The Role of CRVS in Estimating
COVID-19-related Excess Deaths in South Korea

by Eunkoo Lee, Seokmin Lee, and Tanja Brøndsted Sejersen

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INTRODUCTION

Modern-day epidemics, such as COVID-19, are expected to result in short-term mortality shocks. But how many people have actually died from COVID-19? This is a big question and one that is on everyone's mind. While it seems to be a very straightforward question, it is not easy to answer accurately. A well-functioning civil registration and vital statistics (CRVS) system could provide a possible answer to this question. However, during a public health emergency such as COVID-19, even a well-functioning CRVS system is faced with challenges of backlogs in death registrations and diagnostic uncertainties (for example, limited number of testing, misdiagnosis, and difficulties in ascertaining ultimate cause of death to COVID-19).

Calculating excess deaths can be useful in estimating the mortality level by removing the uncertainties associated with COVID-19. It simply estimates the additional deaths that have occurred because of COVID-19 by comparing the reported deaths with the normal number of deaths that would not have occurred had the pandemic not happened. To better quantify the impact of COVID-19 on population mortality, excess deaths can be studied among those officially identified as official COVID-19 deaths, which are dependent on the number of people tested for COVID-19.

In order to inform the response to the pandemic, COVID-19 excess deaths are jointly analyzed by the Korea Disease Control and Prevention Agency, which leads the COVID-19 response, and Statistics Korea (KOSTAT), which manages CRVS in the Republic of Korea.

A robust CRVS system is necessary for an analysis of excess deaths. This is because there is a risk of underestimating excess deaths if the death reporting rate falls due to restricted population movement and activity. In this paper, we present a study of excess deaths and of the CRVS system conditions necessary to produce such estimates. In addition, we present alternative sources of administrative data that can be used in evaluating the impact of COVID-19 on mortality in situations where the traditional CRVS reporting pathway may be disrupted or compromised.

THE CRVS SYSTEM IN KOREA

The Republic of Korea has one of the most well-functioning CRVS systems in Asia. The system is divided into two parts: The family relationship registration and the resident registration. The former is the oldest system, and registers family ties. The latter has been introduced more recently and keeps track of all individual events. The Supreme Court and the Ministry of the Interior and Safety, respectively, assume family relationship

Photo: Ethan Brooke / Pexels

at 3,560 community service centres (*eup*, *myeon*, and *dong*). In 2004, KOSTAT established a link among the family registration systems to produce vital statistics.[2]

DEFINITION AND THE NECESSITY OF MONITORING EXCESS DEATHS

Excess deaths are defined as the difference between the observed numbers of deaths in a specific time period and expected numbers of deaths in that same time period.[3] The excess deaths analysis contributes to the identification of and response to regional hazard signals, complementing the national disease control policy. More specifically, the excess deaths analysis, using CRVS, allows the identification of populations at greatest risk of death (as excess death was mainly seen among the elderly), thereby enabling the efficient allocation of medical resources. For instance, if excess deaths were identified in a particular area among the elderly, a targeted response could be initiated through various actions: procuring hospital beds in the local area, treating milder COVID-19 cases in self-isolation, providing additional medical resources, and prioritizing medical attention among the elderly population.

registration and resident registration. Korea has universal birth and death registration of its citizens and has very small numbers of delayed registration.[1]

The vital statistics system, which relies mostly on data from resident registration, is the responsibility of KOSTAT. Registration takes place in 226 city, county, and district (*si, gun*, and *gu*) offices, and

It is important to define the types of COVID-19-related deaths in order to minimize bias when analyzing excess deaths. Although the types of excess deaths can be defined conceptually (as shown in Table 1), observed deaths without sufficient medical information can make death classification difficult.

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1   Republic of Korea CRVS Decade (2015–2024) Midterm Questionnaire.
      getinthepicture.org/resource/republic-korea-crvs-decade-2015-2024-midterm-questionnaire

2   **getinthepicture.org/country/republic-korea**

3   **cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm**

Table 1: Summary of the types of excess deaths attributed to COVID-19.

COVID-19 relevance	Type of death	Details
Direct cause	COVID-19 death, with confirmation	COVID-19 has been confirmed by laboratory testing (PCR test)
	COVID-19 death, without confirmation	COVID-19 is diagnosed clinically or epidemiologically, but laboratory testing is inconclusive or not available
	Complication or sequelae of COVID-19	Death as a result of complication or sequelae of COVID-19
Indirect cause	Lack of medical care	Death due to lack of medical resources caused by COVID-19
	External factors due to self-isolation	Mental stress or domestic violence caused by self-isolation due to COVID-19
Not relevant	External factors, such as extreme weather, not related to COVID-19	
	In particular, Korea experiences cold waves in January and February, which impact mortality, especially among the elderly	

CRVS CONDITIONS FOR EXCESS DEATHS ANALYSIS

For accurate excess deaths analysis, the CRVS system should be continuous, permanent, compulsory, and provide the universal recording of vital events.[4] In particular, universal coverage and continuity are CRVS system characteristics that are essential for the accurate analysis of excess deaths. The Republic of Korea has universal coverage in the registration of Korean citizens, and the vast majority of registrations are very timely. Birth certificates are issued by health professionals and are needed to register the infant with the registration authority.

For universal coverage to be attained, a vital statistics system must include all of the vital events occurring in every geographical area and among every population group in the country. If the coverage of a specific region or population is not complete, it results in inaccuracies when interpreting the data. Furthermore, in order to ensure the timeliness of statistics, the median time between a death occurring and being registered — known as the delay in death registration — should not exceed a few days. In situations like the current COVID-19 pandemic, when statistics need to be produced quickly, the process of identifying excess deaths becomes harder as death registration becomes increasingly delayed. Thus, the reporting of deaths must

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4   emro.who.int/civil-registration-statistics/about/what-are-civil-registration-and-vital-statistics-crvs-systems.html

Photo: Joel M. B. Marrinan / Pexels

During a pandemic, where deaths cannot be reported in person at a municipality office, two alternative methods for collecting data can be used: data from crematoriums can be collected or deaths can be reported through the internet. In Korea, crematorium data and death certificates are collected for infant deaths, which have a higher risk of being under-reported through normal death registration routes. If death reporting rates are found to be lower than anticipated, it is possible to supplement not only infant death statistics, but also total death counts with the crematorium data.

