CRVS analyses and evaluations
The past, present, and future of three sample registration systems in Asia

February 2019

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CRVS course prospectuses
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CRVS Fellowship reports and profiles
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CRVS country reports describe the capacity-building experiences and successes of strengthening CRVS systems in partner countries. These resources describe the state of CRVS systems-improvement and lessons learnt, and provide a baseline for comparison over time and between countries.

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Specific, technical and instructive resources in the form of *quick reference guides, user guides* and *action guides*. These guides provide a succinct overview and/or instructions for the implementation or operation of a specific CRVS-related intervention or tool.

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Interactive and practical resources designed to influence and align CRVS processes with established international or best-practice standards. These resources, which are used extensively in the Initiative's training courses, aim to change practice and ensure countries benefit from such changes by developing critical CRVS capacity among technical officers and ministries.

Abbreviations

CDC	Center for Disease Control and Prevention (China)
COD	cause of death
CRVS	civil registration and vital statistics
DCO	Directorate of Census Operations
DSP	disease surveillance point system
ICD	International Classification of Diseases
GBD	Global Burden of Disease
IMRSSP	Indonesian Mortality Registration System Strengthening Project
IT	information technology
PTE	part-time enumerator
SDG	Sustainable Development Goal
SRS	sample registration system
UN	United Nations
VA	verbal autopsy
VR	vital registration
WHO	World Health Organization

The past, present and future of three sample registration systems in Asia

Accurate and timely mortality and cause of death (COD) data are necessary to inform and evaluate health policy. Population-based data are crucial for measuring and monitoring countries' performance relative to the 17 Sustainable Development Goals (SDGs) and their associated targets and indicators from now until 2030.[1,2,3] Importantly, improving civil registration and vital statistics (CRVS) systems – notably for birth and death registration – is specifically identified as an SDG imperative in SDG Target 16.9 and SDG Target 17.19.[4] However, many countries do not have complete CRVS systems that can generate these data. This is partially because the majority of deaths occur outside of health facilities and are never registered.[5] Moreover, less than one-third of deaths worldwide are assigned a COD.[6] In India, for example, over three-quarters of deaths occur at home and more than half of these are not assigned a certified COD.[7] Without physicians being available to certify deaths that occur at home or in the community, health priorities are based on COD information from hospital deaths, which is not representative of a country's health situation as a whole.[8]

China, India and Indonesia are the three most populous countries in Asia, and among the most populous countries in the world. About 40 per cent of the global population lives in the three countries,[9] making the collection of reliable mortality information important for the estimation of global mortality. India and China each have a population of over 1.3 billion,[9] rendering complete registration with medical certification of death financially and logistically challenging. However, all three countries have made improving CRVS a national priority, and as such, have developed sample-based vital registration systems to build capacity and generate nationally and sub-nationally representative mortality and COD data in the interim.

Sample registration systems that use validated verbal autopsy (VA) tools represent an affordable and potentially sustainable solution to produce age, sex and cause-specific mortality data. This *CRVS technical outcome series* paper outlines three such systems, namely the Chinese mortality surveillance system, the Indian sample registration system, and the Indonesian sample registration system. The history and principles behind the systems, their operational aspects, vital statistical output and quality of data, along with their strengths and weaknesses and intended future direction, are presented. This is followed by a summary overview highlighting key aspects of each system and their similarities and differences.

1   Sankoh O, Byass P, on behalf of INDEPTH Network and Partners. New INDEPTH strategy for the SDGs using robust population data. *The Lancet* 2017; 5:e647-e648.
2   Mills et al. *Civil registration and vital statistics (CRVS) for monitoring the Sustainable Development Goals (SDGS).* Washington, D.C.: World Bank Group; 2017. Available online: http://documents.worldbank.org/curated/en/979321495190619598/Civil-registration-and-vital-statistics-CRVS-for-monitoring-the-Sustainable-development-goals-SDGS (accessed 12 February 2019).
3   Richards et al. *Why the Sustainable Development Goal agenda needs strong civil registration and vital statistics systems.* CRVS development series. Melbourne, Australia: University of Melbourne Civil Registration and Vital Statistics Improvement and Bloomberg Philanthropies Data for Health Initiative; 2018.
4   UN General Assembly. *Transforming our World: The 2030 Agenda for Sustainable Development, resolution adopted by the UN General Assembly on 25 September 2015.* A/RES/70/1.
5   Philips et al. A composite metric for assessing data on mortality and cause of death: the vital statistics performance index. *Population Health Metrics.* 2014; 12:14.
6   de Savigny et. al. Integrating community based verbal autopsy into civil registration and vital statistics (CRVS): system-level considerations. *Global Health Action,* 2016; 10:1.
7   Jha P et al. Prospective study of one million deaths in India: Rationale, design, and validation results. *PLoS Medicine.* 2006; 3(2):e18.
8   urray et al. Estimating population cause-specific mortality fractions from in-hospital mortality: validation of a new method. *PLoS Medicine.* 2007; 4:e326.
9   UNDESA: United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2017 Revision, Key Findings and Advance Tables. ESA/P/WP/248; 2017.

CRVS best-practice and advocacy

China
History and principles behind the Chinese mortality surveillance system

Historically, China relied on its vital registration (VR) system and disease surveillance points (DSP) system to gather information on COD. The VR system was established in the 1950s to collect mortality data in 13 cities. Over time, the VR system was expanded such that by 2012 it included 319 sites across 22 provinces, and monitored a population of about 230 million. However, most of the sites were in eastern and central China, so the VR system was incomplete. Data from the VR system were reported to the Center for Health Statistics and Information of the National Health Commission (previously the Ministry of Health).

The DSP system began in 1978 with two pilot surveillance sites in Beijing. By 2004, the system had grown to 161 points covering a population of 73 million. Data from the DSP were transmitted to the Chinese Center for Disease Control and Prevention (CDC) for validation and analysis. Taken together, data from the VR and DSP systems provided a good picture of nationally representative mortality and COD data. However, neither could produce mortality estimates at the provincial level.[10]

In an effort to improve VR and the collection of mortality data, and avoid the duplication of effort across overlapping points, in 2013 the Chinese National Health Commission integrated the VR and DSP systems into one national mortality surveillance system. The new system was designed to produce mortality estimates at the provincial level, and covered about 24 per cent of the population (323.8 million people) using 605 surveillance points. Each point covered an entire county or district.[10]

The new national mortality surveillance system followed the sampling principles used by the DSP. In economically developed provinces with populations greater than 10 million, such as Beijing, Shanghai and Tianjin, the sample was to cover no less than 5 million people. In all other provinces, the sample was selected so that at least 20 per cent of the population was covered. These guidelines dictated the number of surveillance points needed in each province.[10] All counties and districts in each province were categorised according to their degree of urbanisation, then population size, and finally crude mortality rate. This resulted in eight strata. Counties and districts in each stratum were selected as surveillance points and assessed for their degree of representativeness of the province as a whole. Demographic data from the 2010 Census were used to determine if,

collectively, the counties and districts selected were an adequate reflection of the province. Selection of points was refined iteratively until the sample was representative of the province from which it was taken. Existing surveillance points were given priority for inclusion, as were counties and districts with strong political will to participate. Additionally, the capacity of provincial CDC staff to implement the new mortality surveillance system was considered when determining the size of the population to cover.[10]

Table 1 shows that the number of deaths registered in China's mortality surveillance system has consistently increased over time, with a more than 15 fold increase in registration between 2004 and 2017.

Table 1 Number of registered deaths by year from China's mortality surveillance system

Year	Registered deaths
2004	437 430
2005	702 296
2006	937 995
2007	1 399 764
2008	2 212 693
2009	2 479 811
2010	2 943 629
2011	3 400 136
2012	3 991 660
2013	4 927 460
2014	5 559 933
2015	6 096 558
2016	6 727 675
2017	6 841 262

Source: China Center for Disease Control and Prevention (pers. comm. 2018).
History and principles behind the Chinese mortality surveillance system

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10   Liu et al. An integrated national mortality surveillance system for death registration and mortality surveillance, China. *Bulletin of the World Health Organization.* 2016; 94:46 57

Operational aspects of the system

The National Health Commission manages China's mortality surveillance system and is responsible for making policy and disseminating information from the system. The Division of Vital Registration and Mortality Surveillance in the Noncommunicable Disease Control and Prevention Center within China CDC is responsible for the operation, supervision and quality control of the 605 surveillance points.[10,11] China CDC provides routine training for the county, city, and provincial-level staffs on death reporting procedures, quality control, data checking and verification, and coding of CODs.[11]

There is a four-level CDC network in China:

■ County-level CDCs are responsible for verification of deaths and reviewing COD at every surveillance site, as well as training and supervision for the sites.

■ City and provincial-level CDCs verify data and facilitate training.

