Socio-economic determinants of suicide rates in transforming China: A spatial-temporal analysis from 1990 to 2015

Ziyi Cai, Mengni Chen, Pengpeng Ye, and Paul S.F. Yip

Abstract

Background China has experienced dramatic social changes in the last three decades. This study aimed to investigate socio-economic factors related to suicide rates in China from 1990 to 2015, and examine how the impacts of these factors on suicide rates changed over time.

Methods Suicide rates in 31 provinces in mainland China between 1990 and 2015 were obtained from the Global Burden of Disease (GBD) Study 2019. Temporal-spatial modelling was applied to assess the effects of GDP per capita, urbanization, migration, employment, divorce, proportions of children and older adults on provincial overall, male and female suicide rates.

Findings The overall suicide rate in China declined from 18.1 /100,000 in 1990 to 8.6 /100,000 in 2015, with considerable spatial variation in the magnitude of decline across provinces. The protective effects of increasing in GDP per capita, and urbanization, on provincial suicide rate were strong in 1990 (log GDP: -3.56 [95% CI: -6.15, -0.96], urbanisation: -0.07 [-0.14, -0.01]), however these effects were negligible by 2015. The association between employment and suicide rates has shifted from positive to negative over the study period, while migration remained a constant risk factor for high suicide rates (0.04 [0.00, 0.09]).

Interpretation This study highlighted the dynamic effects of economic and social factors on suicide rates in the context of transforming China. To maintain further reductions in suicide rates cannot rely simply on improving people’s materialistic and economic conditions. A more holistic approach to improve overall population well-being is needed.

Introduction In the early 1990s, suicide was a serious public health problem in China. Approximately 300,000 Chinese people died by suicide every year, which accounted for about 40% of all suicides around the world. Compared with other countries, suicide in China in the 1990s displayed unique patterns: there were higher suicide rates for females than males; there was a large discrepancy between rural and urban suicide rates; pesticide poisoning was the leading suicide method, and there were relatively low rates of mental disorders amongst suicide decedents.

Key points

- The overall suicide rate in China declined from 18.1 /100,000 in 1990 to 8.6 /100,000 in 2015.
- The protective effects of increasing GDP per capita, and urbanization, on provincial suicide rate were strong in 1990 but negligible by 2015.
- Migration remained a constant risk factor for high suicide rates.
- A more holistic approach is needed to maintain further reductions in suicide rates.

Keywords: Suicide; China; social-economic determinants; spatial-temporal analysis
Research in context

Evidence before this study

We searched PubMed and Scopus for peer-reviewed articles published prior to 31 December 2020 using the terms “suicide rate” and “China”. Most studies in the 1990s documented the high suicide rate in China and its distinctive epidemiological pattern compared to Western countries. Since 2000, research efforts investigating suicide rates in China have increased significantly. National and regional studies have reported a dramatic reduction in suicide rates in the past decades, which was presumably related to economic prosperity and social changes in China. However, to date, there is no study reporting trends of provincial suicide rates in China nationwide, and revealing the spatial diversity within the country. Further, there are few studies comprehensively investigating socio-economic determinants of provincial suicide rates by taking a dynamic perspective, in a rapidly transforming China.

Added value of this study

Our study contributes to literature by providing a comprehensive picture of suicide rates over time, across the provinces in mainland China. It also improves analytical methods by applying a spatial and temporal analytic approach to examine the economic and social drivers of Chinese provincial trends in suicide rates. Differing from earlier studies that generally assumed that the roles of contributing factors to suicide are static, this study takes a dynamic perspective to investigate how the effects of economic and social factors have changed over the study period. Our results present evidence that initial economic prosperity and urbanisation lowered suicide rates in China, but continued economic development and urbanisation in recent years have had limited impacts. Associations between employment and suicide rates also vary by time.

Implications of all the available evidence

Improvements in living standards have contributed significantly to decreasing suicide rates in China. However, these beneficial effects have been increasingly offset by the downsides of rapid economic development and urbanisation on the mental wellness of the population. This implies that for China, and possibly other low- and middle-income countries, the effects of economic prosperity on reducing suicide rates vary with the stages of economic development. To achieve further reduction in suicide rates requires comprehensive measures to improve population mental well-being.

