 58 cases of urban pregnant and lying-in women.

Main outcome measure Classification of accidental mortality and accidental mortality of pregnant women

Results A total of 239 accidental deaths occurred in Hunan Province, with an accident mortality rate of 2.8/100,000 live births. The accident mortality rate in rural areas (3.2/100,000 live births) was greater than that in urban areas (2.0/100,000 live births). The proportion of accidental deaths among pregnancy-related deaths showed an upward trend. The main types of accidental death were suicide (1.0/100,000 live births); traffic accidents (0.8/100,000 live births); accidental poisoning/overdose, assault/homicide (0.2/100,000 live births); and other accidents (0.6/100,000 live births). Maternal accidental deaths were mainly concentrated in low-income families, rural areas and low level of education. 74.5% of accidental deaths occurred before childbirth. 49.2% of pregnant women gave birth by cesarean section.

Conclusion In response to the different causes of accidental maternal death, public health programs and policy interventions should pay special attention to maternal suicide and traffic injuries.

Key words: accidental death; maternal mortality; injure

Strengths and limitations of this study

1. In China, there are few reports about accidental maternal death, and this study fills this gap.
2. The sample of the study includes all cases of accidental maternal deaths from 2009 to 2019, which is representative and persuasive.

3. The diagnostic criteria of accidental maternal death did not change, and the changing trend of accidental maternal death was seen more clearly.

4. However, this study does not further analyze what causes the accident.

Maternal mortality rate (MMRS) is an important indicator of maternal and infant safety [1]. The maternal mortality rate in some developed countries declined in 2015 [2], and the maternal mortality rate in China decreased from 88.8/100,000 in 1990 to 17.8/100,000 in 2019 [3]. However, few articles all over the world have studied accidental death of pregnant women, and reducing the accidental death has become an important measure to ensure the safety of mother and infant.

According to the requirements of the World Health Organization [4] and the China Maternal Mortality Monitoring Program [5], maternal mortality monitoring refers to women during pregnancy or within 42 days after pregnancy termination, excluding deaths caused by accidental or accidental causes (such as car accidents, poisoning, etc.). In China, there are almost no reports of injury maternal deaths in literature. Maternal mortality, whether due to homicide, suicide or pregnancy-related causes, is equally tragic, may be preventable and deserves national attention [6]. The outline of the Healthy China 2030 Plan issued by the CPC Central Committee and the State Council [7] calls for the establishment of a comprehensive injury monitoring system, the development of technical guidelines and standards for key injury intervention, and the prevention and reduction of suicide and accidental poisoning. An issue of concern in China and the rest of the world is the study of the changing rules governing maternal mortality and causes of death and the proposal of targeted interventions to effectively reduce maternal mortality.

The possibility of accidental or intentional injury causing major trauma during pregnancy is increasingly considered to be a major contributor to maternal and infant mobility and mortality [8-9]. Since more than half of all maternal deaths are considered preventable, public health interventions have the potential to enhance maternal health and other pregnancy outcomes [10]. Accidental deaths are underestimated or excluded from maternal mortality reports but have a significant impact on the ability of policymakers to understand potential social and family situations. Many countries have carried out targeted research on accidental maternal deaths. In
Colorado[11], USA, self-injury (suicide and overdose) is the most common cause of pregnancy-related death, and most deaths occur during the postpartum period. In NSW[12], Australia, trauma, including suicides, accidental injuries, motor traffic accidents, and homicides, accounts for 73% of all maternal deaths (early and late) annually. In Ontario[13], Canada, more than 60% of maternal injury-related deaths were from self-harm, poisoning/overdose, and homicide. There is no specific data to show the developmental trend of accidental death and the situation of accidental death throughout pregnancy.

Through the maternal death reporting system in our province, it was found that the number of accidental deaths among pregnant women is increasing, which is a group that has not been fully studied. To more fully grasp the current situation of accidental maternal death in our province and to ensure the safety of mothers, this study included 239 cases and analyzed the distribution of urban and rural areas, and the classification of causes of death. It is the first time to analyze accidental deaths of pregnant women in China. This is an important supplement to the study of accidental deaths of pregnant women in China.

**Data and Methods**

**Data sources**

Hunan Province is located in southeastern China, with an area of 21.18 square kilometers and a population of 73 million. Since 1990, it has been included in the maternal and child health surveillance system. The death surveillance data of this study is the maternal and child health surveillance system of Hunan Province, which is based on the national maternal and child health surveillance system and includes all pregnant and lying-in women in 123 counties (cities) of Hunan Province. The project was approved by the Medical Ethics Committee of Hunan Maternal and Child Health Hospital(No: EC20180319).

