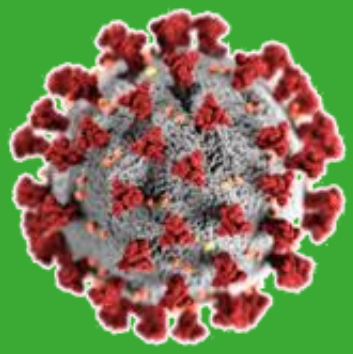
SURVEILLANCE OF COVID-19 MORTALITY IN BELGIUM

Epidemiology and methodology during 1st and 2nd wave (March 2020 - 14 February 2021)



WHO WE ARE

SCIENSANO can count on more than 700 staff members who commit themselves, day after day, to achieving our motto: Healthy all life long. As our name suggests, science and health are central to our mission. Sciensano's strength and uniqueness lie within the holistic and multidisciplinary approach to health. More particularly we focus on the close and indissoluble interconnection between human and animal health and their environment (the "One health" concept). By combining different research perspectives within this framework, Sciensano contributes in a unique way to everybody's health.
For this, Sciensano builds on the more than 100 years of scientific expertise of the former Veterinary and Agrochemical Research Centre (CODA-CERVA) and the ex-Scientific Institute of Public Health (WIV-ISP).

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Epidemiology of infectious diseases • Lifestyle and chronic diseases

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SUMMARY

This report provides epidemiological figures about the characteristics of COVID-19 deaths during the first wave (1 March 2020 until 21 June 2020), the inter wave period (22 June until 30 August 2020) and the second wave (31 August 2020 until 14 February 2021) of the COVID-19 epidemic in Belgium. This is the period before the effects of the nationwide vaccination campaign that started early in 2021 could be assessed. In total 21,860 COVID-19 deaths occurred (43.9% in the first wave and 54.7% in the second wave).

The COVID-19 mortality surveillance system was implemented at the start of the epidemic to acquire real-time COVID-19 mortality data on a daily basis. The surveillance combined information on COVID-19 related deaths from **three surveillances** (the hospital surveillance, the nursing home (NH) surveillance and notifications to regional health inspection authorities) through **nine data sources**. This information included the date of death, date of birth, sex, case classification, type of place of death, type of place of residence (e.g. living in a NH), postal code of the place of death and residence. Continuous improvements as regards the data collection resulted in retrograde adaptations of mortality numbers.

The overall **sex distribution** was fairly even (49.1% in male and 50.8% in female). Almost all deaths occurred in the age group over 64 years and approximately half of the deaths occurred in the age group over 84 years.

Data on **hospitalized COVID-19 patients** showed that higher age, male sex and several comorbidities such as cardiovascular disease and diabetes were risk factors for mortality. Additionally, the estimated COVID-19 case fatality in Belgium confirmed that it was higher for the elderly and male population.

In the second wave, more deaths occurred in **hospitals** (61%) than in **nursing homes** for elderly (NHs) (38%). In contrast, during the first wave, this distribution was more equal (50% in hospitals and 49% in NHs).

The test capacity increased and the testing strategy broadened over time, leading to an increase in the proportion of **laboratory-confirmed COVID-19 cases among deaths** (69% and 95% in the first and second waves respectively).

COVID-19 age-standardized mortality rates (ASMR), which take into account the age distribution of the population, showed that Brussels presented the highest ASMR for the total period and the first wave, while Wallonia has the highest ASMR for the second wave (more precisely in the provinces of Hainaut and Liège). The crude COVID-19 mortality rates for residents of NHs were higher in Flanders than in the other regions, both for the total period and for the second wave.

International comparison and ranking of COVID-19 crude mortality rates are misleading because of very heterogeneous methods used (e.g. case definition, testing and screening strategy, reporting method, availability of specific surveillance in NHs, etc.). Methods might also have changed during the course of the epidemic within the same country. A better comparison will probably be possible when countries have finished analyzing the official death certificates.

The fast initiation of the COVID-19 surveillance in NHs and the inclusion of deaths of possible COVID-19 cases nevertheless allowed Belgium to provide accurate figures on COVID-19 deaths. This helped to assess the seriousness of the epidemiological situation in NHs.

COVID-19 mortality was strongly correlated with **excess all-cause mortality** in Belgium. The excess mortality was a key indicator in the COVID-19 epidemic to validate that the epidemiological reporting of COVID-19-related mortality was correctly conducted during the epidemic.

TABLE OF CONTENT

ABBREVIATIONS

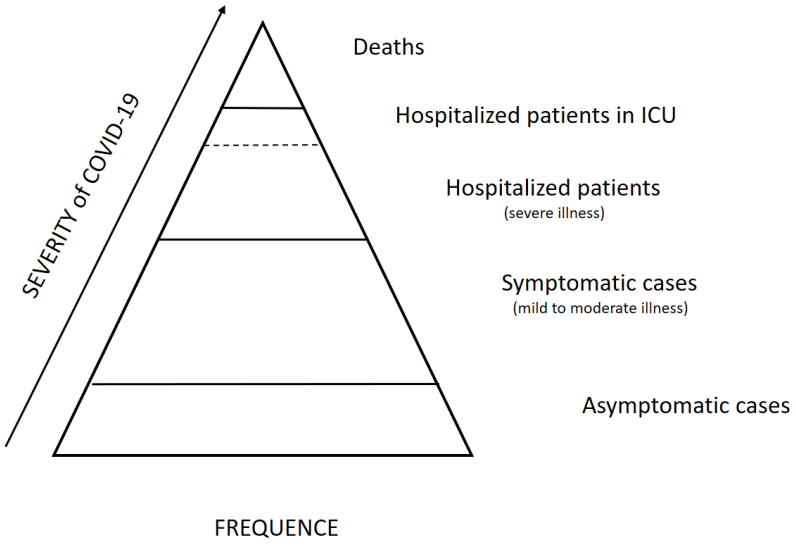
ASMR	Age-standardized mortality rate
AViQ	Agence pour une vie de qualité, Wallonia
AZG	Agentschap Zorg en Gezondheid, Flanders
BEL	Belgium
Be-MOMO	Belgian mortality monitoring
BXL	Brussels Capital Region
CFR	Case fatality ratio
CMR	Crude mortality rate
COPD	Chronic obstructive pulmonary disease
COVID-19	Coronavirus disease 2019
ECDC	European Centre for Disease Prevention and Control
FLA	Flanders
GGC	Joint Community Commissie, Brussels
ICU	Intensive care unit
LTCFs	Long-term care facilities
NH	Nursing home
RT-PCR	Real-time polymerase chain reaction
SC Survey	Hospital surge capacity survey
SMR	Standardized mortality ratio
WAL	Wallonia
WHO	World Health Organisation

1. INTRODUCTION

The first wave of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) epidemic started on 1 March 2020 with a confirmed infection in a traveller returning from France. By 10 March 2020, Belgium had recorded 600 cases of coronavirus disease 2019 (COVID-19) and reported the first COVID-19 related death in Brussels in an elderly woman. As of 14 February 2021, after one year and two epidemic waves, 21,860 people have died of COVID-19 in Belgium.

There are three categories of key indicators for monitoring the epidemic: **intensity indicators** relating to diagnosed cases and tests performed, **severity indicators** relating to hospitalizations and deaths, and **vaccination indicators**. Mortality is a late indicator, as the peak of deaths usually occurs two or three weeks after the peak of cases. as illustrated in Figure 1, the COVID-19 deaths represent only part of the health burden of COVID-19 on our society. Moreover, the consequences of COVID-19 in infected people are not negligible, as some will experience long-term effects after COVID-19 disease with direct and indirect consequences on their lifestyle.

Figure 1. **Health burden of COVID-19**



Note: This figure visualizes the different facets of health burden. Given data limitations, the proportions do not reflect reality and are illustrative.

This report aims to provide an overview of the characteristics of the COVID-19 deaths that occurred during the first wave (1 March 2020 until 21 June 2020, weeks 9 to 25), inter wave period (22 June until 30 August 2020, weeks 26 to 35) and second wave (31 August 2020 until 14 February 2021, week 36 2020 to week 6 2021) of the COVID-19 epidemic in Belgium. Additionally, the methodology used to set up this surveillance and some more in-depth analyses will be presented. The presented daily COVID-19 mortality in the report was extracted on 26 April 2021 from the Sciensano database.

2. EPIDEMIOLOGY OF COVID-19 MORTALITY

2.1. HOW MANY COVID-19 DEATHS HAVE OCCURRED?

Between 10 March 2020 and 14 February 2021, **21,860 COVID-19 deaths** have been reported: 9,595 deaths (43.9%) have occurred during the first wave, 316 (1.4%) during the inter wave and 11,949 (54.7%) during the second wave.

Figure 2. Number of COVID-19 deaths in Belgium per week and region, March 2020 – February 2021

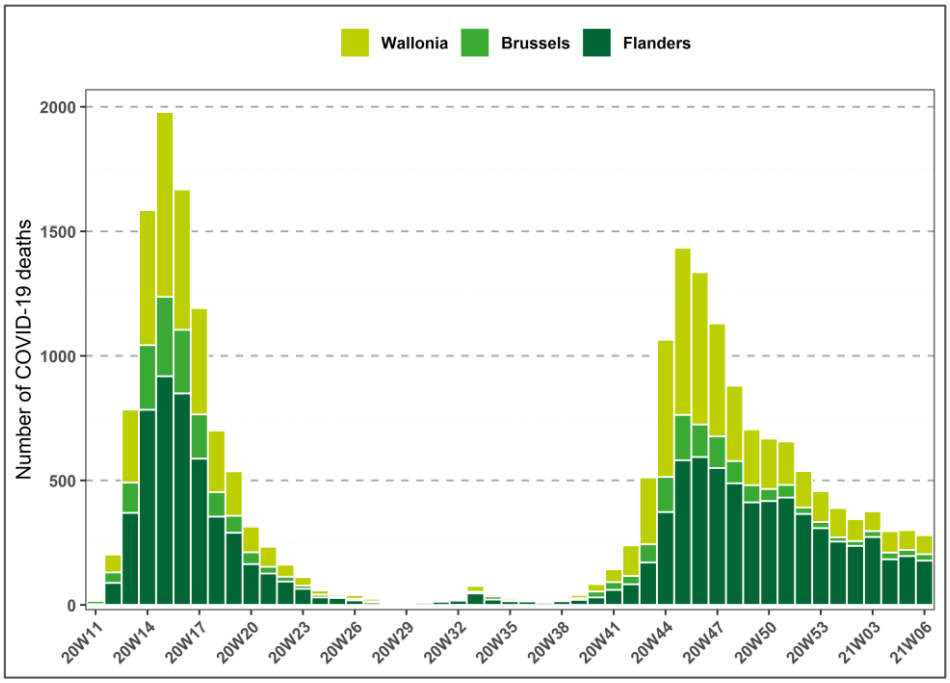


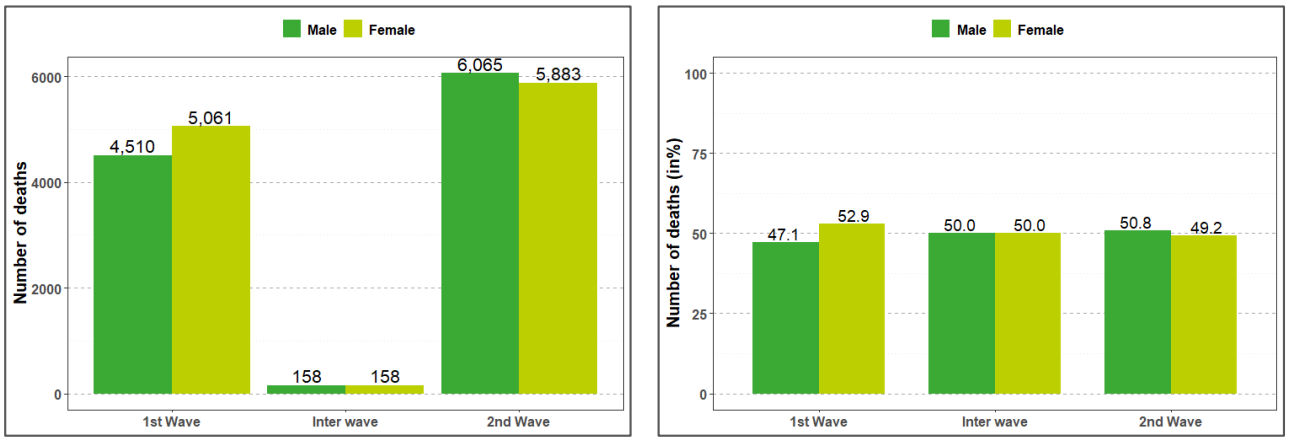
Table 1 | Number of COVID-19 deaths in Belgium by period of the epidemic, by region, March 2020 – February 2021

	1st wave (1/03/2020 until 21/06/2020, weeks 9 to 25)		Inter wave (22/06/2020 until 30/08/2020, weeks 26 to 35)		2nd wave (31/08/2020 until 14/02/2021, week 36 2020 to week 6 2021)	
	n	%	n	%	n	%
Flanders	4,756	49.6	166	52.5	6,252	52.3
Brussels	1,478	15.4	57	18.0	1,207	10.1
Wallonia	3,361	35.0	93	29.5	4,490	37.6

2.2. WHAT WAS THE DISTRIBUTION OF THE COVID-19 DEATHS BY SEX AND AGE?

Between 10 March 2020 and 14 February 2021, **10,733 COVID-19 deaths** (49.1%) occurred in male and **11,102** (50.8%) in female patients. For 25 of the deceased the sex was unknown.