In addition, in order to analyze excess deaths by specific population groups, information such as residence, age, and gender must be included on the death notification form. The results of these analyses can be used to inform policies for specific populations and to prioritize medical resource allocation.

be made compulsory to reduce the time lag between deaths and their official registration and to increase coverage. In 2018 in Korea, only 43 deaths were not registered within a year and the vast majority of deaths were registered within the legally stipulated one month.[5] It is also possible to increase the coverage of death reporting by the direct notification and submission of death certificates from medical institutions or by imposing a penalty on a legal basis.

The continuous registration of vital events is critical to the collection and compilation of vital statistics that will reflect short-term fluctuations, including any seasonal changes. Death notifications must be collected in frequent and regular cycles, and statistics pertaining to excess deaths should be updated regularly in parallel. For example, if death reports are collected on a monthly basis, the number of excess deaths should be updated monthly as well; weekly collection systems should be updated weekly.

METHOD FOR ANALYZING EXCESS DEATHS IN KOREA USING CRVS

When a death occurs in Korea, family members should submit the death report form to local offices along with the medical certificate of death issued by a physician. In the case of death not only in medical institutions, but also in deaths outside medical institutions such as housing, doctors directly examine and issue death certificates. The rates for death registration with medical certificate of death in Korea is 99.7 percent. Most of the remaining 0.3 percent died abroad. The death registration rate in Korea is high because Korean national law requires deaths to be registered within one month. In 2018, the average monthly death reporting rate was 98 percent. Municipal officials input the reported data into the vital statistics system managed by the national statistical office, KOSTAT, on a

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5   Republic of Korea CRVS Decade (2015-2024) Midterm Questionnaire.
     getinthepicture.org/resource/republic-korea-crvs-decade-2015-2024-midterm-questionnaire

monthly basis. The cause of death entered in the vital statistics system is transmitted to the mortality statistics system in real time, and the process for selecting the underlying cause of death is in progress. From this data, KOSTAT is able to generate statistics on demographic dynamics and causes of death. The causes of death are classified as recommended by the World Health Organization, but there are instances where the death certificate has errors or the causal relationship between the recorded conditions turns out to be inaccurate. In order to classify the underlying cause of death more accurately, KOSTAT collected and linked

22 types of administrative data.[6] This way, the cause of death in Korea can be more accurately determined by analyzing not only the death certificate but also medical examination records. This is made possible through the regular collection of various types of administrative data and the ability to link various databases at the individual level (Figure 1).

The collection of administrative data is specified by national statistical law (Figure 2). In addition, most administrative data in Korea includes resident registration numbers, making it possible to link personal data.

Figure 1: The process of cause-of-death statistics collection in Korea.

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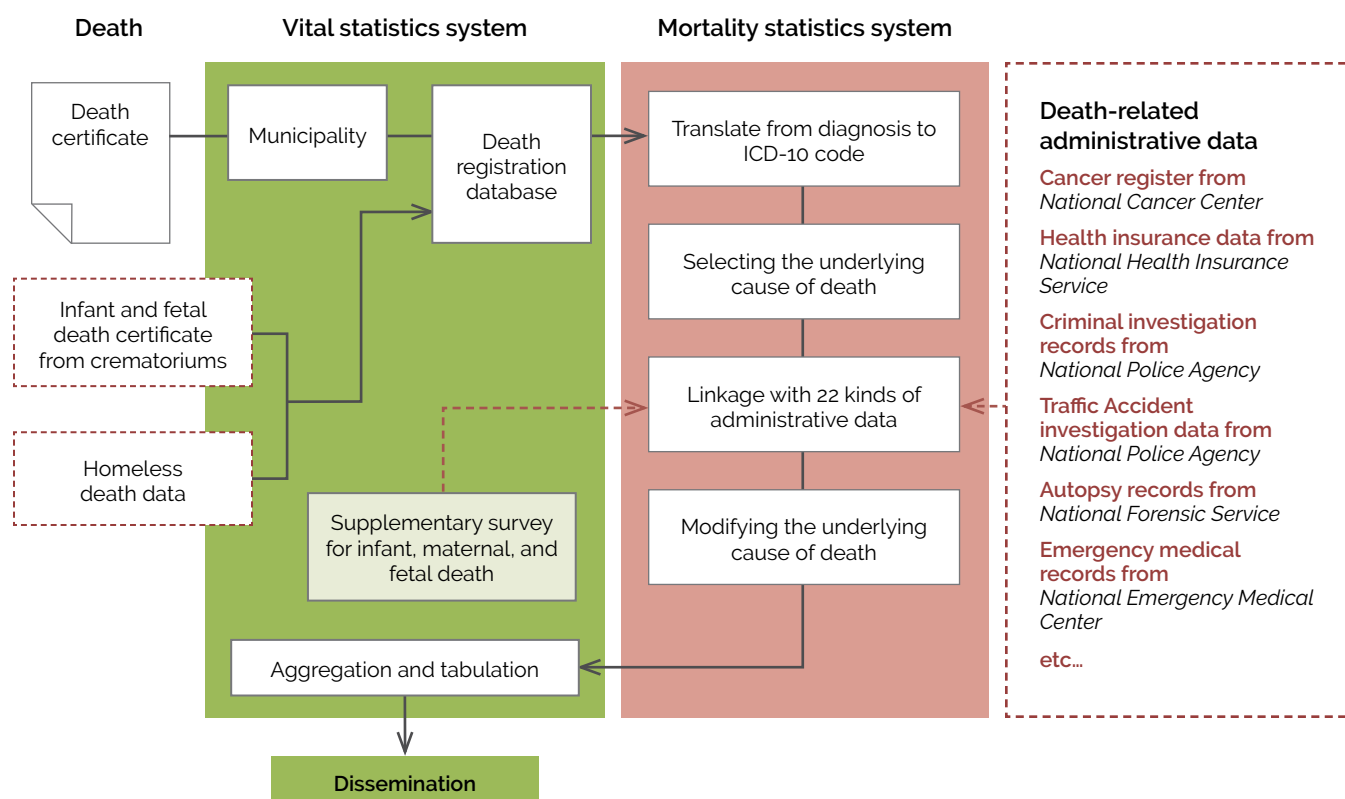
6   Health insurance data from the National Health Insurance Service, cancer register from the National Cancer Center, criminal investigation records and traffic accident investigation data from the National Police Agency, autopsy records from the National Forensic Service, emergency records from the National Emergency Medical Center, etc.

