An integrated national mortality surveillance system for death registration and mortality surveillance, China

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Abstract In China, sample-based mortality surveillance systems, such as the Chinese Center for Disease Control and Prevention’s disease surveillance points system and the Ministry of Health’s vital registration system, have been used for decades to provide nationally representative data on health status for health-care decision-making and performance evaluation. However, neither system provided representative mortality and cause-of-death data at the provincial level to inform regional health service needs and policy priorities. Moreover, the systems overlapped to a considerable extent, thereby entailing a duplication of effort. In 2013, the Chinese Government combined these two systems into an integrated national mortality surveillance system to provide a provincially representative picture of total and cause-specific mortality and to accelerate the development of a comprehensive vital registration and mortality surveillance system for the whole country. This new system increased the surveillance population from 6 to 24% of the Chinese population. The number of surveillance points, each of which covered a district or county, increased from 161 to 605. To ensure representativeness at the provincial level, the 605 surveillance points were selected to cover China’s 31 provinces using an iterative method involving multistage stratification that took into account the sociodemographic characteristics of the population. This paper describes the development and operation of the new national mortality surveillance system, which is expected to yield representative provincial estimates of mortality in China for the first time.

Introduction

Reliable and timely information on cause-specific mortality is fundamental for informing the development, implementation and evaluation of health policy.1,2 China has yet to establish a complete vital registration system for its 1.3 billion population. To date, the essential data on the causes of death in China used for decision-making and performance evaluation have come from sample-based mortality surveillance systems, including the nationally representative disease surveillance points system of the Chinese Center for Disease Control and Prevention (CDC) and the vital registration system of the Chinese Ministry of Health.3

The disease surveillance points system was established in 1978 with a pilot study at two surveillance points in Beijing.4 By 1990, the number of points had increased to 145 and the population covered was approximately 10 million.14 In 2004, the system was expanded again to include 161 points and population coverage increased to 73 million. The sampling strategy and the characteristics of this system have been described in detail elsewhere along with the quality control measures and the procedures for collecting data, coding the cause of death and determining the underlying cause of death.5,6 For deaths in hospital, doctors certified the cause of death and trained coders determined the underlying cause of death by applying the rules of the International Classification of Diseases.6 For hospitals without the capacity to determine or code the underlying cause of death, these functions were carried out by the county or district CDC. For deaths occurring outside hospital, village health workers or township or community hospital staff did a verbal autopsy from which doctors in these hospitals determined the underlying cause of death. Since 2008 information on individual deaths in all population catchment areas has been reported in real time using an Internet-based reporting system.7 In this system, information on each death is systematically validated by local – including county, prefecture and provincial level – Centers for Disease Control and Prevention, which also check the completeness, coding and internal logic of the items reported on death certificates. Causes-of-death are subsequently reported to the national CDC, where data are consolidated.

The Chinese vital registration system was established in the 1950s to collect mortality data in 13 cities. By 2000, the population under surveillance was around 110 million and the system covered 15 large cities, 21 medium-sized or small cities and 90 counties drawn from 15 provinces and municipalities.8 By 2012, the system had expanded to include 319 sites (138 counties and 181 districts) in 22 provinces covering about 230 million people, mostly in eastern and central areas of the country. Forty-two counties in the vital registration system overlapped with population catchments in the disease surveillance points system. The collection of cause-of-death data in the vital registration system was similar to the disease surveillance points system. Data on deaths were compiled according to predetermined aggregation principles and reported monthly by electronic file transfer to the Center for Health Statistics and Information of the National Health and Family Planning Commission (previously the Ministry of Health). Quality control meetings were held annually and regular training was carried out to ensure data quality.

Together, the disease surveillance points and vital registration systems provided a nationally representative picture of...
mortality in China. The vital registration system, while not representative, was able to give more accurate estimates of the proportion of deaths due to specific causes and larger sample of deaths than the disease surveillance points. The disease surveillance points system reflected total mortality, the broad cause-of-death distribution and the geographic distribution of deaths more accurately, because the sampling strategy employed ensured a nationally representative sample. However, neither system was able to provide representative data on mortality or the causes of death at the provincial level. Differences between the two systems and their development are described more fully in Table 1 and Table 2.