■ The national CDC oversees the whole system and provides supervision and feedback to the provinces, cities and counties. Data are consolidated centrally in China CDC.[11]

Notification of hospital deaths

When a death occurs in hospital, doctors certify the COD and create a death certificate. Legislation enacted in 1992 requires physicians in health facilities to use the International Form of Medical Certificate of Cause of Death.[12,13] In hospitals without the capacity to determine COD, this function is performed by the county or district CDC.[11] Coding is mostly performed by local CDC staff, but may also be done by doctors in hospitals' medical records units or by staff in hospitals' disease prevention units. Coding is performed using the International Classification of Diseases (ICD-10) to determine the underlying COD. Staff in the hospital's disease prevention unit enter the information into an internet-based system in which local CDC staff review its quality.[10]

Notification for nonhospital (community) deaths

In rural areas, village health workers are tasked with reporting deaths outside of hospital to the prevention unit at the township hospital.[14] These staff are familiar with the villagers and their families, ensuring community deaths get reported.[11] Village health workers or disease prevention staff from township hospitals in rural areas, or disease prevention staff from community hospitals in urban areas, administer a VA. Event information is checked against databases from agencies such as the local police, the civil affairs department, and the maternal and child department, and then entered into an internet-based system.[10] In these instances, physicians or disease prevention unit staff complete the death certificates. ICD-10 coding is usually performed by local CDC staff, but may also be done by staff in hospitals' disease prevention units. Coded data are entered into an internet-based system and then reviewed by local CDC staff.[10]

Other operational aspects of the system

Since 2008, death records from the DSP and mortality surveillance system have been recorded and transmitted using an internet-based reporting system.[10] In this system, each death record is reviewed by local staff, including county, prefecture and provincial-level CDC staff. Staff check the completeness, ICD-10 coding and logic of death certificates. CDC headquarters consolidates the COD data for analysis and publication. An automated coding tool was developed to support staff in coding and improve the accuracy of COD.[10]

Since 2009, an independent survey has been conducted every 3 years to assess the extent of underreporting in the mortality surveillance system.[11,15] The survey retrospectively asks community leaders about deaths that occurred in the previous 3 years in their jurisdiction. These deaths are then checked against data from public security departments, civil affairs departments, and other agencies and, when identified, additional deaths are added to the list. Once the list is drafted, interviewers contact family members of decedents to verify death record information. A computer compares national IDs from the survey against national IDs in the mortality surveillance system. If the national ID is the same in both systems, the death is considered a match. Cases with missing national IDs are matched when name, gender and age are the same in both systems. Remaining unmatched cases are investigated at the site level.[15] Outcomes of these surveys are discussed in the data quality and completeness sub-section below.

11 Zhou M, Yin P. *Mortality surveillance system in China*. CRVS workshop, Basel, Switzerland, Aug 14–15, 2017.
12 Cited in: Rao et al. Evaluating national cause-of-death statistics: principles and application to the case of China. *Bulletin of the World Health Organization.* 2005; 83:618 625.
13 World Health Organization. International Statistical Classification of Diseases and Related Health Problems, 10th revision, vol. 2. Geneva, Switzerland: WHO; 2016:30 65
14 Yang et al. Mortality registration and surveillance in China: history, current situation and challenges. *Population Health Metrics* 2005; 16(1):3.
15 Zhou M, Yin, P. The experience of China with the Disease Surveillance Point system (DSPs) and validation studies to evaluate the completeness of death registration. United Nations expert group meeting on methodology and lessons learned to evaluate the completeness and quality of vital statistics data from civil registration, New York, 3–4 November 2016.

Vital statistics data summary

China CDC publishes annually the number of deaths by cause, and death rates by age group, sex, urban and rural, and eastern, western and central regions. However, publications are only available in Chinese. Recent national documents and guidelines, including the Health China 2030 and the NCD Control and Prevention Plan 2017–2025, used mortality surveillance system data to prioritise outcomes and inform goals for these programs.[11] Additionally, the Health Statistics Information Center within the National Health Commission uses the data to create official life tables for each province. However, life expectancy estimates from the China National Statistics Bureau do not take these data into account.[11]

Mortality indicators adjusted for underreporting from the China mortality surveillance system are close in value to Global Burden of Disease study 2013 estimates, except for under-5 mortality, which is significantly lower than the Global Burden of Disease (GBD) study 2013 estimate (Table 2).

Table 2 Comparison of most recently reported mortality indicators from China's Mortality surveillance system and the Global Burden of Disease (GBD) study 2013

Mortality indicator	Mortality surveillance system 2012–2014*	GBD 2013+
Under 5 mortality rate	8.4	13.0 (12.0–13.8)
Adult mortality (45q15) males	124.0	130 (110–150)
Adult mortality (45q15) females	55.8	60 (50–70)
Life expectancy at birth males (years)	74.9	73.53 (72.44–75.35)
Life expectancy at birth females (years)	80.7	79.99 (78.92–81.17)

* Adjusted based on the 2015 underreporting survey, data for 2012–2014, based on 605 surveillance points.

† Data from: Wang et al. Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the Global Burden of Disease study 2013. The Lancet. 2014; 384:957-79.

Under 5 mortality rate = Probability of a live-born child dying before reaching the age of 5 years, expressed per 1000 live births.

Adult mortality rate = Probability that those who have reached age 15 will die before reaching age 60 (shown per 1000 persons).

Data quality and completeness

National surveys are undertaken every 3 years to determine the extent of underreporting in the mortality surveillance system. The 2012 survey found the overall underreporting rate in the 161 sampled DSPs to be 12.9 per cent. Underreporting was higher in the west (18.8 per cent) compared to the east (10.1 per cent) and central regions (11.2 per cent). Underreporting in rural areas (13.9 per cent) was higher than urban areas (11.2 per cent). Underreporting was highest among deaths in the 0–5 year age group (23.7%), and lowest among those 65 and above (12.4%).[16]

All data entered into the internet-based system undergo several levels of quality control. An internal system evaluates timeliness of death registration, record completeness and accuracy of data entry. Errors detected are corrected through re-enquiry.[14] Additionally, each death is reviewed by local, prefecture, and provincial-level CDC staff for completeness, correct ICD 10 coding, and correct underlying COD.[10] Data are also evaluated using statistical measures.[14]

Data from the mortality surveillance system show that the proportions of deaths with ill-defined causes were 1.5 per cent, 1.3 per cent, 1.3 per cent and 1.2 per cent for 2013, 2014, 2015 and 2016 respectively.[17,18,19,20] A previous study reviewing data from 1995–99 found that on average, 2.5 per cent of DSP data and 5 per cent of VR data were coded using ill-defined causes.[21]

16 Guo et al. Propensity score weighting for addressing underreporting in mortality surveillance: a proof-of-concept study using the nationally representative mortality data in China. *Population health metrics* 2015; 13:16.

17   Noncommunicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention & Center for Health Statistics and Information, National Health and Family Planning Commission. Chinese Mortality Surveillance Dataset 2013[M]. Beijing: Popular Science Press, 2015.

18 Noncommunicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention & Center for Health Statistics and Information, National Health and Family Planning Commission. Chinese Mortality Surveillance Dataset 2014[M]. Beijing: Popular Science Press, 2015.

19 Noncommunicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention & Center for Health Statistics and Information, National Health and Family Planning Commission. Chinese Mortality Surveillance Dataset 2015[M]. Beijing: China Science and Technology Press, 2016.

20 Noncommunicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention & Center for Health Statistics and Information, National Health and Family Planning Commission. Chinese Mortality Surveillance Dataset 2016[M]. Beijing: China Science and Technology Press, 2017.

21 Rao et al. Evaluating national cause-of-death statistics: principles and application to the case of China. *Bulletin of the World Health Organization*. 2005; 83:618-625.
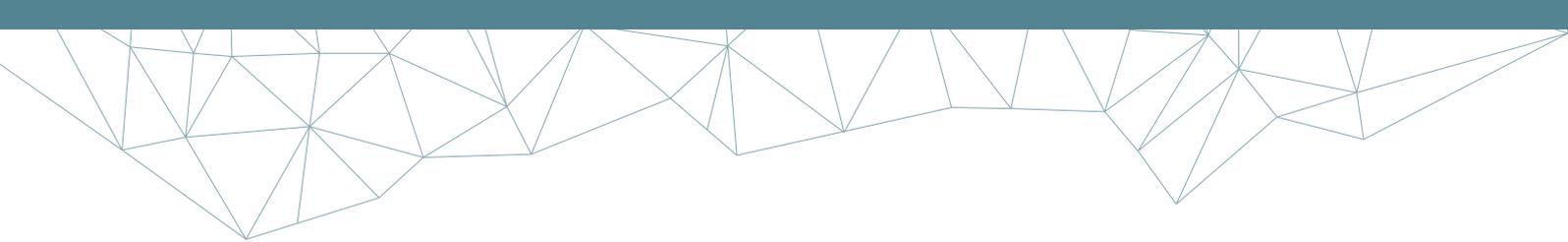
Strengths and weakness of the system

The Chinese mortality surveillance system receives dedicated government funding. In 2014, each surveillance point was allocated US$6444 to cover the cost of collecting data, registering deaths, reporting events, performing quality control, and providing supervision and training for operating the system. Additionally, US$4833 was allocated per point for the cost of the under-registration triannual survey. Money was also allocated for costs that varied with the number of deaths, such as printing, distribution and storage.[10]

The new integrated national mortality surveillance system can generate both national and provincial-level mortality estimates, covering 24 per cent of the population. The web-based system transmits data in real time, increasing the timeliness of data dissemination. Multiple quality control measures are in place, as well as an automated coding tool to improve accuracy of the underlying CODs. Additionally, a survey to assess completeness of death registration is undertaken triannually.[10,11]

However, legislation is needed to strengthen VR in China. Underreporting of deaths remains a problem in the mortality surveillance system, particularly for deaths that occurred at home or deaths of young children.[11] The capacity of staff to produce quality mortality data varies greatly between points, particularly between the urban ones in the east and the rural points in the west.[10,11,14] The quality of COD coding also differs between provinces, and the accuracy of COD needs to be improved, particularly for those who died at home.[11]

Moving forward

China's ultimate goal is to establish a complete VR and mortality surveillance system by 2020. The establishment of a national mortality surveillance system that covers almost a quarter of the population is a significant step in this direction.[10]

The National Health and Family Planning Commission, the Ministry of Public Security and the Ministry of Civil Affairs issued an updated official document with the goal of strengthening death registration.[11] However, appropriate legislation will be needed to strengthen VR and certification of death in China.