The maternal and child health surveillance system follows strict data collection, reporting, audit and quality control procedures and helps to reduce the risk of underreporting. This research is a cross-sectional survey of accidental maternal deaths in Hunan Province from 2009 to 2019. The monitoring data includes information on the main cause of death, date, place of death, sex and age. However, there is too much information missing about the gestational age of accidental death, which was not analyzed in this study. The root causes of death were classified according to the World Health Organization International Classification of Diseases (ICD-10 10th Edition).
According to the International Classification of Diseases (ICD-10) [14-15], maternal death refers to the death of a woman during pregnancy or within 42 days after pregnancy termination, regardless of the length of pregnancy and the location of pregnancy, due to any cause related to or aggravated by pregnancy or pregnancy management, but does not include deaths caused by accidents or accidental causes (such as car accidents, poisoning, etc.). The following conditions should also be reported as maternal deaths: maternal deaths caused by anesthetic accidents or drug allergies and maternal suicides caused by confirmed mental illness; hydatidiform mole women, including complete and partial hydatidiform mole, complications caused by hydatidiform mole dying within 42 days after the last curettage. Or hydatidiform mole is transformed into trophoblastic tumor and causes death within 42 days after the last uterine curettage, all maternal deaths should be reported. Pregnancy-related death refers to the death of a woman during pregnancy or 42 days after pregnancy termination, regardless of the cause of death. An accident refers to the death of a woman during pregnancy or puerperium that is caused by an accident not related to obstetrics. Pregnant women who die as a result of accidents are listed by injury subtypes [16]: intentional self-harm; transport accident; accidental poisoning/overdose; assault/homicide; or others. Experts at all levels in China have evaluated the accidental death of pregnant women to determine the cause of death classification. In addition, doctors must accurately describe injuries as intentional or accidental. In this paper, the accidental death of pregnant women refers to the death determined by experts, which is not caused by pregnancy or pregnancy management, nor is it suicide caused by mental illness.

Data collection method

During the period from January 1, 2009, to December 31, 2019, all pregnant women who died within 42 days from the beginning of pregnancy to the termination of pregnancy were monitored. All pregnancies, live births and maternal deaths were identified by trained certified professionals.

(1) After receiving the report of maternal death, the county-level maternal and child health institutions immediately reported to the local health administrative department and to the municipal and state-level maternal and child health institutions within 24 hours. Within 3 days after the occurrence of maternal death, special personnel, as well as township and village-level maternal and child doctors, midwives or individual practitioners, are organized to investigate the woman’s medical history related to her death. Investigate and understand the medical history related to death, including pregnancy, delivery, postpartum conditions, the course of onset and death, and past medical history. If the maternal death occurs at home and there is no health care
worker present, the relevant informed personnel should enter the home to investigate the death process and medical history. Fill out the death report card and write down the summary of the medical record or the summary of the death investigation.

(2) The district, city and provincial levels respectively organize maternal death evaluation to determine the root cause of death, and one death evaluation occurs. After the provincial evaluation, the evaluation conclusions are filled in the death report card. After the completion of the review work at all levels, the network direct reporting of the respective evaluation results shall be completed.

Data quality control

These data were collected and reported by experienced doctors and were checked for quality and accuracy at the county level by women's health institutions and individuals. The community health service center conducts quality inspections for service stations/neighborhood committees and township health centers in villages using the monthly meeting system. The district, county, city and state organize a comprehensive quality inspection every quarter. The city and state conduct quality inspection and evaluation at least half a year. The provincial level monitors quality inspection and provides two reviews of monitoring districts and counties every year. The districts and counties that do not meet the requirements will undergo a comprehensive leak investigation. Death data must be checked with lists from civil affairs, public security, disease control and other entities to prevent underreporting and misreporting.

Statistical analysis

Statistical data were exported to Microsoft Excel 2010. SPSS 24.0 was used to analyze the ratios and proportions. The chi-square test was used to compare the differences in accident mortality between rural and urban areas. The Cochran-Armitage time trend test of mortality over time was carried out with SAS software. $P < 0.05$ (P-values were assessed as two-tailed) was regarded as the level of statistical significance.

Results

Mortality trends related to accidental maternal deaths

From 2009 to 2019, a total of 8,574,584 live births were monitored in our province, including 1957 pregnancy-related maternal deaths, 1718 maternal deaths and 239 accidental deaths. The pregnancy-related mortality, maternal mortality and accident mortality in our province were 22.6 ±5.5/100,000, 19.8 ±5.3/100,000 and 2.8 ±0.7/100,000, respectively. The proportion of accidental
deaths among pregnancy-related deaths is on the rise, accounting for an increase of 75.11% from 2009 to 2019 (see Table 1).