Figure 3. **COVID-19 deaths in Belgium by sex and period of the epidemic, number (left) and percentage (right), March 2020 - February 2021**



Between 10 March 2020 and 14 February 2021, 11,635 deaths (53.2%) occurred in the age group over 84 years, 8,897 (40.7%) in the age group 65-84 and 1,328 (6.1%) in the age group under 65 years.

Figure 4. **COVID-19 deaths in Belgium by age group and period of the epidemic, number (left) and percentage (right), March 2020 - February 2021**

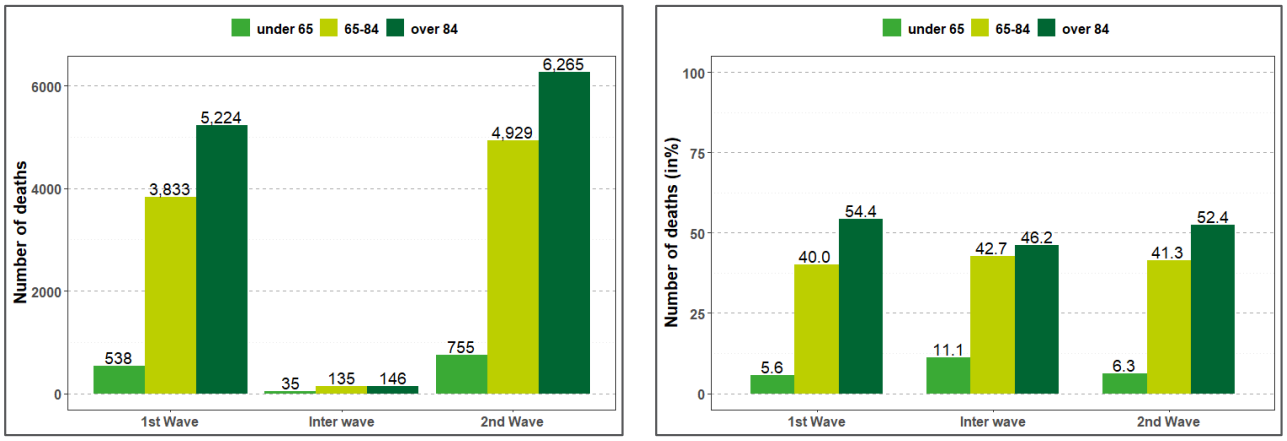
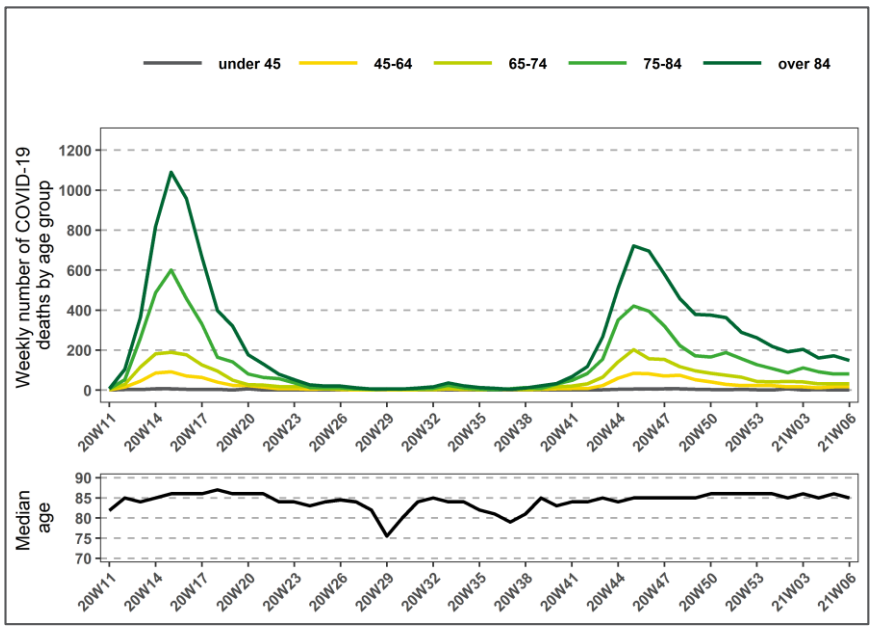


Figure 5. **Weekly number of COVID-19 deaths in Belgium by age group and median age of the deceased, March 2020 - February 2021**



Note: First wave (1 March 2020 until 21 June 2020, weeks 9 to 25), inter wave period (22 June until 30 August 2020, weeks 26 to 35) and second wave (31 August 2020 until 14 February 2021, week 36 2020 to week 6 2021)

What should be considered when looking at the number of COVID-19 deaths by age group?

In the **85-89 age** group, 5,464 people died of COVID-19, representing 25% of all COVID-19 deaths. Of these, 2,552 (46.7%) were males and 2,912 (53.3%) were females. Among the 85-89 age group, therefore, more females than males have died of COVID-19.

Figure 6. **Number of COVID-19 deaths in Belgium by age group, March 2020 – February 2021**

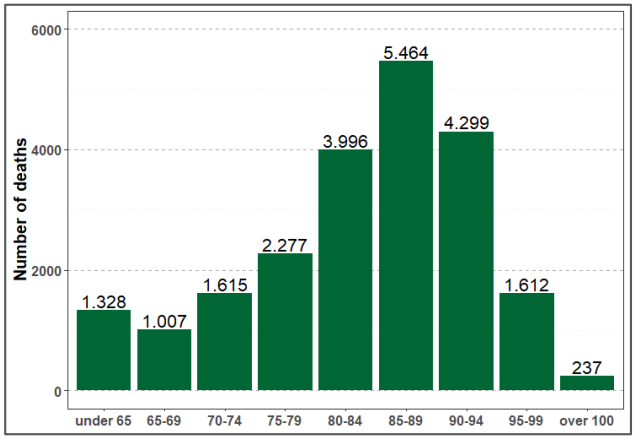
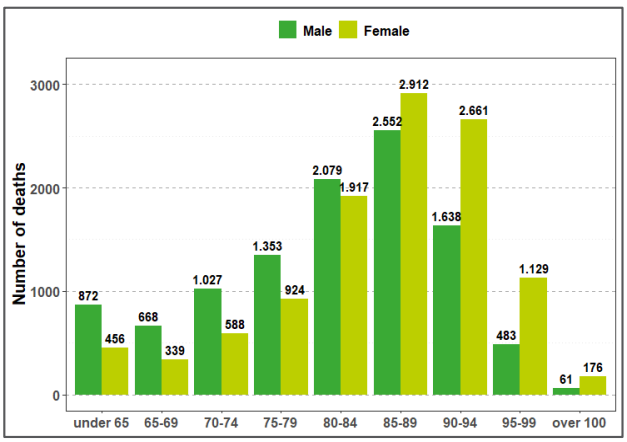


Figure 7. **Number of COVID-19 deaths in Belgium by age group and sex, March 2020 – February 2021**



However, looking at the **composition of the population as of 1 January 2020**, the 85-89 age group was composed of more females (138,933 or 63.8%) than males (78,809 or 36.1%). The 2,552 male COVID-19 deaths represented 3.2% of the total male population aged 85-89 years, and the 2,912 female COVID-19 deaths represented 2.1% of the total number of females in the same age group (Figures 8 and 9). In conclusion, while more females in the 85-89 age group died from COVID-19 than males, **the share of the male population in this age group that died from COVID-19 was greater than that of females**.

Figure 8. **Age pyramid Belgian population (in %), 1 January 2020**

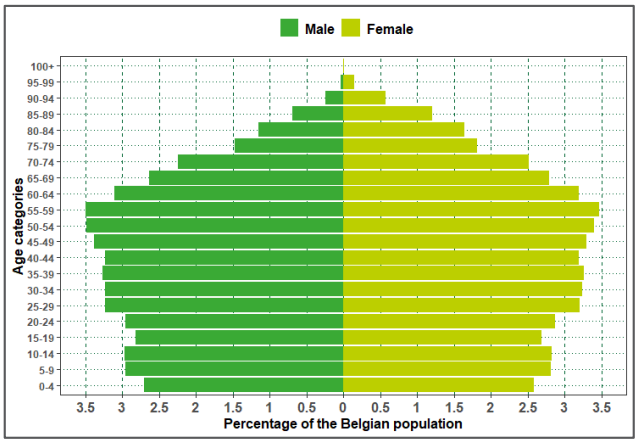
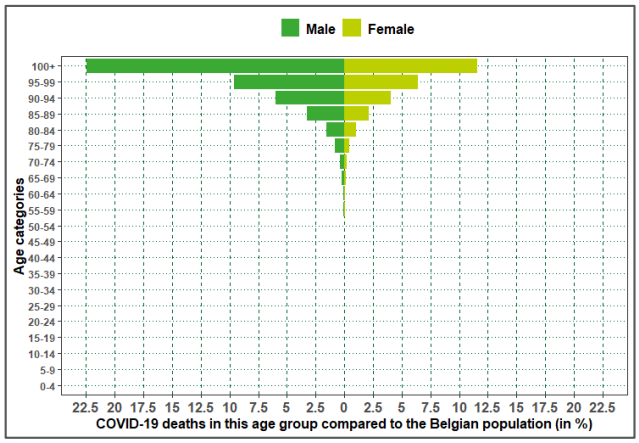


Figure 9. **Belgian population who died from COVID-19 (in %) by age group and sex, March 2020 – February 2021**



2.3. WHAT WERE THE CHARACTERISTICS OF HOSPITALIZED PEOPLE WHO DIED FROM COVID-19?

The clinical hospital surveillance provided data for a sample of the COVID-19 deaths. Information on comorbidities in hospitalized COVID-19 patients, from 15 March 2020 until 14 June 2020, was available for 88.6% of the COVID-19 patients.

Statistical analysis for this period showed that the risk of death (lethality) for hospitalized COVID-19 patients increased when the patient had one of the following pre-existing factors: older age, male sex, cardiovascular disease, diabetes, chronic kidney, liver or lung disease, neurological and cognitive issues and cancer. For patients younger than 65 years, lethality was increased by obesity.

For more information on hospitalized COVID-19 patients: COVID-19 clinical surveillance in hospital (NL/FR)

2.4. WHERE DID COVID-19 PATIENTS DIE?

Between 10 March 2020 and 14 February 2021, 12,350 (56.5%) of the COVID-19 deaths occurred in hospitals, 9,339 (42.7%) died in nursing homes (NH) and 171 (0.8%) in other locations (at home, other long-term care facilities (LTCF), other places, unknown).