China has become one of the world’s fastest-growing economies, with the annual gross domestic product (GDP) growth averaging 9% in the last 30 years. The rapid growth has enabled China to help raise an estimated 800 million people out of poverty. In addition to economic growth, there have been many social changes in the country, including rapid urbanization, massive internal migration, reform of state-owned enterprise, shifting social values, and dramatic demographic transition.

Seminal work by Durkheim suggested that social regulations and integration are the two forces that would influence societal rate of suicide. He posited that economic development, accompanied by modernization, urbanization and migration should increase suicide rates, as development weakens social control over individuals, and disrupts traditional forms of social organization that produce cohesion. However, empirical studies in China have not fully supported this claim. For instance, research in Shandong province found that suicide rates declined during times of economic prosperity. Similarly, a study using nationwide data reported a negative relationship between GDP per capita and suicide rates.

Urbanisation was considered to be an important contributor to reducing suicide rates in China. In the early 1990s, there was a high rural suicide rate in China of approximately 27 per 100,000 population, with a large proportion of these suicides involving ingestion of lethal doses of pesticide. Since then, suicide rates in rural areas have decreased significantly. This may be associated with the rapid process of urbanisation that has led to the shift of labour forces from agriculture to industrial and service sectors, resulting in less access to farming-related pesticides and substantial improvement of living standards. Suicide rates in rural areas dropped by half from 1990 to 2010, this being the main driving force in the downward trend of China’s overall suicide rate over that time. However, migration was positively related to suicide rates. A study by Li et al. found that villages with higher levels of social fragmentation, indicated by migration, had higher suicide rates.

Durkheim also suggested that divorce rate and the presence of children, the indicators of social integration and family ties play an important role in influencing suicide rates. High divorce rates and fewer children in families weaken social integration, and thus suicide rates would be expected to rise accordingly. This claim has been supported in Western literature. However, in China, a negative association between divorce rates and suicide rates has been found. Being married also did not protect young rural females from suicide.

Other factors such as the labour market situation have been associated with suicide rates, but they are not well understood in Chinese society. Employment implies economic opportunities and security. Societies with high proportion of the employed are expected to have lower suicide rates. A study in all world
regions suggested that unemployment elevated the risk of suicide by 20–30%. The impacts of demographic changes, particularly population ageing on suicide rates are worth noting. From 2000 to 2012, the suicide rates in all age groups in China declined except for the oldest adults (aged 80 years and above), and the proportion of older adult suicides amongst total suicides in China has increased from 16–3% in 1987 to 41–2% in 2014.

Considering the economic and societal changes in China over the past 30 years, Durkheim’s suicide theory framework, and evidence from previous empirical investigations, we hypothesised that six domains of socio-economic changes may be potentially linked to the significant over-time change in China’s suicide rates. The domains were economic development, urbanisation, migration, labour market situation, family change and population ageing. There have been few studies systematically investigating how over-time changes in these domains relate to changes in suicide rates in China. Previous studies have mostly focused on one or two domains of social factors, and the investigations have been limited to suicide rates at national level or in “urban-rural” categories. However, China is a huge country with 1.4 billion people. There are 31 provinces located in the mainland, which are heterogeneous in terms of socio-economic development, and over-time change in suicide rates. No detailed study has investigated changing provincial suicide rates in China, taking into account their spatial patterns. Moreover, research to date has largely taken a static lens to examine socioeconomic factors related to suicide, assuming that associations would remain constant over time. However, as social contexts and values in China have changed rapidly over the past three decades, the impacts of these factors are likely to change as well. This study thus aimed to take a dynamic perspective to comprehensively examine the temporal effects of six domains of socio-economic factors on suicide rates over the period 1990 to 2015, at provincial level in mainland China.

Methods

Study design
This study applied an ecological design and analysis.

Independent variables
We selected variables that can indicate the socio-economic changes in six domains, including economic development, urbanisation, migration, labour market situation, family change and population ageing. These variables should be available at provincial-level in each five-year interval from 1990 to 2015, and can be retrieved from reliable sources.

Provincial economic development was indicated by GDP per capita, with the data obtained from the China Statistical Yearbook (in 1990, 1995, 2000, 2005, 2010, and 2015). The level of urbanisation was measured by the proportion of urban residents in the total resident population in each province at these time points, with the data from the China Population & Employment Statistics Yearbook.