In 2013, the National Health and Family Planning Commission combined the vital registration system and disease surveillance points system to create an integrated national mortality surveillance system. The goals were to integrate and rationalize the health resources expended on these systems and to accelerate the development of a complete

### Table 1. Vital registration and disease surveillance points mortality surveillance systems, China, 1950–2013

| Mortality surveillance system | Establishment | Development | Sampling method | Sites covered | Population coverage | Representativeness | Data reporting |
|------------------------------|---------------|-------------|----------------|---------------|---------------------|-------------------|---------------|
| **Vital registration system** | During the 1950s in 13 cities, including Beijing, Shanghai and Nanjing | By 1985, 28 large and medium-sized cities and 70 counties were covered; by 2000, 36 cities (i.e. municipalities and prefecture-level cities, which included many districts) and 90 counties in 15 provinces were covered. | Voluntary | Cities (including counties and districts) and counties | By 1985, 60 million; by 2000, 110 million | Mostly cities and eastern rural areas of the country | Local CDCs made monthly reports by electronic file transfer to the CHSI of the NHFPC |
| **Disease surveillance points system** | In 1978, in Dongcheng district and Tong county, Beijing | In 1989, 71 surveillance points across 29 provinces were covered | Voluntary | Counties and districts | By 2012, 230 million | Mostly eastern and central areas of the country | Local CDCs made monthly reports by electronic file transfer to the CHSI of the NHFPC |
| | In 1990, 145 surveillance points across 31 provinces were covered | | Multistage, stratified, cluster sampling (sampling probability proportional to population size) | 1 or 2 townships in each county or 1 or 2 subdistricts in each district for each surveillance point | 10 million (approximately 1% of the total Chinese population) | Both nationally and regionally (i.e. eastern, central and western; urban and rural) representative | Local CDCs made monthly reports by electronic file transfer to the national CDC |
| | In 2004, 161 surveillance points across 31 provinces were covered | | Multistage stratification, selection, evaluation and adjustment | The whole population covered by each surveillance point | 73 million (approximately 6% of the total Chinese population) | Both nationally and regionally (i.e. eastern, central and western; urban and rural) representative | Since 2008, hospitals and local CDCs have reported to the national CDC using a real-time Internet-based system |

CDC: Center for Disease Control and Prevention; CHSI: Center for Health Statistics and Information; ND: not determined; NHFPC: National Health and Family Planning Commission (previously the Ministry of Health).

* Each surveillance point corresponded to one county or district.
### Table 2. Reporting cause-of-death through vital registration and disease surveillance points systems, China, 1950–2013

| Period, by place of death | Vital registration system | Disease surveillance points system |
|---------------------------|---------------------------|-----------------------------------|
| **Death information collection** | **Death certificate** | **Coding cause of death** | **Determining the underlying cause of death** | **Death information collection** | **Death certificate** | **Coding cause of death** | **Determining the underlying cause of death** |
| **In earlier years, in hospital** | Family members reported to local vital registration offices in hospitals, hospitals reported to local CDCs, and local CDCs provided summaries | Staff in the hospital’s vital registration office completed the certificate using information from family members and any available medical records and documents | Coding was performed by staff in local CDCs, ICD-10 classification used since 2002 | Determined by staff in local CDCs | Staff in the hospital’s disease prevention unit collected death certificates and reported to the local CDC, which provided summaries | Clinical doctors in the hospital completed the certificates | Initially, coding was done by staff in the national CDC (previously the Chinese Academy of Preventive Medicine); then there was a gradual transition to the procedures used in recent years. ICD-10 classification used since 2004 | Initially determined by staff in the national CDC (previously the Chinese Academy of Preventive Medicine); then there was a gradual transition to the procedures used in recent years. |
| **In recent years, in hospital** | Staff in the hospital’s disease prevention unit collected death certificates and reported to the local CDC, which provided summaries | Clinical doctors in the hospital completed the certificates | Coding was done either by: doctors in the hospital’s medical records unit or by staff in the hospital’s disease prevention unit, and checked by local CDC staff when the local hospital did not have the capacity ICD-10 classification used since 2002 | Determined either by doctors in the hospital’s disease prevention unit, and checked by local CDC staff when the local hospital did not have the capacity | Staff in the hospital’s disease prevention unit collected death certificates and entered the details onto a real-time, Internet-based system; local CDC staff checked the information | Clinical doctors in hospitals completed the certificates | Coding was mostly done by local CDC staff, but also by doctors in hospitals’ medical records units or staff in hospitals’ disease prevention units, and checked by local CDC staff. ICD-10 classification used since 2004 | Mostly determined by local CDC staff, but also by doctors in hospitals’ medical records units or staff in hospitals’ disease prevention units, and checked by local CDC staff. |
| **In earlier years, outside hospital** | Family members reported to local vital registration offices in local hospitals, hospitals reported to local CDCs, and local CDCs prepared summaries | Staff in local hospitals’ vital registration offices completed the certificates using information from family members and any available medical records and documents | Coding was performed by staff in local CDCs, ICD-10 classification used since 2002 | Determined by staff in local CDCs | Village health workers and disease prevention unit staff in township hospitals in rural areas and disease prevention unit staff in CHs in urban areas collected information using household surveys; the information was checked with bodies such as the local police, the civil affairs department and the maternal and child department and then reported to the local CDC, which prepared summaries | Staff in local hospitals’ disease prevention units completed the certificates using information from family members and any available medical records and documents | Coding was performed by staff in the national CDC (previously the Chinese Academy of Preventive Medicine); ICD-10 classification used since 2004 | Determined by staff in the national CDC (previously the Chinese Academy of Preventive Medicine). |