**Classification of causes of accidental death**

Intentional self-harm accounted for 35.6% of accidental deaths (including 25 cases of taking drugs/pesticides, 16 cases of jumping from buildings, 30 cases of drowning, 4 cases of hanging oneself and 10 cases of other causes), with a mortality rate of 1.0/100,000. Transportation accidents accounted for 30.1% (N=72) of accidental deaths, with a mortality rate of 0.8/100,000. Accidental poisoning/overdose accounted for 7.9% (including 17 cases of CO poisoning and 2 other cases), with a mortality rate of 0.2/100,000. Assault/homicide accounted for 5.4% of accidental deaths, with a mortality rate of 0.2 per 100,000, while other accidents accounted for 20.9% (N=50), with a mortality rate of 0.6 per 100,000. See Table 2 for details.

**Classification of accidental deaths and comparison**

The accident mortality rate in rural areas was higher than that in urban areas. The types of accidental maternal deaths differed between urban and rural areas. Among them, the mortality rates of intentional self-harm, ingestion of poisons/pesticides and traffic accidents in rural areas were higher than those in urban areas. See Table 3 and 4 for details.

**Epidemiological study on the accidental deaths of pregnant and lying-in women**

The sociodemographic characteristics and obstetric characteristics of women experiencing maternal death from accidents and suicides are summarized in Table 5.

(1) Age distribution: the ages of pregnant women experiencing accidental death in the province were between 16 and 45 years old, with the largest number of deaths (36.8%) occurring among women between 25 and 29 years old, followed by women between 30 and 34 years old (22.6%). The proportion of accidental deaths among pregnant women of advanced age (≥35 years old) was more than 10%.

(2) Economic level: 28.9% of accidental maternal deaths occurred in families with a per capita income of more than RMB 8000 (approximately USD 1,200), and 58.6% of accidental maternal deaths occurred in families with an income of less than RMB 8000 (approximately USD 1,200). Accidental maternal deaths were mainly concentrated in low-income families.

(3) Household registration distribution: maternal deaths are mainly concentrated in rural areas, reaching 74.9%.

(4) Education level: the education level of women experiencing accidental death was generally low: 50.2% with a junior high school education, 9.6% with an education level of college
and above, and 16.7% with a primary school and illiterate background.

(5) Delivery: 74.5% of pregnant women experiencing accidental death did not give birth, and 25.5% of these women did give birth. 49.2% of pregnant women delivered by cesarean section and 39.3% by natural delivery. A total of 9.8% of the pregnant women who had delivered had less than 5 antenatal examinations, and 73.8% of them had more than 5 antenatal examinations.

(6) Diagnostic basis of cause of death: a total of 51.5% of the deaths were diagnosed on a clinical basis, and 44.4% were inferred.

Discussion

To the best of our knowledge, this was the first study to analyze the characteristics of accidental maternal death in China. The main findings of our research are as follows: (1) the proportion of accidental death in pregnancy-related deaths is on the rise; (2) the main types of accidental deaths are suicide, traffic accidents, accidental poisoning / overdose, injury / homicide and other accidents; (3) maternal accidental deaths are mainly concentrated in low-income families, rural areas and low education level; (4) 74.5% of accidental deaths occur before childbirth.

The trend of accidental deaths of pregnant and lying-in women

Many years ago, most women died of complications caused by pregnancy and childbirth, such as bleeding, infection, and pregnancy-induced hypertension, but maternal mortality is usually associated with factors that are directly connected to pregnancy and childbirth [17]. With the improvement of medical standards and the increase of people's health awareness, the death of pregnant women in many countries has been controlled at a relatively low level. By 2019, the maternal mortality rate in Hunan Province continued to decline. According to the narrow definition provided by the World Health Organization (WHO), the maternal mortality rate in 2019 was 9.5/100,000, which is already a low level. Although the accident mortality rate shows a fluctuating downward trend, the proportion of accidental deaths in pregnancy-related deaths increased from 10.17% in 2009 to 17.81% in 2019, reflecting an increase of 75.11%. Because the number of deaths of pregnant women in our province is declining, the number of accidental deaths has not been well controlled in the fluctuations, resulting in an increase in the proportion. At present, there are few studies on accidental deaths of pregnant and lying-in women in the world, and we do not have relevant data from other countries. However, attention to the accidental death of pregnant and lying-in women requires more care from society.

Differences in accidental maternal mortality between urban and rural areas

In this study, the self-harm rate of urban pregnant and lying-in women is higher than other
The accident mortality rate in rural areas was higher than that in urban areas. In particular, maternal self-mutilation mortality, traffic accident mortality and poison/pesticide mortality in rural areas were higher than those in urban. This is consistent with the trend that the maternal mortality rate in rural areas of China[18] was higher than that in urban areas in the same period. The possible explanation is that crop drugs, which are widely used in rural areas, make it easier for people to commit suicide[19]. The educational level of rural women is generally not high, and they tend to go to extremes after conflicts with their families and neighbors[20]. In addition, complex roads and poor infrastructure in rural areas and poor rural health care systems [21] also increase the risk of death from injuries.

