

Covid-19 Incidence And Mortality By Age Strata And Comorbidities In Mexico

City: A Focus In The Pediatric Population.

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1 **Covid-19 incidence and mortality by age strata and comorbidities in Mexico**

2 **City: a focus in the pediatric population.**

3 **Abstract**

4 **Background.** SARS-COV2 appears less frequently and less severely in the
5 pediatric population than in the older age groups. There is a need to precisely
6 estimate the **specific risks** for each age group to design health and education
7 policies suitable for each population

8 **Objective.** This study aimed to describe the risk of death in SARS-COV2 infected
9 subjects by age group and according to the presence of comorbidities.

10 **Methods.** We analyzed data of confirmed SARS-COV2 infection cases where
11 symptoms began between February 22th, 2020, and April 18th, 2021, as published
12 by the General Epidemiology Direction (DGE) of the Mexican Ministry of Health.
13 We calculated COVID-19 incidence and mortality by age group using population
14 data from the Statistics and Population National Institute (INEGI), and estimated
15 the association between risk of death and the presence of comorbidities.

16 **Results.** Mortality in SARS-COV2 infected people varied considerably, between 7
17 to 155 deaths per million per year in the under-20 age groups compared to 441 to
18 15,929 in the older age groups. Mortality in pediatric populations is strongly
19 associated with comorbidities (OR: 4.6- 47.9) compared to the milder association
20 for older age groups (OR: 3.16-1.23).

21 **Conclusions.** The risk of death from SARS-COV2 infection in children is low and
22 is strongly associated with comorbidities.

23 Key Words: COVID-19; SARS-COV2; Children; Mexico City; epidemiology.

24

25 **Introduction**

26

27 After more than a year, the COVID-19 pandemic has generated millions of
28 hospitalizations and deaths worldwide. In addition to the direct impact caused by
29 the SARS-COV2 infection itself, indirect harms have arisen because of the
30 saturation of health systems, lockdown policies, and economic struggle.

31

32 Evidence indicates that children seldom develop a severe clinical presentation of
33 SARS-COV2 infection and are less prone to transmit it than adults (1–4). For
34 example, in China, more than 90% of infected children had a mild or moderate
35 clinical presentation, a finding consistent with later reports (5,6). During the first
36 three months of the pandemic, Mexico reported a 12.6% positivity rate for SARS-
37 COV2 infection in tested children and a case-fatality rate of 1.9% (7). Mexico as a
38 whole has been severely affected by the SARS-COV2 pandemic, as the overall
39 death rate attests.

40

41 Despite the apparent low risk of severe disease in children, policies to mitigate the
42 transmission rate in all age strata populations have restricted activities and settings
43 essential for optimal child well-being and development. Therefore, accurate
44 estimates of the health risks associated with SARS-COV2 infection in the pediatric
45 population are necessary to design policies that optimize children’s well-being and
46 development while protecting more susceptible groups.

47

48 **This analysis aims to describe the epidemiology of SARS-COV2 in Mexico City,**

49 focusing on the children and adolescent population to appraise the specific health
50 risks of this age stratum.

51

52 **Methods**

53 We analyzed the epidemiological information for the SARS-COV2 pandemic in
54 Mexico City. Data were extracted from the open-access data published by the
55 General Epidemiology Direction (DGE) of the Mexican Ministry of Health, which
56 reports data from all symptomatic and tested individuals (8). We included in the
57 analysis the following three categories of cases: 1) virologically confirmed cases
58 (positive RT-PCR or antigenic test) plus 2) confirmed cases by epidemiologic
59 association (symptomatic contact of a virologically confirmed SARS-COV2
60 registered case in whom a valid nasal swab could not be performed), plus 3) cases
61 without a valid virologic test confirmed by expert judgment. Deaths from any of
62 these cases were recorded.

