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Impact of comorbidities on the risk of death and hospitalization among confirmed cases of COVID-19 during the first months of the pandemic in Québec

Québec

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Bureau d'information et d'études en santé des populations
Direction des risques biologiques et santé au travail

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Highlights

- Of the confirmed cases of COVID-19 from February to July 2020, nearly 55% of those affected had at least one pre-existing medical condition, compared to 40% in the general population.
  - Among deceased cases, there was a pre-existing medical condition in 97% of cases. Of those who were hospitalized, 87% had a pre-existing medical condition.
- Fourteen comorbidities were identified as having an impact on the risk of death and 17 on the risk of hospitalization. The most prevalent comorbidities include: cardiovascular diseases, respiratory diseases, diabetes and anaemia.
- The number of comorbidities has an impact on the risk of death and hospitalization in confirmed cases of COVID-19.
- The impact of the number of comorbidities varies according to age and living environment.
  - In a confirmed case of COVID-19 under 60 years of age living at home and with only one comorbidity, the risk of death is five times higher than for someone of the same age with no comorbidities. Excess risk decreases with age.
  - The number of comorbidities has a small impact on death among individuals aged 80 and over residing in long-term care facilities, known in Québec as “centre d’hébergement et de soins de longue durée” (CHSLDs), or private seniors’ residences, known in Québec as “résidence privée pour aînés” (RPAs).

Introduction

During the first months of the pandemic, the SARS-CoV-2 virus infected more than 50,000 people in Québec, with more than 6,000 of them requiring hospitalization and more than 5,000 of the cases resulting in death. The identification of risk factors associated with increased severity of COVID-19 was quickly identified as a research priority in countries affected by the pandemic. The presence of pre-existing medical conditions in COVID-19 cases was soon identified as a risk factor for complications that could lead to death (Guan et al., 2020; Reilev et al., 2020; Williamson et al., 2020). Quickly, the COVID-19 surveillance and monitoring team at the Institut national de santé publique du Québec was able to document pre-existing medical conditions for all cases of COVID-19 confirmed by a laboratory or epidemiological link in Québec.

Several studies conducted primarily in Asia identified that several chronic diseases including hypertension, respiratory disorders, cardiovascular diseases and autoimmune diseases appear to be associated with an increasing risk of death or hospitalization in people with COVID-19 (Guan, 2020; Liang, 2020; Reilev, 2020; Sun, 2020; Williamson, 2020; Zeng, 2020). Currently, no studies assessing the impact of pre-existing conditions have been conducted in Québec.

Identification of comorbidities associated with death or hospitalization in cases of COVID-19 in Québec will make it possible to identify subgroups of the population where the application of infection prevention or control measures (including vaccination) would be more beneficial in limiting the burden and complications associated with COVID-19.

Objectives

This report aims to quantify the effect of comorbidities on the risk of death in confirmed COVID-19 cases. Specifically, its objectives are: 1) to identify comorbidities associated with the risk of death; 2) to evaluate the impact of the number of comorbidities on the risk of death according to living environment and age. In a secondary analysis, we looked at the impact of comorbidities on the risk of hospitalization.

Methodology

Study design and data sources

This retrospective population-based cohort study includes confirmed cases of COVID-19 registered in the V10 information system during the first wave of the pandemic, from February 23 to July 11, 2020, with follow-up of death and hospitalizations until July 26, 2020. The V10 file, which includes all cases confirmed by laboratory and by epidemiological link[1] in Québec, was matched using a unique identifier to the Québec Integrated Chronic Disease Surveillance System (QICDSS) to obtain information on pre-existing medical conditions, and to the MED-ECHO preliminary transmission file to obtain information on hospitalizations related to COVID-19. The QICDSS is a registry that includes the main medico-administrative data for almost all (> 99%) of the Quebec population (Blais, 2014).

Complications

For a confirmed case in the V10 file, a date of death is collected if COVID-19 directly or indirectly contributed to the death. This date of death is collected during the epidemiological investigations of the regional public health departments (known in Québec as Direction de santé publique [DSP]) and validated on the basis of the forms filled in by the doctors at the time of death. An individual is considered hospitalized in relation to COVID-19 if at least one hospital stay of at least one day with the COVID-19 diagnostic code (Canadian coding standard for the International Statistical Classification of Diseases and Health Related Problems, Tenth Revision [ICD-10-CA] diagnosis code: U07.1 version) is recorded in the preliminary transmission of the MED-ECHO file. Hospital stays whose primary purpose is psychiatry, rehabilitation, accommodation or long-term care are excluded.

Pre-existing medical conditions

A total of 21 pre-existing conditions (including chronic diseases, their risk factors or symptoms, see Table 1) are identified from the diagnostic codes entered in the QICDSS. These conditions include potential risk factors for complications in individuals with COVID-19 (Wiliamson, 2020) or other respiratory infections such as influenza (Mertz, 2013). A person is considered to have a medical condition if, between April 1, 2009 and March 31, 2019, at least one diagnostic code (primary or secondary) is recorded in the hospitalization file (MED-ECHO) or at least two diagnostic codes are recorded in the fee-for-service medical services file within two years, with at least 30 days between each diagnostic code (Simard, 2018; Simard, 2019). For cancer, depression, alcohol and drug abuse, search of diagnosis codes took place from April, 2014 to March 31, 2019.

[1] A case confirmed by epidemiological link represents a person who developed compatible symptoms after having had high-risk exposure to a laboratory-confirmed case.

Covariates

Other variables included in the analyses are living environment, age, sex and the material and social deprivation indices. The living environment, age and sex are taken from V10 and the deprivation index from the QICDSS. The living environment is grouped into four categories: home, private seniors' residences (known in Québec as "résidence privée pour aînés" [RPAs]), residential and long-term care centres (known in Québec as "centre d'hébergement et de soins de longue durée" [CHSLDs]) and hospital centres, other/unknown. The age is calculated on the date of reporting a case that corresponds to: 1) the date of receipt of the report at the DSP, 2) otherwise the date of the start of the investigation, 3) otherwise the date of entry in the V10. The material and social deprivation indices are assigned from the 2016 census data according to the postal code of the place of residence (Pampalon, 2003). Material deprivation includes information on income, education and employment status. Social deprivation includes information on the proportions of people living alone, single-parent families and people who are separated, divorced or widowed.

Statistical analyses

The distribution of pre-existing medical conditions and covariates was calculated for all cases included in the cohort and by death status. Comorbidities associated with the risk of death were identified by modelling the risk of developing the complication for each of the pre-existing medical conditions. Thus, for each pre-existing condition, the relative risks adjusted for the other conditions and other covariates were calculated for the whole cohort and for each living environment and by age group. A pre-existing condition associated with an increased risk of death (as measured by the adjusted relative risk) in at least one of the living environments or age groups was considered a comorbidity "significantly" associated with death.

The effect of the number of comorbidities on the risk of death was then modelled in each living environment and age group by introducing interaction terms into the regression models. Models are adjusted for other covariates. The relative effect (adjusted relative risk) and the absolute effect (adjusted risk difference) of the number of comorbidities on the risk of death were assessed using these models. The relative effect makes it possible to estimate, for an individual with COVID-19, the multiplicative factor by which his or her expected risk of death increases when he or she has comorbidities compared to an individual without comorbidities. The absolute effect estimates the population burden of comorbidities by estimating the difference between the risk of death in cases with comorbidities and the risk of death in cases without comorbidities.

The regression model used in all analyses is a Poisson regression model with a robust variance estimator. This model estimates both relative risks and differences in risk. Analyses were performed with SAS using a 5% significance level.

Finally, similar analyses were replicated by considering hospitalization as a complication.

Results

Study population

In the study cohort of 51,880 confirmed COVID-19 cases in Québec from February 23 to July 11, 2020, 56% had at least one pre-existing medical condition (Table 1) and this proportion increases with age (Table 2). The mean age of cases was 54 years (median age 52 years) and 60% were women (Table 1). This cohort includes 92% of the 56,566 cases confirmed during the study period. The most prevalent medical conditions among confirmed cases of COVID-19 are hypertension, cardiovascular diseases, neurological disorders, anaemia, respiratory diseases and diabetes.

Deaths

Deaths occur mainly among individuals aged 70 and over (Figure 1). While one-quarter of the cases resided in CHSLD or RPA facilities, more than 80% of the 5,543 deaths related to COVID-19 occurred in people residing in CHSLD or RPA facilities (Table 1). The deceased were older (mean age 85 years, median age 86 years) and had more pre-existing medical conditions (97% had at least one condition and 88% had at least two) than those who survived (mean age of those who survived is 50 years, median age 49 years, and 47% had at least one condition).

Table 1 Description of confirmed COVID-19 cases from February 23 to July 11, 2020 in Québec by death status (n = 51,880) and comparison with Québec as a whole

