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# Suicide rates in Zhejiang Province, China, from 2006 to 2016: a population-based study

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► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/jech-2018-211556>).

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Received 1 September 2018

Revised 18 February 2019

Accepted 10 March 2019

Published Online First

16 April 2019

## ABSTRACT

**Background** We investigated the current temporal trends of suicide in Zhejiang, China, from 2006 to 2016 to determine possible health disparities in order to establish priorities for intervention.

**Methods** We collected mortality surveillance data from 2006 to 2016 from the Zhejiang Chronic Disease Surveillance Information and Management System from the Zhejiang Provincial Centre for Disease Control and Prevention. We estimated region-specific and gender-specific suicide rates using joinpoint regression analyses to determine the average annual percentage change (AAPC) and its 95% CI.

**Results** The crude suicide rate declined from 9.64 per 100 000 people in 2006 to 4.86 per 100 000 in 2016, and the age-adjusted suicide rate decreased from 9.74 per 100 000 in 2006 to 4.14 per 100 000 in 2016. During 2006–2013, rural males had the highest suicide rate, followed by rural females, urban males, and urban females, while after 2013, urban males suicide rates surpassed rural female suicide rates, and became the second highest suicide rate subgroup. The rate of suicide declined in all region-specific and/or gender-specific subgroups except among urban males between 20 and 34 years of age. Their age-adjusted suicide rate AAPC greatly increased to 28.39 starting in 2013 compared with an AAPC of –13.47 from 2006 to 2013.

**Conclusions** The suicide rate among young urban males has been alarmingly increasing since 2013, and thus, researchers must develop targeted effective strategies to mitigate this escalating loss of life.

## INTRODUCTION

Suicide is a major public health issue with close to 800 000 people globally suicide each year, and 78% of all suicide deaths occur in low-income and middle-income countries.<sup>1</sup> Suicide deaths in China account for an estimated 22% of global suicides.<sup>2</sup>

Suicide is the third-most common cause of injury death in China.<sup>3</sup> In order to develop effective strategies to reduce the high suicide rate, researchers have focused on determining possible aetiological causes. Previous researchers have found a unique pattern of suicide rates in China; suicide rates in rural areas are higher compared with suicide rates in urban area.<sup>4 5</sup> In addition, the suicide rate was previously substantially higher among young rural females than any other category; this high suicide rate among young rural females attracted significant global attention.<sup>4 6</sup> In recent years, researchers have found dramatic decreases in the suicide rates among the rural population, especially among young rural

females, but less pronounced decreases in the suicide rates among the urban population, young males and older populations.<sup>7–11</sup> Studies have suggested that economic growth, urbanisation, increased employment rates and more educational opportunities for the rural population have contributed to the reductions in the suicide rates in China.<sup>7 12</sup>

Over the last few decades, China has experienced rapid economic growth and significant sociocultural changes including substantial rural-to-urban migration and increased life satisfaction.<sup>13</sup> Although recent studies have suggested that the suicide rate in China has significantly declined, some researchers have warned that the positive impact of urbanisation and economic prosperity on the decline of suicide rates has stagnated in recent years.<sup>14</sup> Thus, we investigated the current temporal trends of suicide in Zhejiang, China, to identify possible health disparities in order to develop priorities for intervention.

## METHODS

### Research location and data source

This study was conducted in Zhejiang province, which is located on the southeast coast of the Yangtze River Delta, and Zhejiang is a dynamic and prosperous province in mainland China. The province contains 90 districts and 47.7 million people, with a Gross Domestic Product (GDP) of 4725.13 billion Chinese RMB in 2016.<sup>15</sup> The Zhejiang Provincial Centre for Disease Control and Prevention (CDC) established the Zhejiang Chronic Disease Surveillance Information and Management System in 2001.<sup>16</sup> This system contains 30 representative surveillance districts (12 urban areas and 18 rural areas) and includes 16.6 million residents covering 34.8% of the Zhejiang Province population. The surveillance sample sites were selected through stratified cluster randomised sampling.<sup>16</sup>

We extracted mortality data from 2006 to 2016 from the Zhejiang Chronic Disease Surveillance Information and Management System. The surveillance system data were based on death certificates completed by local hospital staff or by a community doctor if the death occurred outside of a hospital, and the certificate would include information on demographics and cause of death. Once the death record was inputted into the surveillance system, the Zhejiang CDC staff would further confirm the information. In addition, a month following the death of the individual, the community general medical practitioner would also confirm the record information. Causes of death were coded based on the



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**To cite:** Fei F, Liu H, I Leuba S, et al. *J Epidemiol Community Health* 2019;**73**:745–749.

