

MATERNAL AND CHILDHOOD MORTALITY, LIFE EXPECTANCY AT BIRTH: RESULT FROM IMPLEMENTATION OF THE CIVIL REGISTRATION AND VITAL STATISTICS SYSTEM IN DISTRICT OF NORTH BOLAANG MONGONDOW, INDONESIA, 2021

Tin Afifah, Ristrini, Ina Kusriani, Ning Sulistiyowati, Kristina,
Hayani Anastasia, Rachmalina Soerachman and Dede Anwar Musadad

National Research and Innovation Agency, Jakarta, Indonesia

Abstract. The decision making on maternal and child health program needs reliable and actual data on births and deaths, including the cause of death (COD), through a well-functioning civil registration and vital statistics (CRVS) system as the best data source of health information system, in order to make a good health policy. This study aimed to describe the CRVS System in North Bolaang Mongondow to get mortality statistics for health indicators. This study was held in 2021 in District North Bolaang Mongondow. The community health centre (Puskesmas) has responsibility for birth and death data from 1 September 2020 to 31 October 2021, using Form 4 for birth and Form 5 for death. Puskesmas paramedic visited each death case in the outer hospital to perform the autopsy with the smart verbal autopsy (VA) application, calculating the infant mortality rate (IMR), the under-five mortality rate (U5MR), and life expectancy at birth (e^0) followed the lifetable and direct methods for maternal mortality ratio (MMR). Observations of this 2021 study revealed a total of 1,054 live births. In addition, 468 deaths (by all causes) were visited for verbal autopsy in 2021, which included 6 maternal deaths and 21 childhood deaths. The leading health indicators from the CRVS system in North Bolaang Mongondow District include crude death rate (CDR) of 5.2/1,000 population; $e^0 = 72.92$; IMR and U5MR were 15 and 33 by 1000 live births; MMR = 568/100,000 live births. It can be concluded that data collected from the CRVS system in North Bolaang Mongondow was still underreported since community health center staff failed to follow up on some mortality cases. The CRVS system successfully provides the leading mortality indicators at the district level as part of the health information system.

Keywords: health information system, CRVS system, IMR, U5MR, MMR, life expectancy, life table, Indonesia

Correspondence: Tin Afifah, National Research and Innovation Agency, Jl. Bunga Rampai IV Gang 4 No. 213, RT012/RW009, Malaka Jaya-Duren Sawit, Jakarta Timur, Indonesia
Tel: +62 81383811697 E-mail: afifah.tin@gmail.com; tin.afifah@brin.go.id

INTRODUCTION

Health Information System (HIS) aims to provide evidence from some data sources to monitor and evaluate health programs and services for decision-makers (WHO and WHO AFRO, 2000). Birth, death, and fetal deaths are vital statistics for health service programs. These essential data calculate demographic measurement and epidemiology needed for national and district public health planning development. In the health sector, vital statistics are the primary health information system (Danel and Bortman, 2008; Mikkelsen, 2012). Vital statistics derived from civil registration, including births and deaths and causes of death, is a database of health data and other information that provides many advantages for a country (Mikkelsen, 2012).

Civil registration is one of the best sources of life expectancy, infant, child, and maternal mortality data. Some indicators for childhood mortality, such as infant mortality rate (IMR), the under-five mortality rate (U5MR), and maternal mortality ratio (MMR), become the primary health development indicator for monitoring, evaluating, and planning health programs (Mikkelsen, 2012; Health Metrics Network and WHO, 2008). Mortality indicator is one measure used to assess the achievement of targets such as the Sustainable Development Goals (SDGs). The Indonesian government also uses the death indicator to achieve Indonesia's 5-year development, the Strategic Plan of the Ministry of Health (Republic of Indonesia, 2020). The size of death is the main indicator of a country or region because it is reliable, representative,

routine, and low cost (Kandel *et al*, 2010). The Health Metrics Network also states that the civil registration system is the gold standard for mortality indicators (Health Metrics Network and WHO, 2008). However, the civil registration and vital statistics (CRVS) system in Indonesia is not adequate nationally. Hence, the source of death data in Indonesia relies on surveys and censuses that require high costs, so the implementation of surveys/censuses is carried out periodically for five years (Kandel *et al*, 2010).

Since the era of decentralization in Indonesia in 2000, the demand for childhood mortality and MMR has increased since decentralization in Indonesia in 2000 (Pardosi *et al*, 2014).