**Demographic characteristics**

The level of education obtained is an important indicator of early living conditions [22], and it may play a role in other variables in adulthood as a causal effect. Some studies[23] have found that the level of education of a pregnant woman reflects her social status and is inversely proportional to maternal death; that is, the lower the level of maternal education, the less health care knowledge a woman has, the deeper the influence of old customs is [24], and the higher the mortality is. In this research, the education level of pregnant women who had accidental deaths was largely on the low side, with the highest proportion of women with a junior high school education (50.2%) and a primary school and illiterate background (16.7%). Economic characteristics are an important factor affecting maternal mortality. The practice of reducing maternal mortality in China shows that poverty is an important factor affecting maternal mortality [25]. In this study, 58.6% of families experiencing accidental death had a per capita annual income of less than RBM 8000(approximately USD 1,200). Accidental deaths were more concentrated in low-income families.

In 2000, more than 67% of women experiencing maternal deaths in China had fewer than five antenatal check-ups or no antenatal check-ups. By 2013, the proportion had declined but remained as high as 50% [26]. In this study, 74.5% of the pregnant women who had accidental deaths underwent antenatal examinations in the early stage of pregnancy. Among the parturients who had given birth, 73.8% had undergone more than five antenatal examinations. This also reminds us that in the process of prenatal check-ups, medical staff can pay more attention to the psychology and life of pregnant women, teach more health education knowledge, and society provides more help for women, so as to avoid some accidental deaths. In the next step, we will continue to improve data collection to provide more convincing prenatal examination data.

A total of 74.5% of accidental deaths in this research occurred prenatally, but in Colorado
[11], approximately 90% of self-harm deaths occurred during postpartum, with most of these women suffering from substance abuse and mental disorders. In NSW (2000-2006) [12], 67% of deceased pregnant women had mental health diagnoses and/or mental health problems related to drug abuse. Among Australian [27] women who gave birth, the proportion diagnosed with postpartum depression ranged from 10% to 20%. In this study, we did not collect data on maternal mental and drug abuse, so the data cannot be compared directly, but it also suggests that we should strengthen the screening of and interventions for maternal emotional and mental health in a later study.

The major types of accidental deaths

Taking poison, hanging oneself, jumping into a river and electrocution are the main ways for rural residents to commit suicide [28]. In addition to mental illness and psychological distress, the causes of suicide are very complex, including the collapse of social order, the disintegration of families, the misfortune of marriage, financial constraints, domestic violence, despair in serious illness and other factors [29]. Another risk factor is the universal accessibility of pesticides. According to the report "Suicide and Suicide Prevention in Asia" [30], the most common suicide tool used by farmers in China is pesticides, which are used in 62 out of every 100 suicides. In this study, the top three methods of suicide in rural areas were ingesting poisons, falling from buildings and drowning oneself in water. Similar to the situation in China, suicide is also a common cause of death among young people in the community abroad and is related to alcohol and drug abuse [11, 31-32].

Motor vehicle accidents are the leading cause of maternal mortality related to injury [33-34]. China [35-36] has the largest number of road traffic fatalities in the world (26,367 as of 2013; world Health Organization (WHO) 2015). In this research, 30.1% of pregnant women died in traffic accidents, which is the second-leading cause of death. China's rural areas have complex topography, a lack of road safety measures, an increasing number of vehicles, and drivers with weak traffic awareness, all of which can easily lead to all kinds of traffic accidents. Abiding by traffic rules has always formed the basis of road safety education in our country. The use of seat belts can reduce the risk of adverse maternal and fetal outcomes [37].

There were 19 cases of accidental poisoning in this study, of which 17 cases were CO poisoning, most by natural gas in the bath; some poisonings occurred in rural areas and were caused by poor ventilation due to carbon heating in winter and the tight closing of doors and windows. Other accidental deaths include house collapses caused by landslides, deaths caused by fires, bee venom, accidental falls, and so on.
Limitations

Considering some limitations, our research results should be interpreted carefully. First of all, accident-related causes of death depend on the memories of family members, which may be biased. However, after the data quality control at the provincial, municipal and county levels and the review of the death cases with the public security and civil affairs departments, the data quality and reliability are acceptable. Second, there is no data collected on the details of the family background or the urban and rural environment. Third, we were unable to obtain data on gestational age of accidental death among pregnant women. This is the next step we will focus on to improve the information we collect.

Conclusion

From 2009 to 2019, the proportion of accidental deaths in pregnancy-related deaths showed an upward trend, and the differences between urban and rural areas still exist. This proportion in rural areas is higher than that in urban areas, which is related to the underdevelopment of social economy in rural areas. Self-harm and traffic accidents are still the main causes of accidental maternal death, such as pesticides, jumping from buildings and falling into the river are the main ways of maternal self-harm. Therefore, accidental maternal mortality is still a public health problem that has not been deeply studied. Safety education and infrastructure should be strengthened to reduce accident-related deaths, and these policies and programmes should target more vulnerable populations, such as safety education and psychological intervention.