(continues...)
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Disease surveillance points system

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Period

by place of death

Death information collection

Death certificate

Coding cause of death

Determining the underlying cause of death

Death information collection

Death certificate

Coding cause of death

Determining the underlying cause of death

In recent years, outside hospital

Village health workers in rural areas and disease prevention and control staff in CHs in urban areas collected information using household surveys; the information was checked with bodies such as the local police, the civil affairs department and the maternal and child health department and then reported to the local CDC, which prepared summaries.

Certificates were completed by clinical doctors in charge of emergency treatment or by disease prevention unit staff in charge of household surveys or of checking field reports.

Coding was done either by the local hospital's disease prevention unit staff, and checked by local CDC staff; or by the local CDC staff when the hospital did not have the capacity.

Determined by either: (i) the hospital's disease prevention unit staff, and checked by local CDC staff; or (ii) local CDC staff when the local hospital did not have the capacity.

Village health workers and disease prevention unit staff in township hospitals in rural areas and disease prevention unit staff in CHs in urban areas collected information using household surveys; the information was checked with agencies such as the local police, the civil affairs department and the maternal and child health department and then entered onto a real-time, Internet-based system; local CDC staff checked the information.

Certificates were completed by clinical doctors in charge of emergency treatment or by disease prevention unit staff in charge of household surveys or of checking field reports.

Coding mostly done by local CDC staff, but also by staff in hospitals' disease prevention units, with local CDC staff checking the information; ICD-10 classification used since 2004.

Mostly determined by local CDC staff, but also by staff in hospitals' disease prevention units, and local CDC staff checked the information.

Note: Local CDC refers to county and district levels.

CDC: Center for Disease Control and Prevention; CH: community hospital or community health centre or station; ICD-10: International statistical classification of diseases and related health problems, 10th revision.

*Exact time cannot be given since this was a gradual process and different sites have different starting time points.

The final size of the target surveillance population in each province was based on the two criteria used by the national CDC, which took into consideration differences between provinces in population and in the capability and training of provincial CDCs, which took into consideration population density, urbanization, population size and the economic development; for other provinces, the surveillance population should be not less than 5 million in any province that had a population greater than 10 million and was economically well developed, and for other provinces, the surveillance population should be 20% of the total population. These criteria were used to establish the number of surveillance points required in each province (Fig. 1). The final surveillance population comprised 605 surveillance points covering an entire country, each point representing a stratum of surveillance units.