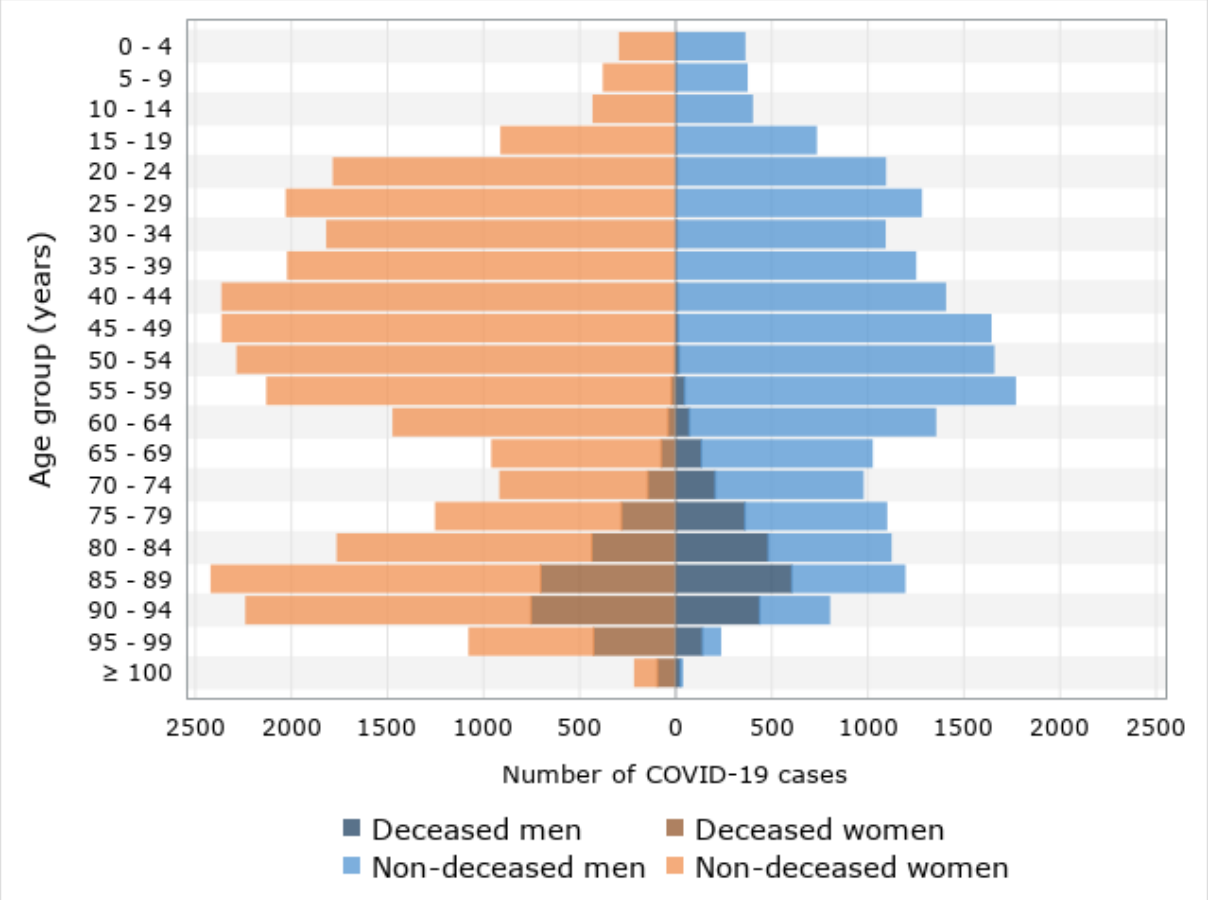
Variables	Deceased (n = 5,543)		Not deceased (n = 46,337)		Total (n = 51,880)		All of Québec (2018) (n = 8,393,536)
	n	(%)	n	(%)	n	(%)	(%)
Age - mean (standard deviation)	84.5	(13.3)	50.0	(10.8)	53.7	(10.8)	42.2 (23.6)
Age group							
0–59 years	122	(2.2)	31,660	(68.3)	31,782	(61.3)	(72.9)
60–69 years	321	(5.8)	4,475	(9.7)	4,796	(9.2)	(13.3)
70–79 years	996	(18)	3,234	(7.0)	4,230	(8.2)	(8.7)
80–89 years	2,226	(40.2)	4,260	(9.2)	6,486	(12.5)	(4.0)
≥ 90 years	1,878	(33.9)	2,708	(5.8)	4,586	(8.8)	(1.1)
Sex							
Women	3,059	(55.2)	28,092	(60.6)	31,151	(60.0)	(50.5)
Men	2,484	(44.8)	18,245	(39.4)	20,729	(40.0)	(49.5)
Living environment							
At home	709	(12.8)	36,792	(79.4)	37,501	(72.3)	n/a
CHSLD	3,654	(65.9)	5,592	(12.1)	9,246	(17.8)	Nd
RPA	931	(16.8)	2,785	(6.0)	3,716	(7.2)	n/a
Other/unknown	249	(4.5)	1,168	(2.5)	1,417	(2.7)	n/a
Number of medical conditions							
0	189	(3.4)	24,437	(52.7)	22,867	(44.1)	(60.3)
1	478	(8.6)	9,266	(20.0)	10,284	(19.8)	(21.2)
2	706	(12.7)	4,292	(9.3)	5,358	(10.3)	(8.7)
3	763	(13.8)	2,658	(5.7)	3,431	(6.6)	(4.1)
4+	3,407	(61.5)	5,684	(12.3)	9,940	(19.2)	(5.7)
Medical conditions							
Hypertension	4,034	(72.8)	11,168	(24.1)	15,202	(29.3)	(15.8)
Cardiovascular diseases	3,108	(56.1)	6,491	(14.0)	9,599	(18.5)	(8.2)
Neurological disorder	2,247	(40.5)	6,099	(13.2)	9,395	(18.1)	(3.1)
Anaemia	2,165	(39.1)	5,420	(11.7)	7,585	(14.6)	(5.2)
Respiratory diseases	1,686	(30.4)	5,574	(12.0)	7,260	(14.0)	(9.8)
Diabetes	1,930	(34.8)	5,285	(11.4)	7,215	(13.9)	(7.1)
Hypothyroidism	1,213	(21.9)	3,689	(8.0)	4,902	(9.4)	(4.9)
Depression	718	(13.0)	4,041	(8.7)	4,759	(9.2)	(6.1)
Fluid and electrolyte disorders	1,312	(23.7)	2,528	(5.5)	3,840	(7.4)	(2.5)
Cancer	879	(15.9)	2,527	(5.5)	3,406	(6.6)	(5.2)
Kidney disease	1,329	(24.0)	1,976	(4.3)	3,305	(6.4)	(2.0)
Obesity	557	(10.0)	2,397	(5.2)	2,954	(5.7)	(2.9)
Psychosis	666	(12.0)	1,664	(3.6)	2,330	(4.5)	(1.2)
Liver disease	356	(6.4)	1,232	(2.7)	1,588	(3.1)	(1.5)
Immune system problem	315	(5.7)	1,125	(2.4)	1,440	(2.8)	(1.8)
Coagulopathy	418	(7.5)	979	(2.1)	1,397	(2.7)	(1.1)
Weight loss	475	(8.6)	887	(1.9)	1,362	(2.6)	(0.8)
Paralysis	410	(7.4)	950	(2.1)	1,360	(2.6)	(0.6)
Alcohol abuse	171	(3.1)	584	(1.3)	755	(1.5)	(0.8)
Ulcer	177	(3.2)	398	(0.9)	575	(1.1)	(0.4)
Drug abuse	66	(1.2)	399	(0.9)	465	(0.9)	(0.7)
Hospitalization	1,745	(27.8)	4,539	(9.8)	6,284	(12.1)	n/a

CHSLD: Long-term care or nursing facilities; n/a: not available; RPA: private seniors' residences.

Table 2 **Distribution of confirmed COVID-19 cases by age group according to the number of pre-existing medical conditions (n = 51,880)**

Number of conditions	0–49 years		50–59 years		60–69 years		70–79 years		80–89 years		≥ 90 years	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
0	17,142	(71.6)	3,653	(46.7)	1,340	(27.9)	360	(8.5)	229	(3.5)	143	(3.1)
1	4,756	(19.9)	2,330	(29.8)	1,367	(28.5)	700	(16.5)	739	(11.5)	392	(8.6)
2	1,344	(5.6)	990	(12.7)	772	(16.1)	675	(16.0)	923	(14.2)	654	(14.2)
3	418	(1.7)	393	(5.0)	417	(8.7)	556	(13.1)	956	(14.7)	691	(15.1)
≥4	295	(1.1)	461	(5.8)	900	(18.8)	1,939	(45.9)	3,639	(56.1)	2,706	(59.0)
Total	23,955		7,827		4,796		4,230		6,486		4,586	

Figure 1 **Distribution of the 5,543 deaths observed between February 23 and July 11, 2020 in Québec among confirmed COVID-19 cases by age group and sex (n = 51,880)**



Comorbidities associated with death

Among the 21 medical conditions considered, 14 comorbidities were associated with an excess risk of death in confirmed COVID-19 cases (Table 3). These 14 comorbidities are associated with an excess risk of death among confirmed COVID-19 cases in at least one living environment or at least one age group (Table A.1). It can be noted that, by living environment or age group, the excess risk is generally comparable among the comorbidities "significantly" associated with death (Table A.1). This is an indication that each of these comorbidities has a similar impact on the risk of death. The number of comorbidities then makes it possible to fully understand the impact of comorbidities on the risk of death.

Table 3 List of comorbidities associated with death in confirmed COVID-19 cases

Comorbidities associated with death	
Anaemia	Liver diseases
Cancer	Kidney disease
Coagulopathy	Respiratory diseases
Diabetes	Obesity
Hypertension	Psychosis
Hypothyroidism	Fluid and electrolyte disorders
Cardiovascular diseases	Neurological disorders

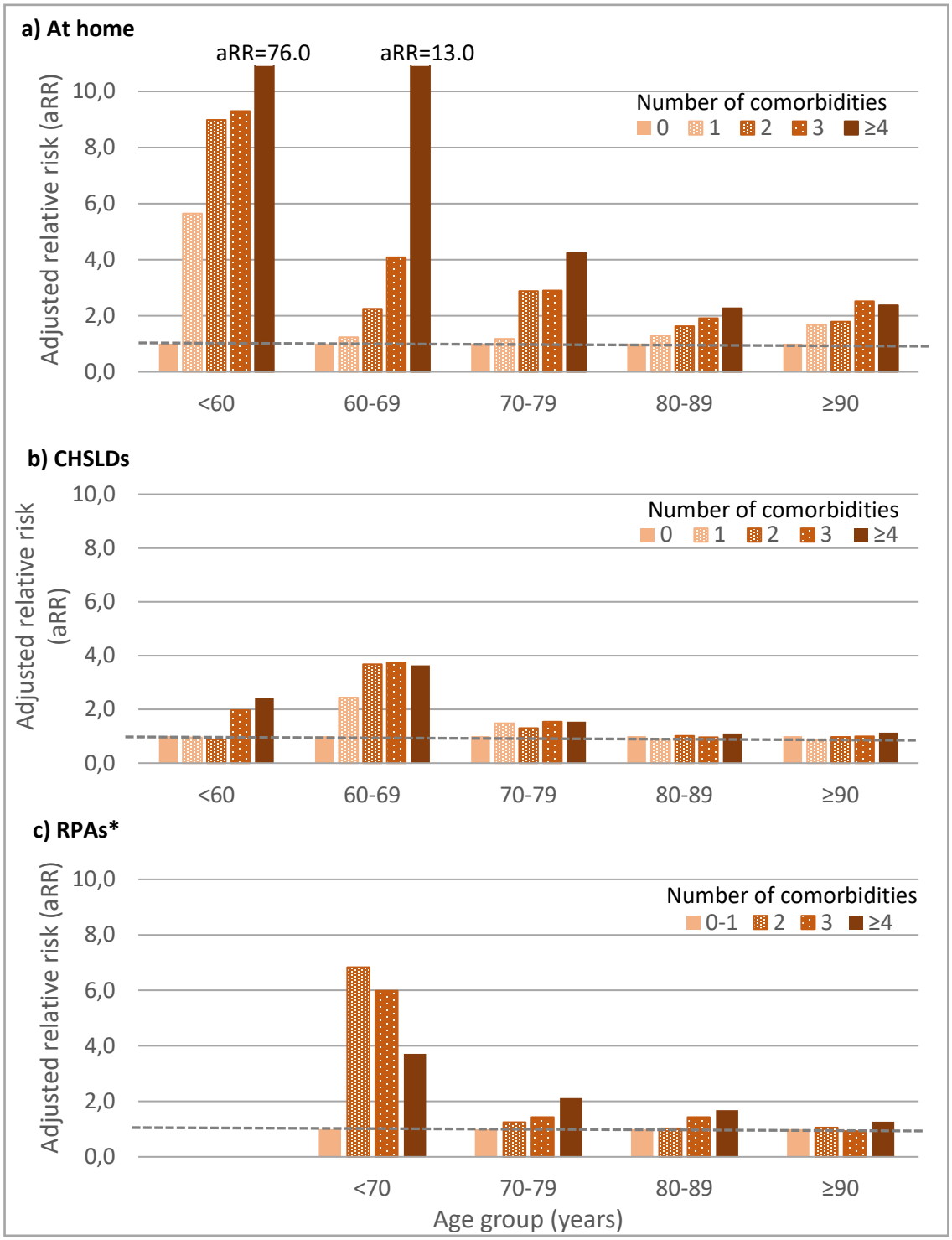
Association between number of comorbidities and relative risk of death

The relative effect between the number of comorbidities and death varies according to age and living environment. For this reason, the results are stratified by living environment and age group.

Among confirmed cases of COVID-19 for people living at home, the relative effect of the number of comorbidities varies significantly with age. The effect of comorbidities increases for each additional comorbidity and this impact is higher in those under 70 years of age (Figure 2). In individuals under 60 years of age, a single comorbidity increases the risk of death by a factor of 5 (adjusted RR: 5.54; 95% confidence interval [CI] [2.82–10.8]), and four or more comorbidities increases the risk by a factor of 76 (adjusted RR: 76.0; 95% CI [37.3–154.7]) (Table 4). In individuals aged 60 and over, the presence of a single comorbidity has little effect on the risk of death. Among individuals aged 60 to 69, those with four or more comorbidities were 13 times more likely to die than those without comorbidities (adjusted RR: 13.0; 95% CI [7.34–23.0]). In individuals aged 70–79 and 80–89 years, the risks of death are 4 times and 2 times higher, respectively, in those with four or more comorbidities compared to those without comorbidities. The risk of death increases very rapidly with age in people without identified comorbidities: compared with people under 60 years of age, the risk of death is 17 times greater in those aged 60–69 years (95% CI [8.2–35.0]), 87 times greater in those aged 70–79 years (95% CI [41.5-183.2]), 216 times greater in those aged 80–89 years (95% CI [90.9–506.3]) and 230 times greater in those aged 90 years and older (95% CI [58.6–906.3]) (results not shown).

Among confirmed COVID-19 cases residing in CHSLDs and RPAs, the variation in the effect of the number of comorbidities on the risk of death by age is less significant than for individuals living at home (Figure 2, Tables 5 and 6). Among individuals under 70 years of age residing in CHSLDs, those with four or more comorbidities are two to four times more likely to die than those without comorbidities (< 60 years: adjusted RR 2.32; 95% CI [0.93–5.79]; 60–69 years: adjusted RR 3.63; 95% CI [1.39–9.47]) (Table 5). In individuals aged 70 years and over residing in CHSLDs, the effect of the number of comorbidities is weak or absent (adjusted RR vary between 0.86 and 1.52 in these age groups).

Figure 2 **Impact of the number of comorbidities on the adjusted relative risk of death among confirmed COVID-19 cases by age group and living environment (n = 51,880)**



aRR: adjusted relative risk; CHSLD: Long-term care or nursing facilities; RPA: private seniors' residences
Relative risk adjusted for deprivation and sex.

* Categories one and zero comorbidity had to be grouped together in order to achieve a sufficient number of observations in the analyses.