References

[1] Campbell OM, Graham WJ, Lancet Maternal Survival Series steering group. Strategies for reducing maternal mortality: getting on with what works [J]. Lancet 2006; 368: 1284-99. DOI: 10.1016/S0140-6736(06)69381-1

[2] Ma Xiaowei. China Health Statistics Yearbook (M). 2019.
[3] Statistical Bulletin on the Development of Health and Health in China in 2019. http://www.nhc.gov.cn/guihuaxxs/s10748/202006/ebfe31f24cc145b198dd730603ec4442.shtml.
[4] Organization WH (1993) International statistical classification of disease and related health problem (ICD-10). 10th revision Vol.2. Geneva.
[5] Division of Maternal and Child Health Services. National Health and Family Planning Commission. National office of maternal and child health monitoring. Handbook of maternal and child health monitoring in China (2013 Edition) [M]. Beijing: Monitoring Program of Maternal Mortality in China, 2013: 26. (in Chinese)
[6] Perlow JH, Lesmes H. Maternal mortality: time for national action [J]. Obstet Gynecol. 2014; 123: 362. DOI: 10.1097/AOG.0000000000000112.
[7] The CPC Central Committee and the State Council issued the outline of the healthy China
2030 Plan.
http://www.gov.cn/zhengce/2016-10/25/content_5124174.htm

[8] Chang J, Berg C, Saltzman L, Herndon J. Homicide: a leading cause of injury deaths among pregnant and postpartum women in the United States, 1991–1999[J]. Am J Public Health 2005;95: 471–7. DOI: 10.2105/ AJPH.2003.029868

[9] Deshpande NA, Kucirka LM, Smith RN, et al. Pregnancy trauma victims experience nearly 2-fold higher mortality compared to their nonpregnant counterparts [J]. Am. J. Obstet. Gynecol. 2017;112(5). doi: 10.1016/j.ajog.2017.08.004.

[10] Bernet P, Gumus G, Vishwasrao S. Maternal Mortality and Public Health Programs: Evidence from Florida [J]. Milbank Q. 2020;98(1):21. DOI: 10.1111/1468-0009.12442

[11] Metz TD, Rovner P, Hoffman MC, Allshouse AA, et al. Maternal Deaths From Suicide and Overdose in Colorado, 2004-2012 [J]. Obstet Gynecol. 2016;128(6):1233-1240. DOI:10.1097/AOG.0000000000001695

[12] Thornton C, Schmied V, Dennis CL, et al. Maternal deaths in NSW (2000-2006) from nonmedical causes (suicide and trauma) in the first year following birth[J]. Biomed Res Int. 2013;2013:1-6. DOI:10.1155/2013/623743.

[13] Ray Joel G., Zipursky Jonathan, Park Alison L. Injury-related maternal mortality[J]. Am. J. Obstet. Gynecol. 2018;219(3):307-308. DOI:10.1016/j.ajog.2018.05.025

[14] World Health Organization. International statistics classification of diseases and related health problem (ICD-10), 10th rev. Geneva: World Health Organization, 1993.

[15] World Health Organization. BEYOND THE NUMBERS-Reviewing maternal deaths and complications to make pregnancy safer[M]. China Union Medical University Press, 2006.

[16] Ray JG, Zipursky J, Park AL. Injury-related maternal mortality[J]. Am. J. Obstet. Gynecol. 2018;219(3). DOI: 10.1016/j.ajog.2018.05.025

[17] The United Nations reports that steady progress has been made in reducing maternal mortality worldwide.
https://news.un.org/zh/story/2014/05/214142

[18] ZHOU Hong-ying, DENG Feng, LV Ju-hong. Analysis on the changes of maternal mortality in China from 1991 to 2016. Chinese jounal of family palmning & gynecotokology. 2019;11(6):34-37. DOI: 10.3969/j.issn.1674-4020. 2019. 06. 10

[19] Hu Huihui. Causes and preventive measures of high suicide rate of rural women. Legal System and Society, 2012(11): 11-182.

[20] Chen Jian, Peng Lu. The main characteristics and intervention measures of suicide behavior of rural women in China. Social Work and Management, 2017,17 (5): 12-17.