The national mortality surveillance system covered the entire population of China. Initially, the national mortality surveillance system covered a population of 323.8 million (24.3% of the total population of the country). This paper describes the surveillance and operation of this new mortality surveillance system.
Fig. 1. Selection of points in the national mortality surveillance system in each province, China, 2013

An iterative process was used to determine whether the population covered by the combination of selected surveillance points in a province was representative of the population of the whole province. If the combination was not representative of the whole province, different points were selected within each stratum until it was representative; however, the number of points in each stratum was not changed.

b Counties and districts were divided into eight strata according to their degree of urbanization, population size and crude mortality rate.

| Province  | No. of counties and districts | No. of surveillance points (% of counties and districts) |
|-----------|------------------------------|--------------------------------------------------------|
| Anhui     | 105                          | 24 (22.9)                                              |
| Beijing   | 18                           | 7 (38.9)                                               |
| Chongqing | 40                           | 11 (27.5)                                              |
| Fujian    | 84                           | 20 (23.8)                                              |
| Gansu     | 87                           | 20 (23.0)                                              |
| Guangdong | 123                          | 28 (22.8)                                              |
| Guangxi   | 110                          | 21 (19.1)                                              |
| Guizhou   | 88                           | 20 (22.7)                                              |
| Hainan    | 24                           | 8 (33.3)                                               |
| Hebei     | 172                          | 30 (17.4)                                              |
| Heilongjiang | 132                         | 27 (20.5)                                              |
| Henan     | 159                          | 36 (22.6)                                              |
| Hubei     | 103                          | 22 (21.4)                                              |
| Hunan     | 122                          | 28 (23.0)                                              |
| Inner Mongolia | 101                      | 20 (19.8)                                              |
| Jiangsu   | 106                          | 27 (25.5)                                              |
| Jiangxi   | 99                           | 20 (20.2)                                              |
| Jilin     | 60                           | 15 (25.0)                                              |
| Liaoning  | 100                          | 22 (22.0)                                              |
| Ningxia   | 22                           | 10 (45.5)                                              |
| Qinghai   | 46                           | 10 (21.7)                                              |
| Shaanxi   | 107                          | 13 (12.1)                                              |
| Shandong  | 140                          | 31 (22.1)                                              |
| Shanghai  | 18                           | 7 (38.9)                                               |
| Shanxi    | 119                          | 20 (16.8)                                              |
| Sichuan   | 181                          | 31 (17.1)                                              |
| Tianjin   | 16                           | 7 (43.8)                                               |
| Tibet     | 73                           | 8 (11.0)                                               |
| Xinjiang  | 98                           | 15 (15.3)                                              |
| Yunnan    | 129                          | 25 (19.4)                                              |
| Zhejiang  | 90                           | 22 (24.4)                                              |

Total 2872 605 (21.1)

a The number of counties and districts in each province was the same as the number used in the 2010 national census.1

b Each surveillance point covered an entire county or district.
Fig. 2. **Surveillance points, national mortality surveillance system, China, 2013**

Note: Dark green lines represent 447 counties with national mortality surveillance points; light green lines represent 158 counties which also have disease surveillance points. The map was produced using QGIS version 2.8.3 (QGIS Development Team).

Source: Map data for China from the Natural Resources and Geospatial Base Information Database (National Development and Reform Commission, China). Map data for neighbouring countries from WHO.

Fig. 3. **Urbanization, population size and mortality rate, China, 2013**

Notes: The county or district representation was calculated as follows: first each U-value for the urbanization index, population size and mortality rate was obtained by using the equation $U = \frac{x - \mu}{\sigma}$, where $x$ is the observed value of the particular index in the country or district, $\mu$ is the mean value of the index in all counties and districts in the province and $\sigma$ is the standard deviation. We then calculated the mean $U$-value for the three indices for each county or district. The map was produced using QGIS version 2.8.3 (QGIS Development Team).

Source: Map data for China from the Natural Resources and Geospatial Base Information Database (National Development and Reform Commission, China). Map data for neighbouring countries from WHO.
of health-care staff and their ability to implement the new surveillance system. For example, the surveillance population chosen for Beijing was large because the city has a good infrastructure, a well-trained workforce and a large population. In contrast, the surveillance population in western provinces was smaller, partly because the local capacity and resources available for carrying out reliable mortality surveillance were limited. Following detailed consideration of the average population of all counties and districts and after consultation with health authorities in each province, we determined that the national mortality surveillance system required a total of 605 surveillance points – the 605 counties and districts covered by these points comprised 21.1% of all counties and districts in China (Table 3; Fig. 2).