Figure 2: Republic of South Korea *Statistics Act.*[7]

Article 24 (Provision of Administrative Data)

(1) If necessary for the production of statistics, the head of a central administrative agency or the head of a local government may request the head of a public institution to provide administrative data.

(2) When the head of a public institution is requested to provide administrative data pursuant to paragraph (1), he/she shall comply therewith unless there is good cause prescribed by Presidential Decree, such as the disclosure, etc. of national secrets or important secrets of individuals or enterprises.

(3) Where administrative data are provided under paragraph (2), the head of a requesting agency and the head of a providing institution shall consult on and determine the scope, method, etc. of the provision, and the head of a providing institution may limit the method of use, departments that can use such data or other necessary matters in order to protect the information of individuals, corporations, organizations, etc. included in the administrative data, or may request the requesting agency to devise necessary measures to ensure the safety of administrative data (hereinafter referred to as "information protection measures").

(4) The administrative data provided by public institutions pursuant to paragraph (2) shall not be used for any purpose other than the production of statistics, nor shall it be provided to other persons.

(5) Where the head of a requesting agency fails to take the information protection measures that is requested under paragraph (3) or violates paragraph (4), the head of an institution providing administrative data may suspend or limit the provision of data.

Article 24-2 (Provision of Data by Judicial Agencies, etc.)

(1) Where it is necessary for the production of statistics, the Commissioner of the Statistics Korea may request the Minister of the National Court Administration to provide digital data on the registration of family relations.

(2) Where it is necessary for the production of statistics, the Commissioner of the Statistics Korea may request the Commissioner General of the Korean National Police Agency and the Commissioner of the Korea Coast Guard to provide information on criminal justice related to statistics on the causes of death.

(3) Article 24 (2) through (5) shall apply *mutatis mutandis* to matters necessary for the provision of data under paragraphs (1) and (2).

(4) The Commissioner of the Statistics Korea shall produce statistics (hereinafter referred to as "vital statistics") to identify demographic changes such as birth, death, marriage and divorce, based on the following data:

    1. Digital data on the registration of family relations under paragraph (1);

    2. Other data prescribed by Presidential Decree, such as data prepared and submitted by a reporting party at the time of reporting matters such as birth, death, marriage and divorce under other Acts.

(5) The scope of data for which provision can be requested pursuant to paragraph (1) and matters such as the scope and method of conducting a survey for production of the vital statistics under paragraph (4) shall be prescribed by Presidential Decree.

Korea has a strong CRVS system, but it is known that registration omissions occur more often among specific populations and in specific situations. For example, there is under-registration of both births and deaths of infants who die in the very early neonatal period (within 24 hours of birth) and also among abandoned infants. In these cases, other data sources are able to supplement the larger database generated from the 22 linked administrative datasets. For instance, data on infant, maternal, and fetal deaths is collected from medical institutions through an online platform. In addition, the database is supplemented by crematorium reports and data on deaths among the homeless and persons without relatives supplement the database.

In Korea, the first confirmed cases of COVID-19 occurred on 20 January 2020 and the first death occurred on 19 February 2020. Based on this, the starting point for the analysis of excess deaths was set as the first week in 2020. Excess deaths can also be analyzed on a monthly basis, but the dynamic nature of the current pandemic makes the more detailed, weekly temporal perspective especially useful.

Excess deaths analyses compare expected with observed deaths in a given time period. Generally, establishing the expected number of deaths involves generating an average number of deaths according to recent historic data and estimating the distribution of the number of deaths in the past. However, we used the maximum number of deaths in the past three years to set our weekly expected number of deaths. The reason for this is to account for Korea's large elderly population that is especially vulnerable to extreme cold weather-related deaths and the fact that the number of deaths in the country is increasing due to the rapidly aging population.

Photo: Ketut Subiyanto / Pexels

The number of deaths and crude death rate[8] have been increasing since 2005 (Figure 3). In 2019, there were 295,100 deaths, a 19.5 percent increase from 2009. Also in 2019, 47 percent of all deaths were among those 80 years old and over, which was 14.8 percentage points more than in 2009 (Figure 4).

Figure 5 compares the number of deaths over 10 years in May and September, both relatively mild months in Korea with few climatic factors affecting mortality and thus more stable estimates of deaths. This decade-long perspective demonstrates an increase in the number of deaths with time, reflecting the aging population.

In contrast, the cold wave that occurs during January and February impacts mortality, especially among the elderly. Figure 6 shows peaks in the number of deaths in February 2012 and January 2018, reflecting record-breaking cold waves that gripped the country at the time. In early February 2020, amid the pandemic, Korea experienced lower-than-average temperatures, which is expected to have had some impact on deaths.