International Classification of Diseases, 10th Revision (ICD-10), and the ICD-10 codes for suicide are X60–X84.

Every 3 years, the Zhejiang CDC conducts an under-reporting survey to determine the amount of under-reporting in mortality rates. In order to avoid potential bias caused by under-reporting in our data source, we adjusted crude mortality rates by the corresponding under-reporting rate through dividing the crude suicide rate by one minus the corresponding under-reporting rate.<sup>17</sup> As this Zhejiang CDC survey was conducted every 3 years, we used the latest under-reporting rate in order to adjust for the specific year (ie, for 2006, we adjusted by the under-reporting rate found in 2004; for 2007, 2008 and 2009, we adjusted by the under-reporting rate found in 2007, etc). Thus, in the following analysis, all suicide rates including reported crude rates have been adjusted for this under-reporting rate in order to prevent bias.

### Data analysis

All the suicide rates were expressed as the number of suicides per 100 000 people (1/100 000), and we excluded all deaths among those between 0 and 4 years of age. We also adjusted mortality rates by the corresponding under-reporting rate in order to determine accurate crude mortality rates. We obtained the age distribution of the Chinese population from the 2010 census and used this age distribution as the standard population when calculating age-adjusted mortality rates.

We then used joinpoint regression analysis to estimate possible changes from 2006 to 2016 in (1) crude total suicide rates; (2) age-adjusted total suicide rates; (3) age-adjusted region-specific suicide rates; (4) age-adjusted gender-specific suicide rates; (5) age-adjusted region-specific and gender-specific suicide rates; (6) crude suicide rates among urban males by age and (7) age-adjusted suicide rates among urban male by age.<sup>18 19</sup> We estimated the average annual percentage change (AAPC) in suicide rates and its 95% CI from joinpoint regression software to analyse the trend of suicide mortality rates in Zhejiang province. Statistical analysis was conducted in Joinpoint Regression Program (V4.6.0.0, National Cancer Institute, USA), and all testing was two-sided with statistical significance set at  $\alpha=0.05$ .

## RESULTS

### Total suicide rates from 2006 to 2016

The crude total suicide rate in Zhejiang province decreased from 9.64/100 000 in 2006 to 4.86/100 000 in 2016, with an AAPC of  $-6.37$  (95% CI  $-7.40$  to  $5.32$ ). The age-adjusted total suicide rate decreased from 9.74/100 000 in 2006 to 4.14/100 000 in

2016, with an AAPC of  $-7.84$  (95% CI  $-8.88$  to  $6.78$ ; table 1 and online supplementary table 1).

### Trends of region-specific and/or gender-specific suicide rates from 2006 to 2016

We first examined age-adjusted suicide rates specific to region or gender. We found that the age-adjusted suicide rate is higher among rural individuals compared with urban individuals and is also higher among males than among females. In addition, while region-specific or gender-specific suicide rates are decreasing in all categories, the decline is less pronounced among urban populations compared with among rural populations (online supplementary figures 1 and 2).

We further subdivided the study population into four groups according to region and gender (ie, rural females, urban females, rural males and urban males) to determine the age-adjusted region-specific and gender-specific suicide rate. We found that from 2006 to 2013, rural males had the highest age-adjusted suicide rate, followed by rural females, urban males and then urban females (figure 1).