CRVS best-practice and advocacy

India

History and principles behind the Indian sample registration system

Historically, the registration of births and deaths in India was voluntary, which resulted in under-registration, inconsistent procedures and unreliable vital statistics. Although, India's civil registration system dates back to the 1860s, by the 1960s it suffered from incomplete coverage, irregular reporting and under-registration, making the analysis of trends from these data almost impossible. The sample registration system (SRS) was initiated in January 1964 as an interim alternative to yield quick and reliable estimates of vital statistics.[22,23,24] After pilot studies in several states, the SRS was scaled up to be nationally representative in 1969–70. With enactment of the Registration of Births & Deaths Act in 1969, coverage of the civil registration system was extended to the entire country. But under-registration and irregular reporting problems persisted, affecting reliability of the civil registration system-based estimates. Hence, the SRS continues to be the mainstay of vital statistic estimates in India.

The SRS was designed to generate reliable estimates of birth rates, death rates, and infant mortality rates at the natural division level for major states, and at the state level for smaller states, along with national-level statistics.[25] It uses a single-stage, stratified simple random sample without replacement, except in larger villages in rural areas, where two-stage stratification is used. The sampling frame consists of villages or village segments in rural areas and census enumeration blocks in urban areas. The number of sample clusters is determined by the number of events that would be needed to accurately estimate the infant mortality rate with an acceptable margin of error, along with financial and operational constraints.[25,26]

Operational aspects of the system

India's SRS is overseen by the Registrar General India (RGI) under the Ministry of Home Affairs. When it was first enacted, the SRS was run by central and state government agencies. The RGI's Directorate of Census Operations (DCO), which is overseen by the RGI, did much of the implementation. Eventually, the SRS was run almost entirely by the RGI's DCOs. The exception to this remains in rural areas of the states of Maharashtra and Kerala, where the state Directorate of Economics and Statistics oversees the work.[26]

The SRS has many different components to ensure vital events are captured in the sample areas (Figure 1). The key components consist of:

- A baseline survey of the sample areas to obtain household listings of usual residents

- Continuous enumeration of vital events for the usual resident population

- An independent, half-yearly household survey that identifies vital events, updates household listings and administers VA for deaths

- The matching of vital events captured by continuous enumeration and by the half-yearly survey

- Field verification of vital events that do not match between the two sources.[25]

22   Agrawal BL, Agrawal RD. Report on sample registration of births and deaths in rural areas (pilot). New Delhi: Registrar General of India – Vital Statistics Division; 1969; accessed 17 January 2008, from Indian Institute of Management, Ahmedabad Library (No. 92883 R312.095416R35). Publication date estimated.
23   Registrar General of India. Sample registration in India. Report on pilot studies in urban areas, 1964–67. New Delhi: RGI; 1969.
24   Bhat et al. *Vital rates in India* 1961–1981. Washington DC: National Academy Press; 1984.
25   India Office of the Registrar General & Census Commissioner. Sample Registration. Available at: http://www.censusindia.gov.in/Vital_Statistics/SRS/Sample_Registration_System.html (accessed 11 February 2019).
26   Mahapatra P. The sample registration system (SRS) in India, an overview, as of 2017. Workshop on National CRVS Verbal Autopsy Sampling Strategies, Basel, 14–15 Aug 2017.

Figure 1 Flow chart for India's sample registration system
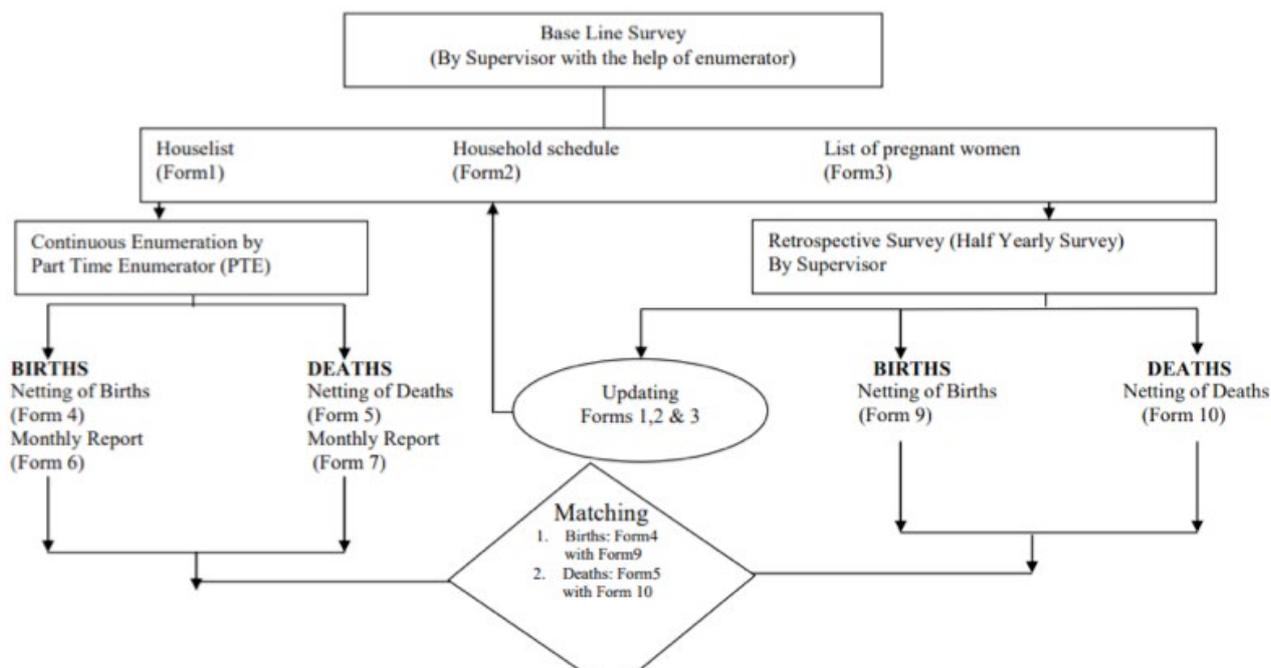
HYS = half-yearly survey; ORGI = Office of the Registrar General, India

Source: Office of the Registrar General & Census Commissioner, India. Sample Registration System Statistical Report 2015. Office of the Registrar General & Census Commissioner, New Delhi. Available at: http://www.censusindia.gov.in/vital_statistics/SRS_Report_2015/5.Chap%201-Introduction-2015.pdf (accessed 11 February 2019).

Baseline survey

To accurately monitor population health, the SRS sampling frame is revised every 10 years based on census results. The sample is updated to better represent changes that have occurred in the population, and to overcome any limitations that were discovered in the previous sample.[25] Once the sample is updated, a new baseline survey is undertaken before data collection. A notational map that lists households in the sample area, along with important landmarks, is then prepared. A household schedule for every house in the sampling unit is prepared, listing household members and their demographic characteristics such as identification code, name, sex, date of birth, age, educational and marital status, relation to head of household, and so on. The pregnancy status of women of reproductive age is also recorded.[25,26]

Continuous enumeration

Part-time enumerators (PTEs) are recruited from school teachers, anganwadi workers, and other similar functionaries who live in the sample unit. Supervisors are usually full-time staff; generally they are compilers, senior compilers,

statistical investigators, or other officers of the RGI's Census Directorates. Supervisors oversee the work of approximately 10 sampling units. PTEs receive an honorarium whereas supervisors are paid, full-time staff.[26]

The enumerator records all births and deaths that occur within his or her sampling unit, as well as those of the usual residents occurring outside the sample unit. To maximise the probability of recording all births and deaths, the PTE obtains information from a variety of sources, including priests, barbers, village leader, midwives and such other functionaries. Additionally, he or she frequently visits hospitals, nursing homes and cremation and burial grounds. To better capture births, the PTE maintains a record of all women of reproductive age and their pregnancy status. Upon hearing about a birth or a death, the PTE pays a visit to the household in question to confirm the event, and records the necessary information. The PTE is required to visit all rural households once every three months, and all urban households once a month to ensure no births or deaths are missed .[26] Every month the PTE is required to send the state headquarters DCO a report of all enumerated births and deaths.[25-27]

27   Office of the Registrar General & Census Commissioner, India. *Sample registration system statistical report 2015.* Office of the Registrar General & Census Commissioner, New Delhi; 2015. Available at: http://www.censusindia.gov.in/vital_statistics/SRS_Report_2015/5.Chap%201-Introduction-2015.pdf (accessed 11 February 2019).

Half-yearly survey

Every six months, a supervisor visits every household in the sample unit and administers an independent, retrospective survey inquiring about past vital events. He or she then records all births and deaths that occurred in the retrospective period, and updates the house-list, household schedule, and pregnancy status of women of reproductive age.[26] A supervisor performs this task in approximately 10 sample units, but these 10 sample units are not the same sample units he or she supervises. Additionally, the supervisor has no access to birth or death records from the field during the survey. This ensures the survey is independent of the continuous enumeration.[25,26]

Since 1999, supervisors have been required to fill out VA questionnaires for each death identified during the half-yearly survey.[28] The VA and COD determination process is discussed in detail below.