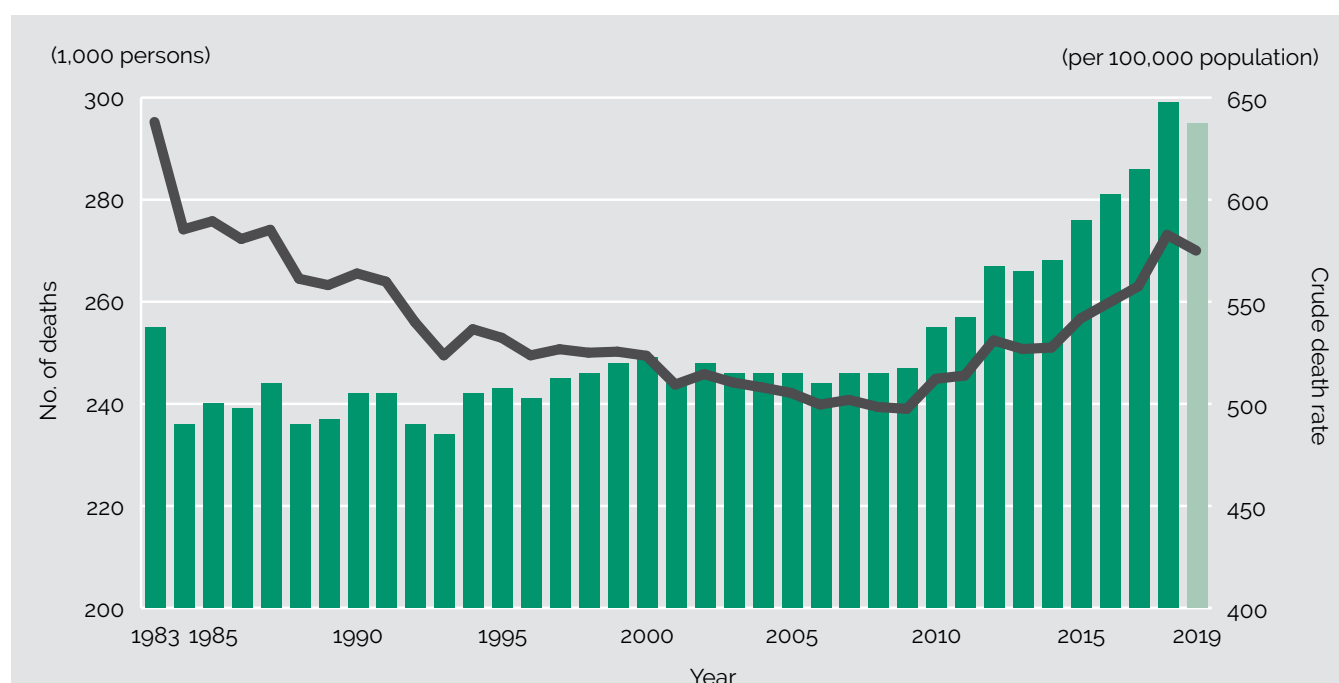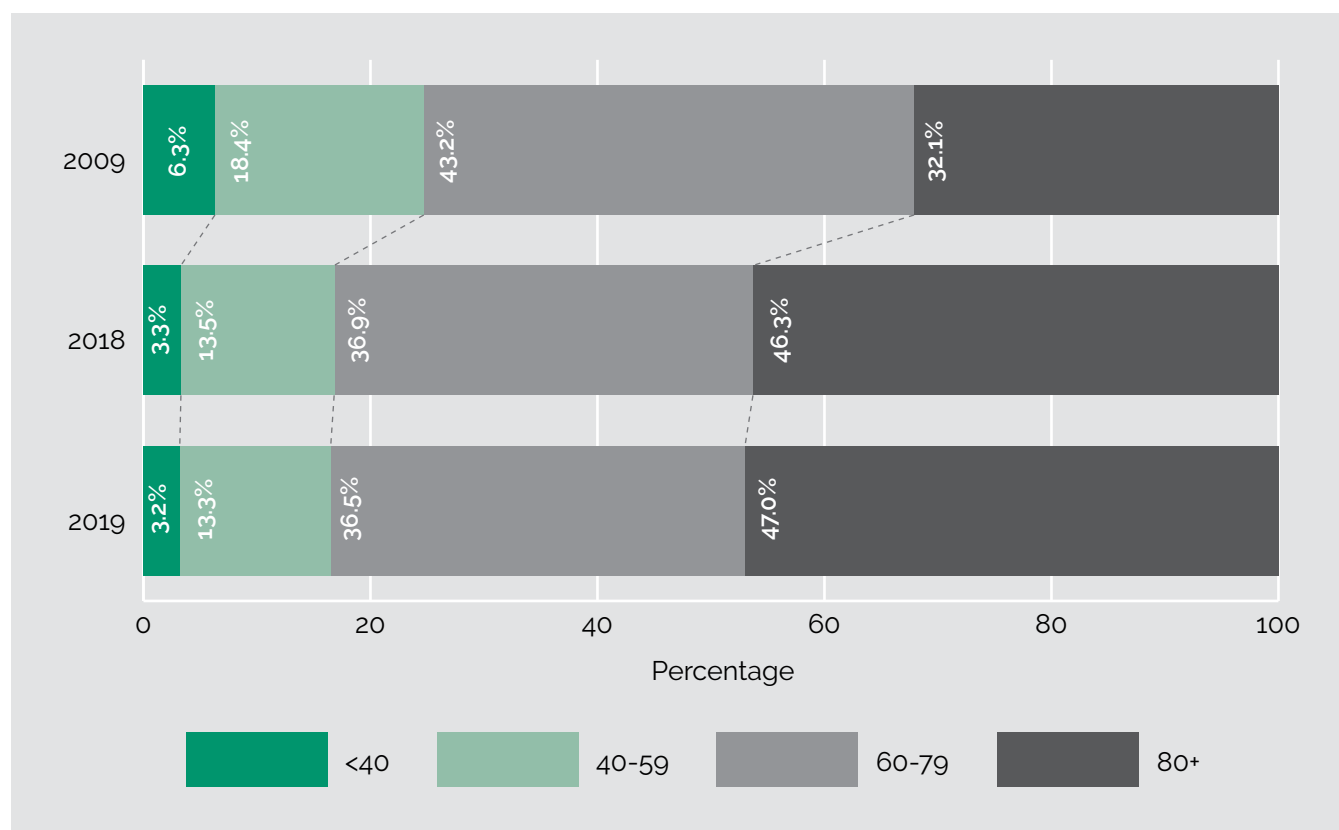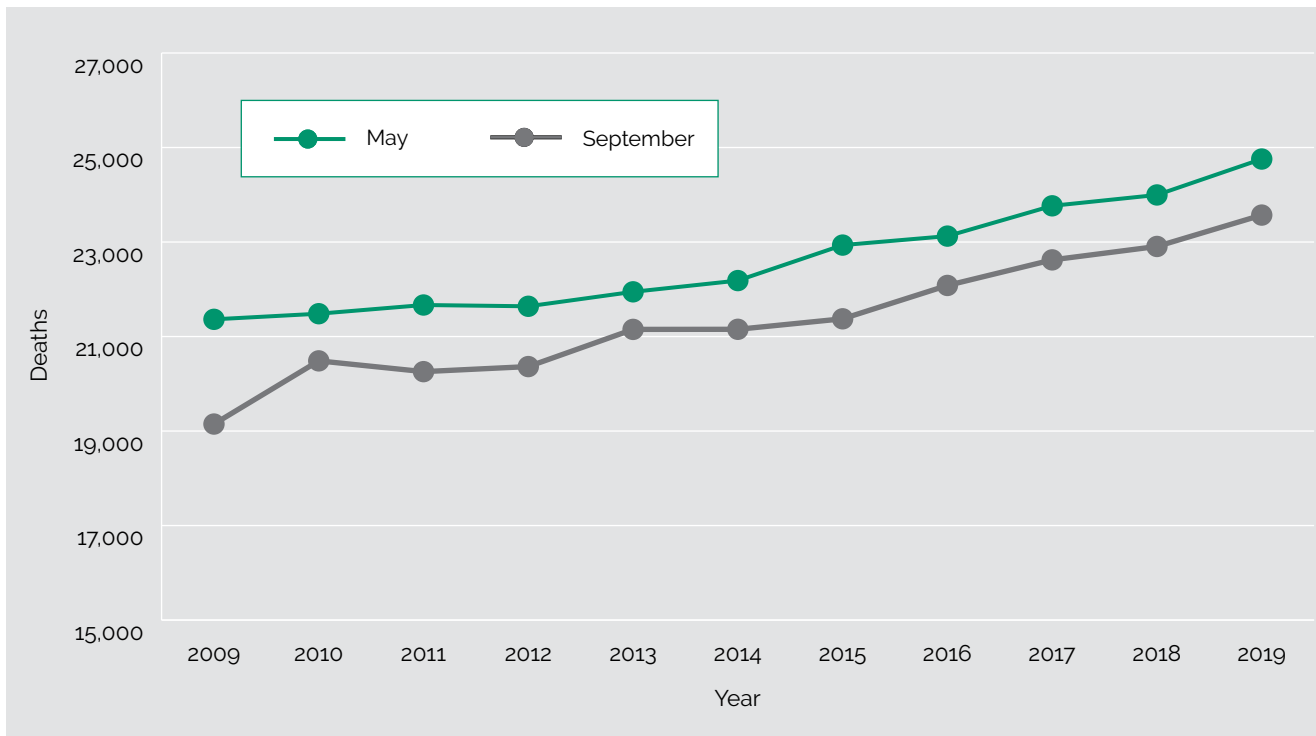