Figure 10. **COVID-19 deaths in Belgium by place of death and period of the epidemic, number (left) and percentage (right), March 2020 - February 2021**

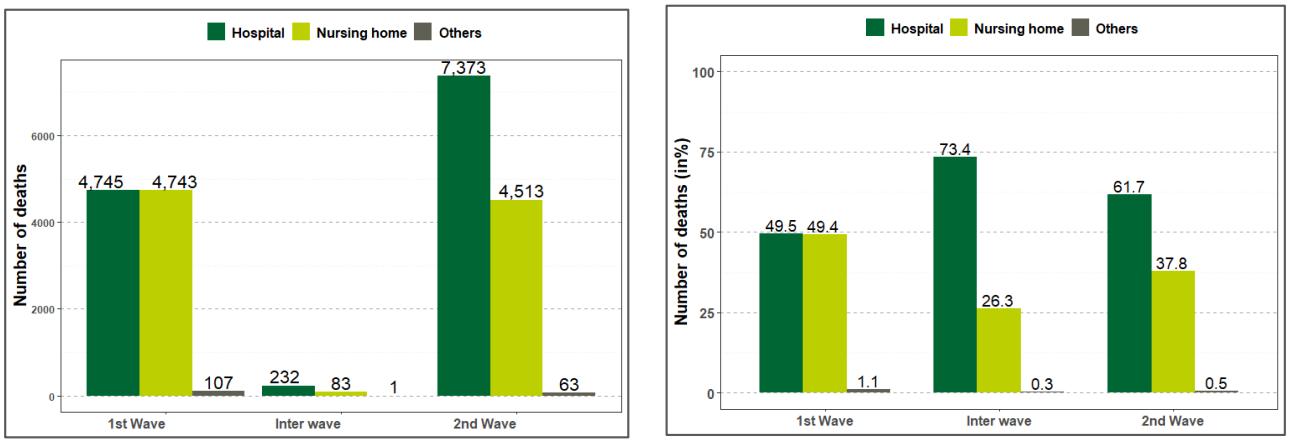
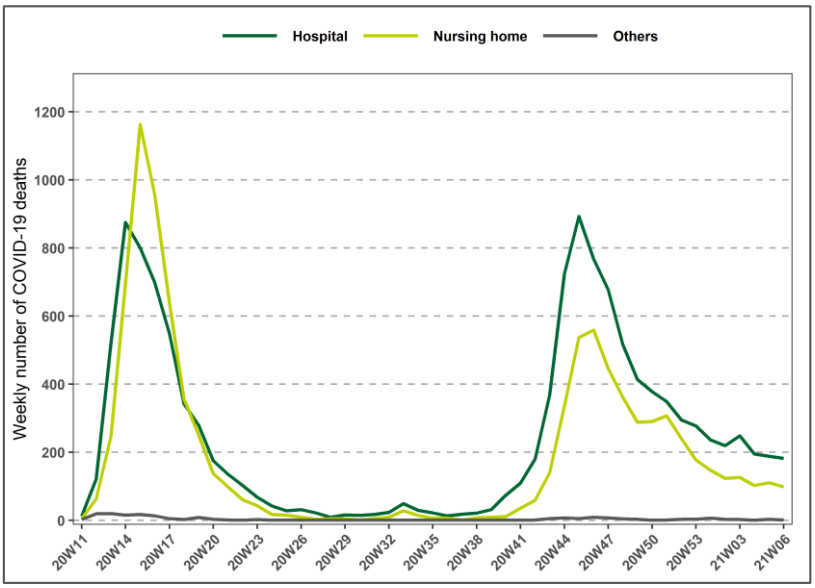


Figure 11. **Weekly number of COVID-19 deaths in Belgium by place of death, March 2020 - February 2021**



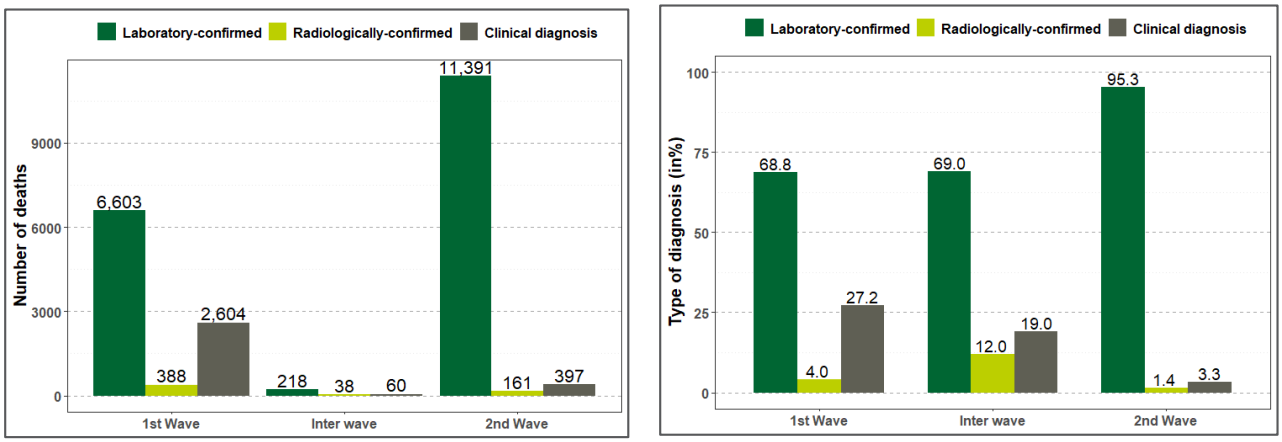
Note: First wave (1 March 2020 until 21 June 2020, weeks 9 to 25), inter wave period (22 June until 30 August 2020, weeks 26 to 35) and second wave (31 August 2020 until 14 February 2021, week 36 2020 to week 6 2021)

2.5. WHAT WAS THE DISTRIBUTION OF THE COVID-19 DEATHS BY CASE CLASSIFICATION?

Between 10 March 2020 and 14 February 2021, 3,061 (14.0%) of COVID-19 deaths were **possible COVID-19 cases** and 18,799 (86.0%) were **confirmed COVID-19 cases**, among which 18,212 (96.9%) were **laboratory-confirmed** and 587 (3.1%) were **radiologically-confirmed** (Figure 12) (More information on case classification).

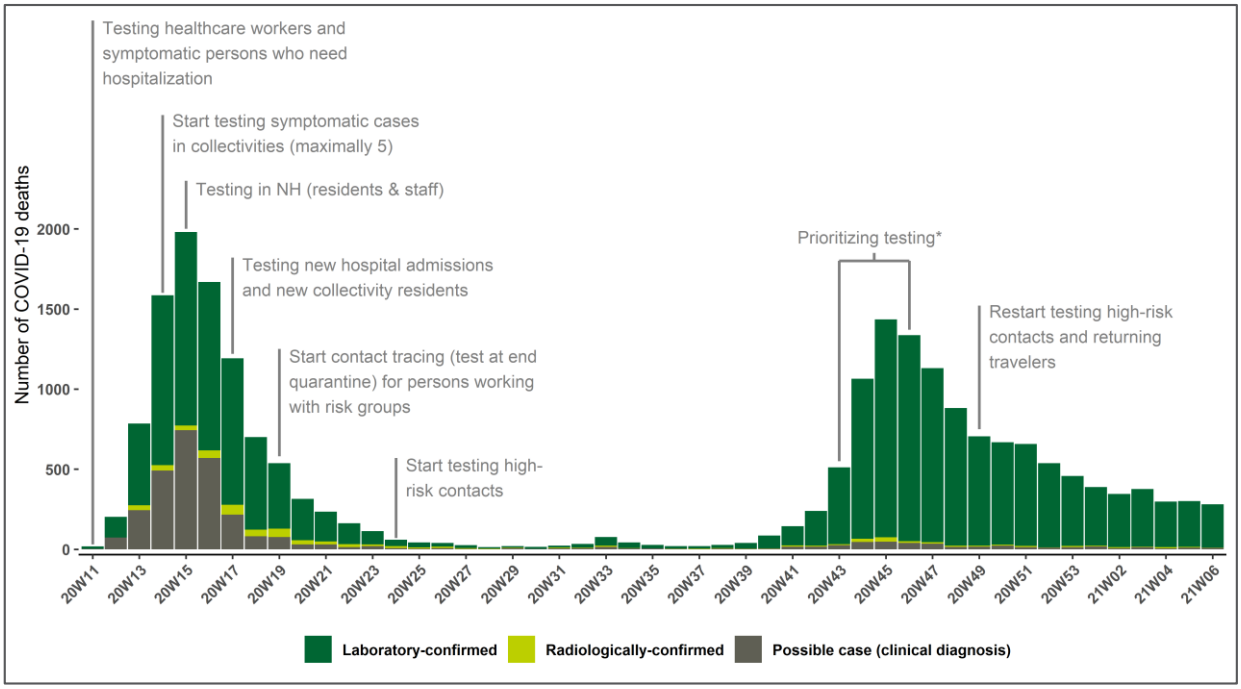
In the first wave, 51.3% of the COVID-19-related deaths **in NHs** were laboratory-confirmed, 48.6% were clinically diagnosed and 0.1% were radiologically-confirmed.

Figure 12. **COVID-19 deaths in Belgium by case classification and period of the epidemic, number (left) and percentage (right), March 2020 - February 2021**



During the COVID-19 epidemic, the proportion of laboratory-confirmed cases increased due to an increasing test capacity and the broadening of the test strategy, as indicated in Figure 13.

Figure 13. Evolution of COVID-19 deaths in Belgium by case classification with markings of some of the changes in testing strategy, March 2020 - February 2021



Note: First wave (1 March 2020 until 21 June 2020, weeks 9 to 25), inter wave period (22 June until 30 August 2020, weeks 26 to 35) and second wave (31 August 2020 until 14 February 2021, week 36 2020 to week 6 2021)

** Due to insufficient testing capacity, test priority was given from 21 October to 15 November 2020 (week 43 to week 46) to symptomatic persons, persons requiring hospitalization and new residents of residential collectivities. During this period, high-risk contacts and returning travellers were no longer systematically tested, except for health personnel.*

2.6. HOW MANY RESIDENTS OF LONG-TERM CARE FACILTIES (LTCF) HAD A COVID-19 RELATED DEATH?

Between 10 March 2020 and 14 February 2021, **12,447 NH residents** died, which represents 56.9% of all COVID-19 deaths. Also, 319 people residing in other collectivities died during this period.

Figure 14. **COVID-19 deaths among residents of LTCF (NH and other collectivities) in Belgium by period of the epidemic, number (left) and percentage (right), March 2020 - February 2021**

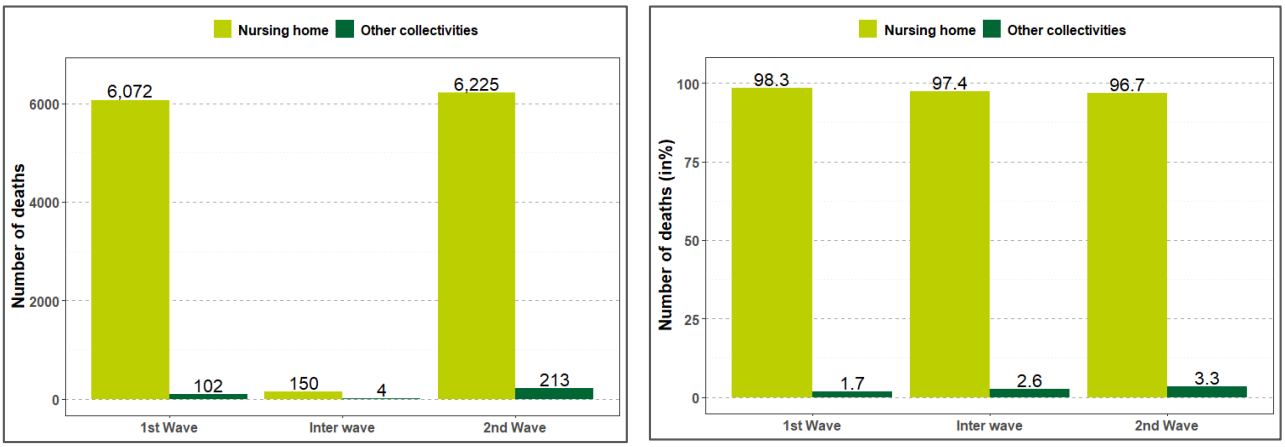
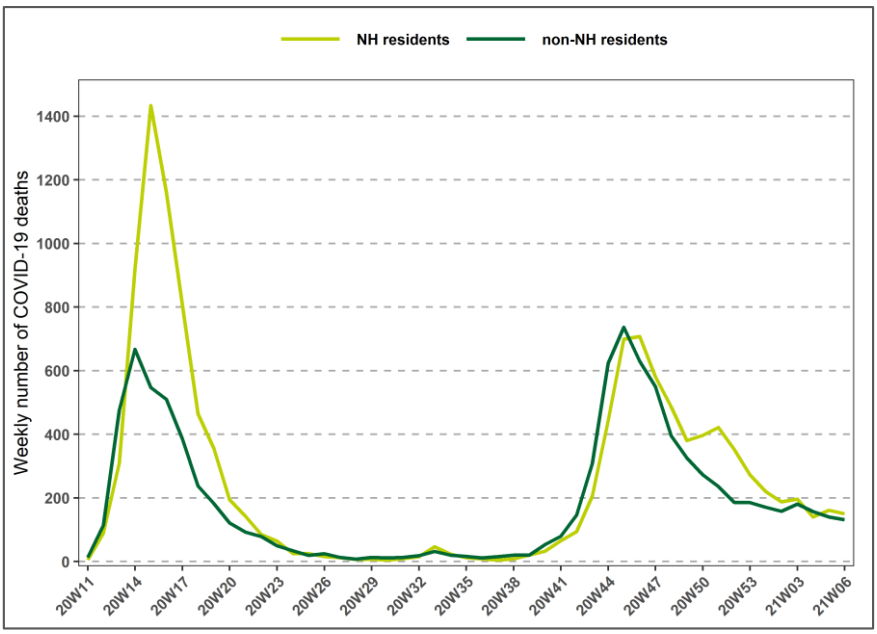


Figure 15. **Weekly number of all COVID-19 deaths by NH and non-NH residents[1] in Belgium, March 2020 - February 2021**



[1] In this report non-NH residents are used to talk about all other persons in the community, not living in a NH (e.g. other collectivity, at home...).