Matching

The relevant DCO[29] compares the continuously enumerated data and the data captured in the half-yearly survey. Key items (ID code, date of occurrence and so on) from the two sources are examined, and events are classified as fully matched if all key items match, partially matched if there are some inconsistencies, or unmatched if none of the items are the same (for example, a missing record in one source).[25,26]

Field verification of unmatched and partially matched events

Unmatched and partially matched events are re-verified by visiting the household in question, and updating the record of the vital event with the correct information. This is done by an independent supervisor, or jointly by the same supervisor and the enumerator, depending on availability of staff. After this is done, the sampling unit supervisor updates the population of each sample unit by age, sex and marital status, and updates the results of the matching and verification exercises. This information, along with updates to household numbers and schedules, is sent to the RGI office in Delhi for national tabulation, analysis and publication.[26]

Data flow and automation

As part of the Digital India initiative, from the 2014 baseline survey onwards, data collection and processing has been completely automated. Accordingly, the supervisor collects data from the sampling units on a handheld device. Dedicated servers are installed at all the DCOs for downloading and uploading files and generating forms. After finalising the data, the State Directorate of Census Operation uploads them to the central server where the Delhi headquarters DCO validates them before creating vital statistical reports.[27]

Verbal autopsy and cause of death determination

Since 1999, supervisors have been required to fill out VA questionnaires for each death identified during the half-yearly survey. When the PTE initially visits a household where a death occurred, he or she will inform the household that a supervisor will administer a VA at a later date (Figure 2). Additionally, the PTE will request that the household retain any medical records until the time of the VA, and provide such records to the supervisor administering the VA. The Indian SRS uses a VA questionnaire developed specifically for this system, called the 'Routine, representative, resampled, household interview of mortality with medical evaluation method' (RHIME). A supervisor can choose one of four different VA forms to administer, depending on the age and sex of the decedent (Figure 3).

CRVS best-practice and advocacy

Figure 2 Verbal autopsy processes in the Indian sample registration system

VA Flow

Part Time Enumerator

Monthly/Quarterly Survey → **Inform households VA will occur**

RG Supervisors

Half yearly survey (or Special Survey of Deaths)

Collection of the circumstances of death And Narrative plus VA forms → Cause of Death Assignment by two Health Professionals

Quality Check 10% Re-sample in the field by independent Re-Sample Teams → Cause of Death Assignment by Two Health Professionals

RG = Registrar General; VA = verbal autopsy

Source: Registrar General of India et al. Verbal autopsy (VA) operations manual. Toronto, Canada: University of Toronto; 2013. Available at: http://vatraining.vm-host.net/wp-content/uploads/2013/07/VA-Manual.pdf (accessed 11 February 2019).

Figure 3 Verbal autopsy forms used in the Indian sample registration system
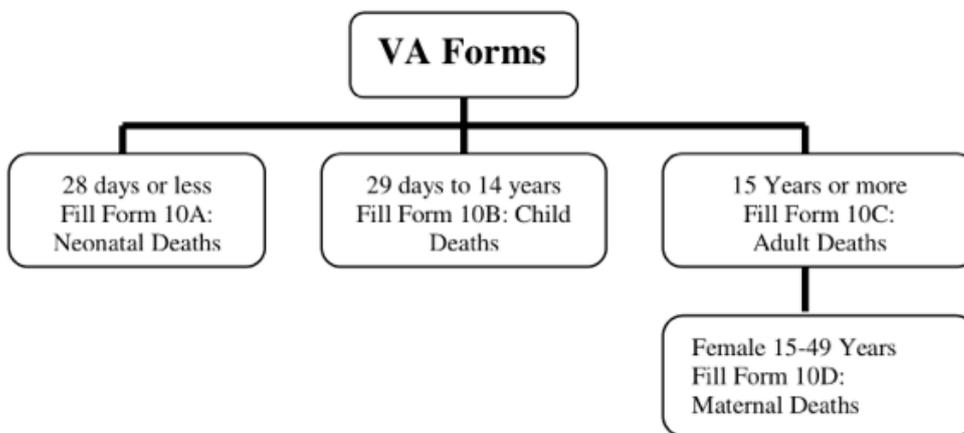
VA Forms

- 28 days or less Fill Form 10A: Neonatal Deaths
- 29 days to 14 years Fill Form 10B: Child Deaths
- 15 Years or more Fill Form 10C: Adult Deaths
  - Female 15-49 Years Fill Form 10D: Maternal Deaths

VA = verbal autopsy

Source: Registrar General of India et al. Verbal autopsy (VA) operations manual. Toronto, Canada: University of Toronto; 2013. Available at: http://vatraining.vm-host.net/wp-content/uploads/2013/07/VA-Manual.pdf (accessed 11 February 2019).

Verbal autopsies completed by supervisors are reviewed by two separate trained physicians. They assign the medical COD, based on the ICD 10, from information in the VA and any medical record documentation.[28] If the two physicians do not agree on the underlying COD, the record returns to them to discuss and reconcile the COD. If no agreement is reached, a third physician is introduced to adjudicate.[30,31] Physicians

access and code all records online through the Central Medical Evaluation online application.[32] At the time of writing this report, there was no documentation on how often or in what manner the coded data are transmitted to the RGI for analysis and publication purposes. However, each individual in the SRS has a unique ID, which can link the COD record to the individual's record and its associated information.[32]

Figure 4 Physician agreement of causes of death from verbal autopsy in the Indian sample registration system
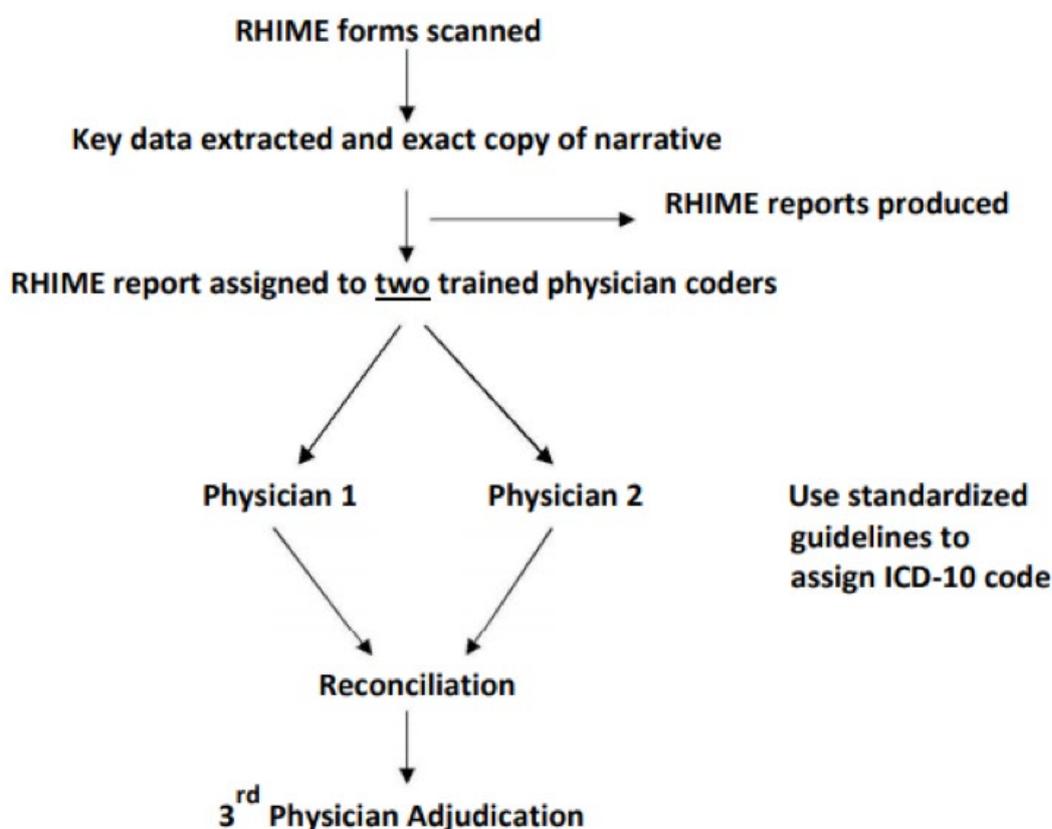
ICD = International Classification of Diseases; RHIME = routine, reliable, representative, resampled household investigation of mortality with medical evaluation

Source: Registrar General of India et al. Health care professional's manual for assigning cause of death (COD) based on RHIME household reports. Toronto, Canada: University of Toronto; 2013. Available at: http://www.cghr.org/cme2-training/reference/MDS-manual_ver2.9.pdf (accessed 11 February 2019).

After the supervisor has administered a VA, about 10 per cent of the households are resampled for quality control purposes. VAs administered during the quality check are also assigned a COD by two separate physicians.[28]

Vital statistics data summary

RGI regularly publishes data from the SRS. Half-yearly bulletins list key fertility and mortality indicators, while the yearly statistical report provides annual estimates of population composition, fertility, mortality, and medical attention at the time of birth or death. Detailed tables provide indicators such as age-specific death rates.