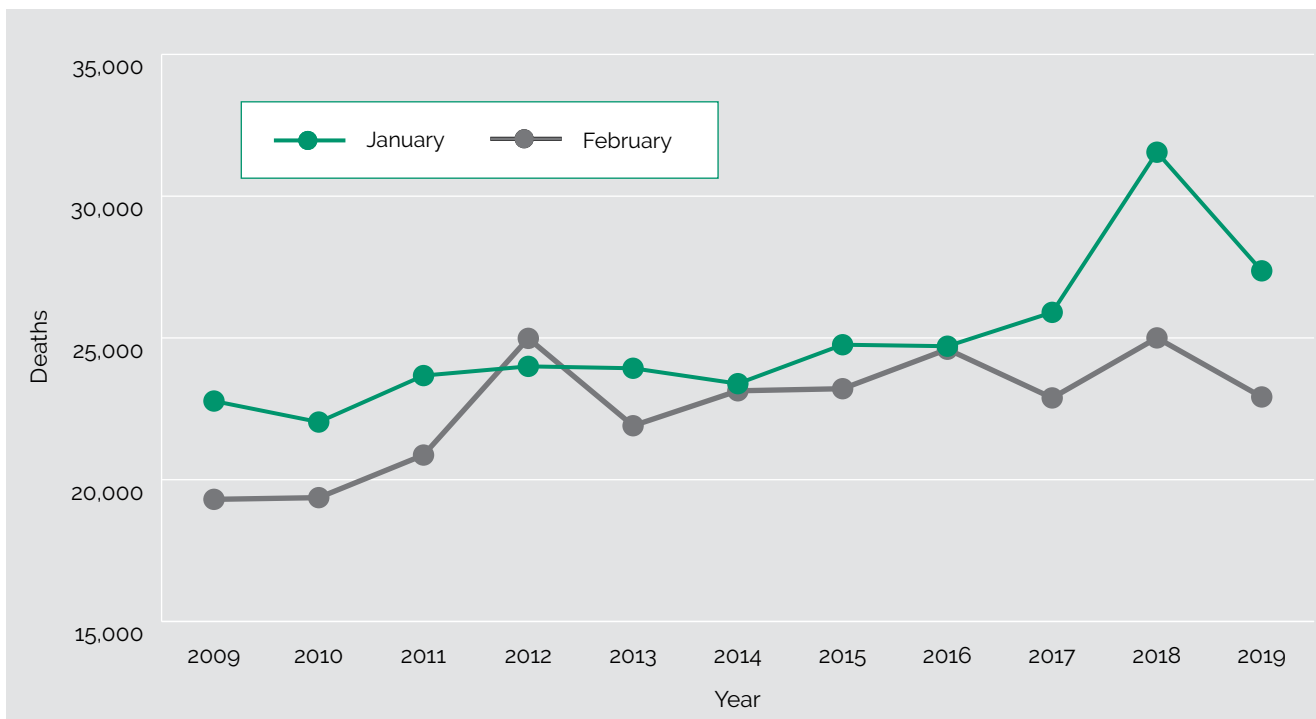8   The total number of deaths per year per 100,000 population.