Almost every birth or death is related to the health sector. Health institutions have a dual role in the vital statistics system; firstly as act as informants of the occurrence of births, fetal deaths, and deaths; secondly, the certification of causes of death can be performed only by physicians attached to health institutions (UN Department of Economic and Social Affairs, 2014). The other important thing for health development is the cause of death information. Ministry of Health Indonesia is active in initiating the CRVS system, primarily to provide the mortality statistics needed by the policymakers on the district level through strengthening the death registry and cause of mortality to increase the quality of birth registration, death, and cause of death. Since 2006, the National Institute of Health Research and Development (NIHRD) has collaborated with WHO Indonesia, and Queensland University initiated the Indonesia Mortality Registration System Strengthening Project (IMRSSP) in three site pilot projects (Indonesian Agency of Health Research and Development, 2021). In 2014, Indonesia and Asia-Pacific declared that the CRVS system would be implemented in 2024 (UN ESCAP, 2021). Then, in 2019, NIHRD developed the Birth, Death, and Cause Death Registration Strengthening Project. The decision maker of the District Health Office (DHO) depends on reliable and timely data on births and deaths, including the cause of death (COD). North Bolaang Mongondow is one of five pilot

projects developed in 2021 to strengthen the CRVS system.

This study is part of CRVS strengthening activities in five districts, and this paper focuses on getting an idea of how to implement the CRVS system to find mortality statistics for health indicators in the district of North Bolaang Mongondow. This study aimed to describe the CRVS System in North Bolaang Mongondow to get mortality statistics for health indicators.

MATERIALS AND METHODS

The study was conducted in the North Bolaang Mongondow District, North Sulawesi. The design of this study was participatory action research (PAR). The CRVS system project was started with the rapid assessment of the CRVS system for birth, death, and cause of death according to the WHO manual of rapid assessment of the CRVS System (WHO, 2010). The rapid assessment produces a score obtained from an assessment of 11 areas with 25 questions. This score was used to evaluate the function of the CRVS system in North Bolaang Mongondow District. CRVS rapid assessment scores are categorized as a) Dysfunctional: scores <35; b) Weak: scores range from 35-64; c) Functional but inadequate: scores range from 65-84; and d) Satisfactory: scores range from 85-100 (WHO, 2010). Then the District Government of North Bolaang Mongondow engaged with NIHRD to strengthen the CRVS system in North Bolaang Mongondow. After the rapid assessment, it was followed by capacity building of human resources involved in the CRVS system in North Bolaang Mongondow in April 2021.

The main step is the implementation of strengthening the birth, death, and cause of death registration system. The verbal autopsy (VA) team collected birth data with Form 4 and death data with Form 5 for the events of births and deaths of residents in their puskesmas area from 1 September 2020 to 31 October 2021.

The principle of the CRVS system developed in 2006 is that every birth and death is registered, and the cause of death follows every death (Rao *et al*, 2010).

The target population of the CRVS system is North Bolaang Mongondow residents based on identity document (ID) card ownership. The exclusion criteria for this study are non-resident birth and death records excluded from implementing the CRVS system.

The health center trained paramedics to collect birth data by name and address (village) from Form 4 of each village monthly (Fig 1).

The death information was obtained from various sources (Fig 2). The death data were collected from medical records as the basis for making MCCD and determining the final UCOD. The death recording system was started by using the hospital's death events from 1 September 2020 to 31 October 2021. Every death case in North Bolaang Mongondo District resident in a hospital was followed up by filling out an MCCD according to the WHO guideline (WHO, 2011). Therefore, the final UCOD was obtained. The person in charge of death data at the hospital sent data and the final cause of death to the District Health Office.