[21] Xiang L, Wang K, Miao L, et al. Injury-related mortality among children younger than 5 years in China during 2009-2016: an analysis from national surveillance system[J]. Inj. Prev. 2019;25(1):60-66. DOI: 10.1136/injuryprev-2018-042853

[22] Koch E, Romero T, Romero C, et al. Impact of education, income and chronic disease risk factors on mortality of adults: does ‘a pauper-rich paradox’ exist in Latin American societies? [J] Public Health. 2010;124(1):39-48. DOI:10.1016/j.puhe.2009.11.008

[23] You F, Hou K, Wang R, et al. Maternal mortality in Henan Province, China: changes between 1996 and 2009[J]. Plos One. 2012;7(10):e47153. DOI: 10.1371/journal.pone.0047153

[24] Xu Zhibing, Liang Yanling. Analysis of Maternal Mortality in Yunfu City from 2000 to
2010 [J]. Chinese medical science.2012,2(12) : 122-123,144.

[25]Zhu Jun, Liang Juan. Reduce maternal mortality to achieve the development goal of the
year before last [J]. Chinese Journal of Preventive Medicine.2011;3(7):8.

[26] National Maternal and Child Health Surveillance Office. Analysis report on the main
results of the National Maternal and Child Health Surveillance Network in 2013(2013) [C].2013.

[27] V. Schmied, M. Johnson, N. Naidoo et al. Maternal mental health in Australia and New
Zealand: a review of longitudinal studies [J]. Women Birth 2013 ;26(3)167-178.
DOI: 10.1016/j.wombi.2013.02.006

[28]JingJun, WuXueya, ZhangJie. Research on the Migration of Rural Women and the
Decline of Chinese Suicide Rate [J]. China Agricultural University Journal of Social Sciences
Edition.2010;27(4):20-31.

[29]World Health Organization. Suicide Prevention. (2010 -07-31).
http://www.who.int/mental-health

[30]Hendin H, et al. Suicide and Suicide Prevention in Asia. Geneva: World Health
Organization, 2008

[31] Birgisdottir H, Bjarnadottir RI, Kristjansdottir K, et al. Maternal deaths in Iceland over
25 years [J]. Acta Obstet Gynecol Scand. 2016;95(1):74-78.DOI: 10.1111/aogs.12797

[32] Goldman-Mellor S, Margerison CE. Maternal drug-related death and suicide are leading
causes of postpartum death in California [J]. Am. J. Obstet. Gynecol. 2019;221(5):489e1-9. DOI:
10.1016/j.ajog.2019.05.045

[33] Sirin H, Weiss HB, Sauber-Schatz EK, Dunning K. Seat belt use, counseling and
motor-vehicle injury during pregnancy: results from a multi-state population-based survey [J].
Matern Child Health J. 2007; 11:505–10.

[34] Sakamoto J, Michels C, Eisfelder B, et al. Trauma in Pregnancy. Emerg[J]. Med. Clin.
North Am. 2019 May;37(2):147-160.DOI: 10.1016/j.emc.2019.01.009

[35] Gao Tianzhu. Research on Traffic Accident Regulation Analysis and Preventive
Measures of China[D]. Chang’an University, Xi’an, China. 2014.

[36] Chu W, Wu C, Atomo C, et al. Traffic climate, driver behaviour, and accidents
involvement in China [J]. Accid Anal Prev. 2019;122:119-126.
DOI: 10.1016/j.aap.2018.09.007

[37] Vladutiu CJ, Marshall SW, Poole C, et al. Adverse pregnancy outcomes following
motor vehicle crashes [J]. Am J Prev Med. 2013;45(5):1-12.
DOI: 10.1016/j.amepre.2013.06.018
| Year | Pregnancy-related mortality (/100000) | Maternal mortality (/100000) | Number of accidental deaths | Accident death rate (/100000) | Accidental death / pregnancy-related death (%) |
|------|--------------------------------------|-----------------------------|-----------------------------|-------------------------------|-----------------------------------------------|
| 2009 | 30.2                                 | 27.1                        | 24                          | 3.1                           | 10.2                                          |
| 2010 | 33.0                                 | 30.2                        | 22                          | 2.8                           | 8.4                                           |
| 2011 | 23.6                                 | 21.5                        | 17                          | 2.1                           | 9.0                                           |
| 2012 | 24.1                                 | 21.8                        | 19                          | 2.3                           | 9.4                                           |
| 2013 | 20.1                                 | 18.4                        | 14                          | 1.7                           | 8.5                                           |
| 2014 | 24.1                                 | 20.4                        | 29                          | 3.7                           | 15.4                                          |
| 2015 | 21.0                                 | 17.5                        | 27                          | 3.5                           | 16.5                                          |
| 2016 | 22.6                                 | 18.9                        | 30                          | 3.8                           | 16.7                                          |
| 2017 | 20.4                                 | 17.5                        | 24                          | 2.9                           | 14.1                                          |
| 2018 | 17.9                                 | 15.0                        | 20                          | 2.8                           | 15.9                                          |
| 2019 | 11.5                                 | 9.5                         | 13                          | 2.1                           | 17.8                                          |
| Total| 22.8                                 | 20.0                        | 239                         | 2.8                           | 12.2                                          |