Figure 3: Number of deaths and crude death rate from 1983 to 2019 in Korea.

Figure 4: Proportion of deaths in Korea, by age group.

Figure 5: Number of deaths per month in May and September from 2009 to 2019.

Figure 6: Number of deaths per month in January and February from 2009 to 2019.

In countries like Korea, where population aging is rapidly progressing or where mortality is greatly impacted by extreme weather events, mortality averages and distributions based on historic data can cause inaccuracies in estimating excess deaths.

## EXCESS DEATHS IN KOREA DURING THE COVID-19 PANDEMIC

Deaths registered by week

In observing total mortality, a continuous trend of excess deaths was not found in Korea since the beginning of the COVID-19 pandemic (Figure 7). The number of registered deaths until the 39th week of 2020 was 224,106, which is 6,577 (3 percent) deaths more than in 2019. The number of deaths in weeks 11–12 (381 deaths), weeks

15–18 (761 deaths), weeks 23–25 (386 deaths), and weeks 33–38 (1,389 deaths) exceeded the maximum number of deaths for the same week over the past three years.

As shown in Figure 8, there were two spreads of COVID-19 in Korea in 2020. The number of COVID-19 confirmed cases was large at 10 and 35 weeks. In both periods, the number of deaths increased 2 to 3 weeks after the increase in the number of confirmed cases. The spread in the 10th week did not have a significant effect on the excess mortality, while the spread in the 35th week had a slight effect on the excess deaths. In particular, Korea's excess deaths were not identified during weeks 9–13 of the first wave of the outbreak, but they appeared similar to the number of confirmed cases in the second wave, during weeks 34–37.

Figure 7: Deaths registered by week (updated 12 November 2020).
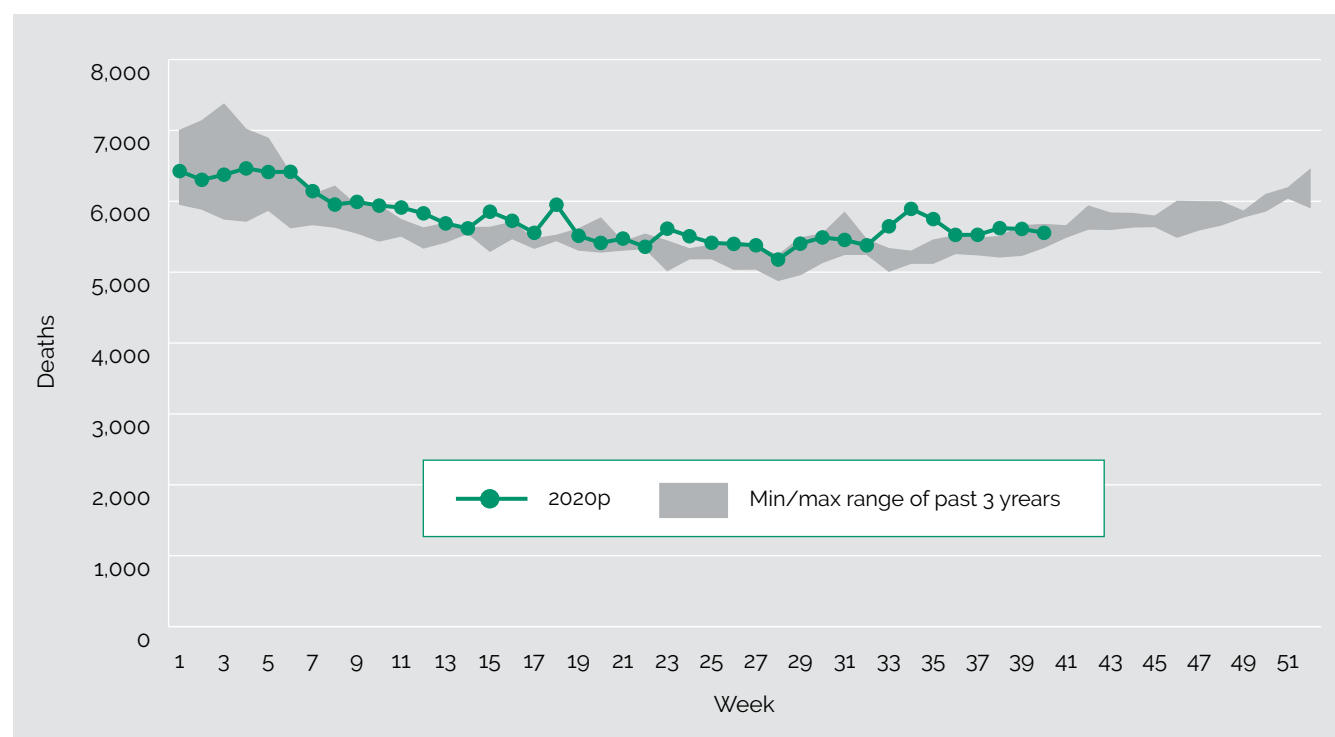
Note: The number of deaths in 2019 and 2020 is provisional data.