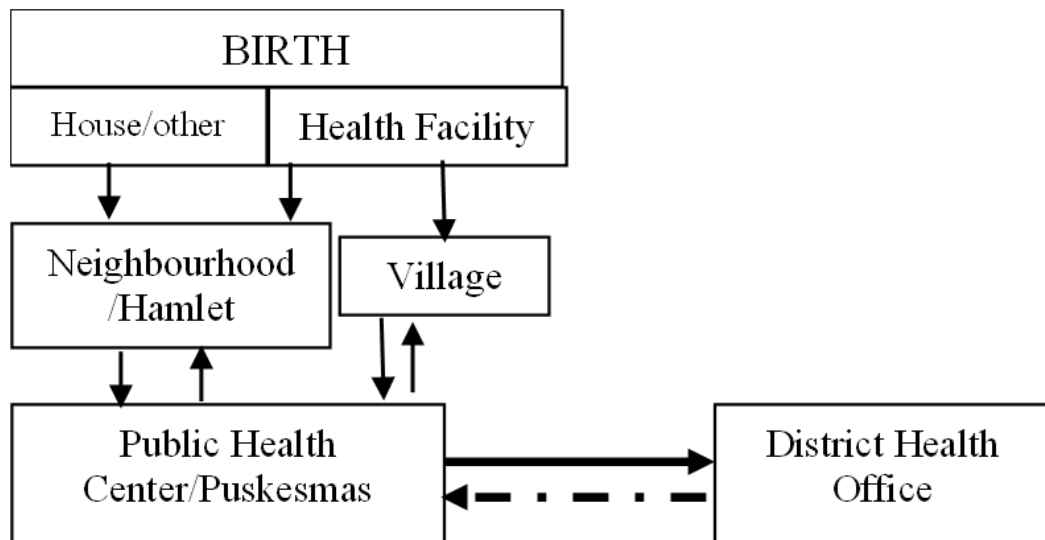


Fig 1 - Birth reporting diagram

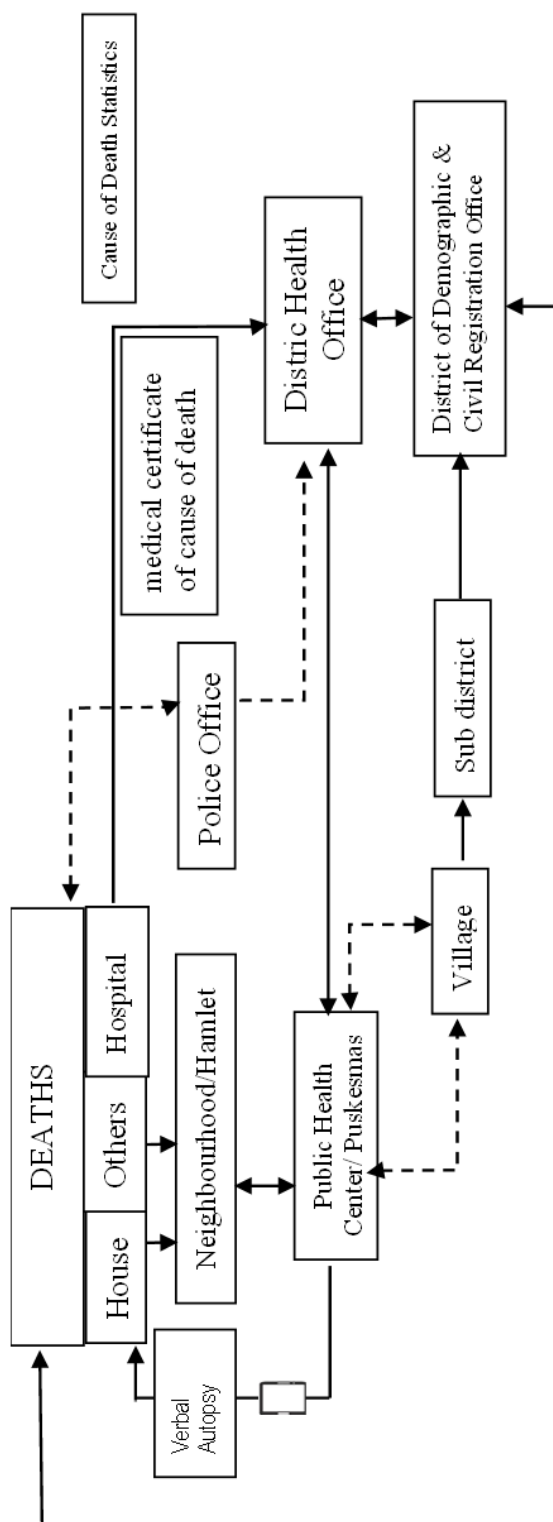


Fig 2 - Death reporting diagram

Furthermore, based on Form 5, if the death occurred outside of the public hospital, then information about the cause of death was obtained from the verbal autopsy method. The verbal autopsy officer from the local Puskesmas, who visited the deceased family, conducted this verbal autopsy. The VA officer then collected verbal autopsy data using the Open Data Kit (ODK) Collect installed on a smartphone. The instrument used in the ODK Collect was the 2016 WHO VA Instrument v1.5 in Bahasa Indonesian (WHO, 2016). The pilot tests were carried out in 2019 to ensure that the ODK Collect application functioned through the data management stages until analysis (IHME, 2022). Data from the ODK Collect were downloaded and cleaned.

The information obtained from the CRVS system in North Bolaang Mongondow was the number of births (Form 4), the number of deaths (Form 5), and the cause of death (MCCD from the hospital and AV from the Puskesmas). Moreover, the number of populations by sex and age group were provided by the Demographic and Civil Registration Office.

All these data were compiled and became the subject of joint evaluation. The numerator number of maternal death was derived from cause of death data, and the denominator of live birth data was derived from Form 4. Based on Form 4, Form 5, AV, and MCCD, we calculated the mortality indicators according to the operational definition in Table 1.