Among all four subdivisions, their specific suicide rate declined from 2006 to 2016, and the suicide rate among rural females had the most pronounced decline. However, the decline in suicide rate among urban males had become increasingly stagnant beginning in 2011 (figure 1), and in 2013, urban male suicide rates surpassed rural female suicide rates and became the second highest suicide rate subgroup. We further examined the suicide rates among urban males in order to elucidate potential causes for the less pronounced decrease in urban male suicide rates from 2011 to 2016.

### Crude suicide rates among urban males by age

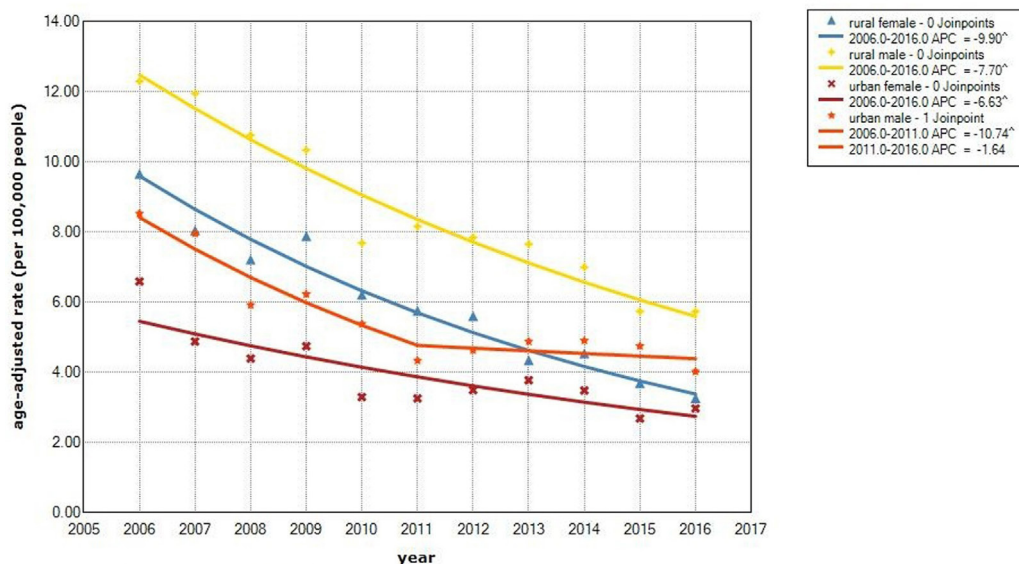
We grouped urban males into five age categories: 5–19 years, 20–34 years, 35–44 years, 45–59 years and 60 years and older. As shown in figure 2, the crude suicide rates decreased among all urban males from 2006 to 2016 except among those between 20 and 34 years of age. After 2013, the AAPC of crude suicide rates among urban males between 20 and 34 years of age increased to 28.99 during 2013–2016 compared with their previous AAPC of  $-13.92$  during 2006–2013.

### Age-adjusted suicide rates among urban males by age

We then calculated the age-adjusted suicide rates from 2006 to 2016 for the five age categories listed above (figure 3). The age-adjusted suicide rates declined among all age groups from

**Table 1** Region-specific and gender-specific crude and age-adjusted suicide rates from 2006 to 2016 (/10<sup>5</sup>)

Year	Rural females		Rural males		Urban females		Urban males		All	
	Crude	Age-adjusted	Crude	Age-adjusted	Crude	Age-adjusted	Crude	Age-adjusted	Crude	Age-adjusted
2006	9.58	9.66	11.18	12.30	7.19	6.59	8.71	8.53	9.64	9.74
2007	8.04	8.05	11.09	11.94	5.31	4.88	8.48	7.96	8.80	8.69
2008	7.23	7.22	10.17	10.76	4.76	4.40	6.10	5.92	7.51	7.41
2009	8.43	7.89	10.40	10.34	5.29	4.75	6.56	6.23	8.13	7.67
2010	6.81	6.22	7.97	7.69	3.58	3.30	5.65	5.38	6.36	5.92
2011	6.18	5.76	8.36	8.16	3.49	3.26	4.49	4.34	6.03	5.73
2012	5.99	5.61	8.06	7.84	3.79	3.50	4.73	4.63	5.98	5.69
2013	4.67	4.35	7.83	7.66	4.12	3.78	4.97	4.89	5.65	5.36
2014	4.86	4.54	7.17	7.00	3.68	3.48	5.00	4.91	5.42	5.18
2015	4.39	3.70	6.53	5.74	3.21	2.69	5.48	4.75	5.08	4.35
2016	3.97	3.27	6.53	5.73	3.55	2.97	4.68	4.03	4.86	4.14