63 The DGE database includes information on the presence of specific comorbidities
64 and risk factors, such as male sex, diabetes, immunosuppression, systemic
65 hypertension, obesity, chronic renal disease, asthma, chronic obstructive
66 pulmonary disease (COPD), tobacco use, or a report for “other comorbidity.” We
67 calculated the frequency of each of these factors by age stratum and computed the
68 risk of death in both the “comorbidity-free” population and the population having
69 any of the reported comorbid condition by age-stratified groups.

70 The adjusted odds ratio (OR) for death in SARS-COV2 cases was calculated by
71 logistic regression. We included factors significantly associated with death in the
72 bivariate analysis.
73 We computed all-cause general mortality in 2019 and annualized COVID-19
74 mortality from February 22, 2020 to April 18th, 2021, using population data from
75 The National Institute of Geography and Statistics (9)(10). We calculated the ratio
76 of COVID-19 annualized mortality rate against 2019- all-cause mortality rate by
77 age strata.
78 Analysis was performed using Stata software, version 13.0 (StataCorp), and
79 graphs were made with GraphPad Prism version 9.1.0 for Windows (GraphPad
80 Software).

81 **RESULTS**

82 The DGE database includes 6,412,677 records of people tested for SARS-COV2
83 from February 20 to April 18, 2021 (422 days), of which 629,527 were confirmed as
84 COVID-19 cases by any of the following three means: 1) clinical- epidemiological
85 association (n= 83,997, 13.3%), 2) by an expert committee judgment (n=2,281,
86 0.4%) or 3) a positive virological test (n=543,249, 86.3%). Overall positivity rates
87 in those tested for SARS-COV2 were 34.5% and 19.7% for those tested with RT-
88 PCR and antigen test, respectively.

89 Total cases, deaths, and frequency of comorbidities by age group are reported in
90 Table 1. There were 52,432 total cases and 52 deaths in population younger than
91 20 years old. The significant differences in incidence and case-fatality rate between
92 pediatric and adult age strata are noticeable, with a case-fatality rate below 0.3%
93 in population between 1 and 20 years old which sharply increases beyond 40 years

94 age and reaches more than 18% beyond 60. The frequency of specific registered
95 comorbid conditions in the pediatric age group was very low, as most were coded
96 as “other comorbidities.”
97 Incidence and mortality by million people, case-fatality rate, and COVID-19/2019
98 all-cause-mortality ratio, are shown in Figure 1. The highest incidence of COVID-19
99 was observed in the 40-59 years old age group, with the case-fatality rate sharply
100 increasing with age. COVID-19 mortality has surpassed more than 50% of the all-
101 cause mortality in 2019 in age groups older than 40, while it has been less than 6%
102 for those younger than 20.

103 The adjusted OR for death in SARS-COV2 infected individuals for each
104 comorbidity and risk factor reported in the database can be consulted in Table 2.
105 Relative risk attributable to the presence of comorbidities was highest among
106 children and adolescents, comorbidities being accountable for 80-98% of the age-
107 specific mortality. In children under ten years of age, comorbid conditions
108 associated with increased mortality were mainly those coded as “other
109 comorbidities.” In those between 11 to 20 years old, diabetes, obesity,
110 immunosuppression, and chronic renal disease were the most significant
111 associated factors. Data for asthma, COPD, and tobacco use were not included
112 because they had no statistical association with death risk in almost any stratum.

113

114 **Discussion.**

115

116 This study describes the epidemiology of SARS-COV2 in the pediatric population
117 in Mexico City as related to the epidemiology of other age strata. COVID-19

118 incidence and case-fatality rate in children younger than ten years are several
119 times lower than in adults. Our results confirm those observed by others about the
120 low frequency of the disease and the low rate of complications and deaths in this
121 age group (5)(6). Besides, the case-fatality rate in youngsters is very strongly
122 associated with present comorbidities.

123

124 The interpretation of these results is limited by the quality of the information
125 provided by the DGA. Mexico is one of the countries with fewer SARS-COV2 tests
126 relative to population (53.2 tests per 1000 people) (11), leading to a significant
127 sub-estimation of cases. To increase the reliability of the information, we chose to
128 limit the analysis to Mexico City since it is one of the Mexican entities with more
129 comprehensive testing policies (283 tests per 1000) (12).