The ethical approval of this study was obtained from the Ethic Commission of Health Research, National Institute of Health Research and Development, Number LB.02.01/2/KE.100/2021.

RESULTS

Generally, the score for rapid assessment of the CRVS system in North Bolaang Mongondow was 37 (weak category), meaning many system aspects did not function well, and multiple issues required attention (WHO, 2010). Implementation CRVS system in North Bolaang Mongondow in 2021 run during pandemic COVID-19. The results of the birth registration with Form

Table 1
Mortality indicators and operational definition

Indicator	Definition	Method
Crude death rate (CDR)	The summary measure of mortality reflects a population's level, age pattern, and age structure (Adair and Lopez, 2018).	Direct calculation
Infant mortality rate (IMR)	The probability of a child born in a specific year or period dying before reaching the age of one.	The life table and probability of dying calculation tool developed by Figueroa <i>et al</i> , 2021. The life table analysis comprised the male, female and total sexes.
Under-five mortality rate (U5MR)	Combination of deaths and population/ births under one year and from 1-4 years, depending on data availability.	The life table and probability of dying calculation tool developed by Figueroa <i>et al</i> , 2021. The life table analysis comprised the male, female and total sexes.
Life expectancy at birth	The number of years left an individual in the hypothetical cohort can be expected to live from birth.	The life table and probability of dying calculation tool developed by Figueroa <i>et al</i> , 2021. The life table analysis comprised the male, female and total sexes.
Maternal mortality ratio (MMR)	Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (WHO, 2012)	Direct calculation: $\text{MMR} = \frac{\text{Number maternal death}}{\text{Number live birth}} \times 100,000$

4 are presented in Table 2.

Form 4 was collected from all Puskesmas in North Bolaang Mongondow District. Then a total of 1,054 birth records was counted, but this number did not include births from Biontong Village. According to the birth recap from DHO, there was no birth reported from this village. There were 15 birth records without sex information, and six were without the status of the fetus. It was underreported. Table 2 confirmed the rapid assessment, which reported that the completeness of the birth report in North Bolaang Mongondow was 50-69%.

Table 2
Birth report based on gender and status of fetus – Form 4 by Puskesmas in North Bolaang Mongondow, 2020/2021

Puskesmas	Village	Sex information			Fetus status	
		Male	Female	Missing information	Live birth	Still-birth
Sangtombolang	Sangtombolang	11	9	2	21	1
Sangkub	Sangkub Timur	75	56	0	131	0
Bintauna	Bintauna	109	92	0	198	3
Bintauna	Bintauna	45	38	12	95	0
Bohabak	Bohabak 1	25	29	0	54	0
Mokoditek	Mokoditek	33	24	0	57	0
Bolangitang	Ollot	12	15	0	27	0
Bolangitang	Bolangitang	76	77	0	146	1
Boroko	Boroko	108	113	0	217	4
Tuntung	Tuntung	24	24	1	49	0
Buko	Buko	28	16	0	43	1
Biontong	Biontong	-	-	-	-	-
		546	493	15	1,038	10
Total		1,054*				

*Including the missing sex information

Table 3 shows the mortality data obtained from Form 5, and the number of deaths successfully followed up by finding the cause of death. Five hundred forty-three deaths were identified from Form 5 recapitulated by the health centers in North Bolaang Mongondow District. There were still 77 deaths that health center officers had not followed up on. Table 3 implies the registration of under-reported mortality in North Bolaang Mongondow.

Based on the death case of North Bolaang Mongondow District from the CRVS system (total of 468 deaths), the crude death rate (CDR) of 5.2 permille was obtained, and when using the number of deaths from Form 5 (534 deaths), the CDR was 6.26 permille.

Tables 2-4 shows that the implementation of the CRVS system can cover more birth and death data than previously reported during the rapid assessment that the completeness of deaths is below 50%.

Table 5 shows the childhood mortality such as IMR, U5MR, and life expectancy at birth as considered without the correction factors and confidence intervals to obtain an IMR of 15 per 1,000 live births, MMR of 568 per 100,000 live births according to total live births of 1,054. The number was underreported due to missed birth reports from Biontong Village.