It should be noted that during the first wave, **information on residence (type[2] and postal code)** of the COVID-19 patients who died in a hospital was often incomplete. As a result, we could not give an exact number but only an estimation of NH residents who died during the first wave[3]. These estimates were possibly an underestimation. Also, for the second wave, the numbers should be interpreted with caution as there probably was some underreporting.

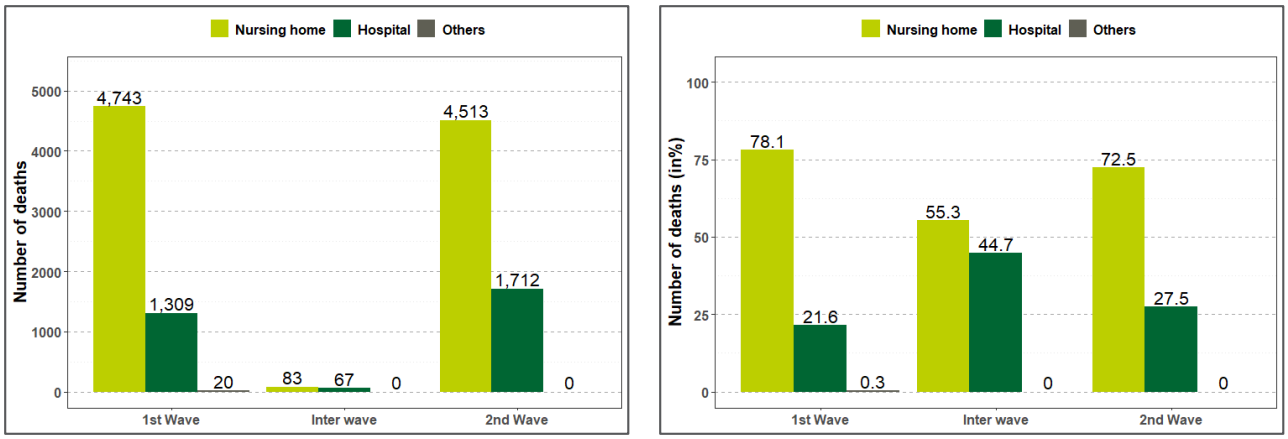
In Belgium, based on the data of IMA of 2018, 5.6% of the population above 65 years old, was living in a LTCF. Belgium also has an important peculiarity compared to other countries: it is the second European country with the highest number of nursing home beds per 100,000 inhabitants (after Sweden) according to WHO(1).

For more information on NH surveillance: COVID-19 NH surveillance. For more information on managing mortality data among NH residents: FAQ COVID-19 surveillance section 6.4.

2.7. WHERE DID THE COVID-19 RELATED DEATHS AMONG NURSING HOME RESIDENTS TOOK PLACE?

Of the 12,447 NH residents who died from COVID-19 between 10 March 2020 and 14 February 2021, 9,339 (75.0%) died in the NH.

Figure 16. **COVID-19 deaths among NH residents in Belgium by place of death and period of the epidemic, number (left) and percentage (right), March 2020 - February 2021**



[2] NH, other LTCF, at home, etc.

[3] The information could not be recovered from NH surveillance because only the total number of deaths of Flemish NH residents in hospital, from all causes, was reported. To estimate the number of Flemish NH residents who died from COVID-19 in hospital, we made the assumption that the ratio COVID-19/non-COVID-19 deaths of NH-residents in hospital was the same as this ratio in NH, and this for a particular week.

Figure 17. **Weekly number of COVID-19 deaths among NH residents in Belgium by place of death, March 2020 - February 2021**

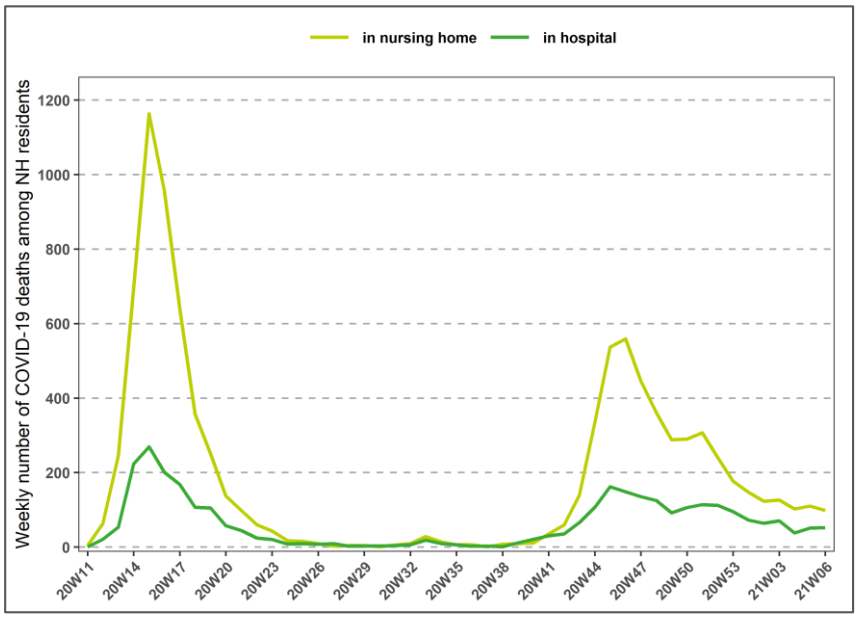
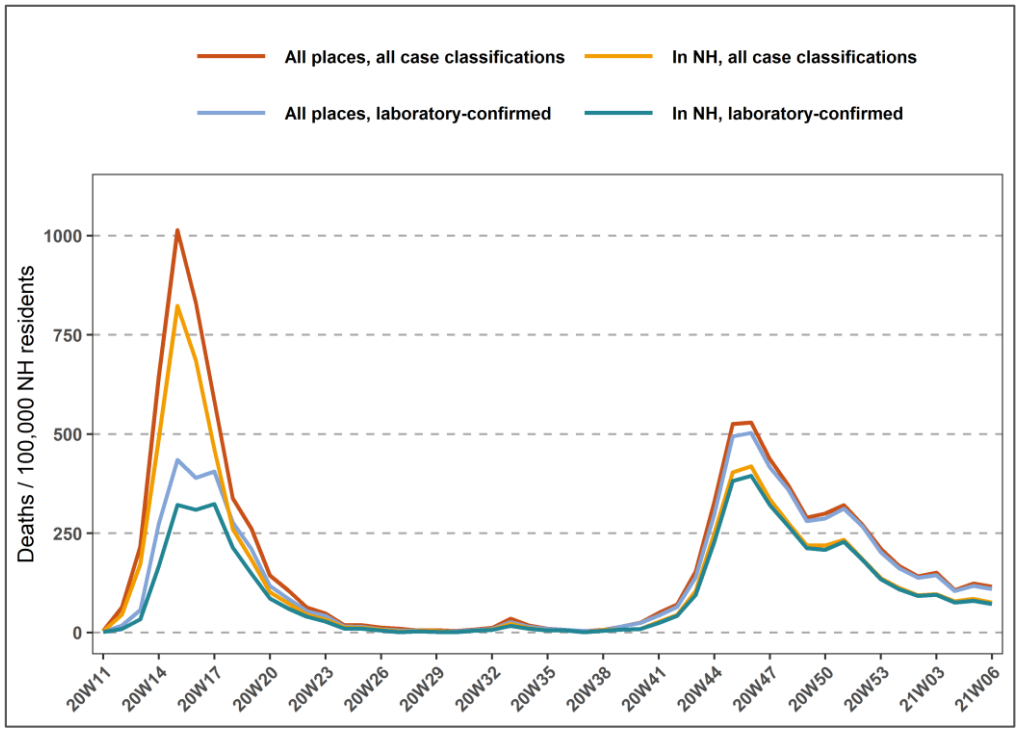


Figure 18 shows the weekly rate of COVID-19 deaths among NH residents according to the place of death (all places or NH only) and case classification (all classifications or laboratory-confirmed only). In the second wave, the weekly rate of laboratory-confirmed COVID-19 deaths among NH residents was higher than in the first wave regardless of the place of death.

Figure 18. **Weekly rate of COVID-19 deaths among NH residents in Belgium by place of death and case classification, March 2020 - February 2021**



For more info on European comparison between COVID-19 mortality in NH residents: https://covid19-country-overviews.ecdc.europa.eu/#7_Belgium

3. METHODOLOGY OF COVID-19 MORTALITY SURVEILLANCE IN BELGIUM

An *ad-hoc* COVID-19 death surveillance had to be put in place by Sciensano as in the usual "cause of death" registration the processing of the official death certificates takes up to three years. This section describes the technical aspects of the COVID-19 mortality surveillance in Belgium. The detailed methodology of the COVID-19 death surveillance is described by Renard F. *et al* (2).

3.1. WHAT WERE THE CASE CLASSIFICATION AND CRITERIA?

In Belgium, the following COVID-19 case classification and criteria were used:

- **Laboratory-confirmed case**: a person who has a confirmed diagnosis by molecular testing of COVID-19 (since 12 February 2021: also by an antigen test).
- **Radiologically-confirmed case**: a person who has a negative PCR test for SARS-CoV-2 but is nonetheless diagnosed with COVID-19 on the basis of a suggestive clinical presentation AND a compatible chest scanner.
- **Possible case**:
  - At least one of the following major symptoms of acute onset, with no other obvious cause: cough, dyspnoea, thoracic pain, anosmia or dysgeusia
  - Or two[4] or more of the following minor symptoms, with no other obvious cause: fever, muscle pain, fatigue, rhinitis, sore throat, headache, anorexia, watery diarrhoea[5], acute confusion[5], sudden fall[5]
  - Or exacerbation of chronic respiratory symptoms (COPD, asthma, chronic cough...), without any other obvious cause.

[4] In children, only a fever without an obvious cause is enough to consider the diagnosis of COVID-19 during this epidemic.
[5] These symptoms are more common in the elderly, where an acute infection can manifest itself atypically.

3.2. WHICH WERE THE CRITERIA TO INCLUDE A DEATH IN THE COVID-19 SURVEILLANCE?

Daily COVID-19 numbers of deaths were included by Sciensano using reports from **hospitals, LTCFs** (e.g. mainly NH, service-flats for elderly persons, institutions for persons with a disability,…), and **general practitioners** (GPs). For each place of death, the case classification was reported.