Stratification

In the previous two adjustments to the disease surveillance points system in 1990 and 2004, urban areas (i.e. districts) and rural areas (i.e. counties and county-level cities) were used as the primary units for stratification and the urban-to-rural population ratio was also taken into account. However, with the rapid socioeconomic development of the last decades, this ratio is no longer appropriate for defining a county or county-level city as a rural area or a district as an urban area. In addition, per-capita gross domestic product (GDP) was used only in the further stratification of rural areas because there was a lack of data on how urban per capita GDP varied by district. Given the incompleteness of these data and the potential positive correlation between urbanization and per capita GDP, we decided to use the urbanization index (i.e. the fraction of the population residing in an urban area) as a stratifying index instead of the urban-to-rural population distribution or per-capita GDP. Following consultations with experts, population size was retained as an important stratifying index in the selection of surveillance points for the National Mortality Surveillance System, as was the crude mortality rate. These three stratifying indices were used as descriptors for each surveillance point and were calculated for each province. To obtain a graphical illustration of the characteristics in each county or district based on the three stratification indices, we first calculated the representation (U) for each index as follows: 

\[ U = \frac{(x-\mu)}{\sigma} \]

where \( x \) is the observed value of the particular index in the country or district, \( \mu \) is the mean value of the index in all counties and districts in the province and \( \sigma \) is the standard deviation. We then calculated the mean \( U \)-value for the three indices for each county or district (Fig. 3).

The multistage stratification process included three steps: (i) counties and districts in each province were divided into two strata based on the median urbanization index for each province (i.e. high or low urbanization); (ii) counties and districts with a high or low urbanization index were further subdivided into two strata according to the median population size in each of the two urbanization strata in each province (i.e. high or low population size); and (iii) counties and districts in these four strata (i.e. two urbanization strata \( \times \) two population-size strata) were subdivided into two further strata using the median total mortality rate in each of these four strata in each province. This process yielded eight strata in each province (Fig. 4) and a total of 248 strata (i.e. \( 8 \times 31 \) provinces) across the whole country.

Ensuring representativeness

After stratification, counties and districts in each province were selected as surveillance points using inclusion criteria and principles developed in consultation with health administrators and disease surveillance experts. First, the number of selected counties and districts in each stratum of each province should be approximately \( n/8 \), where \( n \) is the number of counties and districts in each province included in the new surveillance points system (Table 3). Second, the existing 161 surveillance points in the current disease surveillance points system were considered as a priority for inclusion in the national mortality surveillance system. Then, other counties and districts with experience in mortality surveillance were also considered for inclusion, as far as possible. The vital registration system sites were given a lower priority during the selection process than disease surveillance points system sites because the vital registration system did not provide continuous, longitudinal, mortality data and the sites did not all have the same quality control measures in place. In addition, counties and districts in which local staff expressed a strong desire to participate and where there was demonstrable local government support were also considered. Finally, the counties and districts selected had to be evenly distributed across different geographical areas with different characteristics and all prefecture-level cities had to be included.

At each stage of the selection process, candidate surveillance points were evaluated to determine how representative they were of each province. Reselection and re-evaluation were repeated until the final population sample was
considered sufficiently representative of the province. We employed an iterative process to ensure the representativeness of the candidate surveillance points (Fig. 1). First, the parameters used to evaluate representativeness were similar to those used in the two previous adjustments to the Disease Surveillance Points system: (i) the urbanization index; (ii) the ratio of the size of the population aged 65 years or more to the size of the total population; (iii) the ratio of the size of the population younger than 15 years to the size of the total population; and (iv) the crude mortality rate. Second, there had to be no significant difference between the value of a given parameter in the sample population and the corresponding value for the whole province, as indicated by a statistical test with the threshold of an α-level greater than 0.05. For variables that met the conditions for parametric tests, t tests were performed on log-transformed variables; otherwise, non-parametric tests were used. Although we aimed to select a similar number of counties or districts in each stratum of each province, this was not always possible. Because of the inclusion criteria and the variation in population size between counties and districts, inevitably the counties and districts in a province did not all have the same probability of being selected. Consequently, during the statistical evaluation of representativeness, we weighted each selected county and district according to its population.12–14

**Final surveillance points**

After several rounds of representativeness evaluation and adjustment, we found that there was no significant difference in parameter values between the counties and districts chosen as surveillance points in each province and the entire province for all provinces in the national mortality surveillance system (Table 4). In total, 605 surveillance points were selected across China (Fig. 2): the number of counties and districts selected in each province varied from 7 to 36. Three of the 161 former sites in the disease surveillance points system were excluded because of poor data quality and limited local government support and capacity. Of the existing 319 vital registration system sites, 113 were retained in the national mortality surveillance system.