Inter-provincial migration was measured by the absolute value of the discrepancy between residential population and hukou population divided by hukou population. In mainland China, hukou is a system of household registration that demonstrates individuals' household origins. The hukou population referred to the population according to their household registration under the Ministry of Public Security, while the resident population was referred to as the population residing in a place for more than six months. A larger value of inter-province migration measure indicated a higher level of migration.

www.thelancet.com Vol xx Month xx, 2021 3
The labour market situation was indicated by the proportion of employed persons, which was calculated by the proportion of employed residents in the total resident population, aged 15 years or above. Data were extracted from the China Population & Employment Statistics Yearbook in the corresponding years. Sex-specific proportions of employment were also calculated.

Family change was indicated by divorce rates and the presence of children. Divorce rates in each province were referenced as the number of divorces per 1000 married female residents. Data on the number of divorces were extracted from the China Civil Affairs’ Statistical Yearbook (in 1990, 1995, 2000, 2005, 2010, and 2015). The number of married female residents was extracted from the Population Census (in 1990, 2000, and 2010) and the China 1 per cent Population Sample Survey (in 1995, 2005, and 2015). The presence of children was measured by the proportion of children (aged under 15 years) in the total resident population, with data extracted from the Population Censuses and the China 1 per cent Population Sample Surveys.

Population ageing was indicated by the proportion of older adults (aged 65 years and over) in the total resident population. The data were obtained from the Population Censuses and the China 1 per cent Population Sample Surveys.

Analytical strategies
Our analysis contained 186 observations on suicide rates for 31 provinces at six-time points, overall, and for males and females, respectively. Suicide behaviours could be socially contagious. People contemplating suicide might adopt ‘copycat behaviours’ through exposure to other suicide deaths or media reports, and people living in near places might share similar cultures and beliefs, resulting in similar susceptibilities to suicidal behaviours.38,39 Thus, it is reasonable to expect that provincial suicide rates may be spatially correlated.

To capture the effects of socio-economic factors as accurately as possible, we attempted to control the potential impact from spatial diffusion of suicide. We adopted a spatial autoregression model (SAR model) with province- and time-fixed effects (equation shown in Appendix), because it has taken into account the spatial correlation of suicide rates, and the fixed effects approach had the capacity to remove all unobserved province- and time-specific effects. The unit of analysis in this study was the suicide rate at province level. The assumption of this model is that the suicide rate of a province is spatially clustered rather than randomly dispersed, and it is more likely to be influenced by the suicide rates of the neighbouring provinces than by provinces further away. Before applying SAR models, a test for spatial effect was conducted using Moran’s I and it showed a significant positive spatial correlation. In the SAR model, a spatial weight was introduced and constructed based on the criterion of Queen contiguity, which reflects the geographic closeness of every other province to a specific province. The test of ρ statistics was used to indicate whether the suicide rate in one province was correlated to those of neighbouring provinces. To investigate how the effects of socio-economic factors changed over time, the interactions between each factor and the year (dummy) variable were added separately to the SAR models. In the SAR model with interactions, the main effect indicated the effect of the factor of interest in the reference year. We changed the reference year consecutively to obtain the marginal effects in different years. The SAR model was performed in Stata version 16 using the XSMLE command.30

We were aware that the independent variables considered in this study might be highly correlated, thereby multicollinearity was assessed by using the variance inflation factor (VIF). The VIFs of all independent variables were less than 10, suggesting that multicollinearity would not significantly affect our estimates (shown in the Appendix).41

Role of the funding source
The study funders had no role in study design, data collection, data analysis, interpretation, or writing of the report.

Results
Trends of the provincial suicide rates in China
Based on the GBD data, the national suicide rate in China decreased from 18.1 per 100,000 persons in 1990 to 8.6 per 100,000 persons in 2015. Figure 1 illustrates the overall and sex-specific suicide rates in 31 Chinese provinces in 1990 and 2015. Location codes and suicide rate values are presented in Appendix Table 1A. In 1990, there was considerable heterogeneity of suicide rates across provinces. Most provinces with high suicide rates were located in the central part of China. In particular, Hubei (HUB) and Anhui (AH) province had the highest overall suicide rates, about 34.2 and 33.6 per 100,000 respectively. Female suicide rates in these two provinces were higher than those of males (41.4/100,000 for females, and 26.4/100,000 for males in AH; 37.7/100,000 for females, and 31.0/100,000 for males in HUB). By contrast, Beijing (BJ) had the lowest suicide rate, at 7.6 per 100,000 persons. In 2015, the spatial heterogeneity of suicide rates amongst provinces has been reduced, ranging from 3.8 per 100,000 persons in Beijing (BJ) to 22.4 in Hubei (HUB). The gender pattern of suicide rates had also changed: males now had higher suicide rates than females in all provinces.