Association between number of comorbidities and absolute risk of death

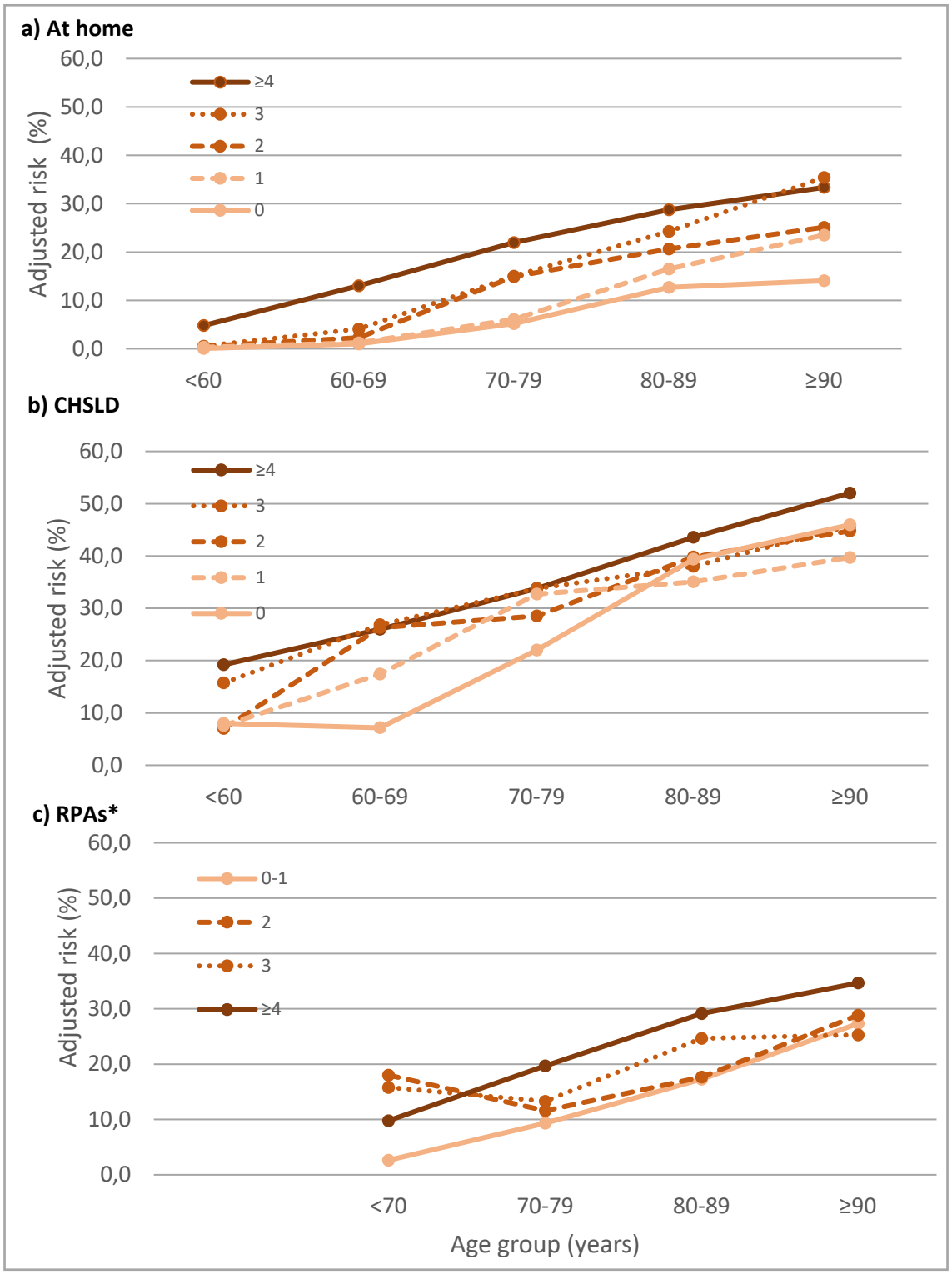
The adjusted risks of mortality for confirmed COVID-19 cases by number of comorbidities and age group are presented in Figure 3 for each living environment. Adjusted risk increases with the number of pre-existing medical conditions and age in all living environments. In each of the age groups, the adjusted mortality risk is higher for confirmed cases residing in CHSLDs or RPAs compared to those living at home.

Among the confirmed cases of COVID-19 in people living at home, the adjusted risk difference between individuals with four or more comorbidities and those without comorbidities increases with increasing age (Figure 3 and Table 4). For individuals under 60 years of age, the adjusted risk ranged from 0.1% for those with no comorbidities to 4.6% for those with four or more comorbidities, corresponding to an adjusted risk difference of 4.6 percentage points (95% CI: 2.3–6.8). The adjusted risk difference increases to 19.2 percentage points (95% CI: -0.3–38.8) among individuals aged 90 years and older. The results for the relative effect of comorbidities on the risk of death (relative risks decrease with age) and those for the absolute effect (risk differences increase with age) may appear contradictory. However, this is because the risk of mortality in individuals without comorbidity (which serves as the reference category in both measures) varies with age.

Among the confirmed cases of COVID-19 for people residing in CHSLDs, the adjusted risk difference between individuals with four or more comorbidities and those without comorbidities is higher among those under 80 years of age (Figure 3 and Table 5). Risk differences range from 10.9 to 18.8 percentage points for those under 80 years of age (under 60 years of age: 10.9%; 95% CI [1.3–20.6], 60–69 years of age: 18.8%; 95% CI [10.8–26.9]). The risk difference is not statistically significant in those 80 years of age or older.

Among the confirmed cases of COVID-19 for people residing in RPAs, the risk difference between individuals with four or more comorbidities and those with one or less comorbidity varies little by age (Figure 3 and Table 6). The adjusted risk differences are between 7.1 and 11.8 percentage points (under 70 years: 7.1%; 95% CI [-0.3–14.5], 80–89 years: 11.8%; 95% CI [6.6–17.0]).

Figure 3 **Impact of the number of comorbidities on the adjusted risk of death among confirmed COVID-19 cases by age group and living environment (n = 51,880)**



CHSLD: Long-term care or nursing facilities; RPA: private seniors' residences

Risk adjusted for deprivation and sex.

* Categories one and zero comorbidity had to be grouped together in order to achieve a sufficient number of observations in the analyses.

Table 4 Risk of death among confirmed cases of COVID-19 for people living at home by number of comorbidities associated with death by age group (n = 37,501)

Age	Number of comorbidites	Frequency		Adjusted risk*		Adjusted risk difference*		Adjusted relative risk*	
		Deceased	Non-deceased	%	95% CI	%	95% CI	aRR	95% CI
< 60 years	0	14	22,105	0.1	(0.0 - 0.1)			1.00	
	1	21	6,227	0.3	(0.2 - 0.5)	0.3	(0.1 - 0.4)	5.54	(2.82 - 10.8)
	2	9	1,724	0.5	(0.3 - 1.0)	0.5	(0.1 - 0.8)	8.67	(3.76 - 20.0)
	3	3	549	0.5	(0.2 - 1.7)	0.5	(-0.1 - 1.1)	8.95	(2.58 - 31.0)
	4+	16	314	4.6	(2.9 - 7.4)	4.6	(2.3 - 6.8)	76.0	(37.3 - 154.7)
60-69 years	0	15	1,370	1.0	(0.6 - 1.7)			1.00	
	1	16	1,182	1.3	(0.8 - 2.1)	0.2	(-0.6 - 1)	1.23	(0.61 - 2.48)
	2	15	587	2.3	(1.4 - 3.8)	1.3	(0.1 - 2.5)	2.24	(1.10 - 4.56)
	3	13	267	4.2	(2.4 - 7.1)	3.1	(0.9 - 5.4)	4.04	(1.94 - 8.42)
	4+	44	248	13.4	(10.2 - 17.5)	12.4	(8.7 - 16)	13.0	(7.34 - 23.0)
70-79 years	0	13	226	5.3	(3.1 - 9.0)			1.00	
	1	27	364	6.3	(4.4 - 9.1)	1.0	(-2.6 - 4.6)	1.19	(0.63 - 2.27)
	2	51	249	15.3	(11.8 - 19.8)	10.0	(5.2 - 14.8)	2.89	(1.61 - 5.19)
	3	35	170	15.5	(11.4 - 21.0)	10.2	(4.7 - 15.7)	2.92	(1.59 - 5.37)
	4+	96	295	22.0	(18.3 - 26.4)	16.7	(11.9 - 21.6)	4.16	(2.38 - 7.27)
80-89 years	0	7	47	13.0	(6.6 - 25.8)			1.00	
	1	31	144	17.1	(12.4 - 23.5)	4.1	(-6.3 - 14.5)	1.31	(0.62 - 2.79)
	2	41	144	21.3	(16.2 - 27.9)	8.3	(-2.3 - 18.8)	1.63	(0.78 - 3.40)
	3	42	120	24.4	(18.7 - 31.9)	11.4	(0.4 - 22.4)	1.87	(0.90 - 3.89)
	4+	116	258	29.1	(24.9 - 33.9)	16.1	(6.1 - 26.0)	2.23	(1.11 - 4.49)
≥ 90 years	0	2	11	14.0	(3.9 - 49.6)			1.00	
	1	8	31	21.2	(11.7 - 38.2)	7.2	(-14.5 - 28.8)	1.51	(0.38 - 6.09)
	2	10	30	25.1	(14.7 - 42.7)	11.1	(-11.1 - 33.3)	1.79	(0.45 - 7.06)
	3	22	40	35.7	(25.9 - 49.0)	21.7	(0.7 - 42.7)	2.55	(0.69 - 9.39)
	4+	42	90	33.2	(25.8 - 42.7)	19.2	(-0.3 - 38.8)	2.37	(0.65 - 8.61)

95% CI: 95% confidence interval; aRR: Relative risk adjusted for deprivation and sex.

* Adjusted for deprivation and sex.

Table 5 Risk of death among confirmed cases of COVID-19 for people residing in CHSLDs by number of comorbidities associated with death by age group (n = 9,246)

Age	Number of comorbidites	Frequency		Adjusted risk*		Adjusted risk difference*		Adjusted relative risk*	
		Deceased	Non-deceased	%	95% CI	%	95% CI	aRR	95% CI
< 60 years	0	5	48	8.3	(3.6 - 19.2)			1.00	
	1	6	68	7.6	(3.5 - 16.4)	0.0	(-9.8 - 8.4)	0.92	(0.29 - 2.88)
	2	5	58	7.0	(3.0 - 16.4)	-1.2	(-10.4 - 7.9)	0.85	(0.26 - 2.81)
	3	11	51	15.7	(9.1 - 27.2)	7.5	(-3.6 - 18.5)	1.90	(0.70 - 5.19)
	4+	25	94	19.2	(13.5 - 27.3)	10.9	(1.3 - 20.6)	2.32	(0.93 - 5.79)
60-69 years	0	4	48	7.2	(2.8 - 18.4)			1.00	
	1	25	107	17.4	(12.2 - 24.8)	10.3	(1.1 - 19.4)	2.43	(0.89 - 6.67)
	2	34	85	26.5	(20.0 - 35.3)	19.4	(9.3 - 29.5)	3.71	(1.39 - 9.93)
	3	21	52	26.8	(18.7 - 38.4)	19.7	(7.9 - 31.4)	3.75	(1.37 - 10.3)
	4+	98	251	26.0	(22.0 - 30.7)	18.8	(10.8 - 26.9)	3.63	(1.39 - 9.47)
70-79 years	0	21	67	22.3	(15.4 - 32.3)			1.00	
	1	84	160	32.8	(27.7 - 39.0)	10.6	(0.6 - 20.5)	1.47	(0.98 - 2.21)
	2	79	179	28.7	(23.8 - 34.4)	6.4	(-3.4 - 16.1)	1.29	(0.85 - 1.94)
	3	100	176	33.8	(29.0 - 39.4)	11.5	(1.8 - 21.2)	1.52	(1.02 - 2.26)
	4+	337	591	33.8	(31.0 - 36.8)	11.5	(2.8 - 20.2)	1.52	(1.04 - 2.21)
80-89 years	0	44	67	39.4	(31.3 - 49.6)			1.00	
	1	131	239	35.2	(30.8 - 40.3)	-4.2	(-14.4 - 6.1)	0.89	(0.69 - 1.17)
	2	191	283	40.0	(35.8 - 44.6)	0.6	(-9.5 - 10.7)	1.01	(0.79 - 1.31)
	3	225	346	38.1	(34.4 - 42.1)	-1.3	(-11.1 - 8.5)	0.97	(0.75 - 1.24)
	4+	880	1,116	43.6	(41.5 - 45.7)	4.2	(-5.1 - 13.5)	1.11	(0.87 - 1.40)
≥ 90 years	0	38	49	46.0	(36.1 - 58.4)			1.00	
	1	94	153	39.7	(34.0 - 46.4)	-6.2	(-18.9 - 6.4)	0.86	(0.65 - 1.15)
	2	178	232	44.9	(40.3 - 50.0)	-1.1	(-13.1 - 11.0)	0.98	(0.75 - 1.27)
	3	202	255	45.7	(41.3 - 50.6)	-0.2	(-12.2 - 11.8)	1.00	(0.77 - 1.29)
	4+	816	817	52.1	(49.7 - 54.7)	6.2	(-5.1 - 17.5)	1.13	(0.89 - 1.45)

95% CI: 95% confidence interval; aRR: Relative risk adjusted for deprivation and sex.