In 2013, the national mortality surveillance system covered 323.8 million people. At the provincial level, the sample population ranged from 753,557 in Tibet to 25,919,659 in Guangdong. In five provinces (Hainan, Ningxia, Qinghai, Tibet, and Xinjiang), the surveillance population was less than 5 million. The population covered by the surveillance points as a proportion of the total population in each province ranged from 14.5% in Shaanxi to 54.2% in Ningxia; it was over 20% in each of the five provinces with a surveillance population less than 5 million (Table 5).

In 2014, the budget allocated by the central government to run the national mortality surveillance system included two types of cost: (i) the cost of basic death registration procedures (i.e. collection, registration, reporting, quality control, supervision and training – 6,444 United States dollars, US$, per surveillance point) and of periodic surveys of

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**Table 4. Representativeness of points in the national mortality surveillance system, by province, China, 2013**

| Province | Urbanization index | Ratio ≥ 65 years | Ratio < 15 years | Mortality rate/1000 | p* |
|----------|--------------------|-----------------|-----------------|---------------------|----|
| Anhui    | 0.69               | 0.17            | 0.35            | 0.36                |    |
| Beijing  | 0.64               | 0.50            | 0.45            | 0.30                |    |
| Chongqing| 0.29               | 0.67            | 0.17            | 0.63                |    |
| Fujian   | 0.52               | 0.88            | 0.42            | 0.75                |    |
| Gansu    | 0.06               | 0.77            | 0.17            | 0.31                |    |
| Guangdong| 0.83               | 0.94            | 0.21            | 0.41                |    |
| Guangxi  | 0.42               | 0.80            | 0.55            | 0.44                |    |
| Guizhou  | 0.23               | 0.69            | 0.39            | 0.43                |    |
| Hainan   | 0.88               | 0.58            | 0.08            | 0.74                |    |
| Hebei    | 0.32               | 0.21            | 0.32            | 0.62                |    |
| Heilongjiang| 0.60          | 0.99            | 0.38            | 0.34                |    |
| Henan    | 0.06               | 0.21            | 0.40            | 0.80                |    |
| Hubei    | 0.72               | 0.66            | 0.19            | 0.43                |    |
| Hunan    | 0.79               | 0.78            | 0.43            | 0.69                |    |
| Inner Mongolia| 0.29    | 0.17            | 0.13            | 0.70                |    |
| Jiangsu  | 0.32               | 0.23            | 0.24            | 0.06                |    |
| Jiangxi  | 0.67               | 0.27            | 0.07            | 0.55                |    |
| Jilin    | 0.59               | 0.80            | 0.67            | 0.52                |    |
| Liaoning | 0.11               | 0.83            | 0.93            | 0.26                |    |
| Ningxia  | 0.86               | 0.96            | 0.94            | 0.29                |    |
| Qinghai  | 0.35               | 0.35            | 0.14            | 0.64                |    |
| Shaanxi  | 0.32               | 0.78            | 0.46            | 0.62                |    |
| Shandong | 0.38               | 0.56            | 0.07            | 0.70                |    |
| Shanghai | 0.13               | 0.21            | 0.70            | 0.63                |    |
| Shanxi   | 0.46               | 0.49            | 0.86            | 0.17                |    |
| Sichuan  | 0.18               | 0.73            | 0.11            | 0.62                |    |
| Tianjin  | 0.29               | 0.16            | 0.99            | 0.18                |    |
| Tibet    | 0.10               | 0.15            | 0.15            | 0.11                |    |
| Xinjiang | 0.26               | 0.84            | 0.50            | 0.84                |    |
| Yunnan   | 0.91               | 0.88            | 0.08            | 0.11                |    |
| Zhejiang | 1.00               | 0.65            | 0.45            | 0.13                |    |

* Whether or not the population covered by the selected surveillance points in a province was representative of the population of the whole province was determined using the four parameters listed in the table.