Figure 8: Number of confirmed cases and deaths due to COVID-19 in Korea.
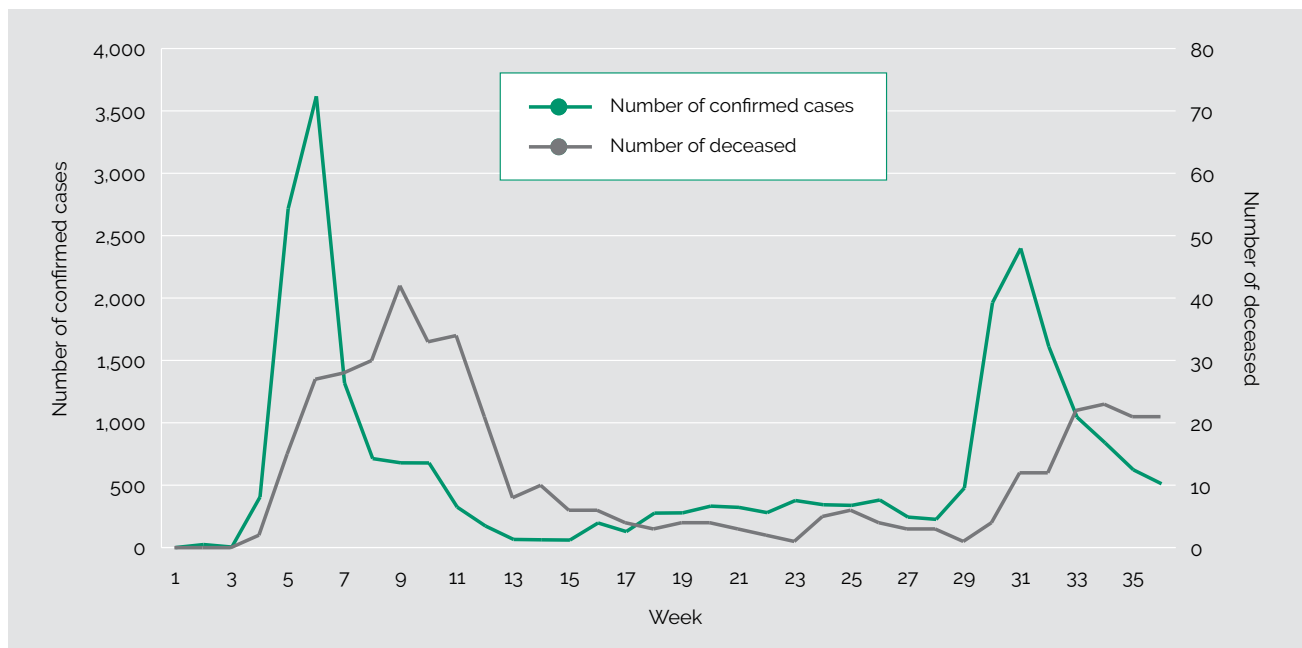
Source: **kosis.kr/covid_eng/covid_index.do**

Deaths registered by age group

The deaths of the elderly, aged 65 years and over, show a U-shaped distribution under the influence of cold weather, and significant changes in the number of deaths occur due to abnormal weather conditions in a specific year. Excess deaths were relatively large among populations aged 85 and over (Figure 9).

Figure 9: Deaths registered by age (updated 12 November 2020).
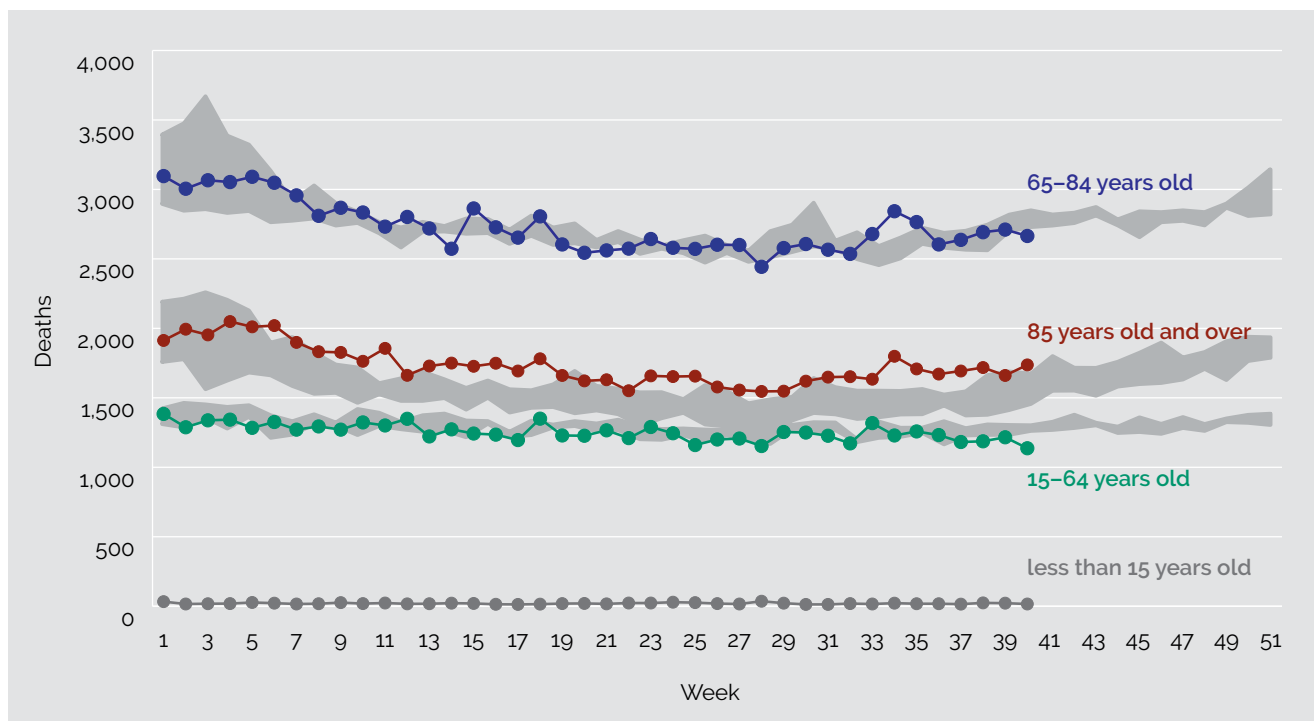
Deaths registered by sex