Mean ± standard deviation

| Cochran-Armitage trend test Z value | P-values* |
|------------------------------------|-----------|
| -8.804                             | < 0.001   |
| -9.5919                            | < 0.001   |
| 0.5242                             | 0.6001    |

Note: *P-values were assessed as two-tailed.
Table 2 Classification of causes of accidental death of pregnant and lying-in women

| Classification                  | N  | Percentage(%) | Mortality rate (/ 100000) |
|---------------------------------|----|---------------|---------------------------|
| 1.Intentional self-harm         | 85 | 35.6          | 1.0                       |
| Among them: taking poison / pesticide | 25 | 10.5          | 0.3                       |
| Jump off a building             | 16 | 6.7           | 0.2                       |
| Jump into the river             | 30 | 12.6          | 0.3                       |
| Hang oneself                    | 4  | 1.7           | 0.0                       |
| Others                          | 10 | 4.2           | 0.1                       |
| 2.Transport accident            | 72 | 30.1          | 0.8                       |
| 3.Accidental poisoning / overdose| 19 | 7.9           | 0.2                       |
| Among them: CO moderate         | 17 | 7.1           | 0.2                       |
| Food poisoning                  | 1  | 0.4           | 0.0                       |
| Accidental use of pesticides    | 1  | 0.4           | 0.0                       |
| 4. Assault/homicide             | 13 | 5.4           | 0.2                       |
| 5.Others                        | 50 | 20.9          | 0.6                       |
| Total                           | 239| 100           | 2.8                       |

Table 3 Accident occurrence of pregnant and lying-in women in urban and rural areas

| Year    | Urban live birth | Rural live birth | Urban Number of accidental deaths | Urban Accident death rate (/ 100000) | Rural Number of accidental deaths | Rural Accident death rate (/ 100000) |
|---------|------------------|------------------|-----------------------------------|--------------------------------------|-----------------------------------|-------------------------------------|
| 2009    | 255649           | 528377           | 5                                 | 2.0                                  | 19                                | 3.6                                 |
| 2010    | 263350           | 534552           | 7                                 | 2.7                                  | 15                                | 2.8                                 |
| 2011    | 267356           | 538004           | 2                                 | 0.7                                  | 15                                | 2.8                                 |
| 2012    | 279088           | 559886           | 5                                 | 1.8                                  | 14                                | 2.5                                 |
| 2013    | 272312           | 549043           | 4                                 | 1.5                                  | 10                                | 1.8                                 |
| 2014    | 266739           | 513835           | 5                                 | 1.9                                  | 24                                | 4.7                                 |
| 2015    | 274312           | 506754           | 6                                 | 2.2                                  | 21                                | 4.1                                 |
| 2016    | 280271           | 515128           | 7                                 | 2.5                                  | 23                                | 4.5                                 |
| 2017    | 304202           | 530753           | 8                                 | 2.6                                  | 16                                | 3.0                                 |
| 2018    | 258183           | 447341           | 7                                 | 2.7                                  | 13                                | 2.9                                 |
| 2019    | 248782           | 383679           | 2                                 | 0.8                                  | 11                                | 2.9                                 |
| Total   | 2970244          | 5604352          | 58                                | 2.0                                  | 181                               | 3.2                                 |
Table 4 Composition of causes of accidental death of pregnant and lying-in women in Hunan Province from 2009 to 2019

| Classification                  | Urban | Rural |
|---------------------------------|-------|-------|
|                                 | Number of accidental deaths | Accident death rate (/ 100000) | Number of accidental deaths | Accident death rate (/ 100000) |
| 1. Intentional self-harm        | 21    | 0.7   | 64    | 1.1   |
| Among them: taking poison / pesticide | 2    | 0.1   | 23    | 0.4   |
| Jump off a building             | 7     | 0.2   | 9     | 0.2   |
| Jump into the river             | 8     | 0.3   | 22    | 0.4   |
| Hang oneself                    | 0     | 0.0   | 4     | 0.1   |
| Others                          | 4     | 0.1   | 6     | 0.1   |
| 2. Transport accident           | 14    | 0.5   | 58    | 1.0   |
| 3. Accidental poisoning / overdose | 2    | 0.1   | 17    | 0.3   |
| Among them: CO moderate         | 2     | 0.1   | 15    | 0.3   |
| Food poisoning                  | 0     | 0.0   | 1     | 0.0   |
| Accidental use of pesticides    | 0     | 0.0   | 1     | 0.0   |
| 4. Assault/homicide             | 3     | 0.1   | 10    | 0.2   |
| 5. Others                       | 18    | 0.6   | 32    | 0.6   |
| **Total**                       | **58**| **2.0**| **179**| **3.2**|

Note: *There were 3 cases of accidental deaths in rural areas. The classification of accidental deaths is not clear.*
Table 5 Demographic characteristics and Obstetric characteristics of accidental deaths of pregnant women in Hunan Province from 2009 to 2019