* We used either t test or the Wilcoxon signed-rank test to calculate if there was significant difference between the parameter value across the surveillance points in a province and the corresponding value for the whole province.

* Represents the fraction of the population residing in an urban area.

* Ratio of the population aged 65 years or more to the total population.

* Ratio of the population younger than 15 years to the total population.

* Total number of deaths per 1000 people per year.

* A non-parametric test was performed for this parameter.
death underreporting (US$ 4833 per surveillance point); and (ii) the cost of work that varied with the estimated number of deaths, such as the printing, distribution and storage of registration cards (US$ 0.97 per death), the management and analysis of cause-of-death data (US$ 0.25 per death) and interdepartmental comparison and verification of data (US$ 0.25 per death).

Discussion

In China, the ultimate aim is to establish a comprehensive vital registration and mortality surveillance system. However, in the interim, a sample-based mortality surveillance system\(^2\) is the only viable option for generating valid and reliable information on total and cause-specific mortality in the country. The establishment of the national mortality surveillance system with 605 surveillance points covering almost one quarter of the Chinese population is a highly significant step towards the goal of achieving the vital registration of all births and deaths across the country by 2020.

Perhaps the greatest advantage of the new system is that it will yield annual data on death rates and the causes of death for all provinces. The inclusion of most of the existing disease surveillance points system surveillance points in the new system ensures the continuity of mortality data from these points without affecting the national or regional representativeness of the data overall. The national mortality surveillance system is now the only mortality surveillance system in China covering all causes of death in people of all ages. Data from the 605 surveillance points will be reported at the time of death registration to the national CDC,\(^3\) which is responsible for the operation and maintenance of the information system. The National Health and Family Planning Commission is responsible for overall project management, policy-making and information dissemination.

One of the main objectives of the national mortality surveillance system is to reliably monitor specific causes of death at both national and provincial levels. Over the long term, surveillance data will become increasingly important for describing changes in mortality, for identifying emerging health-care priorities and for informing health policy development. Although knowing the extent to which the surveillance system reflects mortality patterns is useful for interpreting data, representativeness should not be the only factor considered when constructing a system and should not be overemphasized at the expense of practicality. Many leading epidemiologists have argued that representativeness is not imperative, especially when investigating causal inference or examining associations between diseases and their component causes.\(^4\)\(^\text{-}\)\(^6\) Our view is that building capacity and quality control should be the main priorities in implementing the new surveillance system in addition to ensuring representativeness.

The completeness of death registration and accurate coding of the cause of death and of identification of the underlying cause of death are key issues for any mortality surveillance system. Previous surveys of the disease surveillance points system found underreporting of 12 to 17% – the proportion was even higher among children younger than five years and in rural areas.\(^7\),\(^8\),\(^9\),\(^10\) Moreover, in 2012, a report indicated that 2.73% of causes of death in China were coded inaccurately.\(^11\) One of the main challenges for the new system is the high proportion of deaths occurring outside hospital. Traditional burial customs, including the desire to return to one’s place of original residence before death, mean that approximately 70% of deaths in rural areas (as much as 90% in some places) occur at home and medical records are limited or nonexistent. Second, staff at most new surveillance points lack relevant experience, especially