DISCUSSION

The score of rapid assessment in North Bolaang Mongondow was 37, similar to other districts in Indonesia when they started strengthening the CRVS system (Sulistiyowati *et al*, 2017). The goal of registration is the legal process of recording vital events. Vital statistics consist of data related to vital events, with the civil registration system being the best source for those data (International Statistics Program, 2016). Mortality statistics have become an integral part of the vital statistics system. These mortality statistics have several advantages compared to morbidity statistics (UN, 2001). One can be collected efficiently on routine activities through the vital statistics system because death is unique, clearly defined, and is the last occurrence for each individual. Mortality and morbidity data should be available in health

Table 3
Death recaps, VA, and MCCD, and mortality registration in North Bolaang Mongondow

Source of data	Number of Deaths					
	Death with the completed cause of death			Death in Form 5**		
	Male	Female	Total	Male	Female	Total
Hospitals and Puskesmas						
RSUD Bolaang Mongondow Utara*	22	15	37	ND	ND	ND
Puskesmas Bintauna Pantai	7	7	14	7	7	14
Puskesmas Bintauna	18	10	28	73	69	142
Puskesmas Bontong	18	16	34	8	10	18
Puskesmas Bohabak	6	1	7	5	2	7
Puskesmas Bolangitang	29	30	59	54	60	114
Puskesmas Boroko	36	26	62	27	16	43
Puskesmas Buko	49	34	83	48	35	83
Puskesmas Mokoditek	10	13	23	9	14	23
Puskesmas Ollot	19	19	38	7	9	16
Puskesmas Sangkub	35	22	57	36	21	57
Puskesmas Sangtombolang	5	2	7	5	1	6
Puskesmas Tuntung	8	11	19	8	12	20
Total	262	206	468	287	256	543

*Only deaths in RSUD Bolaang Mongondow Utara were confirmed with the completed cause of death from MCCD while deaths in the all other Puskesmas were confirmed by verbal autopsy.

**Data from Puskesmas

MCCD: medical certificate of cause of death; ND: No data available; VA: verbal autopsy

Table 4
Death and birth recording, North Bolaang Mongondow

Demographic variable	Number	Indicators	
Population	86,721	MMR	568.18/100,000 live birth
Maternal death	6	CDR (Death and cause of death)	5.2 permille
Birth	1,056	CDR (Form 5)	6.3 permille

CDR: crude death rate; MMR: maternal mortality ratio

Table 5
Childhood mortality and expectancy life at birth, North Bolaang Mongondow

Indicators	Point estimate	95% CI
IMR (per 1000 live births)		
Male and female	24.77	12.78-36.75
Male	22.60	7.12-38.08
Female	27.40	8.67-42.12
U5MR (per 1000 live births)		
Male and female	32.51	18.83-46.18
Male	33.90	15.05-52.75
Female	30.82	11.00-50.65
Life expectancy at birth (years)		
Male and female	72.92	71.58-74.27
Male	71.64	69.85-73.43
Female	74.30	72.28-76.32

CI: confidence interval; IMR: infant mortality rate; U5MR: under five mortality rate

information systems (WHO and WHO AFRO, 2000; Mills *et al*, 2017). Mills *et al* (2017) stated that CRVS represents a key data source to monitor 12 of the 17 SDGs and 67 of the 230 SDG indicators. CRVS provides continuous, real-time birth and death data (Cobos Muñoz *et al*, 2018).

In vital statistics, any death followed by an underlying cause will play a significant role in establishing the number of numerators and denominators for child and maternal mortality calculations (WHO, 2012; Peterson *et al*, 2022). Based on the International Classification of Diseases 10th Revision (ICD-10), the underlying cause of death for women is vital to identify as maternal death or not (WHO, 2012). Women who die from an underlying cause of accidental or incidental causes will remove the numerator of maternal death. Conversely, there is potential misclassification for the indirect obstetric underlying that causes hospital death. It has a risk of not being classified as maternal death (Peterson *et al*, 2022). It may happen to the inpatients who initially entered the hospital because of chronic or acute illnesses and not because of their pregnancy, so they are included in the group of non-maternal patients in the care. The ICD-10 data written in the MCCD plays an important role in determining maternal death.

Similarly, child death is a crucial thing that must be considered in determining live birth and stillbirth as the numerator of child mortality. There is a potential for stillbirth/fetal death misclassification. Stillbirth events are not included as the numerator for calculating childhood mortality. Live birth is the denominator of childhood mortality. Conversely, life signs such as breathing, motion, or crying, even for a moment in newborns, become essential at birth (Danel and Bortman, 2008).

The death statistics in North Bolaang Mongondwo have some advantages over the usual death records previously carried out passively, looking for death cases from various data sources. The results of the rapid assessment score noted that the number of deaths recorded in the Demography and Civil Registration District Office was only around 40-50% of Indonesia's estimate of 6.4 permille of the total population (Central Bureau of Statistics, 2013). CDR showed better completeness than the previous

condition. However, it has not reached 8.9 permille as the WHO standard (UNdata, 2022).