* Adjusted for deprivation and sex.

Table 6 Risk of death among confirmed cases of COVID-19 for people residing in private seniors' residences (RPAs) by number of comorbidities associated with death by age group (n = 3,716)

Age	Number of comorbidities*	Frequency		Adjusted risk**		Adjusted risk difference**		Adjusted relative risk**	
		Deceased	Non-deceased	%	95% CI	%	95 % CI	aRR	95% CI
< 70 years	0-1	2	63	2,6	(0,7 - 10,4)			1,00	
	2	6	24	18,0	(8,5 - 38,1)	15,4	(1,4 - 29,4)	6,84	(1,44 - 32,5)
	3	6	26	15,7	(7,8 - 31,7)	13,1	(1,5 - 24,7)	5,97	(1,29 - 27,73)
	4+	8	59	9,8	(5,0 - 18,9)	7,1	(-0,3 - 14,5)	3,71	(0,81 - 16,92)
70–79 years	0-1	14	125	9,5	(5,7 - 15,7)			1,00	
	2	16	110	11,7	(7,4 - 18,5)	2,2	(-4,9 - 9,3)	1,23	(0,63 - 2,42)
	3	13	77	13,4	(8,1 - 22,2)	3,9	(-4,4 - 12,2)	1,41	(0,69 - 2,87)
	4+	68	243	19,7	(15,9 - 24,4)	10,2	(3,9 - 16,5)	2,07	(1,2 - 3,56)
80–89 years	0-1	53	241	17,6	(13,9 - 22,4)			1,00	
	2	51	237	17,5	(13,7 - 22,5)	-0,1	(-6,1 - 6,0)	1,00	(0,71 - 1,40)
	3	74	214	24,8	(20,5 - 30,0)	7,2	(0,9 - 13,5)	1,41	(1,04 - 1,91)
	4+	238	517	29,4	(26,4 - 32,6)	11,8	(6,6 - 17,0)	1,67	(1,29 - 2,16)
≥ 90 years	0-1	45	122	27,4	(21,4 - 35,0)			1,00	
	2	64	164	29,0	(23,6 - 35,5)	1,6	(-7,3 - 10,6)	1,06	(0,77 - 1,46)
	3	52	160	25,0	(19,8 - 31,7)	-2,3	(-11,3 - 6,6)	0,91	(0,65 - 1,29)
	4+	221	403	35,1	(31,6 - 39,0)	7,8	(0,1 - 15,5)	1,28	(0,98 - 1,68)

95% CI: 95% confidence interval; aRR: Relative risk adjusted for deprivation and sex.

* Categories one and zero comorbidity had to be grouped together in order to achieve a sufficient number of observations in the analyses.

** Adjusted for deprivation and sex.

Hospitalizations

Hospitalizations occurred in 12% of cases, mainly among those 70 years of age and older (Figure A.1). More than half (51%) of the 6,284 hospitalizations were observed among people living at home (Table A.2). Among CHSLD residents, 10.2% were hospitalized. Individuals who were hospitalized were older (mean age: 73 years; median age: 77 years) and had more pre-existing medical conditions (87% had at least one condition) than those who were not hospitalized.

Comorbidities associated with hospitalization

Of the 21 medical conditions under consideration, 17 were associated with an excess risk of hospitalization for confirmed COVID-19 cases and include the 14 comorbidities already associated with death (Table 3) plus drug abuse, paralysis and immune system problems (Table 7). These 17 comorbidities are associated with an excess risk of hospitalization for confirmed COVID-19 cases in at least one living environment or at least one age group (Table A.3).

Table 7 List of comorbidities associated with hospitalization in confirmed cases of COVID-19

Comorbidities associated with hospitalization	
Drug abuse	Kidney disease
Anaemia	Respiratory diseases
Cancer	Obesity
Coagulopathy	Paralysis
Diabetes	Immune system problem
Hypertension	Psychosis
Hypothyroidism	Fluid and electrolyte disorders
Cardiovascular diseases	Neurological disorders
Liver diseases	

Association between number of comorbidities and the relative risk of hospitalization

The relative effect of number of comorbidities on the risk of hospitalization varies by age and living environment.

Among the confirmed cases of COVID-19 for people living at home, the relative effect of number of comorbidities on the risk of hospitalization increases for each additional comorbidity and this effect is higher among younger patients (Figure A.2). The relative risks and their confidence intervals are presented in the annex in Table A.4. The risk of hospitalization increases with age in individuals without identified comorbidities: compared with those under 50 years of age, the risk of hospitalization is 4 times greater in those aged 50–59 (95% CI [3.0–4.2]), 6 times greater in those aged 60–69 (95% CI [4.8–7.0]), 15 times greater among 70–79 year olds (95% CI [11.6–18.8]), 28 times greater among 80–89 year olds (95% CI [21.2–38.3]) and 35 times greater among those aged 90 years and older (95% CI [23.3–52.5]) (results not shown).

Among the confirmed cases of COVID-19 for people residing in CHSLDs or RPAs, the relative effect of the number of comorbidies on the risk of hospitalization is small or non-existent (Figure A.2). The relative risks and their confidence intervals are presented in the annex in Tables A.5 and A.6.

Association between number of comorbidities and the absolute risk of hospitalization

The adjusted risks of hospitalization for confirmed COVID-19 cases by number of comorbidities and age group are presented in Figure A.3 for each living environment. Adjusted risk increases with the number of comorbidities and age in individuals living at home. For individuals residing in CHSLDs, the number of comorbidities has little impact on the risk of hospitalization (almost all adjusted risk differences are not statistically different from zero), and the risk of hospitalization decreases with age (Table A.5). Among RPA residents, the number of comorbidities and age had little or no effect on the risk of hospitalization (Table A.6).

Discussion

Pre-existing medical conditions have a significant impact on the risk of death and hospitalization in confirmed COVID-19 cases. Nearly 55% of cases had at least one pre-existing medical condition compared to more than 95% of cases of death (n = 5,543) and more than 85% of cases of hospitalization (n = 6,284).

We identified 14 comorbidities associated with an excess risk of death due to COVID-19. The impact of the number of comorbidities varies according to age and living environment. The relative effect of the number of comorbidities on the risk of death increases for each additional comorbidity (from 0 to ≥ 4 comorbidities). Since the risk of hospitalization and death is very low among the youngest and individuals living at home, the increase in relative risk is proportionally greater for them than for those living in CHSLDs and RPAs. In people under 70 years of age, the risk of death is multiplied by a factor of 5 or more in individuals with four or more comorbidities compared to those without comorbidities. In individuals under 60 years of age living at home, the presence of a single comorbidity increases the risk of death by a factor of 5. The risk of death increases with the number of comorbidities and age. The absolute effect of each additional comorbidity on the risk of death, measured as the adjusted risk difference, is higher in older individuals. For example, among individuals living at home who are under the age of 60, the adjusted risk difference between individuals with zero or ≥ 4 comorbidities is 4.6 percentage points (the risk of death is 0.1% in the absence of comorbidities and 4.6% in the presence of ≥ 4 comorbidities). This difference increases to 19.2 percentage points for patients aged 90 years and older.

We identified 17 comorbidities associated with an excess risk of hospitalization due to COVID-19 (these comorbidities include the 14 comorbidities associated with death). The impact of the number of comorbidities on the risk of hospitalization, although less important than the impact on the risk of death, also varies with age, but is mainly observed in patients living at home. Other aspects related to hospitalization, such as intensive care or length of stay, were not taken into account in this study, whose main objective was to study the association between comorbidities and the risk of death. A study that includes, among others, a description of the first hospital episode of a confirmed COVID-19 case will be published shortly by the Institut national d'excellence en santé et services sociaux (INESSS, 2020).

Many of the comorbidities associated with death during the first months of the pandemic in confirmed cases of COVID-19 in Québec were also identified in an English study on more than 10,000 deaths attributable to COVID-19 in hospitals (Williamson,2020). In this study, respiratory diseases, cardiovascular diseases, liver diseases, kidney diseases, diabetes, and obesity were the major risk factors associated with death in confirmed COVID-19 cases, and the relative risks (adjusted for age and other comorbidities) ranged from 1.25 to 2.36.

The weak association that we observe between comorbidities and the risk of death or hospitalization among residents in CHSLDs could be explained by several reasons. First of all, these residents have several severe comorbidities and significant frailty that our analyses cannot take into account. Frailty is defined as a generalized reduction in physiological reserves leading to a state of increased vulnerability that makes the person less able to recover from a health problem or adapt to a stressful event, regardless of comorbidities (Fried, 2004). Indeed, the level of severity of comorbidities and the fragility of residents were associated with an excess of deaths due to COVID-19 among residents of long-term care facilities in the Boston area (Shi, 2020). In addition, many residents in CHSLDs receive palliative care and will generally not be transferred to the hospital during an infectious episode.

The variations in the effect of the number of comorbidities that we observed according to age and living environment indicate that age and living environment are associated with excess mortality and hospitalization, regardless of the presence of comorbidities. We noted that in people without any comorbidities, the effect of age on the risk of death appears to be greater than on the risk of hospitalization. Age is recognized as being strongly associated with the risk of death and hospitalization (Williamson, 2020; Reilev, 2020), even after taking into account the presence of comorbidities. Factors such as frailty and immune system impairment in older people may explain these results (Fried, 2004; Mueller, 2020).

Our study has several strengths. First, we measured the association between comorbidities and the risk of death and hospitalization associated with COVID-19 by separating into living environment and age. This allowed us to identify subgroups of individuals where comorbidities appear to have a greater effect on complications related to COVID-19. Second, only chronic comorbidities significantly associated with the risk of death (or hospitalization) were considered for the calculation of the number of comorbidities. This methodology made it possible to highlight the impact of the number of comorbidities potentially associated with the severity of COVID-19. Another strength of our study is that the search for pre-existing conditions in medico-administrative databases is performed over a 10-year retroactive period, which limits the potential underestimation of the prevalence of these conditions. Since the average length of stay of individuals in CHSLDs in our study is approximately 3 years, a shorter retroactive period could have led to a significant underestimation of the prevalence of comorbidities, mainly among individuals residing in CHSLDs for whom medical examinations performed by physicians in CHSLDs are generally not accounted for in the medico-administrative data. As expected, we observe that the average number of pre-existing conditions among residents in CHSLDs (mean: 4.5) is higher than that of residents in RPAs (mean: 4.0) and individuals living at home (mean: 0.8).

Our study has certain limitations. First, 8% (n = 4,686) of confirmed COVID-19 cases between February 23 and July 11, 2020 are excluded from the analyses since merging with the QICDSS medico-administrative data was impossible. The excluded cases are on average younger patients (37 years old) and come more from the Montreal area (66% vs. 45% of the included cases). Since the health region does not influence the impact of comorbidities on death or hospitalization (results not presented) and very few deaths occur among young people (117 deaths occurred among those excluded), we believe that our results can be generalized to all confirmed cases in Québec. Second, the fact that some carriers of the virus are asymptomatic or are not eligible for testing results in an underestimation of reported cases, which in turn overestimates the risk of death or hospitalization. The overestimation of risk is potentially higher in virus carriers without comorbidities since carriers with comorbidities are at greater risk of complications, and therefore more likely to be screened. The effect measures in this study (relative risk and risk difference) are based on comparing the risk of death between groups with and without comorbidities by age group and they potentially underestimate the true impact of comorbidities on death. Thirdly, pre-existing conditions potentially associated with complications of COVID-19, such as pregnancy and smoking, could not be taken into account. In addition, the direct effect of several autoimmune diseases could not be quantified because it was concealed in other comorbidities (e.g., cancer patients treated with chemotherapy could not be distinguished from other cancer patients). This may explain why the immune system diseases we considered (rheumatoid arthritis and HIV/AIDS) were not associated with the risk of death. Nevertheless, the use of medico-administrative data to identify pre-existing conditions has allowed the attribution of up to 21 conditions to 92% of confirmed COVID-19 cases between February 23 and July 11, 2020. Finally, some deaths or hospitalizations considered in this study may be related to a cause other than COVID-19.