For all COVID-19 cases, **unless there was a clear alternative cause of death that could not be linked to COVID-19 (e.g. trauma)**, the death was included in the surveillance. There must have been no period of complete recovery between the illness and death. The used criteria were based on the ECDC and WHO guidelines (3). The main difference was that the WHO's definition of **probable case** was not used because this definition, at first, concerned people with an inconclusive test, which was infrequently observed in Belgium.

The criteria for including COVID-19 deaths in the statistics were communicated to the physicians via the COVID-19 procedures and online questionnaires for institutions. Additional checks were systematically made in case of deaths in the 0-24 age group.

Based on the pre-existing networks and collaborations set up for different health topics in LTCF it was possible to rapidly start up the **COVID-19 surveillance in LTCFs** (2). **Possible cases** (cases who were clinically diagnosed but who were not tested) were included in order not to underestimate the seriousness of the situation in LTCFs. Due to the limited testing capacity at the beginning of the epidemic, testing was not allowed outside the hospital. **The inclusion of possible cases affected the COVID-19 mortality results, but this was only relevant and substantial for the first six weeks of the first wave** (Figure 25). A mass screening campaign of all residents and staff in NHs implemented early April resulted in an increase in the proportion of deaths in confirmed cases at the expense of the proportion of deaths in possible cases. From then onwards (almost) all COVID-19 deaths were tested cases.

3.3. HOW WAS THE DATA FLOW ORGANIZED?

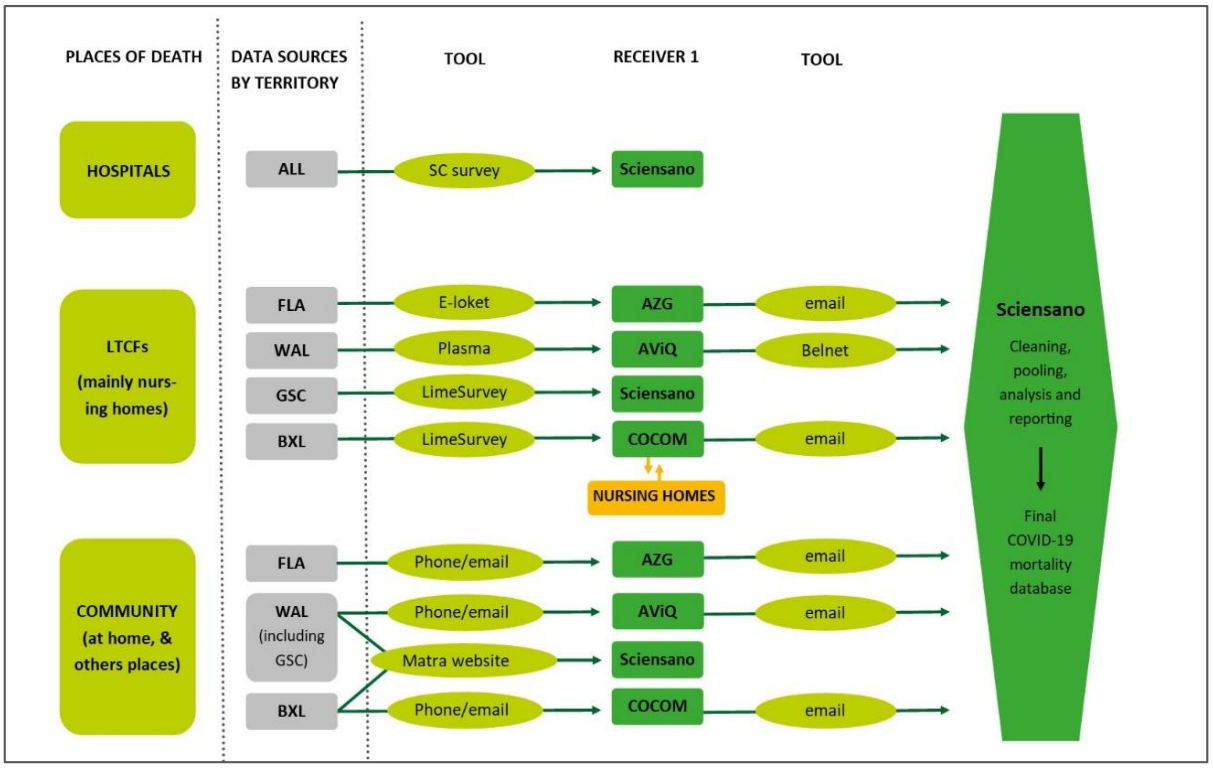
Sciensano received on a daily basis information on COVID-19 deaths from **nine different sources** depending on the region and the type of place of death (Figure 19).

Deaths occurring in one of the 104 **hospitals** were notified through a LimeSurvey[6] to Sciensano, in the framework of the "Surge Capacity Survey" (4).

LTCFs- encompassing mainly 1,500 NHs- notified COVID-19 deaths to the regional authorities through region-specific registration systems (e-loket in Flanders (AZG[7]), AViQ[8] web-portal Plasma in Wallonia, LimeSurvey in Brussels (COCOM[9]) and in the German-speaking Community). At the level of the regional authorities data were harmonized and transmitted to Sciensano.

COVID-19 deaths occurring in the **community** (at home or other places) were declared by the GPs via an online tool (Matra) for Wallonia, Brussels and the German-speaking Community, and were declared by phone or email to the regional health inspectors for Flanders and Brussels.

Figure 19. **Data flow of COVID-19 death notifications in Belgium**



Note : FLA: Flanders, WAL: Wallonia, GSC: German-speaking Community, BXL: Brussels, AZG: Agentschap Zorg en Gezondheid (Flanders), AViQ: Agence pour une Vie de Qualité (Wallonia), COCOM (Commission communautaire commune de la Région de Bruxelles-Capitale (Brussels)

6 An online survey tool.
7 Agentschap Zorg en Gezondheid, Flanders.
8 Agence pour une vie de qualité, Wallonia.
9 Commission communautaire commune de la Région de Bruxelles-Capitale, Brussels.

3.4. WHICH INFORMATION WAS COLLECTED?

For every deceased person, information was collected on: date of death, case classification, place of death, postal code of the place of death, date of birth[10], sex, type of residence[11] and postal code of residence[12].

Until June 2020, the nursing home network of the Flemish region collected deaths in an aggregated way; a retrospective update was performed on 26 August 2020 **(FR/NL)**.

3.5. WHAT WAS THE PUBLICATION DELAY?

Usually, 90% of COVID-19 deaths were recorded within two calendar days[13]. At several moments, however, COVID-19 deaths have been added at a later point. All of these deaths and information were retrospectively added according to the date of death, leading to retrospective updates in the epidemiological curve. The most important updates were:

- 31 March 2020: the first COVID-19 deaths **in LTCFs** were included with 81 deaths of **possible cases**
- 6 May 2020: inclusion of 232 deaths of **possible or radiologically-confirmed** cases in hospitals
- Inclusion of **deaths among LTCFs** due to extra data becoming available:
    - 7 April 2020: 242 deaths in Flanders
    - 10 April 2020: 171 deaths in Flanders
    - 22 April 2020: 23 deaths in the German-speaking Community
    - 26 August 2020: adaptation from 2,744 to 2,623 deaths in Flanders (Update NH data)
- 16 March 2021: inclusion of 86 deaths from hospitals in Flanders (Update hospital data)

[10] Full date of birth available since 24 April 2020 from hospitals.
[11] Available since 21 June 2020 from hospitals: to live or not in a NH, a residential community for the elderly, a psychiatric institute, an institute for people with disabilities or another kind of community.
[12] Available since 24 April 2020 from hospitals..
[13] 12% the same day, 44% after one day, and 34% the second day.

3.6. WHAT WERE THE LIMITATIONS OF THE COVID-19 MORTALITY SURVEILLANCE?

The most important limitations were:

- Limited testing capacity and narrower testing strategy during the first six weeks of the epidemic
  In this period most NH residents could not be tested, and the COVID-19 diagnosis was clinically based only. This may have led to misclassifications.
- Unknown accuracy of COVID-19 death reporting outside hospitals and NHs
  Some deaths occurring in LTCFs other than NH and at home were possibly missing.
- Some variables of the COVID-19 mortality surveillance were introduced later in the epidemic limiting certain analyses
  This limited the identification of NH residents who died in hospital early in the epidemic.
- Data were manually encoded by the field
  This may have led to registration errors.
- When a death was declared by several different sources, data had to be checked to eliminate duplicates
  This process was time-consuming and, although mainly automated, it may have been a source of human error.

These limitations may have led to an over- or underestimation of the number of COVID-19 deaths, but the system seems to have worked if we refer to all-cause mortality.

Moreover, people who died in a hospital **whose postal code of residence was not in Belgium** were not included in the surveillance (37 deaths, until 14 February 2021) to avoid double counting in the countries concerned.

4. IN-DEPTH ANALYSIS

4.1. COVID-19 MORTALITY RATES

This section describes the COVID-19 mortality rates for Belgium, by geographical entity (region and province), by profile (being a NH resident or not) for the two waves separately and between 10 March 2020 and 14 February 2021.

First, the **crude COVID-19 mortality rate** (CMR) is presented, which is the number of COVID-19 deaths per 100,000 inhabitants, using the population of 1 January 2020 as the denominator.

Second, to remove the effect of possible differences in the age structure of the geographical entities, the **COVID-19 mortality rates after direct age-standardization** (age-standardized mortality rate - ASMR) are calculated[14]. Those ASMR rates are fictitious, influenced by the selected reference population, but they allow to compare mortality rates between different geographic entities in a certain period.

Third, **standardized COVID-19 mortality ratios** (SMRs) are presented, obtained by indirect standardization. These ratio compare the number of deaths that occurred in an entity with the number that would have been expected if this entity had had the age-specific mortality rates of the entire Belgian population. The SMRs of the different entities are not compared with each other. Indirect standardization is preferred to direct standardization when small numbers of deaths are involved.

Mortality rates are presented by **place of residence**, with place of death used as a proxy when place of residence was unknown (during the first wave, 33% of the information on place of residence was missing). Therefore, COVID-19 mortality rates per province during the first wave can be overestimated for provinces with many large hospitals (for example in Brussels and Antwerp), that can have attracted patients living in other provinces. However, the analysis of all-cause mortality by place of residence, revealed a high excess mortality in Brussels, unexplained by the "large-hospital attraction". Factors as population density, with high transmissibility, and specific socio-demographic and economic characteristics could account for a part of this difference. It has to be noted that as the three analysis periods have **different durations** their mortality rate cannot be directly compared with each other.

[14] ASMR are calculated using the total Belgium population 2020 as reference population (https://statbel.fgov.be/nl/themas/bevolking/structuur-van-de-bevolking#figures).

4.1.1. COVID-19 mortality rates by region

For the total period, the COVID-19 CMR for Belgium reached 190 per 100,000 inhabitants (Table 2). The CMR was highest in Wallonia, then in Brussels and finally in Flanders. After standardization, this order differed, with Brussels having the highest ASMR and Flanders still the lowest one. Brussels and Wallonia had respectively SMRs of 147% and 124%, meaning a COVID-19 mortality rate 47% and 24% higher than the Belgian SMR.

For the first wave there was a similar trend. As mentioned before, the high SMR in Brussels (189%) could partly be due to the use of the place of death when the place of residence was unknown. In the second wave, Wallonia had the highest SMR (130%).

Table 2 | COVID-19 mortality rates in Belgium by region, by period of the epidemic, March 2020 – February 2021

Total period

(1/03/2020 up to and including 14/02/2021, week 9 2020 to week 6 2021)

Region	CMR (/100,000)	Region	ASMR (/100,000)	SMR
WAL	224	BXL	282	*147%
BXL	208	WAL	217	*124%
BEL	190	BEL	209	100%
FLA	169	FLA	144	83%

Wave 1

(1/03/2020 up to and including 21/06/2020, weeks 9 to 25)

Region	CMR (/100,000)	Region	ASMR (/100,000)	SMR
BXL	117	BXL	159	*189%
WAL	93	WAL	90	*117%
BEL	83	BEL	83	100%
FLA	72	FLA	62	81%

Wave 2

(31/08/2020 up to and including 14/02/2021, week 36 2020 to week 6 2021)

Region	CMR (/100,000)	Region	ASMR (/100,000)	SMR
WAL	128	WAL	124	*130%
BEL	104	BXL	118	*112%
FLA	94	BEL	103	100%
BXL	87	FLA	80	84%

CMR: crude mortality rate, ASMR: age-standardized mortality rate, SMR: standardized mortality rate
WAL: Wallonia, BXL: Brussels, BEL: Belgium, FLA: Flanders
** statistically significant SMR*

4.1.2. COVID-19 mortality rates by province (and Brussels)

For the total period the highest COVID-19 CMR was noted in the province of Hainaut (254/100,000 inhabitants) (Table 3). After standardization, the highest ASMR was noted in Brussels and the lowest ASMR in the province of Flemish Brabant .