Continuous and permanent CRVS make it possible for health programs to obtain accurate child and maternal mortality data. Each vital event in all geographical areas will be covered by the system and be registered only once, so a vital statistics system requires universal coverage or 100 percent (UN Department of Economic and Social Affairs, 2014). Specific data about complete birth and death registration in North Bolaang Mongondow is unknown, so it should be followed up by an evaluation of the quality of data to address the level of completeness of the civil registration and vital statistics. There is some method to find the completeness level (Adair and Lopez, 2018; National Center for Health Statistics, n.d.). The childhood mortality rate obtained from the CRVS system has considered the correction factor so that it is more convincing than the child mortality rate in Ende with a survey that states the limitations of may not be representative of Ende (Pardosi *et al*, 2014). This is because the CRVS system is not affected by sample problems and has the advantages of comparability and relevance to small-area statistics (Mahapatra *et al*, 2007).

The district government must evaluate and elaborate the system to apply in North Bolaang Mongondow. WHO states that CRVS is declared complete if completeness reaches 90%. Otherwise, it will be categorized as incomplete (Health Metrics Network and WHO, 2008; National Center for Health Statistics, n.d.). The experience of other countries in developing CRVS shows an improvement in the quality of its registration coverage. In Kenya, CRVS records about two-thirds of birth and death. The integrated child registration system's effectiveness and intervention increased birth registration coverage over five years. The same study in Kenya reported death registration coverage lower than birth registration coverage (Amin *et al*, 2018). The results of the mid-term review of the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) initiative in 2019-2020 stated that only three countries (India, Sri Lanka, and Thailand)

had reported more than 90% completeness of death registrations (UN ESCAP, 2021). In this case, the calculation of MMR is still needed to calculate the correction factor (Adair and Lopez 2018; Mahapatra *et al*, 2007), which is the study's limitation.

Generally, the completeness of birth and death events in Indonesia is below 90%. IMRSSP reported completeness in Surakarta between 52-72.5 percent (Rao *et al*, 2010). Moreover, Irianto *et al* (2012) reported dual system analyses used Population Census 2010, 66% for Metro, 74% for Surakarta City, 40% for Pekalongan, and 53% for Gorontalo District. Underreporting of infant deaths in several regions in Indonesia has been influenced by culture and the community's beliefs (Soerachman *et al*, 2016).

Health institution has a dual role in the vital statistics system; they act as informants of the occurrence of births, fetal deaths, and deaths, and second, the certification of causes of death can be performed only by physicians attached to health institutions (UN Department of Economic and Social Affairs, 2014). The minimum service standard in health sectors is 100% pregnant women delivered in health facilities, which is also an opportunity to increase coverage of birth recordings (MOH RI, 2019). The development of puskesmas networks and networks can also be used to improve birth and death registration.

Generally, this CRVS system study has answered the study's purpose, obtaining health indicators in the form of childhood mortality, maternal mortality, and life expectancy at birth at the district level. The system has proven to provide districts with the health indicators needed by program planners and decision-makers. However, this activity still needs to be continued and keep sustainability in the implementation, and the related personnel is better prepared and more involved in birth registration activities, deaths, and efforts to obtain the cause of death. At the national level, a national strategy is needed to strengthen mortality statistics systems to meet immediate and long-term data (Rao *et al*, 2021).

In summary, the system of strengthening the registration of births, deaths, and causes of death in North Bolaang Mongondow has begun to run even though it is still not optimal. This pilot project activity successfully provides main health indicators timely from registration civil and vital statistics at the district level. North Bolaang Mongondow local government has IMR, U5MR, and life expectancy at birth from timely data sources that can be sustainable. To ensure the continuity of CRVS system activities in North Bolaang Mongondow, efforts are needed to improve implementation through strengthening primary services that become puskesmas networks and networks in obtaining birth and death information. The capacity building of human resources implementing the CRVS system through technical assistance can be obtained while coordinating with the research team. Building capacity for how regions utilize this CRVS system data for program evaluation and planning is considered necessary.

ACKNOWLEDGMENTS

The authors are grateful to the District Government of North Bolaang Mongondow District and all the institutions engaged in this study. We also would like to give our appreciation to the Head of Center for Humanity and Health Management Research and Development and team especially Tri Juni Angkasawati, Yuslely Usman, Tita Rosita, Ida Muis and to all CRVS team members.

This work was supported by the National Institute of Health Research and Development, Ministry of Health.

CONFLICT OF INTEREST DISCLOSURE

The authors declare no potential conflicts of interest with respect to the research, authorship, or publication of this article.