From 1990 to 2015, overall suicide rates in all provinces decreased. As shown in Figure 2, both male and
Figure 1. The suicide rates for 31 provinces in mainland China in 1990 and 2015, overall and by sex.
| Variables                  | Overall ( Male | Female |  |
|---------------------------|----------------|--------|---|
|                          | β   | 95% CI | p  | β   | 95% CI | p  | β   | 95% CI | p  |
| Log GDP per capita        | −1.87| (−4.07, 0.33) | 0.097| −1.97*| (−3.71, −0.22) | 0.027| −1.21| (−4.44, 0.03) | 0.464|
| Urbanisation (%)          | −0.05| (−0.11, 0.01) | 0.099| 0.01| (−0.04, 0.05) | 0.804| −0.11*| (−0.20, −0.02) | 0.016|
| Migration (%)             | 0.04*| (0.00, 0.09) | 0.034| 0.05**| (0.02, 0.09) | 0.001| 0.05| (−0.01, 0.11) | 0.131|
| Employment (%)            | 0.08| (−0.10, 0.10) | 0.950| −0.01| (−0.11, 0.09) | 0.845| 0.05| (−0.06, 0.15) | 0.418|
| Divorce (%)               | 0.03| (−0.26, 0.31) | 0.849| −0.05| (−0.28, 0.18) | 0.642| 0.13| (−0.29, 0.55) | 0.533|
| Proportion of children (%)| −0.27**| (−0.45, −0.09) | 0.003| −0.21**| (−0.35, −0.07) | 0.004| −0.35*| (−0.61, −0.08) | 0.011|
| Proportion of old adults (%)| −0.14| (−0.58, 0.31) | 0.549| 0.27| (−0.08, 0.63) | 0.130| −0.54| (−1.18, 0.10) | 0.099|
| ρ                         | 0.24*| (0.05, 0.44) | 0.014| −0.01| (−0.23, 0.20) | 0.908| 0.26**| (0.07, 0.45) | 0.008|

Table 1: Results of the SAR models.

Note: * p<0.05, ** p<0.01, *** p<0.001. Urbanization refers to the proportion of urban residents in the total resident population. Migration refers to the absolute value of the discrepancy between residential population and hukou population divided by hukou population. Employment refers to the proportion of employed persons in the total resident population. Divorce refers to the divorce rate (per 1000 married women). The unit of change for urbanization, migration, employment, proportion of children, and proportion of old adults is %; the unit of change for divorce is %.

Table 2: Illustrates the relationships between factors and suicide rates over time. The coefficients of the interaction terms in the SAR models. The coefficients of the interaction terms between Log GDP per capita and urbanisation increased gradually over time for overall and female suicide rates, while male suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and migration increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and employment increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and divorce increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and proportion of children increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and proportion of old adults increased gradually over time for overall suicide rates, while female suicide rates decreased over time.

Factors affecting provincial suicide rates over the period from 1990 to 2015.

Table 3: Presents the results of the SAR model that controlled for the spatial autocorrelation coefficients ρ for the overall suicide rates, the impacts of study factors on suicide rates (Log GDP per capita, urbanisation, migration, employment, and divorce), and the spatial autocorrelation coefficients ρ for the overall suicide rates. The SAR model was estimated using the maximum likelihood method. The coefficients of the interaction terms between Log GDP per capita and urbanisation increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and migration increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and employment increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and divorce increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and proportion of children increased gradually over time for overall suicide rates, while female suicide rates decreased over time. The coefficients of the interaction terms between Log GDP per capita and proportion of old adults increased gradually over time for overall suicide rates, while female suicide rates decreased over time.

Female suicide rates decreased with the largest magnitude of decrease observed for females (female suicide rates decreased by more than 45% in all provinces). Paradoxically, in Jiangsu (P) province in females decreased by only 8%, the largest decrease in the period from 1990 to 2015. The greatest decrease in female suicide rates was by no more than 45%.
salient. There was a significant interaction between divorce and female suicide rates in 2015, as well as significant interactions between the proportion of children in the population and female suicide rates in 2005 and 2015. For migration and the proportion of older adults in the population, no significant time interactions were found (results not presented in the table, but available on request).