30   Jha P et al. Prospective study of one million deaths in India: Rationale, design, and validation results. *PLoS Medicine*. 2006; 3(2):e18.
31   Lal et al. National innovative approach in identifying the causes of deaths in India. Meeting of the WHO Collaborating Centres for the Family of International Classifications, 10–16 October 2009, Seoul, Republic of Korea. Available at: http://who.int/classifications/network/WHOFIC2009_D025p_NandLal.pdf (accessed 11 February 2019).
32   Jha et al. Prospective study of one million deaths in India: Rationale, design, and validation results. *PLoS Medicine*. 2006; 3(2): Supplementary materials S1.
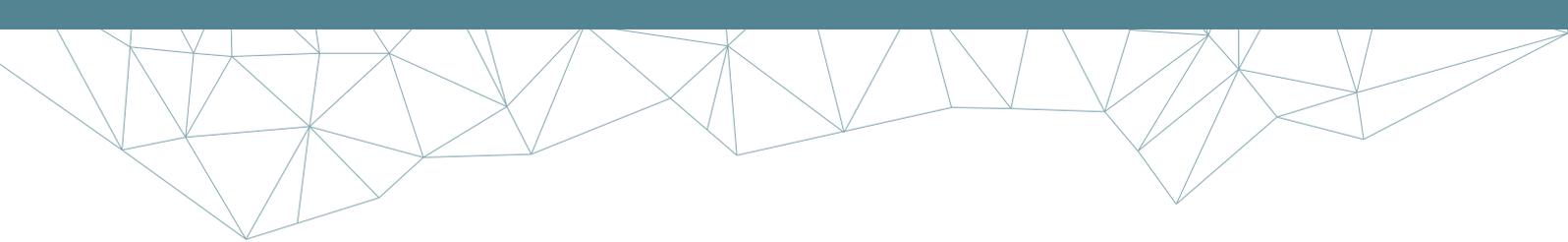
Life tables are available from data aggregated over five years. All data are disaggregated by urban and rural areas for each state, and the nation as a whole.[26,27]

Data on COD are published less frequently, likely because several years of data are needed to have enough events to report causes by age, sex, and area, and that tabulation and analysis of such data are more time-intensive.[26]

Mortality indicators as reported in the SRS can be compared to GBD estimates (Table 3). Under 5 mortality rates from GBD 2016 and the India SRS are similar, as is female life expectancy at birth. However, the SRS figure for male life expectancy at birth is higher than the 2015 GBD estimate. While the SRS calculates a life table using several years of aggregated data, it does not report adult mortality indicators.

Table 3 Comparison of most recently reported mortality indicators from India's sample registration system (SRS) and the Global Burden of Disease (GBD) study

Mortality indicator	SRS 2016, 2012–2016	GBD 2016, GBD 2015
Under 5 mortality rate	39[†]	39·2 (33·0–47·3)[‡]
Adult mortality (45q15) males	NR	151.0 (142.3–159.6)[~]
Adult mortality (45q15) females	NR	245.6 (233.4–258.4)[~]
Life expectancy at birth males (years)	67.4[¶]	65.2 (64.5–66.0)[~]
Life expectancy at birth females (years)	70.2[¶]	69.5 (68.7–70.4)[~]

NR = not reported

Under 5 mortality rate = Probability of a live-born child dying before reaching the age of 5 years, expressed per 1000 live births.

Adult mortality rate = Probability that those who have reached age 15 will die before reaching age 60 (shown per 1000 persons).

† Data for 2016 from: Office of the Registrar General & Census Commissioner, India. Sample Registration System Statistical Report 2016. Office of the Registrar General & Census Commissioner, New Delhi; 2017. Available at: http://www.censusindia.gov.in/vital_statistics/SRS_Report_2016/8.Chap%204-Mortality%20Indicators-2016.pdf (accessed 11 February 2019).

‡Data from: Wang et al. Global, regional, and national under-5 mortality, adult mortality, age-specific mortality, and life expectancy, 1970–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet. 2017; 390:1084-1150.

~ Supplementary annex to GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 2016; 388: 1459–544.

¶ Data for 2012–2016 from: Office of the Registrar General & Census Commissioner, India. SRS-based life table 2012–16. Office of the Registrar General & Census Commissioner, New Delhi; 2018. Available at: http://www.censusindia.gov.in/Vital_Statistics/SRS_Life_Table/Srs_life_Table_2012-16.html (accessed 11 February 2019).

Data quality and completeness

The SRS takes significant care to ensure no deaths are missed. The PTE is expected to visit urban households monthly, and rural households quarterly. Additionally, a half-yearly household survey is performed and the results from the survey and continuous enumeration are matched to ensure no vital events are missed. However, the RGI does not report on completeness or the number of events that do not match between continuous enumeration and the half-yearly surveys.[26] Previous evaluations in the 1970s and 1980s showed that under-registration was below 10 per cent. A study using indirect methods showed completeness ranged from 77 to 99 per cent in the years 1990–2007.[33]

The move to a paperless system has cut down on missing data fields, illegible information and invalid entries, improving the quality of the data. The automated system does not allow for records to be submitted without sex or other essential details.[27]

The Registration of Births and Deaths Act of 1969 requires physicians to certify CODs under the medical certification of COD scheme using the International Form of Medical Certificate of Cause of Death.[34,35] However, this is generally only done in urban hospitals, and its application is not consistent, which can affect the quality of the data.[35]

Strengths and weakness of the system

The Indian SRS is a thorough system with procedures in place to decrease the probability of missing vital events. However, this requires more human resources and is costly, especially when factoring in physician review of VA. Aside from identifying deaths and administrating VAs, the half-yearly survey has the added value of regularly updating household listings and demographic characteristics.[25] However, it is not clear if unmatched deaths verified in the field will later be administered a VA, or if only deaths identified during the half-yearly survey are included in the VA procedure. If the latter is the case, the exclusion of deaths only identified during continuous enumeration could result in biased COD statistics.

33   Mahapatra P. An Overview of the Sample Registration System in India. Prince Mahidol Award Conference & Global Health Information Forum 2010 Jan 27–30, Bangkok: Prince Mahidol Award Foundation; 2010. Available at: http://unstats.un.org/unsd/vitalstatkb/KnowledgebaseArticle50447.aspx (accessed 12 February 2019).

34   Kumar A, Raut DK, Gupta P, Singh U. Status of mortality statistics reporting in India: a report. Mortality statistics in India 2006. New Delhi: Central Bureau of Health Intelligence, Ministry of Health and Family Welfare; 2007

35   Report on medical certification of cause of death 2011. New Delhi: Office of the Registrar General and Census Commissioner, Ministry of Home Affairs; 2015
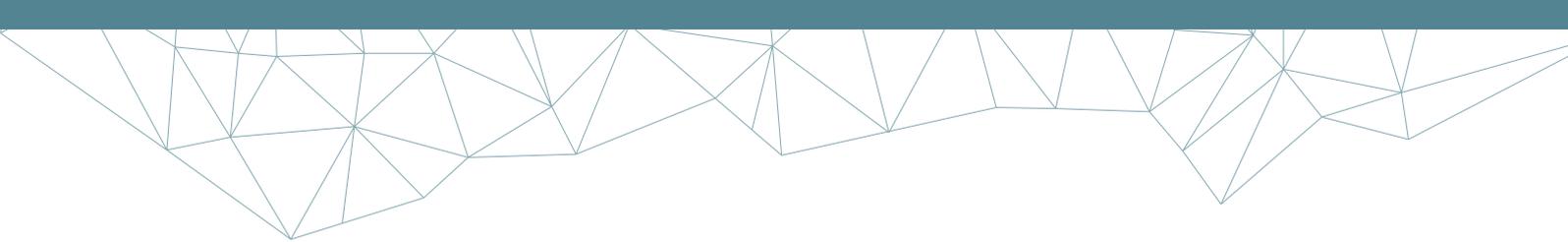
Systematic evaluation of the SRS has not been done for some time, although indirect estimates from the 1990s and onwards indicate that registration completeness has worsened over time, and quality and completeness vary between different states.[33] While there is a mandate to collect COD information, the inconsistency of the use of the WHO International Form of Medical Certificate of Cause of Death among hospitals also affects data quality.[35] Additionally, more than 10 per cent of causes are coded as ill-defined (12.4% in 2010–2013 for all ages, and much higher for adults aged 70 and older – 29%), indicating that additional training in medical certification of death may be needed.[25]

The Indian SRS is diligent about the timely dissemination of mortality data. Publications are released half-yearly and yearly, apart from reports about COD, which are disseminated less frequently. Information on the number of events that matched between the half-yearly surveys and continuous enumeration is currently not published, but dissemination of such data would be key to monitor and evaluate completeness of the system.[26]

Moving forward

After each baseline assessment, the number of sampling units has increased with time (see Table 4) and the SRS has slowly expanded. By 2012, policy makers were requesting district-level statistics, which led RGI to investigate the possibility of adding 46 000 sample units for 2015–16. However, the additional cost was estimated to be US$50 million, which, along with operational difficulties, made the proposal unfeasible.[33] Cost and logistics determine the size of the SRS sample and its possible expansion. In the meantime, the SRS fills a critical data gap, even though there are currently no formal linkages between the SRS and the CRVS system.[36]

Table 4 Number of sampling units at different replacement periods in India's sample registration system

Residence	Number of sample units at different replacement periods					
	1969–70	**1977–78**	**1983–85**	**1993–95**	**2004**	**2014**
Rural	2432	3684	4176	4436	4433	4964
Urban	1290	1738	1846	2235	3164	3897
Total	3722	5422	6022	6671	7597	8861

Source: India Office of the Registrar General & Census Commissioner. Sample Registration. Available at: http://www.censusindia.gov.in/Vital_Statistics/SRS/Sample_Registration_System.html (accessed 7 February 2019).

36   Abouzahr et al. Strengthening civil registration and vital statistics in the Asia-Pacifc region: learning from country experiences. *Asia–Pacific Population Journal.* 2014; 29(1):39
74.

Indonesia
History and principles behind the Indian sample registration system

The current Indonesian SRS is based on the Indonesian Mortality Registration System Strengthening Project (IMRSSP), which was implemented to compensate for the lack of mortality data needed to monitor population health and progress towards the Millennium Development Goals.[37,38] While a new law in 2006 mandated the registration of births and deaths, completeness of registration is poor and remains low. Additionally, the law did not explicitly state that recording the COD was compulsory.[39] The IMRSSP was developed to both increase the number of registered deaths and introduce a formal mechanism for recording the COD at the time of registration.