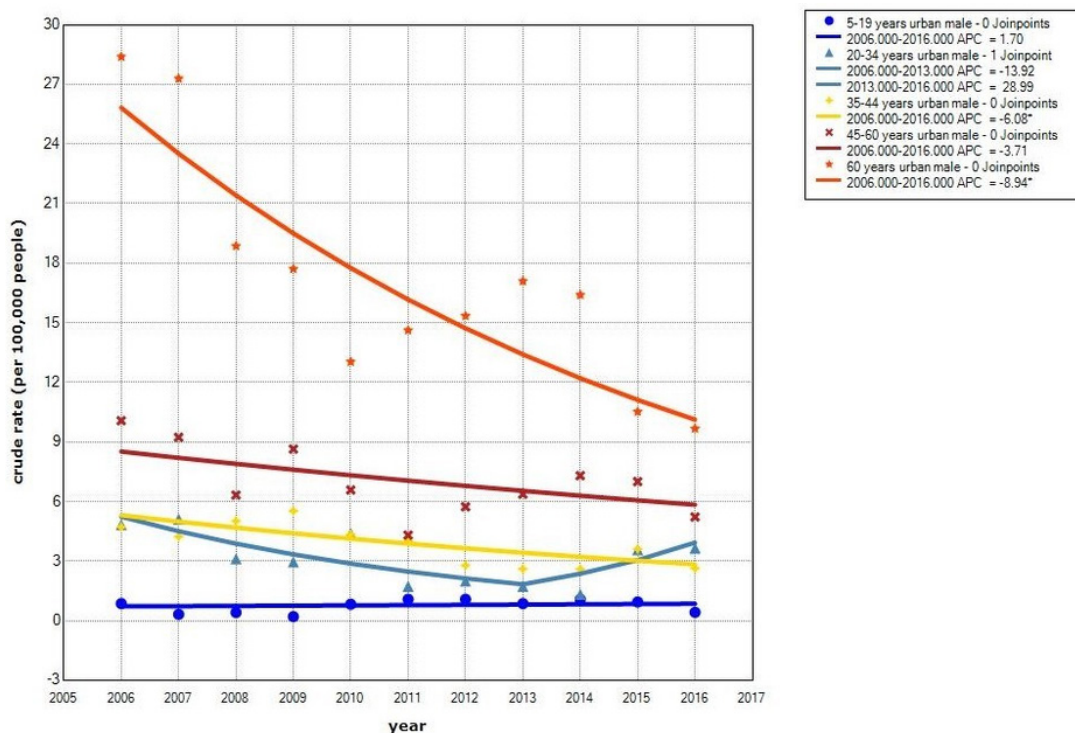
**Figure 1** Age-adjusted suicide rates by region and gender from 2006 to 2016.

2006 to 2016 except for among urban males aged 20–34 years; these age-adjusted suicide rates decreased from 2006 to 2013 (AAPC=−13.47), while increased from 2013 to 2016 (AAPC=28.39). Consistent with the results found in crude suicide rate analysis, the age-adjusted suicide rates among urban males aged 20–34 years had an increase in AAPC beginning in 2013 (figure 3b).