Based on the results of the regression models shown in Table 2, marginal effects of these factors were illustrated in Figure 3. This shows that the protective effect of GDP per capita on suicide rates was strong in 1990 ($\beta = -3.36, 95\% \text{ CI: } [-6.15, -0.96], p < 0.01$) but reduced over time and became insignificant since 2000. Similarly, the contributory role of urbanisation in reducing female suicide rates has decreased over time. In 1990, urbanisation increased by one percent, female suicide rates would decrease by 0.15 per 100,000 persons. However, in 2015, one percent increase in urbanisation increased female suicide rates by 0.02 per 100,000 persons, although this positive association hasn’t reached the significant level. We observed that employment had a positive association with suicide rates in 1990 ($\beta = 0.19, 95\% \text{ CI: } [0.02, 0.36], p < 0.05$). However, this association had reversed by 2015. Although no significant association between divorce and suicide rates was observed from 1990 to 2015, its role in affecting suicide, specifically for females, changed significantly. In 1990, divorce tended to decrease female suicide rates while it was likely to increase female suicide rates in 2015. The proportion of children showed stable protective effects on male suicide rates, while its protective effects on female suicide rates became stronger over time. The coefficients of the association between proportion of children and female suicide rates changed from -0.07 in 1990 to -0.46 in 2015.

**Discussion**

**Main finding**

This study, to the best of our knowledge, is the first that reports on an investigation of provincial suicide trends in mainland China. Suicide rates in all provinces, especially female suicide rates, decreased substantially from 1990 to 2015. Suicide was spatially contagious: an increase of suicide rates in one province appeared to diffuse into neighbouring provinces. Economic development, urbanisation, migration, and the presence of children were important determinants of suicide rates across provinces during the whole study period but there were sex-specific effects. We also found that the effects of economic development, urbanisation, employment, divorce, and presence of children were neither constant nor static. The magnitude and even direction of their effects on suicide rates changed at different time periods.
Our findings showed that economic development in China from 1990 to 2015 led to a decline of suicide rates. This result was consistent with many previous studies in China, suggesting that developing the economy to reduce poverty also reduces suicide rates. Besides, the rapid urbanisation has benefited females in...
Figure 3. Marginal effects of GDP per capita, urbanisation, employment, divorce and proportion of children, based on Table 2.
terms of reducing suicide rates. In the early 1990s, China was notorious for its high female suicide rates in rural areas. This was largely explained by limited opportunities, domestic violence and family abuse, as well as easy access to lethal pesticides. However, with acceleration of urbanization, more and more rural women who used to be confined to traditional family roles and farming lives, now had opportunities to receive education and participate in labour force markets that could help them escape from rural poverty and family conflicts. Urbanisation also reduced access to pesticides, an accepted and frequently used suicide method amongst rural females. Consistent with previous studies in other countries, we found that the presence of children, an indicator reflecting vigour and unity of the family, has a protective effect on suicide in China. By contrast, migration was found to be a risk factor: higher levels of migration led to higher suicide rates, particularly for males. This supported Durkheim’s theory, suggesting that migration might disrupt institutional continuity and existing social networks, thus reducing social integration and subsequently increasing the risk of suicide. The adverse effect of migration was larger for males, which concurs with other studies reporting that males were more likely to be affected by the disruption of social integration. Although previous studies have reported that older adults had the highest suicide rate compared with other age groups in China, we did not find a significant association between the proportion of old adults and all-age suicide rates, which may suggest that the changing age structure of the population has yet significantly influenced overall change of suicide rates in China.

We note that the impacts of some socio-economic factors for suicide changed in the context of a rapidly transforming China. Although economic development and urbanisation have contributed to a substantial decline of suicide rates, our findings indicate that their beneficial effects have decreased over time. This implies that once people’s living standards have reached a subsistence level, further improvements in materialistic and economic conditions may have a smaller effect on well-being—the diminishing marginal return of economic prosperity. Besides, the association between employment and suicide rates has changed significantly in the past 25 years. In the 1990s, employment was associated with high suicide rates, which might be due to high levels of stress that working people experienced, especially males who traditionally assumed the family breadwinner role. However, in recent years, employment has become a protective factor on suicide. Since the state-owned enterprise reforms, the “Iron Rice Bowl” guarantee of lifetime employment in the labour market was abolished, triggering massive layoffs of employers working in state-owned companies. The labour market in China now is more market-orientated and competition amongst job seekers has significantly increased. Being employed means economic security, becoming a crucial factor in maintaining well-being and protecting people from suicide. The adverse impact of divorce on increasing suicide rates amongst females has emerged over time, whilst the protective effect of the presence of children has become stronger. This indicates that family cohesion and support are playing an increasingly important role in reducing female suicide rates.