REFERENCES

- Adair T, Lopez AD. Estimating the completeness of death registration: an empirical method. *PLoS One* 2018; 13: e0197047.
- Amin A, Lairunbi G, Watson-Grant S. MEASURE Evaluation PIMA - Final Project Report (2012-2017), 2018 [cited 2022 Aug 25]. Available from: URL: https://www.measureevaluation.org/resources/publications/tr-17-215/at_download/document
- Central Bureau of Statistics. Indonesia population projection 2010-2035, 2013 [cited 2022 Aug 27]. Available from: URL: https://indonesia.unfpa.org/sites/default/files/pub-pdf/PROYEKSI_2010-2035_Bilingual.pdf
- Cobos Muñoz D, Abouzahr C, de Savigny D. The 'Ten CRVS Milestones' framework for understanding Civil Registration and Vital Statistics systems. *BMJ Glob Health* 2018; 3: e000673.
- Danel I, Bortman M. An assessment of LAC's vital statistics system: the foundation of maternal and infant mortality monitoring, 2008 [cited 2022 Aug 25]. Available from: URL: <https://openknowledge.worldbank.org/bitstream/handle/10986/13646/448620WP0Box3210paper01LACVitalStat.pdf?sequence=1&isAllowed=y>
- Figueroa C, Linhart C, Fusimalohi L, *et al.* Mortality in Tonga over three triennia, 2010-2018. *BMC Public Health* 2021; 21: 36.
- Health Metrics Network and World Health Organization (WHO). Framework and standards for country health information system development, 2nd ed, 2008 [cited 2022 Aug 28]. Available from: URL: https://apps.who.int/iris/bitstream/handle/10665/43872/9789241595940_eng.pdf?sequence=1&isAllowed=y
- Indonesian Agency of Health Research and Development. Indonesia Mortality Registration System Strengthening Project covering January - December 2006, 2021 [cited 2022 Aug 25]. Available from: URL: <https://ghdx.healthdata.org/record/indonesia-mortality-registration-system-strengthening-project>

- Institute of Health Metrics Evaluation (IHME). Verbal autopsy tool, 2022 [cited 2022 Aug 27]. Available from: <https://www.healthdata.org/data-tools-practices/verbal-autopsy>
- International Statistics Program. Training course on civil registration and vital statistics systems, 2016 [cited 2022 Oct 07]. Available from: URL: https://www.cdc.gov/nchs/isp/isp_fetp.htm#print
- Irianto J, Afifah T, Hermawan, Simamarta O. Utilization of completeness as a correction of mortality rate from death registration results and SP-2010, 2012 [cited 2022 Aug 26]. Available from: URL: <https://media.neliti.com/media/publications/79955-ID-pemanfaatan-completeness-sebagai-koreksi.pdf> [in Indonesian]
- Kandel N, Singh N, Fric A. Mortality statistics from national censuses: a low cost viable method. *J Nepal Health Res Counc* 2010; 8: 63-8.
- Mahapatra P, Shibuya K, Lopez AD, *et al.* Civil registration systems and vital statistics: successes and missed opportunities. *Lancet* 2007; 370: 1653-63.
- Mikkelsen L. Strategic planning to strengthen civil registration and vital statistics systems : Guidance for using findings from a comprehensive assessment, 2012 [cited 2022 Aug 25]. Available from: URL: https://getinthepicture.org/sites/default/files/resources/Strategic%20planning%20to%20strengthen%20civil%20registration%20and%20vital%20statistics%20systems%20Guidance%20for%20using%20findings%20from%20a%20comprehensive%20assessment_0.pdf
- Mills S, Abouzahr C, Kim J, Rassekh BM, Sarpong D. Civil registration and vital statistics for monitoring the sustainable development goals, 2017 [cited 2022 Oct 02]. Available from: URL: <https://openknowledge.worldbank.org/bitstream/handle/10986/27533/115150.pdf?sequence=2&isAllowed=y>
- Ministry of Health Republic of Indonesia (MOH RI). Regulation of the Minister of Health of the Republic of Indonesia No. 4 of 2019 concerning technical standards for the fulfillment of basic service

quality at minimum service standards in the health sector, 2019 [cited 2022 Aug 19]. Available from: URL: <https://peraturan.bpk.go.id/Home/Download/102664/Permenkes%20Nomor%204%20Tahun%202019.pdf> [in Indonesian]

National Center for Health Statistics. Assessing vital statistics, n.d. [cited 2022 Aug 20]. Available from: URL: <https://slideplayer.com/slide/8632681/>

Pardosi JF, Adair T, Rao C, Kosen S, Tarigan IU. Measuring subnational under-5 mortality: lessons from a survey in the eastern Indonesian district of Ende. *Asia Pac J Public Health* 2014; 26: 367-77.