### Demographic characteristics

| Age in years | Project | N  | Percent (%) | Degree of education                  | Project | N  | Percent (%) |
|--------------|---------|----|-------------|--------------------------------------|---------|----|-------------|
| 1. ≤19       |         | 8  | 3.4         | 1. College or above                   |         | 23 | 9.6         |
| 2. 20–24     |         | 60 | 25.1        | 2. High school or technical secondary school |         | 49 | 20.5        |
| 3. 25–29     |         | 88 | 36.8        | 3. Junior middle school                |         | 120| 50.2        |
| 4. 30–34     |         | 54 | 22.6        | 4. Primary school                     |         | 21 | 8.8         |
| 5. 35–39     |         | 22 | 9.2         | 5. Illiterate                         |         | 19 | 8           |
| 6. > 40      |         | 6  | 2.5         | 6. Unknown                            |         | 7  | 2.9         |
| 7. Unknown   |         | 1  | 0.4         |                                       |         |    |             |

### Annual per capita income of family

| Urban and rural areas | Project | N  | Percent (%) |
|-----------------------|---------|----|-------------|
| 1. Urban              |         | 58 | 24.3        |
| 2. Rural              |         | 179| 74.9        |
| 3. Unknown            |         | 2  | 0.8         |
| 4. Unknown            |         | 40 | 16.7        |

### Obstetric characteristics

| Whether or not to give birth | Project | N  | Percent (%) |
|------------------------------|---------|----|-------------|
| 1. Undelivered               |         | 178| 74.5        |
| 2. Delivery                  |         | 61 | 25.5        |

| Delivery mode               | Project | N  | Percent (%) |
|------------------------------|---------|----|-------------|
| 1. Natural birth            |         | 24 | 39.3        |
| 2. Cesarean section         |         | 30 | 49.2        |

| Gestational week for first examination | Project | N  | Percent (%) |
|---------------------------------------|---------|----|-------------|
| 1. Within 12 weeks                    |         | 178| 74.5        |

| Diagnostic basis of cause of death   | Project | N  | Percent (%) |
|--------------------------------------|---------|----|-------------|
| 1. Clinical                           |         | 123| 51.5        |

| The number of antenatal examinations of parturients who have given birth | Project | N  | Percent (%) |
|-----------------------------------------------------------------------|---------|----|-------------|
| 1. <5                                                                  |         | 6  | 9.8         |
| 2. ≥5                                                                  |         | 45 | 73.8        |

| No antenatal examination | Project | N  | Percent (%) |
|--------------------------|---------|----|-------------|
| 3. No antenatal examination |         | 1  | 1.6         |

| Unknown                  | Project | N  | Percent (%) |
|--------------------------|---------|----|-------------|
| 4. Unknown               |         | 9  | 14.8        |
STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

| Item No | Recommendation | Page No |
|---------|----------------|---------|
| **Title and abstract** | 1  
(a) Indicate the study’s design with a commonly used term in the title or the abstract | P1/P3 |
| |  
(b) Provide in the abstract an informative and balanced summary of what was done and what was found | P3 |
| **Introduction** | 2  
Explain the scientific background and rationale for the investigation being reported | P4-5 |
| **Objectives** | 3  
State specific objectives, including any prespecified hypotheses | P3 |
| **Methods** | 4  
Present key elements of study design early in the paper | P6 |
| | 5  
Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | P6-7 |
| | 6  
(a) Give the eligibility criteria, and the sources and methods of selection of participants | P6-7 |
| | 7  
Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | P6-7 |
| | 8*  
For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | P5-7 |
| | 9  
Describe any efforts to address potential sources of bias | P7 |
| | 10  
Explain how the study size was arrived at | P6 |
| | 11  
Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | P6-7 |
| | 12  
(a) Describe all statistical methods, including those used to control for confounding | P7 |
| |  
(b) Describe any methods used to examine subgroups and interactions | NA |
| |  
(c) Explain how missing data were addressed | NA |
| |  
(d) If applicable, describe analytical methods taking account of sampling strategy | NA |
| |  
(e) Describe any sensitivity analyses | NA |
| **Results** | 13*  
(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | P7 |
| |  
(b) Give reasons for non-participation at each stage | NA |
| |  
(c) Consider use of a flow diagram | NA |
| | 14*  
(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | P10-11 |
| |  
(b) Indicate number of participants with missing data for each variable of interest | P17 |
| **Outcome data** | 15*  
Report numbers of outcome events or summary measures | P7 |
| **Main results** | 16  
(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | NA |
(b) Report category boundaries when continuous variables were categorized

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |

**Discussion**

| Key results | 18 | Summarise key results with reference to study objectives | P9 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | P12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | P9-11 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | P9-11 |

**Other information**

| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | P1 |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.