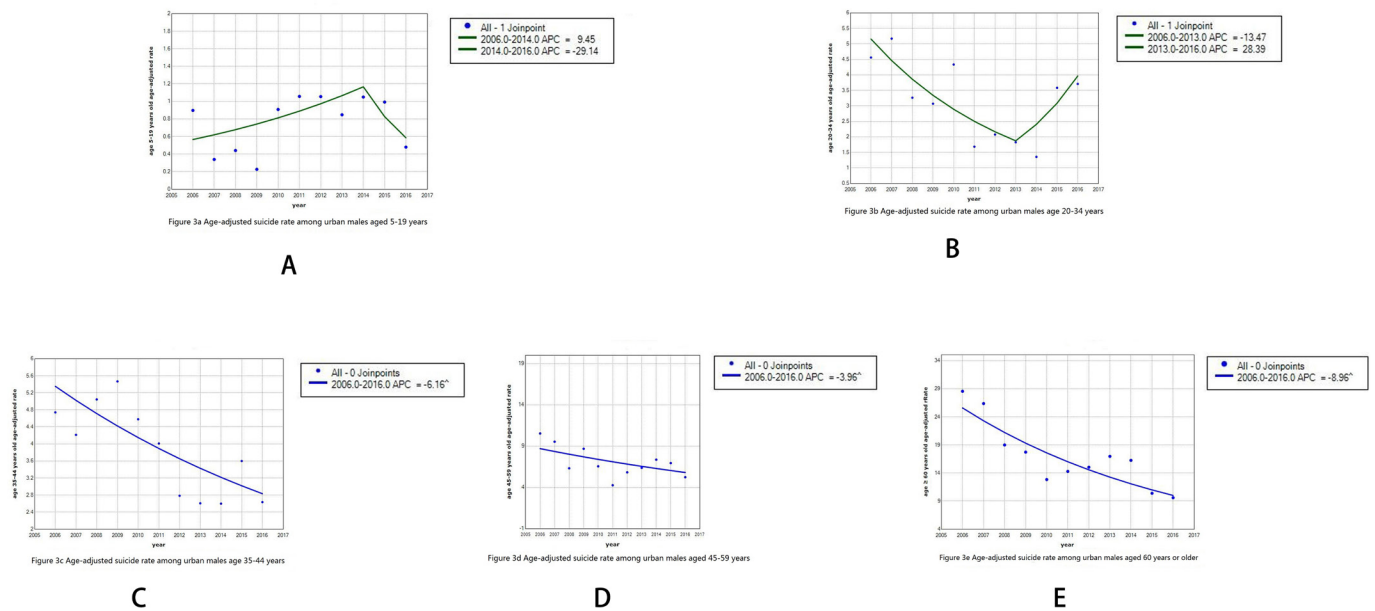
### DISCUSSION

Over the past few decades, the official national suicide rate in China has dramatically declined from 24.3/100 000 in 1997 to 6.75/100 000 in 2015.<sup>5 8 20 21</sup> In the last several decades, research has focused on the exceptionally high suicide rate among rural

individuals in China, but recently, studies have shown a dramatic decrease in suicide rates, especially among rural communities.<sup>7 8</sup> Our results have also found that the suicide rates in the rural population have declined over recent years. In Zhejiang province, the age-adjusted suicide rate among rural females has declined from 9.66/100 000 in 2006 to 3.27/100 000 in 2016, and the age-adjusted suicide rate among rural males has decreased from 12.30/100 000 in 2006 to 5.73/100 000 in 2016. Previous studies have attributed this rapid decline in suicide rates among the rural community to economic growth, increased employment rates and more educational opportunities for the rural population.<sup>7 8</sup> In addition, suicide rates among the urban community have also declined from 2006 to 2016. In



**Figure 2** Crude suicide rates among urban males based on age from 2006 to 2016.



**Figure 3** Age-adjusted suicide rates among urban males by age.

Zhejiang province, the age-adjusted suicide rate among urban females has decreased from 6.59/100 000 in 2006 to 2.97/100 000 in 2016, and the age-adjusted suicide rate among urban males has declined from 8.53/100 000 in 2006 to 4.03/100 000 in 2016. Suicide rate in Zhejiang province is much lower than

inland province like Hubei province, where suicide rate could reach as high as 19.7/100 000 in the year of 2013.<sup>22</sup>

Unlike previous publications, we found that the decline in the suicide rate among urban males has become more gradual since 2011, to the extent that in 2013, the age-adjusted suicide rate among urban males surpassed the age-adjusted suicide rate among rural females and continued to be higher in subsequent years. As Zhejiang province is the fourth highest GDP in China,<sup>23</sup> the economic in Zhejiang is more prosperous than other provinces, further studies are needed to find out whether this is the reason why we have different suicide patterns compared with other provinces.