Conclusion

The number of comorbidities has an impact on the risk of death and hospitalization among confirmed cases of COVID-19 in Québec. Of the 21 pre-existing conditions considered, 14 have an impact on the risk of death and 17 on the risk of hospitalization. The relative effect of comorbidities on the risk of death and hospitalization is greater for individuals under 60 years of age and those living at home. These results make it possible to identify groups of individuals where the implementation of infection prevention or control activities (including vaccination) would be beneficial to limit the burden and complications associated with COVID-19. Future analyses including confirmed cases of COVID-19 since the end of the first wave will add to the understanding of the association between comorbidities and the risk of complications related to COVID-19.

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Annex 1

Additional tables and figures

Table A.1 Identification of comorbidities associated with risk of death in confirmed COVID-19 cases (n = 51,880)

Medical condition	All cases						By living environment					
	Crude RR		Age-adjusted RR		Adjusted RR		CHSLD		RPA		At home	
	RR	95% CI	RR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI
Respiratory diseases	2.69	(2.55 - 2.83)	1.35	(1.28 - 1.41)	1.15	(1.09 - 1.20)	**1.07**	(1.01 - 1.13)	**1.24**	(1.10 - 1.39)	**1.44**	(1.24 - 1.69)
Cardiovascular diseases	5.62	(5.36 - 5.90)	1.45	(1.38 - 1.52)	1.12	(1.07 - 1.18)	0.99	(0.91 - 1.09)	1.00	(0.82 - 1.21)	**1.36**	(1.11 - 1.67)
Diabetes	3.31	(3.15 - 3.47)	1.47	(1.40 - 1.54)	1.13	(1.08 - 1.19)	**1.08**	(1.03 - 1.14)	**1.19**	(1.05 - 1.33)	**1.29**	(1.11 - 1.50)
Cancer	2.68	(2.52 - 2.86)	1.29	(1.21 - 1.37)	1.12	(1.05 - 1.18)	1.02	(0.95 - 1.09)	**1.16**	(1.02 - 1.33)	**1.36**	(1.16 - 1.60)
Neurological disorders	6.63	(6.32 - 6.96)	1.56	(1.48 - 1.65)	1.17	(1.11 - 1.23)	**1.19**	(1.13 - 1.26)	**1.14**	(1.02 - 1.27)	0.81	(0.65 - 1.00)
Kidney disease	4.64	(4.41 - 4.88)	1.44	(1.36 - 1.51)	1.22	(1.16 - 1.29)	**1.19**	(1.12 - 1.27)	**1.16**	(1.02 - 1.33)	**1.33**	(1.11 - 1.58)
Liver disease	2.17	(1.98 - 2.39)	1.41	(1.29 - 1.55)	1.04	(0.95 - 1.13)	0.94	(0.85 - 1.05)	1.02	(0.82 - 1.27)	**1.34**	(1.05 - 1.70)
Immune syst. conditions	2.11	(1.91 - 2.33)	1.13	(1.03 - 1.24)	1.03	(0.94 - 1.13)	1.02	(0.91 - 1.13)	0.93	(0.72 - 1.19)	1.14	(0.88 - 1.47)
Hypertension	6.45	(6.10 - 6.82)	1.28	(1.21 - 1.36)	1.03	(0.98 - 1.09)	0.97	(0.91 - 1.04)	1.03	(0.90 - 1.19)	1.17	(0.97 - 1.40)
Obesity	1.85	(1.71 - 2.00)	1.46	(1.35 - 1.57)	1.06	(0.98 - 1.14)	0.99	(0.91 - 1.09)	1.00	(0.82 - 1.21)	**1.36**	(1.11 - 1.67)
Fluid disorders, electrolytes	3.88	(3.68 - 4.09)	1.30	(1.23 - 1.37)	1.03	(0.98 - 1.09)	1.04	(0.98 - 1.10)	1.06	(0.92 - 1.22)	1.13	(0.93 - 1.38)
Hypothyroidism	2.68	(2.54 - 2.84)	1.04	(0.98 - 1.10)	1.04	(0.98 - 1.09)	1.00	(0.94 - 1.06)	**1.14**	(1.00 - 1.29)	1.14	(0.95 - 1.36)
Depression	1.47	(1.37 - 1.58)	1.11	(1.04 - 1.19)	0.95	(0.89 - 1.01)	0.93	(0.86 - 1.00)	1.05	(0.90 - 1.24)	0.92	(0.71 - 1.21)
Alcohol abuse	2.16	(1.88 - 2.47)	1.52	(1.34 - 1.73)	0.85	(0.74 - 0.96)	0.79	(0.68 - 0.92)	0.88	(0.63 - 1.22)	**1.49**	(1.04 - 2.13)
Drug abuse	1.33	(1.06 - 1.67)	1.27	(1.03 - 1.57)	0.95	(0.77 - 1.16)	0.91	(0.72 - 1.16)	0.77	(0.47 - 1.28)	0.91	(0.45 - 1.83)
Psychosis	2.90	(2.71 - 3.11)	1.45	(1.35 - 1.55)	1.04	(0.98 - 1.12)	1.01	(0.94 - 1.08)	1.11	(0.91 - 1.36)	1.11	(0.75 - 1.64)
Anaemia	3.74	(3.57 - 3.93)	1.26	(1.21 - 1.33)	1.01	(0.96 - 1.06)	0.95	(0.90 - 1.01)	1.04	(0.92 - 1.17)	**1.29**	(1.09 - 1.53)
Weight loss	3.48	(3.22 - 3.76)	1.23	(1.14 - 1.33)	1.01	(0.94 - 1.09)	1.02	(0.94 - 1.10)	0.96	(0.76 - 1.20)	**1.38**	(1.01 - 1.89)
Coagulopathy	2.95	(2.71 - 3.21)	1.35	(1.24 - 1.47)	1.07	(0.99 - 1.16)	1.05	(0.96 - 1.15)	1.06	(0.87 - 1.31)	0.94	(0.74 - 1.20)
Paralysis	2.97	(2.73 - 3.23)	1.51	(1.39 - 1.65)	0.98	(0.91 - 1.07)	0.98	(0.90 - 1.08)	0.69	(0.50 - 0.96)	0.86	(0.59 - 1.25)
Ulcer	2.94	(2.60 - 3.34)	1.23	(1.08 - 1.40)	0.99	(0.88 - 1.11)	0.99	(0.86 - 1.14)	0.97	(0.71 - 1.32)	1.11	(0.77 - 1.59)

Table A.1 Identification of comorbidities associated with risk of death in confirmed COVID-19 cases (n = 51,880) (continued)

Medical condition	By age							
	< 60 years		60–69 years		70–79 years		≥ 80 years	
	aRR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI
Respiratory diseases	1.58	(0.91 - 2.75)	1.26	(0.98 - 1.61)	**1.24**	(1.10 - 1.40)	**1.13**	(1.05 - 1.22)
Cardiovascular diseases	1.48	(0.75 - 2.89)	**1.96**	(1.51 - 2.55)	**1.13**	(1.01 - 1.28)	1.07	(0.99 - 1.15)
Diabetes	1.21	(0.70 - 2.09)	**1.36**	(1.06 - 1.75)	**1.13**	(1.01 - 1.27)	**1.12**	(1.04 - 1.20)
Cancer	**2.81**	(1.49 - 5.32)	**1.55**	(1.20 - 2.02)	1.00	(0.87 - 1.15)	**1.09**	(1.00 - 1.18)
Neurological disorders	**6.03**	(3.34 - 10.89)	**2.28**	(1.77 - 2.95)	**1.22**	(1.09 - 1.37)	**1.09**	(1.02 - 1.17)
Kidney disease	**2.25**	(1.09 - 4.65)	**1.54**	(1.15 - 2.07)	**1.36**	(1.18 - 1.56)	**1.23**	(1.13 - 1.33)
Liver disease	1.71	(0.84 - 3.49)	0.85	(0.60 - 1.22)	0.99	(0.82 - 1.20)	1.03	(0.90 - 1.18)
Immune system conditions	1.33	(0.50 - 3.55)	0.83	(0.49 - 1.40)	0.93	(0.72 - 1.20)	1.09	(0.95 - 1.24)
Hypertension	**2.54**	(1.55 - 4.15)	1.04	(0.82 - 1.32)	1.00	(0.88 - 1.14)	0.97	(0.90 - 1.06)
Obesity	1.16	(0.60 - 2.24)	1.32	(0.98 - 1.77)	1.00	(0.86 - 1.17)	1.01	(0.90 - 1.13)
Fluid disorders, electrolytes	**2.26**	(1.16 - 4.40)	1.19	(0.88 - 1.61)	0.97	(0.84 - 1.12)	0.99	(0.91 - 1.08)
Hypothyroidism	1.70	(0.96 - 3.00)	1.19	(0.88 - 1.60)	0.94	(0.81 - 1.09)	1.04	(0.95 - 1.12)
Depression	0.69	(0.38 - 1.25)	0.92	(0.66 - 1.28)	1.02	(0.87 - 1.18)	0.92	(0.84 - 1.02)
Alcohol abuse	0.70	(0.22 - 2.22)	0.52	(0.31 - 0.88)	0.79	(0.62 - 1.01)	0.90	(0.75 - 1.07)
Drug abuse	0.84	(0.30 - 2.37)	0.46	(0.21 - 0.99)	1.02	(0.70 - 1.48)	0.77	(0.53 - 1.11)
Psychosis	**2.24**	(1.12 - 4.44)	1.03	(0.76 - 1.39)	0.98	(0.84 - 1.13)	1.01	(0.91 - 1.12)
Anaemia	0.65	(0.34 - 1.27)	0.95	(0.72 - 1.25)	1.10	(0.97 - 1.25)	1.04	(0.97 - 1.13)
Weight loss	0.95	(0.36 - 2.50)	1.28	(0.84 - 1.94)	0.81	(0.65 - 1.03)	1.05	(0.94 - 1.18)
Coagulopathy	0.76	(0.34 - 1.69)	1.18	(0.79 - 1.76)	**1.24**	(1.02 - 1.50)	0.94	(0.82 - 1.07)
Paralysis	1.17	(0.58 - 2.32)	1.06	(0.78 - 1.44)	0.80	(0.66 - 0.97)	0.93	(0.81 - 1.05)
Ulcer	1.43	(0.44 - 4.68)	1.15	(0.68 - 1.93)	1.04	(0.80 - 1.36)	1.12	(0.95 - 1.33)

CHSLD: Long-term care or nursing facilities; 95% CI: 95% confidence interval; RPA: Private seniors' residence; RR: Relative risk;
aRR: Relative risk adjusted for age, other medical conditions, sex, deprivation and living environment.

* Pre-existing medical conditions and bolded aRR are associated with an increased risk of death in at least one living environment or age group.