The IMRSSP started with two pilot sites, in Solo City and Pekalongan District in 2006.[37] In 2007, it was expanded to four additional provinces, covering 158 urban wards (kelurahan) and 638 rural villages (desa).[40] As part of a health systems strengthening initiative supported by the Global Fund for AIDS, Tuberculosis, and Malaria, the IMRSSP was scaled up to become a nationally representative sample in 2012 and thus became known and the Indonesian SRS.[37,41,42] The SRS continued to receive partial funding in 2013-2015 from the Global Fund for AIDS, Tuberculosis, and Malaria, but became self-funded in 2016 by the Indonesian National Development Planning Agency. The SRS is also supported by a technical partnership between Indonesian and Australian academic institutions.[43]

The SRS sample covers approximately three per cent of the population according to the 2011 Population Census. The sample was designed to represent the seven geographic/administrative regions and consists of a representative sample of 103 rural and 25 urban sub-districts distributed across 30 provinces.[43]

Operational aspects of the system

The SRS was implemented through, and is overseen by, the Ministry of Health's National Institute of Health Research and Development.[38,43] Oversight of the SRS is done in close collaboration with the Directorate General of Population Administration, Ministry of Home Affairs (the ministry that oversees civil registration). A joint decree was issued in January of 2010 between the Ministry of Home Affairs and the Ministry of Health mandating collaboration for the registration of births, deaths and causes of death.[37,43]

The SRS is designed to operate at the district and sub-district level, with Ministry of Health institutions collecting and compiling data with support from staff at community health centres. Prior to 2018, the SRS was only concerned with collecting mortality-related data. However, starting in 2018, information on births is also being collected.[43]

Prior to implementing the SRS in a sub-district, community leaders and local officials are educated about the purpose and operational procedures of the SRS and encouraged to support the system. Furthermore, all village, health centre and district level field staff receive training before performing their duties.[43]

In villages, death information is collected by government midwives through a network of local informants which include the village administrator, neighbourhood/community associations, and community health volunteers. Midwives complete monthly reports of all persons who have died in their catchment area. These reports include the name, age, gender, date of death, and address of the deceased. Reports are then transferred to the local Community Health Centres. Local paramedics then periodically visit the households of the deceased to administer the WHO standard VA questionnaire to surviving family members.[43,44]

Completed VAs are reviewed by trained physicians who assign cause(s) of death. Local Community Health Centres then send the VA data to the local district health office where they are compiled by the district SRS coordinator. District health offices send the data to the National Institute of Health Research and Development, where the cause of death data is reviewed for quality purposes and assigned ICD-10 codes according to the

37 Pratiwi et al. Development of an Indonesian sample registration system: a longitudinal study. *The Lancet*. 2013; 381:S118.
38 Rao et al. Mortality in Central Java: results from the Indonesian Mortality Registration System Strengthening Project. *BMC Research Notes*. 2010; 3(1):325.
39 Rao et al. Mortality in Central Java: results from the Indonesian Mortality Registration System Strengthening Project, additional file 2. *BMC Research Notes* 2010; 3(1):325.
40 Rao et al. Tuberculosis mortality differentials in Indonesia during 2007–2008: evidence for health policy and monitoring. *International Journal of Tuberculosis and Lung Disease*. 2011; 15(12):1608-1614
41 Terms of reference for the Technical Workshop on the Indonesian Sample Registration System (SRS), Jakarta, 26–27 February 2015.
42 Strengthening Civil Registration and Vital Statistic Indonesia Country Perspectives. Multi-country Workshop to develop country roadmaps to translate the recommendations of the Commission on Information and Accountability for Women's and Children's Health. Bangkok, Thailand, 24–26 September 2012. Available at: http://www.who.int/woman_child_accountability/resources/Day1_Session2_CRVS_Indonesia_02.pdf (accessed 11 February 2019).
43 Usman et al. Indonesia's Sample Registration System in 2018: A work in progress. *Journal of Population and Social Studies*. 2019; 27(1):39-52.
44 World Health Organization. *Verbal autopsy standards: ascertaining and attributing causes of death.* Geneva, Switzerland: WHO, 2007.

principles of the WHO ICD-10.[45] The National Institute of Health Research and Development tabulates and analyses the data and calculates standard mortality indicators.[43]

No recent information was available regarding operational processes for deaths that occurred in urban wards or in hospitals. However, the SRS does not operate independently of the civil registration system,[43] thus operational practices are likely to be similar for deaths that occurred in urban wards, hospitals, and villages.

Vital statistics data summary

Only one publication presenting mortality data from the Indonesian SRS was available at the time of writing. These data are shown in Table 5, with the latest GBD estimates for comparison. The only other published vital statistics were from the two pilot sites established upon the implementation of the IMRSSP, and the expansion to sites within five provinces for the IMRSSP.[46]

A recent assessment found that the SRS is only capturing about 55 percent of male deaths and 51 percent of female deaths.[43] As there is extensive underreporting of deaths, it is not possible to make valid comparisons between the Indonesian SRS data and the GBD estimates (see data quality section below for more discussion on these indicators).

Usman et al. published data on the leading causes of death from the SRS for 2015 and 2016, however no information was available by age and sex for causes of death. The only other publication with nationally representative data from the SRS was a UN SDG report which cited the leading causes of death in children. In 2014 these causes were listed as low birth weight (38.8%), asphyxia (26.5%) and congenital malformation (12.7%). Presumably, this data is for neonates, but the UN SDG report did not explicitly state what ages of children the causes applied to.[47]

Table 5 Comparison of most recently reported mortality indicators from Indonesia's sample registration system and the Global Burden of Disease (GBD) study

Mortality indicator	SRS 2016*	GBD 2016, GBD 2015
Under 5 mortality rate	9.6–10.3‡	25.2 (20.5–31.0)§
Adult mortality (45q15) males	105.9	200.4 (155.3-249.2)¶
Adult mortality (45q15) females	88.6	138.1 (105.7-175.6)¶
Life expectancy at birth males (years)	80.9	69.8 (68.8–70.7)§
Life expectancy at birth females (years)	81.6	73.6 (73.0–74.1)§

* Mortality measures from SRS data are not adjusted for underreporting of deaths. Data for 2016 from: Usman et al. Indonesia's Sample Registration System in 2018: A work in progress. *Journal of Population and Social Studies*. 2019; 27(1):39-52.

Under 5 mortality rate = Probability of a live-born child dying before reaching the age of 5 years, expressed per 1000 live births.

Adult mortality rate = Probability that those who have reached age 15 will die before reaching age 60 (shown per 1000 persons).

‡ Range for males and females – data for both sexes combined not available.

§ Data from: Wang et al. Global, regional, and national under-5 mortality, adult mortality, age-specific mortality, and life expectancy, 1970–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet*. 2017; 390:1084-1150.

¶ Supplementary annex to GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* 2016; 388: 1459–544.

45   World Health Organization. *Mortality: guidelines for certification and rules for coding*. In: International Statistical Classification of Diseases and Related Health Problems, 10th revision, vol. 2. Geneva, Switzerland: WHO; 2016: 30-65.

46   For more information, see: Rao et al. Mortality in Central Java: results from the Indonesian Mortality Registration System Strengthening Project. *BMC Research Notes*. 2010; 3(1):325 and Rao et al. Tuberculosis mortality differentials in Indonesia during 2007–2008: evidence for health policy and monitoring. *International Journal of Tuberculosis and Lung Disease*. 2011; 15(12):1608-1614.

47   Republic of Indonesia, 2017, Voluntary National Review (VNR), Eradicating Poverty and Promoting Prosperity In A Changing World. Indonesia National Development Planning Agency, Jakarta. Available at: https://sustainabledevelopment.un.org/content/documents/15705Indonesia.pdf
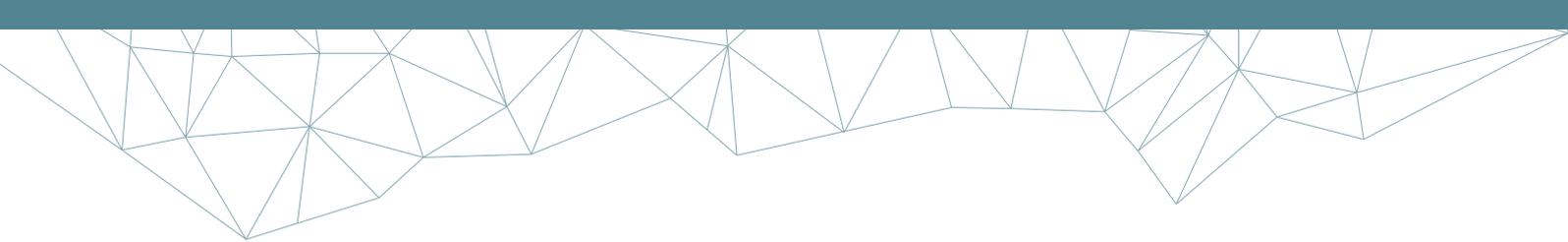
Table 6 Leading causes of death in the Indonesian SRS for 2015 and 2016, all ages, both sexes

Rank	2015 Cause	%	2016 Cause	%
1	Cerebrovascular disease (I60-I69)	20.4	Cerebrovascular disease	19.9
2	Ischaemic Heart Disease (I20-I25)	13.2	Ischaemic Heart Disease	13.3
3	Diabetes mellitus (E10-E14)	7.8	Diabetes mellitus	7.9
4	Hypertensive diseases (I11-I13)	6.2	Hypertensive diseases	5.8
5	Chronic lung diseases (J40-J47)	5.7	Respiratory tuberculosis	5.6
6	Respiratory tuberculosis (A15-16)	5.3	Chronic lung diseases	5.1
7	Diseases of the liver (K70-K76)	2.8	Diarrhoea / Intestinal infections	4.2
8	Transport accidents (V01-V99)	2.6	Other heart disease (I26-I51	3.4
9	Diarrhoea/intestinal infections (A00-A09)	2.5	Ill-defined conditions (R00-R99)	2.9
10	Pneumonia (J12-J18)	2.1	Transport accident	2.6
11	Breast cancer (C50)	1.0	Nutritional & metabolic disorders*	2.5
12	Falls (W00-W19)	0.9	Kidney disease (N00-N98)	2.2
13	Peptic ulcer (K25-K27)	0.8	Diseases of the liver	2.0
14	Viral hepatitis (B15-B19)	0.7	Perinatal conditions (P00-P96)	1.9
15	Dengue fever (A90-A91)	0.6	Pneumonia	1.8
	All other causes	26.3	All other causes	18.9
	Total Deaths	25,228	**Total Deaths**	30,633

* E00-E07, E15-E34, E50-E88

Source: Usman et al. Indonesia's Sample Registration System in 2018: A work in progress. *Journal of Population and Social Studies*. 2019; 27(1):39-52.