Peterson E, Chou D, Moller AB, Gemmill A, Say L, Alkema L. Estimating misclassification errors in the reporting of maternal mortality in national civil registration vital statistics systems: a Bayesian hierarchical bivariate random walk model to estimate sensitivity and specificity for multiple countries and year. *Stat Med* 2022; 41: 2483-96.

Rao C, Bundhamcharoen K, Kelly M, Tangcharoensathien V. Mortality estimates for WHO SEAR countries: problems and prospects. *BMJ Glob Health* 2021; 6: e007177.

Rao C, Soemantri S, Djaja S, *et al*. Mortality in Central Java: results from the Indonesia mortality registration system strengthening project. *BMC Res Notes* 2010; 3: 325.

Republic of Indonesia. Presidential Regulation No. 18 of 2020 concerning the National Medium-Term Development Plan for 2020-2024, 2020 [cited 2022 Aug 22]. Available from: URL: <https://peraturan.bpk.go.id/Home/Details/131386/perpres-no-18-tahun-2020> [in Indonesian]

Soerachman R, Wiryawan Y, Kosen S, Jennaway M. An exploration of cultural perception and communities behaviour related to mortality: a qualitative study of communities in Solo and Pekalongan, Central Java Province, 2016 [cited 2022 Oct 07]. Available from: URL: <https://media.neliti.com/media/publications-test/83784-an-exploration-of-cultural-perception-an-6910af2a.pdf>

Sulistiyowati N, Irianto J, Usman Y. Accuracy of the death and cause of death registration system (typical study of several regions in Indonesia) still needs much improvement: death and cause of death registration system in several regions, Indonesia 2014, 2017 [cited 2022 Aug 26]. Available from: URL: <http://ejournal.litbang.kemkes.go.id/index.php/MPK/article/view/4822> [Indonesian]

UNdata. Crude death rate Indonesia, 2022 [cited 2022 Aug 27]. Available from: https://data.un.org/Data.aspx?q=crude+death+rate&d=Pop-Div&f=variableID%3a65%3bcrID%3a360%3btimeID%3a66%2c67%2c68%2c69%2c70%2c71%2c72&c=2,4,6,7&s=_crEngNameOrderBy:asc,_timeEngNameOrderBy:desc,_varEngNameOrderBy:asc&v=1

United Nations (UN). Principles and recommendations for a vital statistics system: Revision 2, 2001 [cited 2022 Aug 21]. Available from: URL: https://unstats.un.org/unsd/publication/SeriesM/SeriesM_19rev2E.pdf

United Nations (UN) Department of Economic and Social Affairs. Principles and recommendations for a vital statistics system - Revision 3, 2014 [cited 2022 Aug 24]. Available from: URL: <https://unstats.un.org/unsd/demographic/standmeth/principles/m19rev3en.pdf>

United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP). Getting everyone in the picture: a snapshot of progress midway through the Asian and Pacific Civil Registration and Vital Statistics Decade, 2021 [cited 2022 Aug 25]. Available from: URL: <https://getinthepicture.org/sites/default/files/resources/CRVS-midterm-FINAL.pdf>

World Health Organization (WHO). International statistical classification of diseases and related health problems - 10th Revision Volume 2 Instruction manual 2010 Edition, 2011 [cited 2022 Aug 25]. Available from: URL: https://icd.who.int/browse10/Content/statichtml/ICD10Volume2_en_2010.pdf

- World Health Organization (WHO). Rapid assessment of national civil registration and vital statistics systems, 2010 [cited 2022 Aug 23]. Available from: URL: <https://apps.who.int/iris/rest/bitstreams/66706/retrieve>
- World Health Organization (WHO). The WHO Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM, 2012 [cited 2022 Oct 07]. Available from: URL: https://apps.who.int/iris/bitstream/handle/10665/70929/9789241548458_eng.pdf
- World Health Organization (WHO). Verbal autopsy standard: the 2016 WHO verbal autopsy instrument, 2016 [cited 2021 Dec 04]. Available from: https://cdn.who.int/media/docs/default-source/classification/other-classifications/autopsy/whova2016instrumentmanualandquestionnaire.zip?sfvrsn=9a844253_5&download=true
- World Health Organization and WHO Regional Office for Africa (WHO and WHO AFRO). Health information systems development and strengthening: Guidance on needs assessment for national health information systems development, 2000 [cited 2022 Aug 21]. Available from: URL: https://apps.who.int/iris/bitstream/handle/10665/66203/WHO_EIP_OSD_00.6.pdf?sequence=1&isAllowed=y