Limitations
We acknowledge limitations that might constrain interpretations of our findings. First, this is an ecological study using provincial data, and thus the findings should not be interpreted at an individual level. Second, some socio-economic effects on suicide may be age specific. However, we could not identify these effects as we applied all-age suicide rates. Third, some important factors such as Gini index, limits of access to lethal means, improvement of medical and mental care services may potentially affect suicide rates but they cannot be investigated in the current study due to the data availability. However, some of these factors may be closely related to the level of urbanisation. Cultural factors such as the acceptability of suicide may also play a role but was not covered in this study. Previous research has suggested that suicide was more likely to occur if it was viewed as a culturally acceptable way for individuals to respond to hardship. Qualitative research may be needed to explore whether culturally-specific factors may operate in some provinces with high suicide rates. Another limitation is the quality of suicide data. The data used in this study was extracted from the GBD study in China that estimated the population distribution of deaths by cause at national and province levels. As the NMS system was the main data source for GBD study to estimate suicide mortality, the accuracy of estimations was subject to the quality and reliability of suicide data from this system. The data quality in the NMS system might be less than ideal in the early years due to the limited number of surveillance points, manual data management and the lack of strict auditing and reviewing procedures. Although the GBD study team applied a series of methods that include data standardisation and redistribution of ‘garbage’ codes to adjust for variations of data quality across time and locations, how much of this can be addressed remained unknown.

Policy implications
In the past three decades, rapid economic growth and urbanization in China has contributed significantly to reducing suicide rates. However, the ongoing trajectory of China’s suicide rates is difficult to determine. We anticipate that further economic development and urbanisation in China might not necessarily lead to an ongoing decrease in the country’s suicide rates. By
contrast, the drawbacks of economic advances and modernisation lifestyles, such as income inequality, lack of job security, role conflicts and family separation due to migration may adversely affect people’s mental health, thus offsetting any advantageous effects that economic development and urbanisation have had to date, on suicide rates. How to cope with new social problems brought by the rapid social and economic changes in China is a key component of future suicide reduction strategies. The changing roles of economic development and urbanisation observed in our study provide important information for policymakers in China, as well as other low-and middle-countries. The effects of economic prosperity on reducing suicide rates may be limited to the early stages of economic development. When economic development reaches a certain level, efforts to improve overall well-being amongst population, such as launching comprehensive mental health campaigns and improving social safety nets deserve more attention.

Conclusion
This study reports the over-time effects of socio-economic factors on provincial suicide rates in mainland China between 1990 and 2015. The initially protective effects of economic development and urbanisation on suicide rates have diminished over time, while the roles of employment and family ties (indicated by marital stability and presence of children) in protecting suicide have increased. Internal migration has been a significant risk factor for suicide over the past 25 years. While maintaining socio-economic development in China, the promotion of population wellbeing economically and socially in a rapidly changing society appears to be the key to sustainably reducing China’s suicide rates into the future.

Declaration of interests
The authors declare that there are no competing interests.

Acknowledgements
We are grateful for the insightful comments of the reviewers and the support of the Humanities and Social Sciences Prestigious Fellowship Scheme (370000320) and the General Research Fund (17611619).

Editor note: The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Author contributions
Ziyi Cai: Conceptualization, Formal analysis, Methodology, Visualization, Writing-original draft, Writing-review & editing
Mengni Chen: Conceptualization, Formal analysis, Methodology, Validation, Visualization, Writing-review & editing
Pengpeng Ye: Data curation, Methodology, Writing-review & editing
Paul S. F. Yip: Conceptualization, Methodology, Visualization, Supervision, Writing-review & editing

Data sharing statement
Suicide data can be obtained through the IHME website on request (http://ghdx.healthdata.org/ihme_data).

Supplementary materials
Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.lanwpc.2021.100341.