No data were found on births or related fertility indicators for the Indonesian SRS.

Data quality and completeness

The National Institute of Health Research and Development holds yearly coordination meetings at the national and district level to monitor the SRS. Staff from the district and health centres, as well as staff from sub-district and village local administrations when possible, review reports from each SRS site and to address any issues found. The National Institute of Health Research and Development also reviews compiled data at the national level to assess quality of the data and assign the appropriate ICD-10 codes.[43]

Usman et al. assessed the completeness of death registration by sex in the seven different regions of the SRS sample. Completeness ranged from 22 per cent for women in Eastern Indonesia to 69 per cent in men in Central Java. Nationally, death registration completeness was 55 per cent for men and 51 per cent for women. Completeness was higher for men across all seven regions.[43]

The authors found a wide range of death registration completeness within regions and within individual sites over time. In all regions in 2016, some sites had achieved completeness of above 75 per cent, but other sites had very low completeness, estimated to be below 20 per cent. In reviewing individual sites from 2014 to 2016, only 20 per cent had consistently high or low completeness over the three-year period. And while more than half had achieved completeness of greater than 75 per cent in at least one of the three years, just 19 per cent had achieved this goal all three years.[43]

CRVS best-practice and advocacy

Table 7 Estimated percent completeness of death registration by sex and region in the Indonesian SRS, 2016

Region	Male	Female
1. North Sumatra	46	38
2. West & South Sumatra	55	52
3. Jakarta & Kalimantan	42	36
4. West Java	53	50
5. Central Java	69	68
6. East Java, Bali, Nusa Tenggara	68	63
7. Eastern Indonesia	24	22
National sample	**55**	**51**

Source: Usman et al. Indonesia's Sample Registration System in 2018: A work in progress. *Journal of Population and Social Studies.* 2019; 27(1):39-52.

Strengths and weakness of the system

The Indonesian SRS is a continuous, nationally and regionally representative source of data on births, deaths and COD, and acts as a capacity-building measure to strengthen the national CRVS system.[43,48] As stated by Usman et al., the SRS provides, *"training and establishment of field experience among registration staff, verbal autopsy interviewers and physician certifiers of causes of death, and data managers and data analysts, all of whom serve as a critical mass of human resources for national vital statistics development."*[43]

The SRS is backed by a 2006 law mandating the registration of births and deaths, which has fostered interdepartmental agreements. A joint decree was issued in January of 2010 between the Ministry of Home Affairs (home to the civil registry), and the Ministry of Health to share data.[37,43,44] As of 2016, the SRS has also received political support in the form of a dedicated operational budget from the Indonesian National Development Planning Agency.[43]

Despite these strengths, the Indonesian SRS is not yet able to produce the reliable mortality statistics it was designed to create due to low levels of death registration completeness. In 2016, all seven regions contained some sites that had completeness rates below 20 per cent, making the resulting data unusable. However, every region also had at least one site where completeness was above 75 per cent, suggesting that it was possible to implement the SRS successfully given the right approach.[43]

Although the underreporting of deaths does not allow for reliable mortality indicator calculation, recent analyses of SRS data suggest that the VA method used was robust enough to accurately assign CODs. Resulting sex and age-specific distributions of deaths by specific CODs were plausible, and the proportion of deaths coded to ill-defined conditions was less than three per cent in 2016.[43]

The IMRSSP, which was the precursor to the nationally representative SRS, put in place a formal mechanism to medically certify and document COD by using the International Form of Medical Certificate of Cause of Death.[39] It would appear this process has greatly benefited community deaths where VA is administered. It is unclear how widely this process has been adopted for those deaths that occurred in medical institutions.

The SRS also faces administrative and technical challenges from catering to a large population scattered across 17,000 islands. The wide geographical distribution of the SRS sites impacts timely data collection and compilation and limits the amount of technical support that can be provided.[43]

In a qualitative review, Usman et al. found other weaknesses to be, *"the high turnover of field verbal autopsy staff and physician reviewers, inadequate local coordination between health staff and other key informants, absence of field supervision, and irregular availability of funds for local activities. In addition, the centralised mechanisms for data computerization precluded the potential for efficient local data compilation and monitoring as a tool to enable immediate local follow up of data reports not submitted by primary sampling units".*[43]

48   Strengthening Civil Registration and Vital Statistic Indonesia Country Perspectives. Multi-country Workshop to develop country roadmaps to translate the recommendations of the Commission on Information and Accountability for Women's and Children's Health. Bangkok, Thailand, 24–26 September 2012. Available at: http://www.who.int/woman_child_accountability/resources/Day1_Session2_CRVS_Indonesia_02.pdf (accessed 11 February 2019).
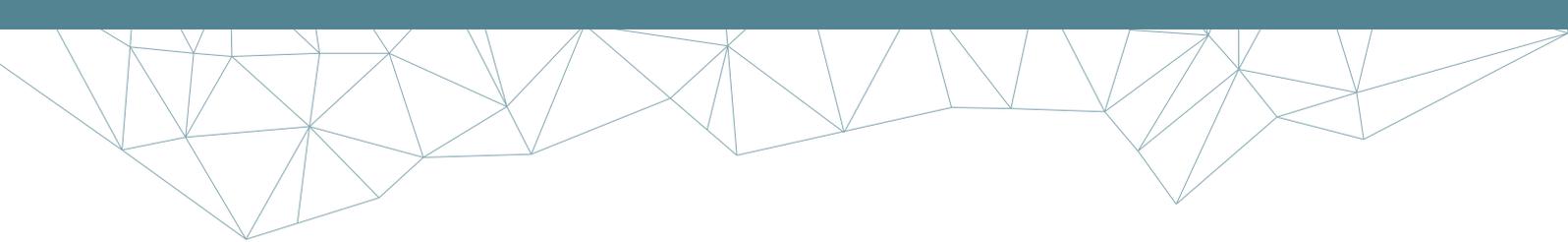
Finally, the lack of published data is one of the biggest weaknesses of the SRS. To date, just one source has published nationally representative information from Indonesia's SRS. In order to increase demand and use of vital statistics, information from the SRS will need to be published on a timelier basis.

Moving forward

The 2006 changes to population administration law were aimed at achieving a CRVS system with complete registration, and stated that establishing an SRS would be a step towards this goal.[41] Since then, the SRS has been used as a model to strengthen registration sites in several districts and municipalities.[49] Recently, the Indonesian Government committed to a national program to 'accelerate and expand the ownership of civil registry documents'.[49] Further, a 'Presidential Decree on National Strategy of Civil Registration and Vital Statistics (CRVS) 2017–2024 is being formulated, with the aim to ensure that each Indonesian citizen and resident are properly recorded, served and protected'.[43] To support the SRS in strengthening CRVS, the Indonesian Government has increased the local budget for SRS field operations.[43]

Additionally, the National Institute of Health Research and Development, in collaboration with Indonesian and Australian academic institutions, the Indonesian Ministry of Health, and the Indonesian National Development Planning Agency, developed a comprehensive system strengthening strategy. The strategy was implemented in 2018 and supports the decentralisation of data management to improve performance at the site level. A data entry tool has been developed that will capture information at the level of the community health centre and district office. The data can then be transferred into a database where it will be assessed against different reporting and data quality metrics to monitor and improve collection processes in the field. Data can also be exported for automated ICD coding in IRIS.[43]

The SRS improvement strategy also calls upon academic institutions to provide local technical support and evaluate the completeness and quality of SRS data through dual-record linkage mechanisms and studies measuring the validity of causes of death from verbal autopsies. All of these efforts are meant to strengthen the SRS in hopes of generating reliable national mortality estimates for Indonesia.[43]

49   Republic of Indonesia. *Voluntary National Review (VNR): eradicating poverty and promoting prosperity in a changing world.* Jakarta: Indonesia National Development Planning Agency; 2017. Available at: https://sustainabledevelopment.un.org/content/documents/15705Indonesia.pdf (accessed 11 February 2019).
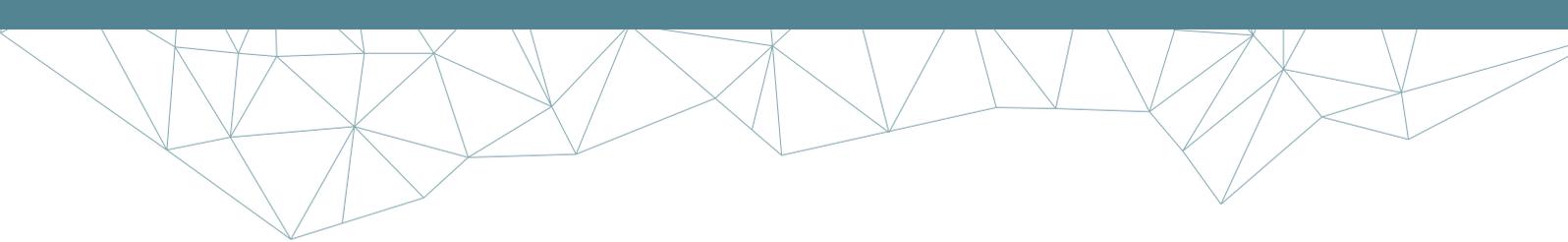
Similarities and differences between the three sample registration systems