Table A.2 Description of confirmed COVID-19 cases from February 23 to July 11, 2020 by hospitalization status (n = 51,880)

Variables	Hospitalized (n = 6,284)		Not hospitalized (n = 45,596)		Total (n = 51,880)	
	n	%	n	%	n	%
Average age (avg, SD)	72.8	(21.6)	51.1	(11.4)	53.7	(10.8)
Age group						
0–49 years	648	(10.3)	23,307	(51.1)	23,955	(46.2)
49–59 years	692	(11.0)	7,135	(15.6)	7,827	(15,1)
60–69 years	894	(14.2)	3,902	(8.6)	4,796	(9.2)
70–79 years	1,342	(21.4)	2,888	(6.3)	4,230	(8.2)
80–89 years	1,792	(28.5)	4,694	(10.3)	6,486	(12.5)
≥ 90 years	916	(14.6)	3,670	(8.0)	4,586	(8.8)
Sex						
Women	3,265	(52.0)	27,886	(61.2)	31,151	(60.0)
Men	3,019	(48.0)	17,710	(38.8)	20,729	(40.0)
Living environment						
At home	3,233	(51.4)	34,268	(75.2)	37,501	(72.3)
CHSLD	942	(15.0)	8,304	(18.2)	9,246	(17.8)
RPA	1,651	(26.3)	2,065	(4.5)	3,716	(7.2)
Other/unknown	458	(7.3)	959	(2.1)	1,417	(2.7)
Number of medical conditions						
0	841	(13.4)	22,026	(48.3)	22,867	(44.1)
1	1,050	(16.7)	9,234	(20.3)	10,284	(19.8)
2	915	(14.6)	4,443	(9.7)	5,358	(10.3)
3	804	(12.8)	2,627	(5.8)	3,431	(6.6)
4+	2,674	(42.6)	7,266	(15.9)	9,940	(19.2)
Medical conditions						
Hypertension	3,725	(59.3)	11,477	(25.2)	15,202	(29.3)
Cardiovascular diseases	2,492	(39.7)	7,107	(15.6)	9,599	(18.5)
Neurological disorder	1,683	(26.8)	7,712	(16.9)	9,395	(18.1)
Anaemia	1,787	(28.4)	5,798	(12.7)	7,585	(14.6)
Respiratory diseases	1,703	(27.1)	5,557	(12.2)	7,260	(14.0)
Diabetes	2,009	(32.0)	5,206	(11.4)	7,215	(13.9)
Hypothyroidism	1,006	(16.0)	3,896	(8.5)	4,902	(9.4)
Depression	712	(11.3)	4,047	(8.9)	4,759	(9.2)
Fluid and electrolyte disorders	1,016	(16.2)	2,824	(6.2)	3,840	(7.4)
Cancer	948	(15.1)	2,458	(5.4)	3,406	(6.6)
Kidney disease	1,040	(16.5)	2,265	(5.0)	3,305	(6.4)
Obesity	724	(11.5)	2,230	(4.9)	2,954	(5.7)
Psychosis	522	(8.3),	1,808	(4.0)	2,330	(4.5)
Liver disease	404	(6.4)	1,184	(2.6)	1,588	(3.1)
Immune system problem	337	(5.4)	1,103	(2.4)	1,440	(2.8)
Coagulopathy	371	(5.9)	1,026	(2.3)	1,397	(2.7)
Weight loss	283	(4.5)	1,079	(2.4)	1,362	(2.6)
Paralysis	325	(5.2)	1,035	(2.3)	1,360	(2.6)
Alcohol abuse	175	(2.8)	580	(1.3)	755	(1.5)
Ulcer	156	(2.5)	419	(0.9)	575	(1.1)
Drug abuse	118	(1.9)	347	(0.8)	465	(0.9)
Deaths	1,745	(27.8)	3,798	(8.3)	5,543	(10.7)

CHSLD: Long-term care or nursing facilities; RPA: private seniors' residences

Figure A.1 Distribution of the 6,284 hospitalizations observed between February 23 and July 11, 2020 in Québec among confirmed COVID-19 cases by age group and sex (n = 51,880)

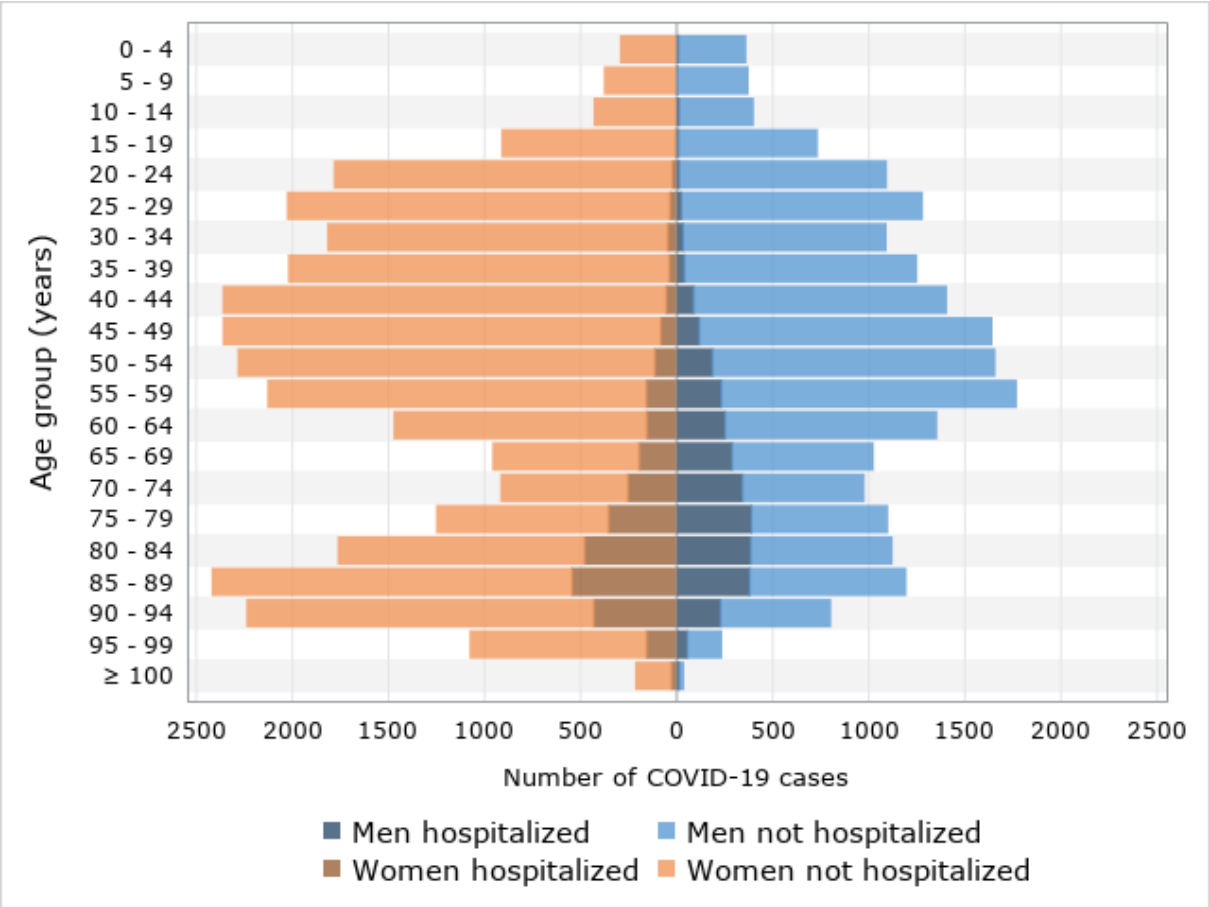


Table A.3 Identification of comorbidities associated with risk of hospitalization in confirmed COVID-19 cases (n = 51,880)

Medical condition	All cases						By living environment					
	Crude RR		Age-adjusted RR		Adjusted RR		CHSLD		RPA		At home	
	RR	95% CI	RR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI
Respiratory diseases	2.28	(2.17 - 2.40)	1.45	(1.38 - 1.53)	1.18	(1.13 - 1.25)	**1.15**	(1.00 - 1.32)	**1.10**	(1.02 - 1.19)	**1.26**	(1.17 - 1.36)
Cardiovascular diseases	2.89	(2.77 - 3.03)	1.24	(1.18 - 1.31)	1.04	(0.99 - 1.10)	**1.25**	(1.04 - 1.48)	1.09	(0.97 - 1.22)	**1.27**	(1.14 - 1.40)
Diabetes	2.91	(2.78 - 3.05)	1.65	(1.57 - 1.73)	1.25	(1.19 - 1.31)	**1.15**	(1.00 - 1.31)	**1.09**	(1.01 - 1.18)	**1.44**	(1.34 - 1.55)
Cancer	2.53	(2.38 - 2.68)	1.48	(1.39 - 1.57)	1.14	(1.07 - 1.20)	1.05	(0.89 - 1.24)	1.08	(0.99 - 1.18)	**1.18**	(1.08 - 1.28)
Neurological disorders	1.65	(1.57 - 1.74)	0.57	(0.54 - 0.61)	0.82	(0.77 - 0.87)	0.56	(0.50 - 0.64)	0.88	(0.82 - 0.95)	0.87	(0.78 - 0.98)
Kidney disease	2.91	(2.75 - 3.08)	1.35	(1.27 - 1.44)	1.09	(1.03 - 1.16)	1.01	(0.86 - 1.18)	1.05	(0.96 - 1.15)	**1.13**	(1.03 - 1.25)
Liver disease	2.18	(1.99 - 2.38)	1.53	(1.40 - 1.67)	1.12	(1.03 - 1.21)	0.87	(0.69 - 1.10)	1.05	(0.91 - 1.20)	**1.24**	(1.10 - 1.40)
Immune system conditions	1.98	(1.80 - 2.19)	1.28	(1.16 - 1.41)	1.15	(1.05 - 1.25)	**1.31**	(1.05 - 1.65)	1.06	(0.92 - 1.23)	**1.15**	(1.01 - 1.32)
Hypertension	3.51	(3.35 - 3.68)	1.47	(1.38 - 1.56)	1.18	(1.12 - 1.25)	1.14	(0.98 - 1.33)	**1.11**	(1.02 - 1.22)	**1.22**	(1.13 - 1.32)
Obesity	2.16	(2.02 - 2.31)	1.72	(1.60 - 1.84)	1.22	(1.14 - 1.31)	**1.25**	(1.04 - 1.48)	1.09	(0.97 - 1.22)	**1.27**	(1.14 - 1.40)
Fluid disorders, electrolytes	2.41	(2.28 - 2.56)	1.17	(1.09 - 1.24)	1.11	(1.04 - 1.18)	**1.19**	(1.02 - 1.38)	1.05	(0.95 - 1.15)	**1.13**	(1.01 - 1.26)
Hypothyroidism	1.83	(1.72 - 1.94)	0.98	(0.92 - 1.05)	1.02	(0.96 - 1.08)	1.02	(0.87 - 1.19)	1.03	(0.94 - 1.12)	0.98	(0.89 - 1.08)
Depression	1.27	(1.18 - 1.36)	1.02	(0.95 - 1.10)	0.98	(0.91 - 1.05)	1.01	(0.86 - 1.20)	0.97	(0.87 - 1.08)	0.94	(0.84 - 1.06)
Alcohol abuse	1.94	(1.70 - 2.21)	1.37	(1.19 - 1.57)	0.94	(0.83 - 1.07)	0.76	(0.55 - 1.04)	0.84	(0.67 - 1.05)	1.14	(0.92 - 1.42)
Drug abuse	2.12	(1.81 - 2.48)	1.91	(1.63 - 2.24)	1.49	(1.28 - 1.74)	**1.40**	(1.00 - 1.95)	1.22	(0.97 - 1.55)	**1.49**	(1.14 - 1.94)
Psychosis	1.93	(1.78 - 2.09)	1.15	(1.05 - 1.25)	1.25	(1.15 - 1.36)	1.12	(0.96 - 1.31)	0.99	(0.87 - 1.13)	**1.41**	(1.17 - 1.69)
Anaemia	2.32	(2.21 - 2.44)	1.16	(1.10 - 1.23)	1.09	(1.03 - 1.15)	1.13	(0.98 - 1.29)	1.04	(0.96 - 1.13)	**1.10**	(1.01 - 1.20)
Weight loss	1.75	(1.57 - 1.95)	0.86	(0.77 - 0.96)	0.94	(0.84 - 1.04)	0.75	(0.59 - 0.96)	1.01	(0.88 - 1.17)	1.06	(0.87 - 1.30)
Coagulopathy	2.27	(2.07 - 2.48)	1.34	(1.22 - 1.47)	1.11	(1.02 - 1.21)	0.94	(0.75 - 1.19)	**1.19**	(1.05 - 1.36)	1.06	(0.92 - 1.21)
Paralysis	2.03	(1.84 - 2.23)	1.22	(1.01 - 1.35)	1.28	(1.16 - 1.42)	0.99	(0.82 - 1.19)	1.03	(0.86 - 1.22)	**1.33**	(1.11 - 1.60)
Ulcer	2.27	(1.98 - 2.60)	1.24	(1.08 - 1.42)	0.98	(0.86 - 1.11)	0.95	(0.68 - 1.32)	0.92	(0.75 - 1.14)	1.02	(0.84 - 1.24)