During the first wave, Brussels had the highest SMR (189%). During the inter wave period, Antwerp presented the highest SMR (200%). In the second wave, Hainaut had the highest SMR (148%).

Table 3 | COVID-19 mortality rates in Belgium by province, by period of the epidemic, March 2020 - February 2021

Total period (1/03/2020 up to and including 14/02/2021, week 9 2020 to week 6 2021)				
Province	**CMR (/100,000)**	**Province**	**ASMR (/100,000)**	**SMR**
Hainaut	254	Brussels	282	*147%
Liège	246	Hainaut	267	*141%
Brussels	208	Liège	257	*136%
Namur	194	Namur	207	*109%
West-Vlaanderen	185	Luxembourg	186	98%
Oost-Vlaanderen	182	Oost-Vlaanderen	172	91%
Limburg	166	Limburg	164	87%
Luxembourg	166	Antwerpen	163	86%
Antwerpen	166	West-Vlaanderen	145	77%
Vlaams-Brabant	140	Brabant Wallon	138	73%
Brabant Wallon	136	Vlaams-Brabant	133	71%
Wave 1 (1/03/2020 up to and including 21/06/2020, week 9 to 25)				
Province	**CMR (/100,000)**	**Province**	**ASMR (/100,000)**	**SMR**
Brussels	117	Brussels	159	*189%
Limburg	110	Liège	113	*136%
Liège	108	Limburg	109	*132%
Hainaut	104	Hainaut	109	*131%
Namur	78	Namur	85	101%
Luxembourg	74	Luxembourg	83	100%
West-Vlaanderen	71	Antwerpen	66	79%
Antwerpen	67	Vlaams-Brabant	62	75%
Vlaams-Brabant	65	Oost-Vlaanderen	59	71%
Oost-Vlaanderen	63	West-Vlaanderen	56	68%
Brabant Wallon	46	Brabant Wallon	46	55%
Wave 2 (31/08/2020 up to and including 14/02/2021, week 36 2020 to week 6 2021)				
Province	**CMR (/100,000)**	**Province**	**ASMR (/100,000)**	**SMR**
Hainaut	147	Hainaut	154	*148%
Liège	136	Liège	141	*137%
Oost-Vlaanderen	118	Namur	122	*118%
Namur	115	Brussels	118	*112%
West-Vlaanderen	112	Oost-Vlaanderen	111	*108%
Luxembourg	92	Luxembourg	103	99%
Antwerpen	94	Antwerpen	92	88%
Brussels	87	Brabant Wallon	90	87%
Brabant Wallon	89	West-Vlaanderen	88	85%
Vlaams-Brabant	74	Vlaams-Brabant	70	68%
Limburg	54	Limburg	53	52%

CMR: crude mortality rate, ASMR: age-standardized mortality rate, SMR: standardized mortality rate
** statistically significant SMR*

4.1.3. COVID-19 mortality rates in nursing home and non-nursing home residents[1]

In this section only COVID-19 CMR are presented for all **NH residents (all ages) and non-NH residents aged 65 years and over**, as the limitation of age-specific data in the NH population did not allow to perform an age standardization. In the denominator, the average NH population from the NH surveillance was used for the NH residents, and the Statbel general population aged 65 years and over for the non-NH residents.

For the total period, the COVID-19 CMR for Belgium among NH residents reached 6,866 per 100,000 inhabitants and 545 per 100,000 inhabitants among non-NH residents (Table 4). However, the age distribution in NH residents strongly varies from that of the non-NH residents: the older age groups are much more represented in the NH residents than in the 65+ population living at home. Therefore, the comparison of crude rates should be interpreted with caution. Age-adjusted mortality rates would be better suited, but those could currently not be computed due to data limitations.

For the total period, the **CMR among NH residents was highest in Flanders and at the province level in Liège and Antwerp**. The CMR among NH residents was higher in Limburg and East Flanders during the 1st and 2nd wave respectively. Flanders had the highest CMR among NH residents for both the total period (7,162 per 100,000 inhabitants) and the second wave (3,828 per 100,000 inhabitants). This indicates that NH residents in Flanders were severely affected by this epidemic.

Table 4 | COVID-19 crude mortality rate per 100,000 inhabitants for NH residents (all ages) and non-NH residents (aged 65 years and over) in Belgium, by region and province, by period of the epidemic, March 2020 - February 2021

Total period (1/03/2020 up to and including 14/02/202, week 9 2020 to week 6 2021)			
NH residents		**Non-NH residents 65 years and over**	
Region			
Flanders	7162	Brussels	954
Brussels	7121	Wallonia	717
Belgium	6866	Belgium	545
Wallonia	6320	Flanders	412
Province			
Liège	7847	Brussels	954
Antwerpen	7563	Hainaut	877
Oost-Vlaanderen	7483	Liège	723
Vlaams-Brabant	7284	Namur	596
Brussels	7121	Luxembourg	592
Limburg	7009	Oost-Vlaanderen	455
Namur	6422	Limburg	453
West-Vlaanderen	6309	Brabant Wallon	415
Luxembourg	5644	Antwerpen	414
Hainaut	5583	West-Vlaanderen	412
Brabant Wallon	4890	Vlaams-Brabant	316

Wave 1 (1/03/2020 up to and including 21/06/2020, week 9 to 25)			
NH residents		**Non-NH residents 65 years and over**	
Region			
Brussels	5043	Brussels	460
Flanders	3300	Wallonia	251
Belgium	3417	Belgium	211
Wallonia	3175	Flanders	162
Province			
Limburg	5636	Brussels	460
Brussels	5043	Hainaut	318
Liège	4087	Luxembourg	260
Vlaams-Brabant	3915	Liège	257
Namur	3559	Limburg	255
Antwerpen	3131	Namur	186
West-Vlaanderen	2716	Antwerpen	160
Hainaut	2686	Oost-Vlaanderen	158
Luxembourg	2556	West-Vlaanderen	142
Oost-Vlaanderen	2513	Vlaams-Brabant	120
Brabant Wallon	2267	Brabant Wallon	97
Wave 2 (31/08/2020 up to and including 14/02/2021, week 36 2020 to week 6 2021)			
NH residents		**Non-NH residents 65 years and over**	
Region			
Flanders	3828	Brussels	472
Belgium	3392	Wallonia	455
Wallonia	2503	Belgium	324
Brussels	1966	Flanders	242
Province			
Oost-Vlaanderen	5004	Hainaut	541
Antwerpen	4281	Brussels	472
Liège	3668	Liège	456
West-Vlaanderen	3646	Namur	406
Vlaams-Brabant	3349	Luxembourg	332
Luxembourg	3056	Brabant Wallon	314
Hainaut	2820	Oost-Vlaanderen	292
Namur	2799	West-Vlaanderen	262
Brabant Wallon	2503	Antwerpen	238
Brussels	1966	Vlaams-Brabant	193
Limburg	1321	Limburg	191

NH: nursing home

For **non-NH residents**, Brussels presented the highest CMR for every period, with the necessity to take into account the above-mentioned limitation about the use of place of death when place of residence was unknown. By province, the highest CMR among non-NH residents during the total period and the first wave was observed in Brussels, during the inter wave in Antwerp (203 per 100,000) and in Hainaut for the second wave.

4.2. COVID-19 CASE FATALITY RATIO

The probability of dying from a disease when identified as a confirmed case is a measure of epidemiological frequency called the case-fatality ratio (CFR) (5). It is defined as the proportion of deaths from a certain disease compared to the total number of people diagnosed with the disease for a particular period. On the other hand, there is another lethality indicator, the "infection fatality ratio" (IFR), which relates the number of deaths to the total number of people who were infected (and not just the cases diagnosed by a laboratory test). As it is impossible to know the exact total number of people who have been infected with SARS-CoV-2, the IFR's denominator is calculated based on statistical modelling. The IFR is generally lower than the CFR. The CFR is thus driven both by the IFR and the testing strategy. Interpretation of CFR requires knowledge of the methodological limitations for identifying cases and deaths. As the surveillance of COVID-19 confirmed deaths is generally more exhaustive than the surveillance of confirmed cases, the CFR is sometimes presented as an upper bound for the IFR.

For the following CFR estimation, **cases and deaths confirmed by a laboratory test were selected** (this underestimates deaths by 16.7%). Up to three weeks of delay between laboratory confirmation (becoming a case) and dying were considered. The delay distribution was estimated jointly with the CFR. A binomial distribution with the CFR and the delay-adjusted number of confirmed cases as parameters for the CFR estimation was used. Age-group and sex specific estimates were calculated.

Pitfalls in the calculation of the COVID-19 CFR

In Belgium, COVID-19 cases represent cases confirmed by a laboratory test, while possible and radiologically-confirmed cases are not included in the statistics. On the other hand, COVID-19 deaths include laboratory-confirmed, radiologically-confirmed and possible cases. As of 3 March 2021, there were 774,344 cases and 22,141 deaths. But the CFR that would be obtained by dividing 22,141 by 774,344 (2.9%) is biased due to different inclusion criteria in the numerator and denominator. Hence we included only laboratory-confirmed deaths in the CFR calculation.

Also, as stressed by WHO, attempts to determine lethality in a population by a single measure will not take into account the underlying heterogeneities of different risk groups and the significant bias due to their different distribution within and between different populations. Therefore, efforts should be made to calculate risk group-specific estimates in order to better describe the true patterns of lethality in a population.

4.2.1. Estimation of the CFR by age and sex

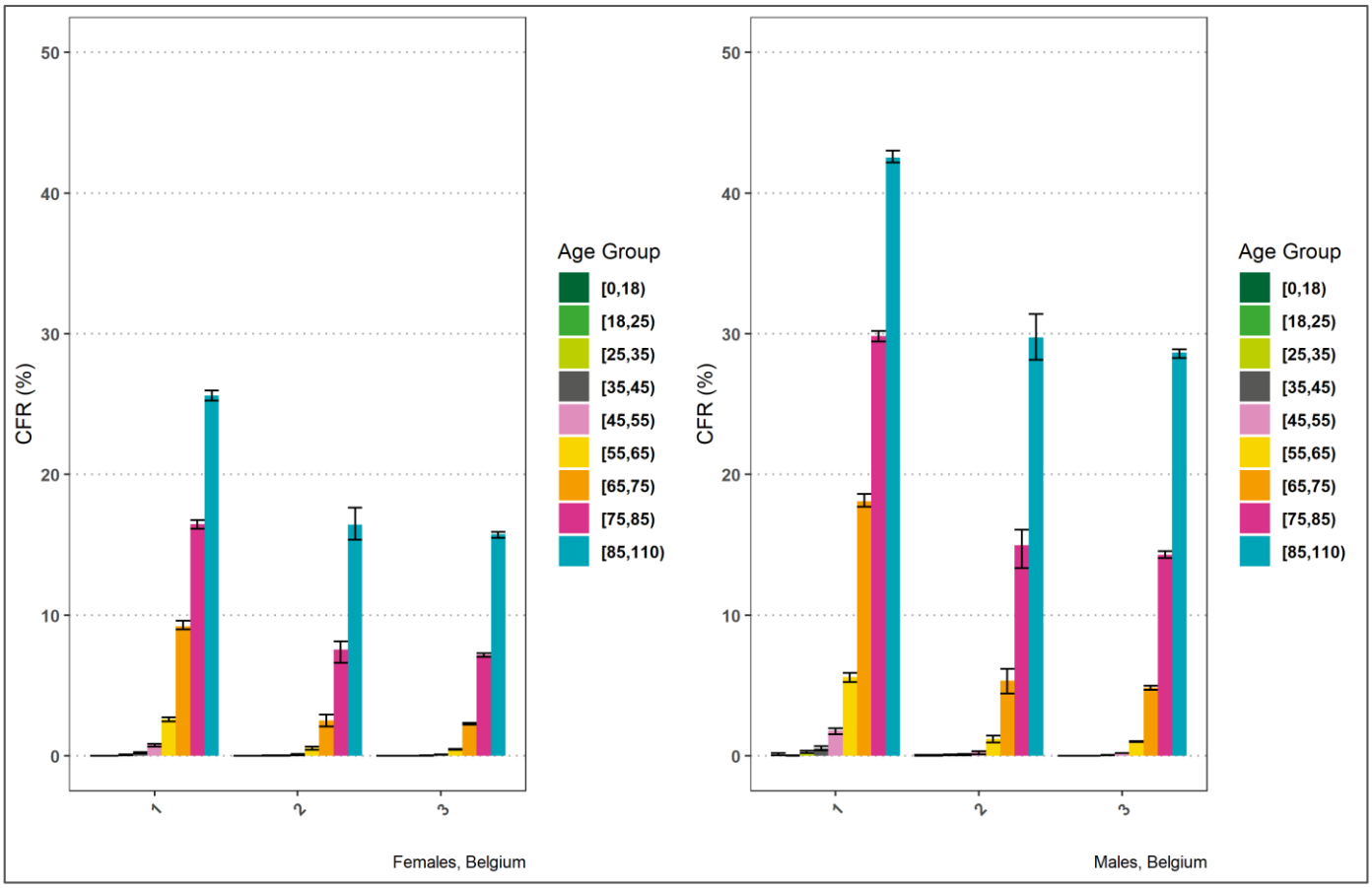
A higher age and male sex are associated with a higher probability of dying from COVID-19 (Figure 20). Over the age of 45 years, this probability varied between 0.1% and 26% for women, and between 0.2% and 43% for men, depending on the age category and the period of the epidemic. For people under 45, the CFRs were less than 1% because there were very few deaths in this age category (n= 51 deaths).