The SRSs in China, India and Indonesia share some key features; they are all designed to be nationally representative, identify community and home-based deaths, administer VA to determine COD for deaths outside of hospital, and have physicians medically certify COD for deaths in hospital. However, they differ in operational procedures and the way they link to the national CRVS system. The Indonesian SRS is aligned with the national CRVS system, which is a capacity-building measure working towards complete registration.[39, 43] When the Chinese VR system was integrated with the DSP, they became one system with coverage of 24 per cent of the population.[10] The Indian SRS, on the other hand, does not have a formal link to the national CRVS system.[36]

The sample systems also differ in their quality control measures. The Indian SRS relies on a half-yearly household survey to ensure vital events were not missed and records are complete, while the Chinese mortality surveillance system administers a survey every three years to determine completeness and adjust estimates. To date, the Indonesian system has not implemented regular surveys as part of the ongoing operations of the system.

The Chinese and Indian SRSs regularly publish data, while the Indonesian SRS has only one published report of nationally representative data. Policy makers in China and India regularly use data from their systems and have even requested the expansion of the systems to generate data at the district level. No documentation could be obtained on the internal dissemination and use of data from the Indonesian SRS, but due to the low level of registration completeness, it cannot yet produce mortality statistics reliable enough for policy use.

All three systems now receive dedicated funding from their governments, but this is a relatively new development for the Indonesian SRS, making future funding of the system less certain. Additionally, the governments of all three countries have committed to strengthening their CRVS systems, and their ministers signed the United Nations Economic and Social Commission for Asia and the Pacific Ministerial Declaration to 'Get every one in the picture' and achieve universal registration of all births and deaths by 2024.[50]

50   United Nations Economic and Social Commission for Asia and the Pacific. Get everyone in the picture. Ministerial Conference on Civil Registration and Vital Statistics in Asia and Pacific, 28 November 2014, Bangkok. Available at: http://getinthepicture.org/sites/default/files/resources/Ministerial.Declaration.English.final_.pdf (accessed 11 February 2019).

Table 8 Key features of the sample registration systems in China, India and Indonesia

	China	India	Indonesia
Percentage of population covered (number)	24% (323.8 million)[*]	0.6% (7.6 million)[†]	3% (8.6 million)[‡]
Estimated completeness	87%[§]	77–99%[¶]	51–55%[‡]
Provincially representative?	Yes	Yes	Regionally representative
SRS and CRVS follow same operational principals/are aligned?	Yes	No	Yes
Method to find deaths outside of hospital	Village health workers notify hospital	Regular household visits by an enumerator, half-yearly surveys	Network of village informants notify midwife who records all deaths monthly
Independent surveys to assess completeness?	Every 3 years to assess completeness	Every 6 months to detect incomplete or missed events	No
Registration of deaths compulsory under legislation?	No	Yes	Yes
Compulsory to medically certify COD for hospital deaths?	Yes	Yes[††]	Not specified in law[‡‡]
International form of the medical certificate of cause of death used for hospital deaths?	Yes[**]	Yes, but not consistently, mostly in urban hospitals	Yes, but no recent assessment of practice since IMRSSP
Percentage of deaths assigned ill-defined causes of death	1.2%[§§]	12.4%[~]	2.9%[‡]
VA questionnaire used	Country-specific questionnaire	RHIME (country-specific)	WHO standard questionnaire[‡]
SRS data published annually	Yes (in Chinese only)	Yes	No
Funding source	Chinese Government	Indian Government	Indonesian Government

COD = cause of death; CRVS = civil registration and vital statistics; IMRSSP = Indonesian Mortality Registration System Strengthening Project; RHIME = routine, reliable, representative, resampled household investigation of mortality with medical evaluation; SRS = sample registration system; VA = verbal autopsy; WHO = World Health Organization

[*] Liu et al. An integrated national mortality surveillance system for death registration and mortality surveillance, China. *Bulletin of the World Health Organization.* 2016; 94:46 57.

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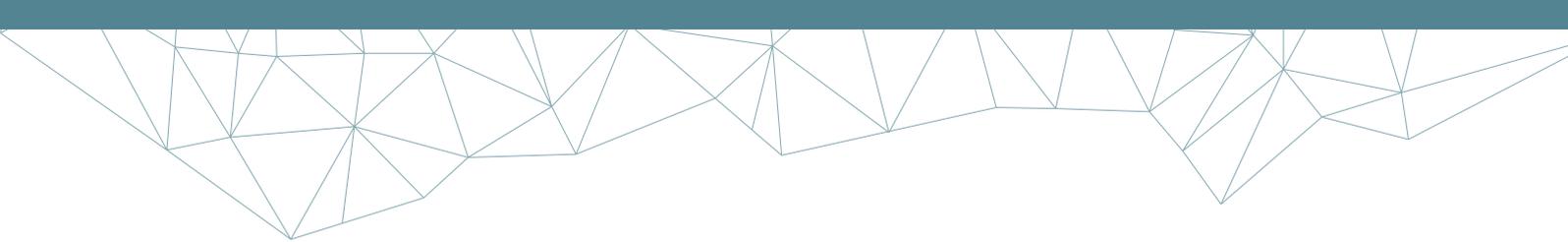
Summary

Accurate and timely mortality and cause of death (COD) data are necessary to inform and evaluate health policy. However, many countries do not have complete civil registration and vital statistics (CRVS) systems that can generate these data. As an interim measure towards strengthening their CRVS systems, China, India, and Indonesia developed sample registration systems (SRSs) to generate nationally representative mortality and COD data and build system capacity. This information is essential for the development of public health policies and programs for preventing disease, and to provide information on changing and emerging patterns of disease and injury. Because these three countries collectively constitute about 40% of the world's population, reliable information on numbers and CODs will influence global mortality information and resulting public health responses.

While the SRSs in all three countries share some common features, they differ in many ways. Taking an overview of these systems, this paper outlines the history and principles behind them, their operational aspects, their vital statistical output and quality of data, their strengths and weaknesses, and their intended future direction. This will inform the consideration and development of SRSs in other countries where the collection of national mortality statistics is poor and where a well-designed SRS could provide information on representative patterns of mortality.

Related resources and products

University of Melbourne, D4H Initiative, CRVS Knowledge Gateway: Library

https://crvsgateway.info/library

A framework for evaluating national CRVS systems as baseline. CRVS technical outcome series.

Action guide on process mapping for CRVS systems. CRVS action guides.

Fellowship profile: Assessing the quality of mortality statistics in Shanghai. CRVS development series.

Integrating community-based verbal autopsy into CRVS: System level considerations. CRVS technical outcome series.

Maximising synergies between Health observatories and CRVS. CRVS technical outcome series.

Understanding CRVS systems: The importance of process mapping. CRVS development series.

Where there is no physician: Improving the notification of community deaths. CRVS technical outcome series.

Why the Sustainable Development Goal agenda needs strong civil registration and vital statistics systems. CRVS development series.

University of Melbourne, D4H Initiative, CRVS Knowledge Gateway: Learning Centre

https://crvsgateway.info/learningcentre

Topic 2: CRVS governance and architecture.

Topic 4: Cause of death in CRVS.

Topic 6: CRVS tools – Automated verbal autopsy tools.

University of Melbourne, D4H Initiative, CRVS Knowledge Gateway: Courses

https://crvsgateway.info/courses

SmartVA.

CRVS best-practice and advocacy
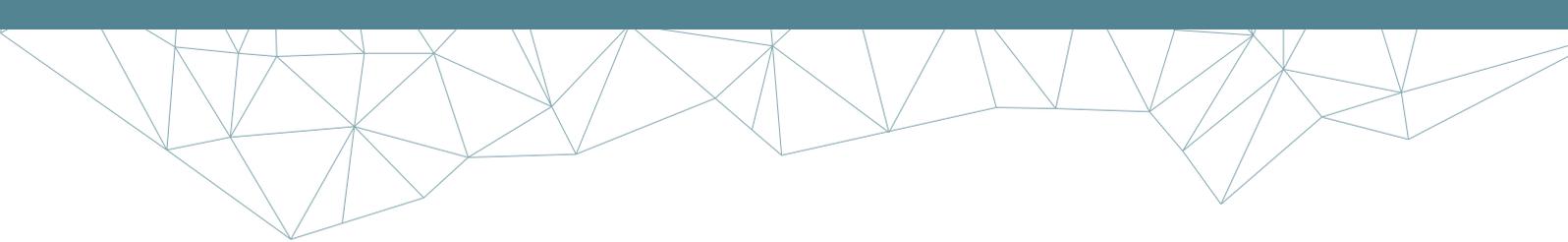
Further reading

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The program partners on this initiative include: The University of Melbourne, Australia; CDC Foundation, USA; Vital Strategies, USA; Johns Hopkins Bloomberg School of Public Health, USA; World Health Organization, Switzerland.

Civil Registration and Vital Statistics partners:

The University of Melbourne recognises the Swiss Tropical and Public Health Institute for their partnership and contribution

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