References
1 Phillips MR, Liu H, Zhang Y. Suicide and social change in China. Calt Med Psychiatry 1999;23(1):25-50.
2 Phillips MR, Li X, Zhang Y. Suicide rates in China, 1995–99. Lancet 2002;359(929):815-40.
3 Pritchard C. Suicide in the People’s Republic of China categorized by age and gender: evidence of the influence of culture on suicide. Acta Psychiatr Scand 1996;93(1):152–7.
4 Qin P, Mortensen PB. Specific characteristics of suicide in China. Acta Psychiatr Scand 2001;103(2):117–21.
5 Yip PS, Liu KY, Hu J, Song X. Suicide rates in China during a decade of rapid social changes. Soc Psychiatry Psychiatr Epidemiol 2005;40(10):792-8.
6 Sun J, Guo X, Zhang J, Jia C, Xu A. Suicide rates in Shandong, China, 1991–2010: rapid decrease in rural rates and steady increase in male-female ratio. J Affect Disord 2013;146(1):361–8.
7 Zhang J, Ma J, Jia C. Economic growth and suicide rate changes: a case in China from 1982 to. Eur Psychiatry 2005;23(3):159-63. 2010.
8 Sha F, Yip PS, Law YW. Decomposing change in China’s suicide rate, 1990–2010: ageing and urbanisation. Int J Prev 2017;3(1):40-5.
9 Wang CW, Chan CL, Yip PS. Suicide rates in China from 2002 to 2011: an update. Soc Psychiatry Psychiatr Epidemiol 2014;49(6):929-41.
10 Leilei D, Pengpeng Y, Haaguna JA. The burden of injury in China, 1990–2017: findings from the global burden of disease study 2017. Lancet Public Health 2019;4(9): e449-e61.
11 Naghavi M, Global, regional, and national burden of suicide mortality 1990 to 2016: systematic analysis for the Global Burden of Disease Study 2016. BMJ 2019;364.
12 Chen S. Revallion M. Reconciling the conflicting narratives on poverty in China. J Dev Econ 2011;100711.
13 Sun J, Ryder AG. The Chinese experience of rapid modernization: sociocultural changes, psychological consequences? Front Physiol 2016;7.477.
14 Lin JY, Cai F, Li Z. Competition, policy burdens, and state-owned enterprise reform. Am Econ Rev 1998;88(2):422-7.
15 Wei Z, Hao R. Demographic structure and economic growth: evidence from China. J Comp Econ 2012;38(4):472-91.
16 Chen M, Rizzi EL, Yip PS. Divorce trends in China across time and space: an update. Asian Popul Stud 2017;13(2):121-47.
17 Durkheim E. Suicide: a study in sociology. Glencoe, Illinois: The Free Press; 1951 Spaulding JA and Simpson G, translator.
18 Yin H, Xu L, Shao Y, Li L, Wan C. Relationship between suicide rate and economic growth and stock market in the People’s republic of China: 2004–2013. Neuropsychiatr Dis Treat 2016;12:3119.
19 Parry J. Falling suicide rates in China mask emerging upward trends. BMJ 2014;349:g4486.
20 Page A, Liu S, Gunnell D. Suicide by pesticide poisoning remains a priority for suicide prevention in China: analysis of national mortality trends 2006–2013. J Affect Disord 2017;200:18-23.
21 Li LW, Xu H, Zhang Z, Liu J. An ecological study of social fragmentation, socioeconomic deprivation, and suicide in rural China: 2008–2010. SSM Popul Health 2016;2:165–72.

22 Inoue K. The correlation of the suicide rates with the rates of unemployment and divorce in the United States during seventeen years. Am J Forensic Med Pathol 2009;30(1):111–2.

23 Denney JT, Rogers RG, Krueger PM, Wadsworth T. Adult suicide mortality in the United States: marital status, family size, socioeconomic status, and differences by sex. Soc Sci Med 2009;69(11):1667–75.

24 Corcoran P, Nagar A. Suicide and marital status in Northern Ireland. Soc Psychiatry Psychiatr Epidemiol 2010;45(8):795–800.

25 Yip PS, Thorburn J. Marital status and the risk of suicide: experience from England and Wales, 1982–1996. Psychol Rep 2004;94(3):401–7.