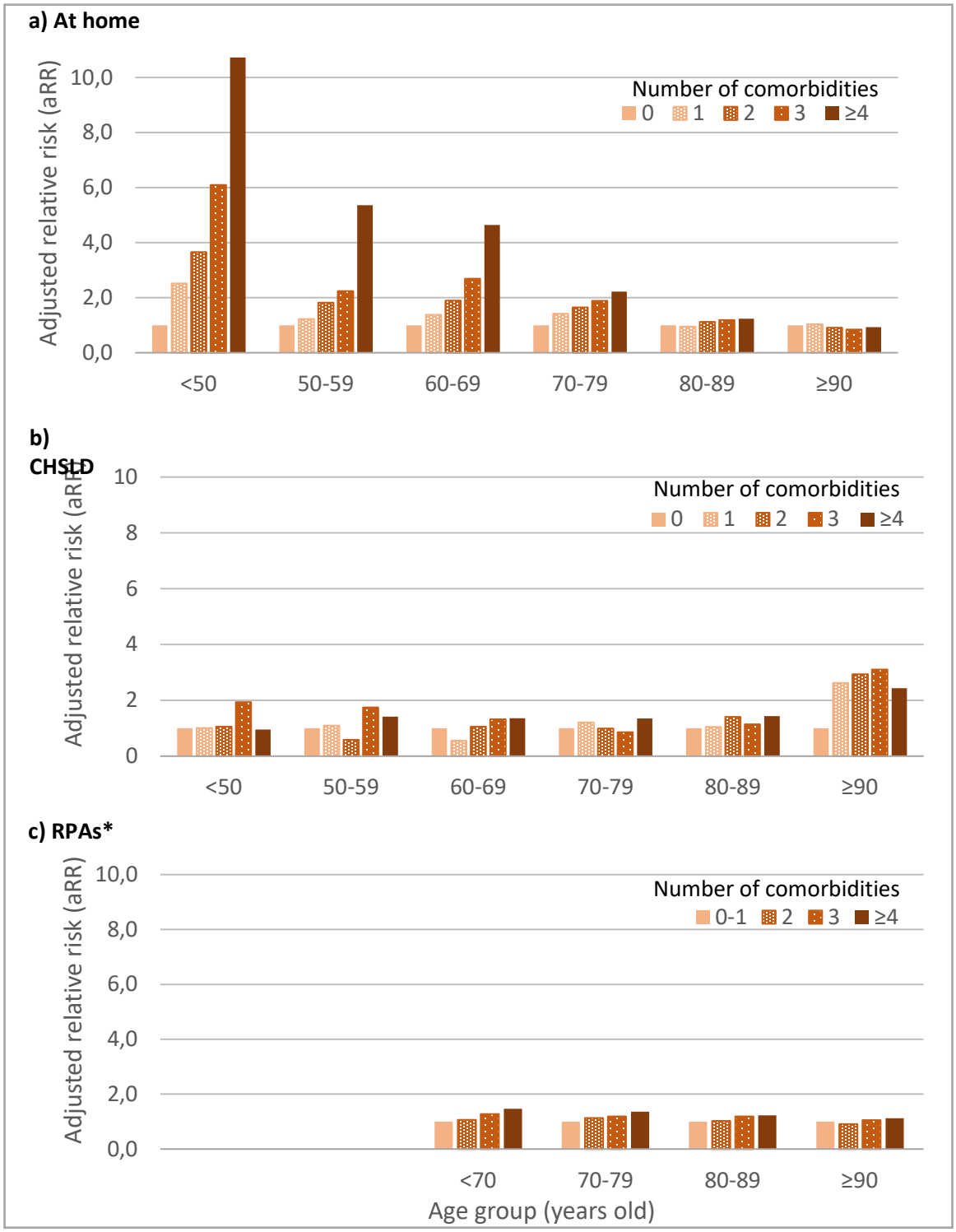
Table A.3 Identification of comorbidities associated with risk of hospitalization in confirmed COVID-19 cases (n = 51,880) (continued)

Medical condition	By age group											
	< 50 years		50–59 years		60–69 years		70–79 years		80–89 years		≥ 90 years	
	aRR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI
Respiratory diseases	**1.32**	(1.01 - 1.72)	**1.42**	(1.17 - 1.73)	**1.38**	(1.20 - 1.59)	**1.20**	(1.10 - 1.32)	**1.10**	(1.02 - 1.20)	1.05	(0.93 - 1.18)
Cardiovascular diseases	0.82	(0.51 - 1.31)	**1.28**	(1.01 - 1.62)	1.12	(0.96 - 1.30)	1.08	(0.98 - 1.19)	0.99	(0.91 - 1.07)	1.02	(0.91 - 1.15)
Diabetes	3.48	(2.61 - 4.63)	**1.62**	(1.34 - 1.95)	**1.32**	(1.15 - 1.51)	**1.14**	(1.04 - 1.24)	**1.13**	(1.05 - 1.22)	1.08	(0.96 - 1.21)
Cancer	**2.12**	(1.35 - 3.31)	1.24	(0.94 - 1.64)	**1.31**	(1.12 - 1.53)	1.05	(0.95 - 1.16)	1.10	(1.01 - 1.19)	1.01	(0.88 - 1.17)
Neurological disorders	**2.85**	(1.95 - 4.18)	**1.77**	(1.27 - 2.47)	**1.34**	(1.12 - 1.61)	0.84	(0.76 - 0.94)	0.71	(0.66 - 0.77)	0.72	(0.64 - 0.80)
Kidney disease	1.58	(0.84 - 2.97)	**1.65**	(1.16 - 2.36)	**1.54**	(1.28 - 1.85)	**1.19**	(1.07 - 1.32)	1.07	(0.98 - 1.17)	0.93	(0.81 - 1.06)
Liver disease	**1.59**	(1.02 - 2.49)	1.24	(0.89 - 1.72)	1.21	(0.99 - 1.47)	0.97	(0.83 - 1.12)	0.99	(0.85 - 1.15)	1.05	(0.81 - 1.36)
Immune system conditions	1.34	(0.84 - 2.15)	1.26	(0.88 - 1.78)	1.20	(0.93 - 1.54)	1.02	(0.86 - 1.21)	**1.17**	(1.02 - 1.34)	1.10	(0.88 - 1.38)
Hypertension	**1.52**	(1.12 - 2.07)	1.14	(0.96 - 1.35)	**1.21**	(1.06 - 1.38)	1.10	(0.99 - 1.21)	1.08	(0.99 - 1.18)	1.15	(0.99 - 1.33)
Obesity	**1.46**	(1.05 - 2.01)	**1.64**	(1.29 - 2.08)	**1.31**	(1.11 - 1.54)	**1.16**	(1.04 - 1.30)	1.06	(0.94 - 1.20)	0.98	(0.78 - 1.23)
Fluid disorders, electrolytes	1.05	(0.59 - 1.86)	1.18	(0.80 - 1.76)	1.05	(0.85 - 1.29)	**1.13**	(1.01 - 1.27)	**1.16**	(1.06 - 1.28)	1.05	(0.91 - 1.20)
Hypothyroidism	0.83	(0.54 - 1.28)	0.72	(0.52 - 0.99)	**1.30**	(1.10 - 1.53)	1.04	(0.93 - 1.17)	0.97	(0.89 - 1.06)	1.05	(0.94 - 1.18)
Depression	1.02	(0.77 - 1.35)	0.96	(0.76 - 1.21)	1.09	(0.91 - 1.29)	1.00	(0.87 - 1.14)	0.95	(0.85 - 1.07)	0.88	(0.73 - 1.06)
Alcohol abuse	1.11	(0.58 - 2.13)	1.06	(0.63 - 1.79)	0.70	(0.49 - 0.99)	0.95	(0.77 - 1.17)	0.82	(0.65 - 1.03)	0.80	(0.40 - 1.61)
Drug abuse	**1.75**	(1.03 - 2.99)	0.69	(0.37 - 1.28)	**1.75**	(1.23 - 2.50)	**1.34**	(1.01 - 1.79)	1.07	(0.79 - 1.44)	1.39	(0.91 - 2.13)
Psychosis	**2.54**	(1.67 - 3.85)	**2.02**	(1.43 - 2.86)	**1.52**	(1.25 - 1.85)	1.04	(0.90 - 1.21)	1.09	(0.94 - 1.25)	0.85	(0.65 - 1.10)
Anaemia	**1.73**	(1.32 - 2.27)	1.23	(0.97 - 1.54)	**1.20**	(1.02 - 1.41)	1.03	(0.92 - 1.14)	1.07	(0.98 - 1.16)	1.05	(0.93 - 1.18)
Weight loss	0.94	(0.38 - 2.31)	1.19	(0.65 - 2.18)	1.04	(0.79 - 1.35)	0.95	(0.76 - 1.18)	0.90	(0.77 - 1.06)	0.88	(0.71 - 1.10)
Coagulopathy	1.56	(0.98 - 2.50)	0.97	(0.58 - 1.63)	1.00	(0.77 - 1.30)	1.08	(0.92 - 1.26)	1.02	(0.88 - 1.17)	**1.24**	(1.04 - 1.48)
Paralysis	**2.71**	(1.46 - 5.04)	**1.64**	(1.03 - 2.60)	1.25	(0.97 - 1.60)	1.13	(0.95 - 1.34)	1.09	(0.92 - 1.28)	1.02	(0.77 - 1.36)
Ulcer	1.72	(0.69 - 4.29)	0.83	(0.30 - 2.29)	1.01	(0.72 - 1.43)	0.96	(0.74 - 1.24)	1.02	(0.85 - 1.22)	1.02	(0.76 - 1.36)

CHSLD: Long-term care or nursing facilities; RPA: Private seniors' residence; aRR: Relative risk adjusted for age, other medical conditions, sex, deprivation and living environment.

* Pre-existing medical conditions and bolded aRR are associated with an increased risk of hospitalization in at least one living environment or age group.

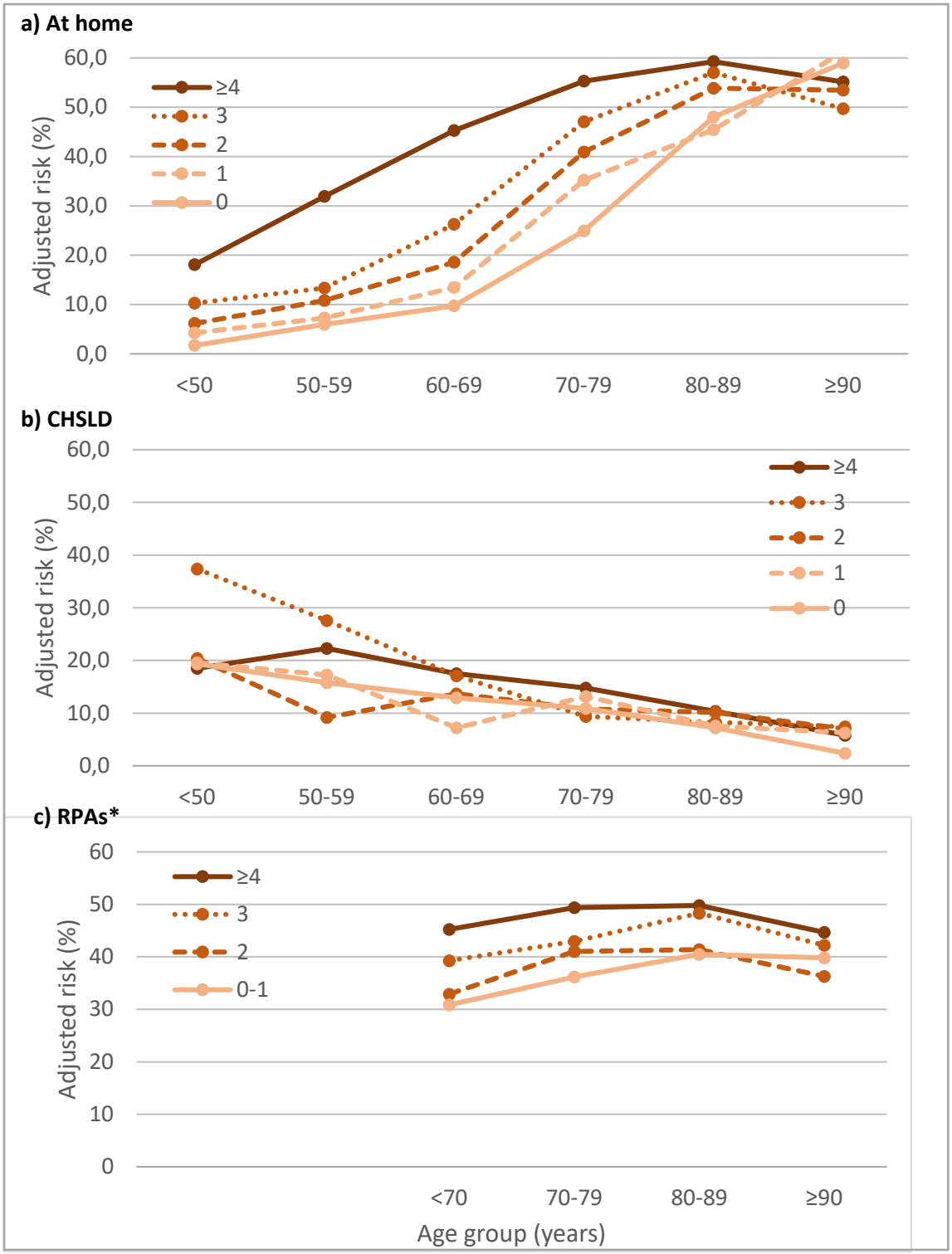
Figure A.2 **Impact of number of comorbidities on the adjusted relative risk (aRR) of hospitalization among confirmed COVID-19 cases by age and living environment (n = 51,880)**



CHSLD: Long-term care or nursing facilities; RPA: private seniors' residences
Relative risk adjusted for deprivation and sex.