CFRs were generally higher during the first wave for each sex. In the first wave, the age-specific CFR for women ranged from 0.8% (for the 45-55 age group) to 26% (in the age group 85 years and over); for men, the CFR varied from 2% (for age 45-55 age group) to 43% (in the age group 85 years and over).

In the second wave, for women the CFR varied between about 0.1% (for the 45-55 age group) and 16% (from 85 years old); for men, the CFR was about 0.2% (for the 45-55 age group) and 29% from 85 years old.

The CFR was higher when the case incidence was high and was artifactually higher at the start of the epidemic in Belgium when testing was limited. CFR results should be interpreted with caution for two reasons: only seriously ill and hospitalized people were included in the cases because they could be tested during the first weeks of the first wave, and NH residents who mostly died due to COVID-19 without laboratory testing were not included in the cases or deaths.

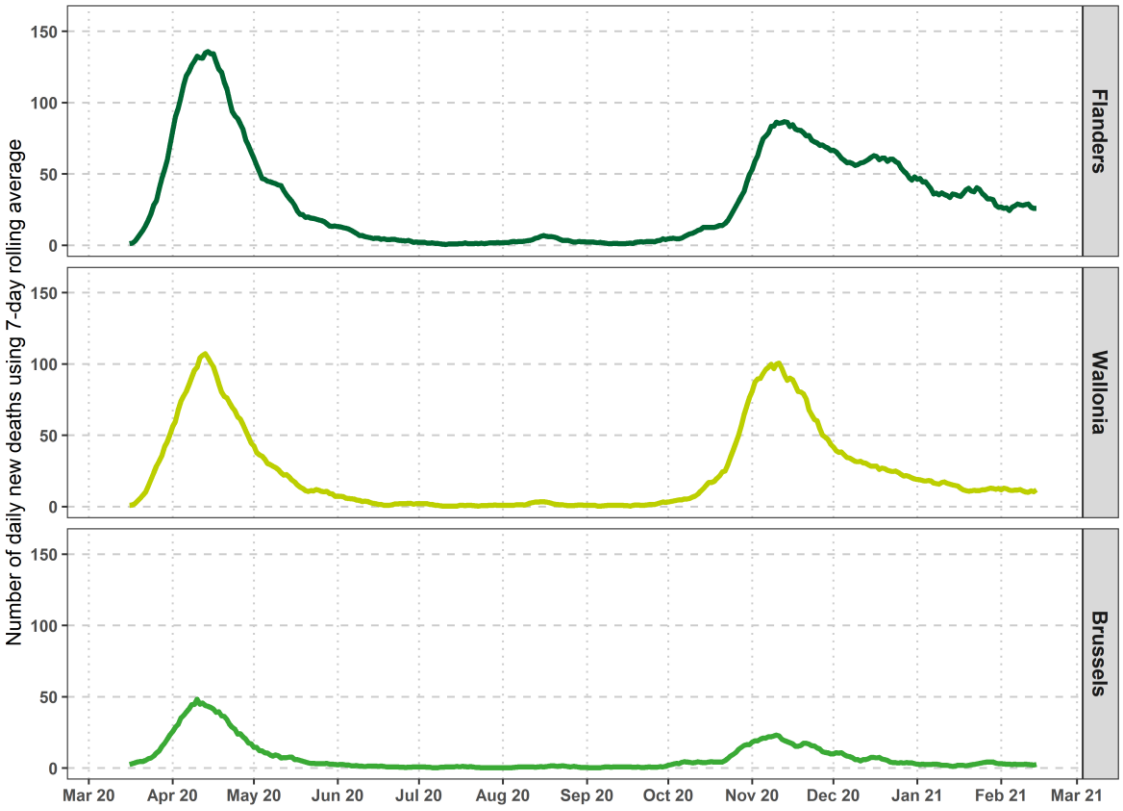
Figure 20. COVID-19 CFR and 95% credibility intervals, laboratory-confirmed cases and laboratory-confirmed deaths, by age group, by period of the epidemic (1 = wave 1, 2 = inter wave, 3 = wave 2) for females (left) and males (right), Belgium, March 2020 - February 2021



4.3. THE VELOCITY AT WHICH THE NUMBER OF COVID-19 DEATHS INCREASED AND DECREASED DURING THE DIFFERENT WAVES OF THE EPIDEMIC

The curve of COVID-19 deaths in the first wave had a high peak, was steep and skewed slightly to the right, while the second wave had a broader base and, above all, a much slower decline (see Figures 2 and 21).

Figure 21. **Figure 21 • Number of daily new COVID-19 deaths in Belgium (using 7-day rolling average) by region, March 2020 - February 2021**



4.3.1. Comparison of the increase of COVID-19 deaths

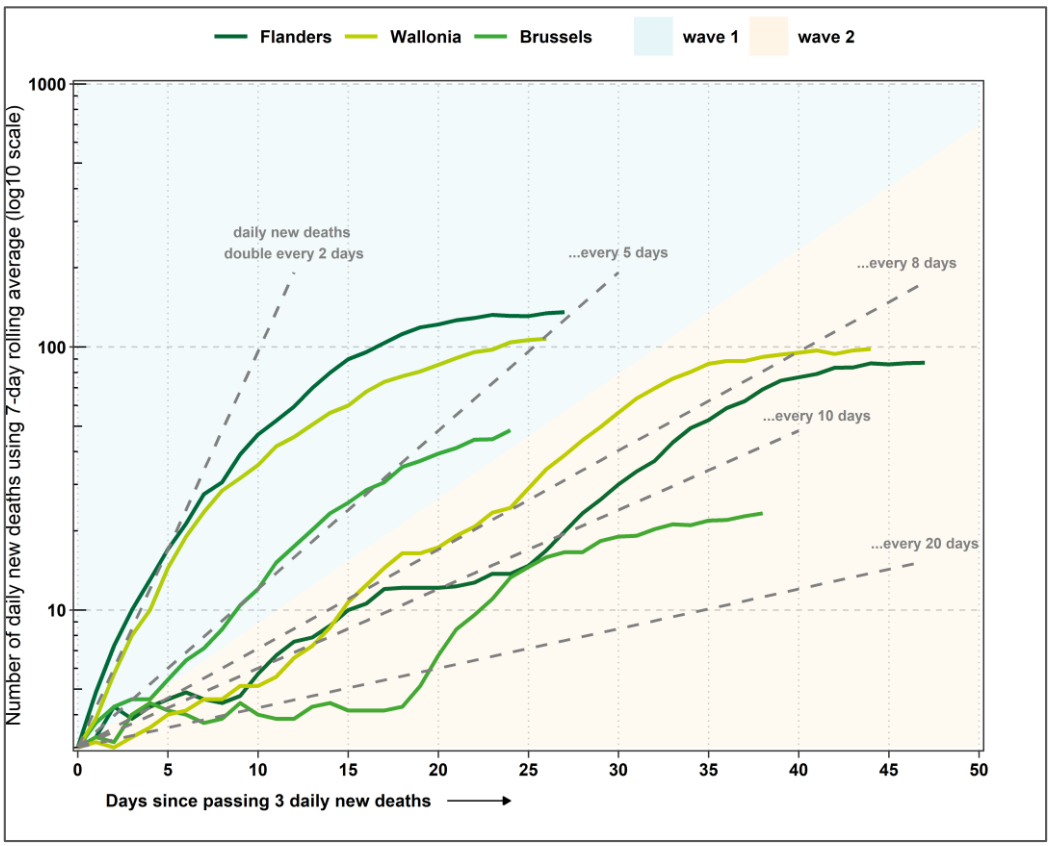
Only the increasing parts, starting on the day at which three daily new COVID-19 deaths were surpassed, of both waves are presented (Figure 22). The corresponding start and end dates per region and wave are:

- Flanders: 18 March to 14 April 2020 (wave 1) & 27 September to 13 November 2020 (wave 2)
- Wallonia: 18 March to 13 April 2020 (wave 1) & 28 September to 11 November 2020 (wave 2)
- Brussels: 17 March to 10 April 2020 (wave 1) & 3 October to 10 November 2020 (wave 2)

For the first wave the growth of the number of daily new COVID-19 deaths was higher for all regions compared to the second wave. The time it took to reach the peaks was smaller and the peaks themselves were higher for the first wave[15]. Initially, the time it took for the daily new deaths to double in Flanders and Wallonia was only about two days. Brussels started off a little bit slower. However, overall, the growth of deaths has been continuously declining in the first wave, in contrast to the second wave where the concavity changed drastically.

For the second wave, slower starts were observed for all regions, especially Brussels appeared to stagnate for a few weeks before a rapid increase occurred. Growths started to become comparable to the first wave from approximately 25 days after passing three daily new deaths.

Figure 22. **Number of daily new COVID-19 deaths in Belgium, for the increasing part of the wave (using 7-day rolling average, logarithmic scale) by region, wave 1 and wave 2**



Note: The grey linear dotted curves indicate the trajectories in case the daily new deaths would double every two days, five days, eight days, etc. Those calculations include laboratory-confirmed, radiologically-confirmed and possible COVID-19 deaths in the general population as well as the nursing home population. The region is the region of residence if known, otherwise the region of death is used.

[15] Peak of the number of daily COVID-19 mortality numbers based on 7-day rolling average by region: for the 1st wave: FLA (136), WAL (107), BXL (48) / and 2nd wave: FLA (87), WAL (101), BXL (23).