### Table 5. National mortality surveillance system surveillance population, by province, China, 2010

| Province      | Total population\(^a\) | Surveillance population\(^a\) | Proportion of total population (%) |
|---------------|------------------------|------------------------------|-----------------------------------|
| Anhui         | 59,500,468             | 14,580,012                   | 24.5                              |
| Beijing       | 19,612,368             | 6,605,681                    | 33.7                              |
| Chongqing     | 28,846,170             | 8,167,594                    | 28.3                              |
| Fujian        | 36,894,217             | 10,146,129                   | 27.5                              |
| Gansu         | 25,575,263             | 7,803,139                    | 30.5                              |
| Guangdong     | 104,320,459            | 25,919,659                   | 24.8                              |
| Guangxi       | 46,023,761             | 9,025,031                    | 19.6                              |
| Guizhou       | 34,748,556             | 8,997,602                    | 25.9                              |
| Hainan        | 8,671,485              | 3,097,131                    | 35.7                              |
| Hebei         | 71,854,210             | 13,896,574                   | 19.3                              |
| Heilongjiang  | 38,313,991             | 10,069,900                   | 26.3                              |
| Henan         | 94,029,939             | 21,785,954                   | 23.2                              |
| Hubei         | 57,237,727             | 12,513,533                   | 21.9                              |
| Hunan         | 65,700,762             | 17,661,802                   | 26.9                              |
| Inner Mongolia| 24,706,291             | 5,840,040                    | 23.6                              |
| Jiangsu       | 78,660,941             | 22,084,484                   | 28.1                              |
| Jiangxi       | 44,567,797             | 8,141,229                    | 18.3                              |
| Jilin         | 27,452,815             | 7,044,428                    | 25.7                              |
| Liaoning      | 43,746,323             | 10,729,378                   | 24.5                              |
| Ningxia       | 6,301,350              | 3,417,327                    | 54.2                              |
| Qinghai       | 5,626,723              | 1,649,165                    | 29.3                              |
| Shaanxi       | 37,327,379             | 5,424,499                    | 14.5                              |
| Shandong      | 95,792,719             | 23,067,010                   | 24.1                              |
| Shanghai      | 23,019,196             | 8,055,902                    | 35.0                              |
| Shanxi        | 35,712,101             | 7,222,517                    | 20.2                              |
| Sichuan       | 80,417,528             | 18,066,478                   | 22.5                              |
| Tianjin       | 12,938,693             | 5,548,441                    | 42.9                              |
| Tibet         | 3,002,165              | 753,557                      | 25.1                              |
| Xinjiang      | 21,815,813             | 5,432,804                    | 20.8                              |
| Yunnan        | 45,966,766             | 9,269,827                    | 20.2                              |
| Zhejiang      | 54,426,891             | 12,656,460                   | 23.3                              |

| Total         | 1,332,810,869          | 323,773,287                  | 24.3                              |

\(^a\) Population data are from the 2010 national census.\(^1\)
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with standardized workflow procedures and mechanisms for interdepartmental collaboration. Third, it may be difficult to recruit enough professional health workers, particularly at the local level. Fourth, there is an enormous difference in local capacity between the provinces due to large variations in economic development. To meet these challenges the integration and application of new automated methods for collecting information on the cause of death identified by verbal autopsy should be a priority. Also, uniform training materials should be used by national and provincial trainers to strengthen training; supervision and information-sharing should be enhanced and additional technical and financial support should be offered to underdeveloped provinces when necessary. In 2014, central government agencies, including the National Health and Family Planning Commission, the Ministry of Public Security and the Ministry of Civil Affairs, issued an updated official document aimed at strengthening death registration. However, appropriate legislation to ensure all deaths are registered and properly certified is also essential.

Reliable information on mortality and the cause of death is essential for the development of national and international health policy and of programs for preventing and controlling disease and preventing injury. Data from the disease surveillance points and vital registration systems have been extensively used to assess the burden of disease both regionally and nationally in China and globally, as well as for other research purposes. For the future, there are plans to use the national mortality surveillance system sample populations to carry out periodic national surveys of chronic disease, nutrition and injury. Electronic linkage of data is becoming easier in China and it may soon be possible to convert these periodic surveys into prospective cohort studies. The national mortality surveillance system will not only play a unique and critical role in providing health metrics for China but will also serve as an essential resource for evaluating health-care policy at provincial, national and international levels, particularly for the prevention and control of chronic diseases.

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Resumen

Un sistema nacional integrado de vigilancia de la mortalidad para el registro de defunciones y la vigilancia de la mortalidad en China

En China, los sistemas de vigilancia de la mortalidad basados en muestras, tales como el sistema de puntos de vigilancia de las enfermedades del Centro de Prevención y Control de Enfermedades de China y el sistema de registro civil del Ministerio de Salud, se han utilizado durante décadas para proporcionar datos nacionalmente representativos del estado de salud. Sin embargo, ninguno de estos sistemas proporciona datos representativos a nivel provincial.

En 2013, el gobierno chino combinó estos dos sistemas en un sistema de vigilancia de la mortalidad para proporcionar datos nacionalmente representativos del estado de salud. Este nuevo sistema aumentó la población de vigilancia de 161 a 605 puntos de vigilancia, lo que permitió obtener una imagen representativa a nivel provincial de la mortalidad total.

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