* Categories one and zero comorbidity had to be grouped together in order to achieve a sufficient number of observations in the analyses.

Figure A.3 Impact of number of comorbidities on the adjusted risk of hospitalization among confirmed COVID-19 cases by age group and living environment (n = 51,880)



CHSLD: Long-term care or nursing facilities; RPA: private seniors' residences
Risk adjusted for deprivation and sex.

* Categories one and zero comorbidity had to be grouped together in order to achieve a sufficient number of observations in the analyses.

Table A.4 Risk of hospitalization among the confirmed cases of COVID-19 for people living at home by number of comorbidities associated with hospitalization by age group (n= 37,501)

Age	Number of comorbidities	Frequency		Adjusted risk*		Adjusted risk difference*		Adjusted relative risk*	
		Hosp.	Not hosp.	%	95% CI	%	95% CI	aRR	95% CI
< 50 years	0	316	17,844	1.7	(1.5 - 1.9)			1.00	
	1	170	3,893	4.2	(3.7 - 4.9)	2.6	(1.9 - 3.2)	2.52	(2.10 -3.03)
	2	57	899	6.2	(4.8 - 7.9)	4.5	(2.9 - 6.0)	3.65	(2.78 -4.80)
	3	25	228	10.3	(7.1 - 14.8)	8.6	(4.8 - 12.4)	6.09	(4.15 -8.95)
	4+	25	111	18.1	(12.8 - 25.5)	16.4	(10.2 - 22.6)	10.7	(7.47 -15.4)
50–59 years	0	243	3,716	5.9	(5.3 - 6.7)			1.00	
	1	162	2,023	7.3	(6.3 - 8.4)	1.3	(0.1 - 2.6)	1.22	(1.01 -1.48)
	2	85	692	10.8	(8.9 - 13.2)	4.9	(2.6 - 7.1)	1.82	(1.44 -2.29)
	3	41	258	13.4	(10.1 - 17.7)	7.4	(3.6 - 11.2)	2.24	(1.65 -3.05)
	4+	66	128	31.9	(26.2 - 38.8)	25.9	(19.6 - 32.2)	5.36	(4.26 -6.75)
60–69 years	0	141	1,244	9.8	(8.4 - 11.4)			1.00	
	1	168	1,030	13.5	(11.7 - 15.5)	3.7	(1.3 - 6.1)	1.38	(1.12 -1.70)
	2	119	483	18.5	(15.8 - 21.7)	8.8	(5.5 - 12.1)	1.90	(1.52 -2.37)
	3	81	199	26.2	(21.8 - 31.5)	16.5	(11.4 - 21.5)	2.69	(2.12 -3.42)
	4+	147	145	45.3	(40.3 - 50.8)	35.5	(30.1 - 40.9)	4.64	(3.83 -5.63)
70–79 years	0	61	178	24.9	(20.1 - 30.9)			1.00	
	1	149	242	35.2	(31.0 - 39.9)	10.3	(3.4 - 17.3)	1.41	(1.10 -1.81)
	2	134	166	40.9	(36.0 - 46.6)	16.0	(8.5 - 23.5)	1.64	(1.28 -2.11)
	3	105	100	47.0	(41.1 - 53.9)	22.1	(13.8 - 30.4)	1.89	(1.47 -2.43)
	4+	238	153	55.3	(50.9 - 60.1)	30.4	(23.4 - 37.4)	2.22	(1.76 -2.80)
80–89 years	0	26	28	48.0	(36.5 - 63.1)			1.00	
	1	83	92	45.5	(38.9 - 53.1)	-2.6	(-17.5 - 12.4)	0.95	(0.69 -1.30)
	2	104	81	53.9	(47.3 - 61.3)	5.8	(-9.0 - 20.7)	1.12	(0.83 -1.52)
	3	98	64	57.0	(50.2 - 64.8)	9.0	(-6.0 - 24.0)	1.19	(0.88 -1.61)
	4+	236	138	59.2	(54.7 - 64.1)	11.2	(-2.7 - 25.2)	1.23	(0.93 -1.64)
≥ 90 years	0	8	5	59.0	(39.9 - 87.2)			1.00	
	1	23	16	61.3	(48.2 - 77.9)	2.3	(-25.0 - 29.5)	1.04	(0.66 -1.64)
	2	21	19	53.4	(39.4 - 72.4)	-5.5	(-33.6 - 22.6)	0.91	(0.55 -1.49)
	3	31	31	49.7	(39.2 - 63.1)	-9.3	(-35.1 - 16.6)	0.84	(0.53 -1.33)
	4+	70	62	55.1	(46.9 - 64.8)	-3.8	(-28.5 - 20.9)	0.93	(0.61 -1.43)

Hosp: hospitalized; 95% CI: 95% confidence interval; aRR: Relative risk adjusted for deprivation and sex.

* Adjusted for deprivation and sex.

Table A.5 Risk of hospitalization among confirmed cases of COVID-19 for people residing in CHSLDs by number of comorbidities associated with hospitalization by age group (n = 9,246)

Age	Number of comorbidities	Frequency		Adjusted risk*		Adjusted risk difference*		Adjusted relative risk*	
		Hosp.	Not hosp.	%	95% CI	%	95% CI	aRR	95% CI
< 50 years	0	5	19	19.3	(8.9 - 41.9)			1.00	
	1	6	23	19.6	(9.6 - 39.8)	0.2	(-20.2 - 20.6)	1.01	(0.35 -2.88)
	2	5	17	20.4	(9.5 - 43.6)	1.0	(-20.5 - 22.5)	1.05	(0.36 -3.11)
	3	6	9	37.4	(19.8 - 70.5)	18.0	(-10 - 46.0)	1.93	(0.71 -5.24)
	4+	5	20	18.5	(8.4 - 40.7)	-0.8	(-21.7 - 20.0)	0.96	(0.32 -2.88)
50–59 years	0	5	24	15.8	(7.2 - 34.6)			1.00	
	1	8	37	17.3	(9.1 - 32.7)	1.5	(-15 - 18.0)	1.10	(0.40 -3.01)
	2	4	37	9.2	(3.6 - 23.4)	-6.6	(-21.6 - 8.5)	0.58	(0.17 -1.98)
	3	14	33	27.6	(17.6 - 43.2)	11.8	(-5.7 - 29.3)	1.75	(0.71 -4.32)
	4+	22	72	22.3	(15.5 - 32.0)	6.5	(-8.2 - 21.3)	1.41	(0.60 -3.36)
60–69 years	0	7	45	12.9	(6.4 - 25.8)			1.00	
	1	10	122	7.2	(4.0 - 13.1)	-5.7	(5.0 - 4.2)	0.56	(0.22 -1.39)
	2	17	102	13.7	(8.8 - 21.3)	0.8	(5.5 - 11.5)	1.06	(0.47 -2.41)
	3	13	60	17.1	(10.5 - 27.9)	4.2	(6.2 - 16.4)	1.33	(0.57 -3.09)
	4+	64	285	17.5	(14.0 - 21.9)	4.6	(5.0 - 14.3)	1.36	(0.66 -2.81)
70–79 years	0	10	78	10.9	(6.1 - 19.5)			1.00	
	1	33	211	13.2	(9.6 - 18.1)	2.3	(3.9 - 9.8)	1.21	(0.62 -2.34)
	2	29	229	10.8	(7.7 - 15.2)	-0.1	(3.7 - 7.2)	0.99	(0.50 -1.95)
	3	27	249	9.4	(6.6 - 13.4)	-1.5	(3.7 - 5.6)	0.86	(0.43 -1.70)
	4+	143	785	14.8	(12.6 - 17.2)	3.8	(3.4 - 10.6)	1.35	(0.74 -2.47)
80–89 years	0	8	103	7.2	(3.7 - 14.0)			1.00	
	1	28	342	7.6	(5.3 - 10.8)	0.4	(2.8 - 5.8)	1.05	(0.49 -2.23)
	2	48	426	10.1	(7.7 - 13.2)	2.9	(2.8 - 8.4)	1.40	(0.69 -2.87)
	3	48	523	8.3	(6.3 - 10.8)	1.0	(2.7 - 6.3)	1.15	(0.56 -2.35)
	4+	207	1,789	10.3	(9.1 - 11.8)	3.1	(2.5 - 8.1)	1.43	(0.73 -2.82)
≥ 90 years	0	2	85	2.4	(0.6 - 9.4)			1.00	
	1	15	232	6.3	(3.8 - 10.2)	3.9	(2.3 - 8.4)	2.63	(0.61 -11.3)
	2	28	382	7.0	(4.9 - 10.0)	4.6	(2.1 - 8.7)	2.94	(0.71 -12.1)
	3	33	424	7.4	(5.3 - 10.3)	5.0	(2.1 - 9.1)	3.11	(0.76 -12.7)
	4+	92	1,541	5.8	(4.8 - 7.1)	3.4	(1.8 - 6.9)	2.44	(0.61 -9.75)

Hosp: hospitalization; 95% CI: 95% confidence interval; aRR: Relative risk adjusted for deprivation and sex.

* Adjusted for deprivation and sex.

Table A.6 Risk of hospitalization among confirmed cases of COVID-19 for people living in private seniors' residences (RPAs) by number of comorbidities associated with hospitalization by age group (n = 3,716)

Age	Number of comorbidities*	Frequency		Adjusted risk**		Adjusted risk difference**		Adjusted relative risk**	
		Hosp.	Not hosp.	%	95% CI	%	95% CI	aRR	95% CI
< 70 years	0-1	21	44	30.8	(21.8 - 43.7)			1.00	
	2	10	20	32.9	(19.7 - 55.1)	2.0	(-18.0 - 22.0)	1.07	(0.57 - 1.98)
	3	13	19	39.3	(25.6 - 60.2)	8.4	(-11.4 - 28.2)	1.27	(0.74 - 2.21)
	4+	33	34	45.2	(35.3 - 57.9)	14.3	(-1.1 - 29.8)	1.47	(0.96 - 2.25)
70–79 years	0-1	52	87	36.2	(29.1 - 45.0)			1.00	
	2	52	74	41.0	(33.3 - 50.6)	4.8	(-6.8 - 16.4)	1.13	(0.84 - 1.53)
	3	40	50	43.0	(34.1 - 54.1)	6.8	(-5.8 - 19.3)	1.19	(0.87 - 1.63)
	4+	160	151	49.4	(44.3 - 55.1)	13.2	(3.8 - 22.6)	1.37	(1.07 - 1.74)
80–89 years	0-1	120	174	40.5	(35.3 - 46.5)			1.00	
	2	118	170	41.4	(36.1 - 47.5)	0.9	(-7.1 - 8.9)	1.02	(0.84 - 1.24)
	3	141	147	48.3	(43.1 - 54.3)	7.8	(0.1 - 15.7)	1.19	(1.01 - 1.43)
	4+	381	374	49.8	(46.4 - 53.5)	9.3	(2.7 - 15.9)	1.23	(1.05 - 1.44)
≥ 90 years	0-1	65	102	39.8	(32.9 - 48.3)			1.00	
	2	81	147	36.3	(30.5 - 43.1)	-3.6	(-13.4 - 6.3)	0.91	(0.70 - 1.18)
	3	88	124	42.2	(36.0 - 49.5)	2.3	(-7.8 - 12.5)	1.06	(0.83 - 1.36)
	4+	276	348	44.7	(40.9 - 48.8)	4.8	(-3.7 - 13.4)	1.12	(0.91 - 1.38)

Hosp: hospitalized; 95% CI: 95% confidence interval; aRR: Relative risk adjusted for deprivation and sex.

* Categories one and zero comorbidity had to be grouped together in order to achieve a sufficient number of observations in the analyses.

** Adjusted for deprivation and sex.

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