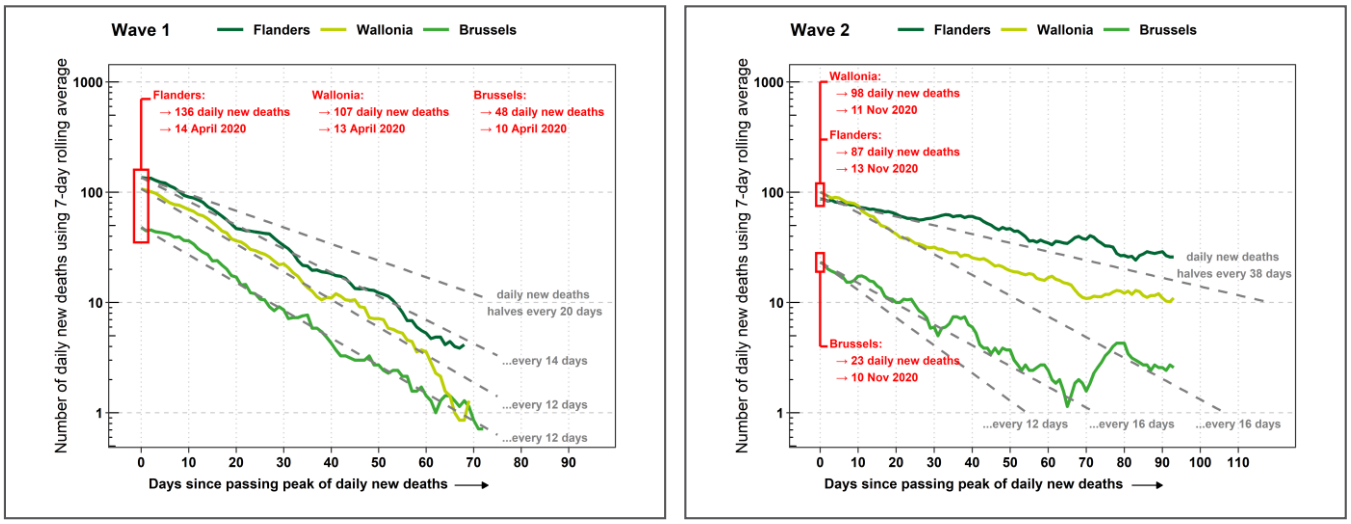
4.3.2. Comparison of the decrease of COVID-19 deaths

A similar approach is used for the decreasing parts of the waves. The corresponding start and end dates per region and wave are:

- Flanders: 14 April to 21 June 2020 (wave 1) & 13 November 2020 to 14 February 2021 (wave 2)
- Wallonia: 13 April to 21 June 2020 (wave 1) & 11 November 2020 to 14 February 2021 (wave 2)
- Brussels: 10 April to 21 June 2020 (wave 1) & 10 November 2020 to 14 February 2021 (wave 2)

Figure 23 shows a slower decrease for all regions during the second wave than the first, especially in Flanders and from onwards 25 days since passing the peak of daily new deaths in Wallonia.

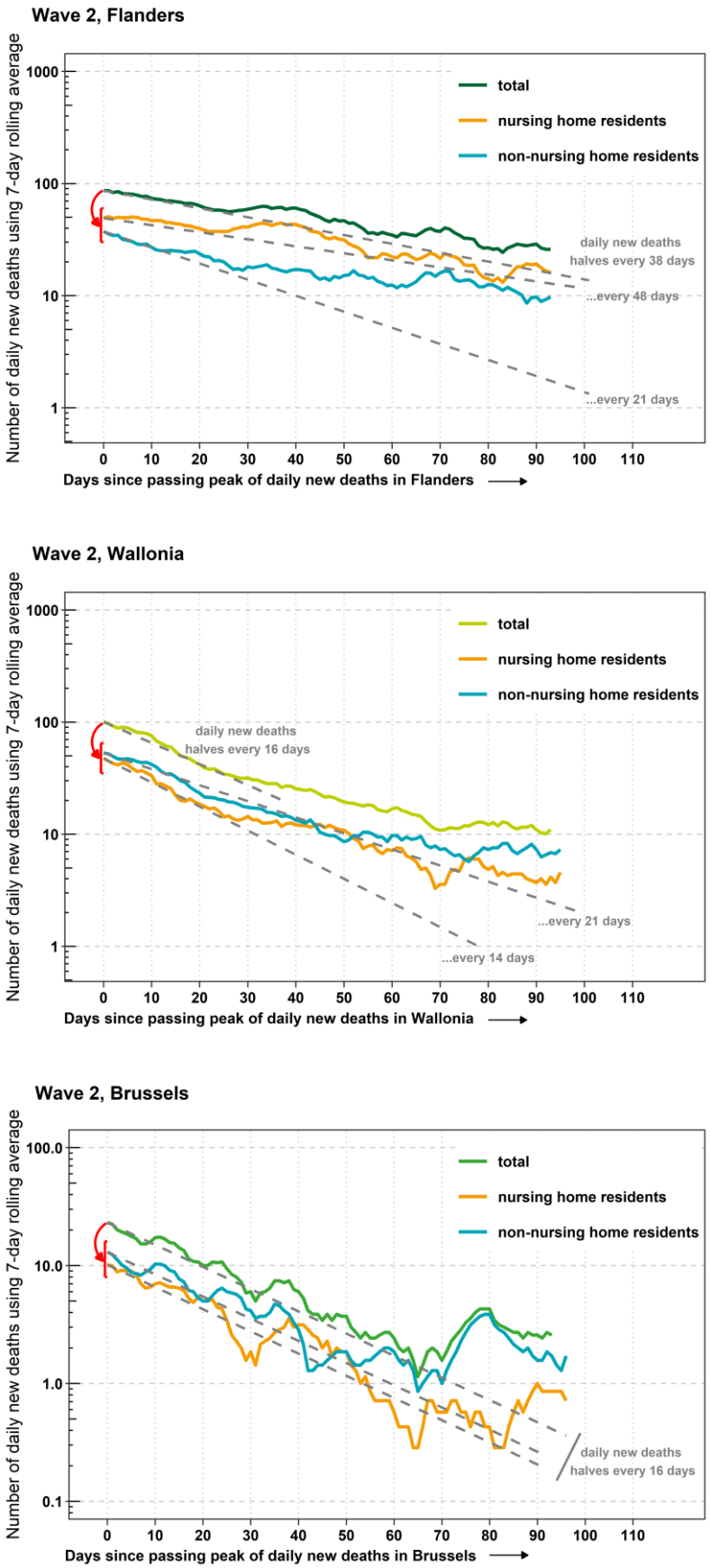
Figure 23. **Figure 23 • Number of daily new COVID-19 deaths in Belgium, for the decreasing part of the wave (using 7-day rolling average, logarithmic scale) by region, wave 1 and wave 2.**



Note: The grey linear curves indicate the trajectories in case the daily new deaths would halve every twenty days, fourteen days, twelve days, etc.

Although further investigation is needed, a possible explanation for this overall slow decrease in Flanders, as compared to Wallonia and Brussels, is plotted below by presenting COVID-19 deaths among NH and non-NH residents separately (Figure 24). In Flanders a very slow decrease in daily deaths among NH residents is observed during the whole decreasing part, whereas in Wallonia and Brussels, this decrease happens overall a lot faster.

Figure 24. Number of daily new COVID-19 deaths, for the decreasing part (using 7-day rolling average, logarithmic scale) in Flanders, Wallonia and Brussels, split up according to nursing home residents versus non-nursing home residents, wave 2



5. INTERNATIONAL COMPARISON OF COVID-19 MORTALITY

Comparing the COVID-19 mortality surveillance data reported by each country can be very misleading because of the heterogeneous methods used (e.g. case definition, testing and screening strategy, reporting method, availability of specific surveillance in NHs, etc.) and because, especially at the beginning of the epidemic, countries still needed to optimize access to testing.

INED France mentions seven data-related key issues that limit those premature international comparisons (6). Before any international comparison of COVID-19 mortality rates, we should answer the following methodological questions: 1) What was the time lag between the occurrence of death and its publication?, 2) What was the coverage of different places of death?, 3) What were the criteria for attributing the cause of death to COVID-19?, 4) What was the start date of the epidemic?, 5) What was the magnitude and dynamics of the death curve?, 6) Was it the whole country or individual regions that were facing the epidemic? and 7) What was the age and gender structure of the population? Finally, these criteria may also have changed over time within the same country. Differences in country methods for COVID-19 mortality data collection should be better communicated.

Excess mortality rate[16] is a more reliable indicator to gauge the severity of the pandemic. It is a crude tool to draw direct preliminary conclusions between countries (7). But it also relies on accurate, timely reporting of deaths (limited by using underdeveloped registration systems).

Eventually, a better comparison will be possible when countries have finished analysing the official death certificates.

[16] Comparison of expected deaths with actual deaths as a proportion of the country's population.

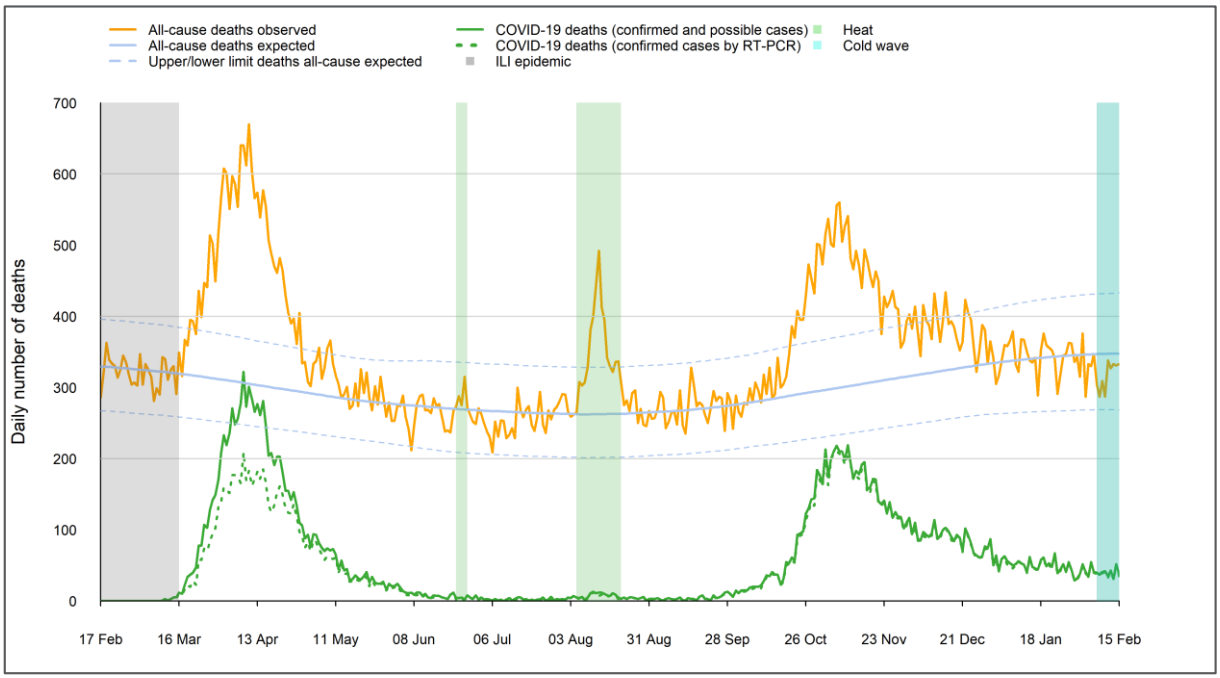
6. THE LINK BETWEEN ALL-CAUSE MORTALITY AND COVID-19 MORTALITY DATA

The all-cause mortality data are provided by the National Register. This data is used, inter alia in the project Be-MOMO in Sciensano (Belgian Mortality Monitoring, https://epistat.wiv-isp.be/momo/). Be-MOMO is designed to serve as a tool for early detection and quantification of unusual mortality and to assess health threats to public health in Belgium.

The COVID-19 mortality data were strongly correlated with excess mortality during the first two waves of the epidemic (8). All-cause mortality was a key indicator to evaluate the COVID-19 mortality surveillance for completeness of the COVID-19 mortality data and to confirm the high mortality figures in Belgium being realistic (9). This good correlation was largely due to the availability of data concerning deaths occurring in NHs and the inclusion of deaths from possible COVID-19 cases (mainly NH residents) at the beginning of the epidemic. The graphical juxtaposition of the data of both surveillances illustrates their concordance (Figure 25).

For a more in-depth description of the excess mortality during the first and second waves of the COVID-19 epidemic in Belgium and in comparison with history, see the report on excess mortality by *Bustos Sierra et. al, 2021* (8) .

Figure 25. All-cause mortality and COVID-19 mortality in Belgium, February 2020 to February 2021



Note: How to read this graph? When the number of all-cause deaths per day (orange line) exceeds the upper or lower limits of deaths predicted by the modelling (light blue dashed lines), there is a statistically significant excess or under-mortality.

7. ACKNOWLEDGMENTS

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We hope that this report will add value to their work.

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We would also like to reflect on the fact that behind these epidemiological figures there are human beings. All scientists of the COVID-19 surveillance express their deepest sympathy to all the families bereaved by the loss a loved one due to this epidemic.

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