26 Bhanderkar R, Shah A. Association of general population suicide rates with fertility rates: a test of fertility as a measure of social integration. Psychol Rep 2008;103(1):81–8.

27 Yip PS, Youssuf S, Chan CH, Yung T, Wu KC-C. The roles of culture and gender in the relationship between divorce and suicide risk: a meta-analysis. Soc Sci Med 2015;128:87–94.

28 Liu S, Page A, Yin P. Spatiotemporal variation and social determinants of suicide in China, 2006–2012: findings from a nationally representative mortality surveillance system. Psychol Med 2015;45(15):2559–68.

29 Zhang J. Marriage and suicide among Chinese rural young women. Soc Forces 2010;89(1):31–26.

30 Nord C, Warman I, Seifrit F, Kawohl W. Modelling suicide and unemployment: a longitudinal analysis covering 63 countries, 2000–11. Lancet Psychiatry 2015;4(1):29–41.

31 Milner A, McClure R, De Leo D. Socio-economic determinants of suicide: an ecological analysis of 35 countries. Soc Psychiatry Psychiatr Epidemiol 2012;47(1):15–27.

32 Chen Y-Y, Chen M, Lui CS, Yip PS. Female labour force participation and suicide rates in the world. Soc Sci Med 2017;195:61–7.

33 Zhong B-L, Chiu HH, Conwell Y. Elderly suicide trends in the context of transforming China, 1987–2014. Sci Rep 2016;6:1–9.

34 Zhou M, Wang H, Zeng X. Mortality, morbidity, and risk factors in China and its provinces, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2019;394(10244):1141–53.

35 Zhou M, Wang H, Zhu J. Cause-specific mortality for 240 causes in China during 1990–2017: a systematic subnational analysis for the Global Burden of Disease Study 2017. Lancet 2018;392(10103):247–72.

36 James SL, Castle CD, Dingels ZV. Estimating global injuries morbidity and mortality: methods and data used in the Global Burden of Disease 2017 study. Inj Prev 2020;26(3 Suppl 2):ii23–33.

37 Vos T, Lim SS, Abaffy C. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet 2020;396(10248):1204–22.

38 Romer D, Jamieson PE, Jamieson KH. Are news reports of suicide contagious? A stringent test in six US cities. J Comm 2006;36(1):249–70.

39 Balint I, Dome P, Daroczi G, Gonda X, Rilmer Z. Investigation of the marked and long-standing spatial inhomogeneity of the Hungarian suicide rate: a spatial regression approach. J Affect Disord 2014;155:280–5.

40 Belotti F, Hughes G, Mortari AP. Spatial panel-data models using Stata. Stata J 2017;17(1):139–80.

41 Marquandt D. You should standardize the predictor variables in your regression models. Discussion of: a critique of some ridge regression methods. J Am Stat Assoc 1983;78(382):37–91.

42 Canetto SS. Women and suicidal behavior: a cultural analysis. Am J Orthopsychiatry 2008;78(2):239–66.

43 Meng L. Rebellion and revenge: the meaning of suicide of women in rural China. Int J Soc Welf 2002;11(4):300–9.

44 Kposowa AJ, McElvain JP, Breault KD. Immigration and suicide: the role of marital status, duration of residence, and social integration. Arch Suicide Res 2005;8(1):82–92.

45 Stack S. Suicide: a 15-year review of the sociological literature part I: cultural and economic factors. Suicide Life Threat Behav 2000;30(2):149–62.

46 Wong DFK, He X, Leung G, Lau Y, Chang Y. Mental health of migrant workers in China: prevalence and correlates. Soc Psychiatry Psychiatr Epidemiol 2008;43(6):483–9.

47 Ernst M, Klein EM, Beutel ME, Brahler E. Gender-specific associations of loneliness and suicidal ideation in a representative population sample: young, lonely men are particularly at risk. J Affect Disord 2021;294:63–70.

48 Kong N, Osberg L, Zhou W. The shattered “Iron Rice Bowl”: inter-generational effects of Chinese state-owned enterprise reform. J Health Econ 2019;67:102220.

49 Wang P, VanderWeele TJ. Empirical research on factors related to the subjective well-being of Chinese urban residents. Soc Indic Res 2011;100(1):447–59.

50 Cai Z, Canetto SS, Chang Q, Yip PS. Women’s suicide in low- and middle- and high-income countries: do laws discriminating against women matter? Soc Sci Med 2021;114:035.