There was no significant difference in excess deaths between men and women. Analysis by sex and age group was not done with the Korean data because low numbers could cause a bias. The weeks that showed an exceeding number of deaths compared with the maximum number of deaths over the past three years by sex were:

- Men: weeks 6–7, weeks 11–12, week 15, weeks 17–18, weeks 23–24, weeks 33–35

- Women: weeks 10–13, weeks 15–19, weeks 23–25, weeks 32–39 (Figure 10)

**Figure 10:** Deaths registered by sex (updated 12 November 2020).

Provisional suicide deaths

The increased stress caused by COVID-19 can be a major social problem, a phenomenon called the "Corona blues" in Korea. In analyzing mortality during the pandemic, the number of deaths by suicide should also be considered. For deaths by suicide, KOSTAT links the death certificate with the police investigation record and provides provisional estimates for these deaths, two months after they occur. According to the results, no specific trend has been found in the number of suicides (Figure 11).

Figure 11: Number of deaths due to intentional self-harm.
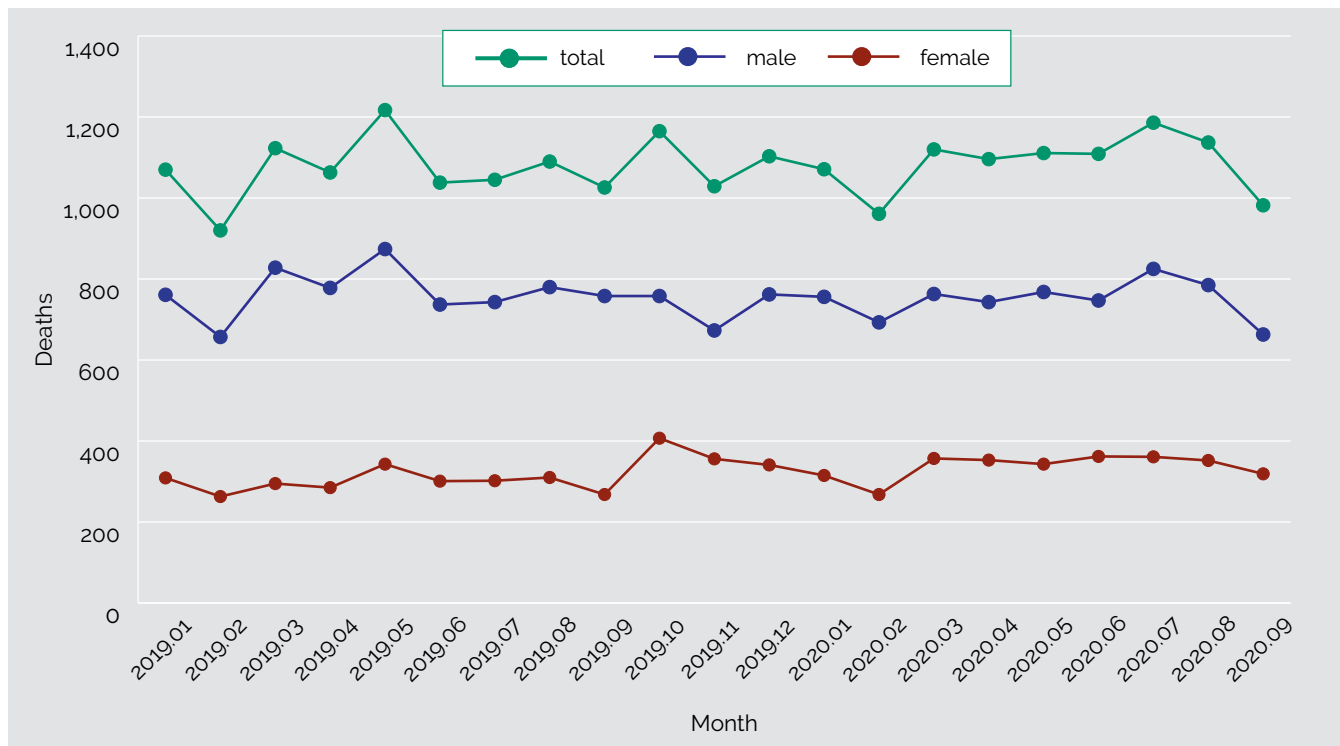
Note: The number of deaths in 2020 is provisional data.

CONCLUSION

In situations like the COVID-19 pandemic, deaths can be both directly and indirectly linked to COVID-19. People may succumb to the virus, but other deaths will result from the lack of medical resources while they are being directed intensely toward the pandemic response. An analysis of excess deaths is an important tool for the government to ascertain the full impact of COVID-19 as it manifests in both direct and indirect mortality in the population. A robustly designed and operated CRVS system is necessary to generate accurate excess death statistics.

Completeness is one of the most important attributes of a robust CRVS system. High degrees of completeness and coverage are enabled by a legal underpinning that makes birth and death registration compulsory. For instance, high coverage and completeness can be facilitated by the legal requirement to register deaths within a specific timeframe after a death. A system in which medical institutions report deaths directly to the CRVS system can also advance this purpose. Finally, CRVS data quality can be improved by linking with other administrative datasets at the individual level.

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