We then subdivided urban males into five age categories and determined that specifically the suicide rate among urban males aged between 20 and 34 years alarmingly began increasing starting in 2013, resulting in the stagnation of the decline in the overall urban male suicide rate. One possible causes of this phenomenon might because males were more likely use aggressive method in suicide behaviour, resulting to more suicide completions.<sup>24</sup> In addition, increased feelings of stress and anxiety caused by urbanisation-driven social, economic and occupational changes may have led to this increase in the suicide rate among Zhejiang province urban males aged between 20 and 34 years.<sup>25-28</sup> Economic growth might be another possible cause of the increasing suicide rate among young urban males; some researchers have found that economic changes may adversely affect mental health.<sup>29</sup> Previous researchers have found that suicide rates are positively correlated with economic activity, increase during economic upswings and are higher in wealthier areas.<sup>30 31</sup>

Previous researchers have also found that the highest suicide rates are among rural populations and have focused on decreasing the suicide rates among rural females, the middle aged and the elderly.<sup>7-11</sup> However, our study found increase in suicide rates among young urban males. In order to address this alarming increase in suicide rates, tailored social preventive measures must be developed and implemented in Zhejiang province.

There are several limitations of our study, first, as the Zhejiang Chronic Disease Surveillance Information and Management

**What is already known on this subject**

- ▶ We identified 64 relevant articles and found that suicide rates were higher among rural females than rural males in the past but have reversed in recent years.
- ▶ The overall suicide rate in China has decreased rapidly over the past several decades, and researchers have attributed this decrease to China’s swift social and economic development including increased employment rates and better educational opportunities.
- ▶ The suicide rates among the middle-aged and among the elderly are high but are also decreasing.

**What this study adds**

- ▶ We found that age-adjusted suicide rates were declining stably among all region and gender categories except for among urban males whose decline in suicide rate stagnated in recent years.
- ▶ The suicide rate among urban males aged between 20 and 34 years has actually been increasing. From 2013 to 2016, the age-adjusted suicide rate among urban males between 20 and 34 years of age had an average annual percentage change (AAPC) of 28.39, which is much higher compared with the previous AAPC of -13.47 between 2006 and 2013.
- ▶ The suicide rate among young urban males is increasing, and thus, public health researchers must develop and implement effective targeted social interventions in Zhejiang province to prevent further suicide death among young urban males.

System did not include information on the reason of suicide or the mental health status of the person who did suicide, we could not analyse potential reasons for their death in order to develop specific preventive strategies. In addition, since we did not have the data on people who did not suicide, made it is impossible for us to figure out the reason why the trend of suicide rate in young male people is different from others; we would develop further studies to find out the cause of this phenomenon.

**Acknowledgements** We would like to thank our colleagues at Zhejiang Provincial Centre for Disease Control and Prevention for sharing their data for our analysis. We also would like to thank Zuofeng Zhang for his support in the discussion and development of this paper. Finally, we would like to thank Yongfu Yu for his support in the statistical analysis and clarifying the language of the paper.

**Contributors** F-FR and L-HX conceived, designed and organised the study. Z-JM, H-RY and YM coordinated and monitored the study. F-FR and PJ collected data. F-FR, L-HX and L-YC did the analysis. F-FR, L-HX and SIL wrote the first manuscript draft and all authors contributed to the subsequent drafts and approved the final version.

**Funding** This study was supported by National Natural Science Foundation of China (NSFC No. 81602939 and No. 81201063) and Medicine and Health Care in Zhejiang Province Science and Technology Plan (grant No. 2019KY355).

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** This study was approved by the ethics committee of Zhejiang Provincial Centre for Disease Control and Prevention.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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