130 Besides, we decided to include cases confirmed by clinical-epidemiological
131 association and expert panel judgment to mitigate the known underreporting
132 derived from the low testing frequency. Together, non-virologically confirmed
133 cases represent 14% of analyzed registers. While this decision might have biased
134 absolute frequency estimates upwards, it does not modify our conclusion about the
135 extremely low mortality by COVID-19 in the pediatric age group. Meanwhile, the
136 relative estimates between age strata are still informative.

137

138 There is a lack of systematized information on the factors that increase the risk of
139 death in the pediatric age group in Mexico. The mandatory epidemiological report
140 in Mexico does not contain detailed information on the most frequent comorbidities
141 in the pediatric age group, and those that exist frequently are reported under the

142 umbrella term “other comorbidities.” This comorbidity category is the most
143 commonly associated with lethality in the pediatric age group. Informal personal
144 communications let us know that under this “umbrella term,” there is a high
145 proportion of premature neonates with major congenital anomalies, disabled
146 children with chronic neurological diseases, and cancer patients. A population-
147 based cohort study in the United Kingdom(13) found 26,322 SARS-COV2
148 virologically confirmed cases younger than 18 years of age (1% cumulative
149 incidence). Of these, 159 (0.006%) children were admitted to the hospital for more
150 than 36 hours, while 73 were admitted to an intensive care unit (ICU).
151 Comorbidities associated with hospital admission were type 1 diabetes (OR: 10.1,
152 IC 95%: 4.12-24.8), congenital heart disease (OR: 2.69, IC 95%: 1.27-5.71),
153 cerebral palsy (OR: 7.96, IC95%: 2.79 -22.76), epilepsy (OR: 6.17, IC 95%: 2.77-
154 13.73) and sickle cell disease (OR: 8.24, IC 95%: 2.02-33.5). Interestingly, this
155 study did not found a significant association between asthma and hospital
156 admission, and neither did ours. Only one death during the study period was
157 reported so that no analysis could be done for this outcome. Other comorbidities
158 found to be associated with ICU admissions are obesity and prematurity (14)(15).

159

160 In addition to the diverse risk factors for death, there is a need to establish the
161 causal role of SARS-Cov 2 in pediatric fatalities in our population, including
162 whether the SARS-COV2 infection was an incidental finding in a severely ill child,
163 a contributing agent in a vulnerable patient, a nosocomial infection in a person
164 hospitalized for another severe disease or indeed a major cause of death. Besides,
165 as was pointed in a previous report, the quality of health care might be an

166 essential contributing factor for the increased case-fatality rate in comparison to
167 other high-income countries (16).

168

169

170 While COVID-19 mortality represents a substantial proportion of the expected
171 deaths in the pre-pandemic years or has almost equaled it in older age groups,
172 there is no excess mortality rate in the pediatric age group. Relevant data on other
173 health problems in the young Mexican population is helpful to contextualize the
174 probability of death because of SARS-COV2 infection in children and adolescents
175 (~10 per million). For example, some of the preventable causes of death in Mexico
176 City in 2019 were more frequent than COVID-19 mortality in pediatric age groups:
177 congenital infections (1871 deaths per million in <1 age), violence (16 deaths per
178 million in 1-4 year-olds), accidents (15 deaths per million in 5-14-year-olds) and
179 suicide (47 deaths per million in 15-19-year-olds). Many other Mexican states had
180 comparable or higher mortality because of malnutrition and gastrointestinal
181 infections. (9,10) Besides deaths, additional important health issues are being
182 affected as a secondary effect of the pandemic, such as immunization, (13)
183 perinatal health care, and chronic diseases attention programs. (7)(14)(15) In
184 Mexico, schools have been closed for about 50 million children and adolescents for
185 longer than a year. Increasing evidence suggests that prolonged school closure,
186 home confinement, and social restrictions could have significant consequences for
187 the mental health of both children and adolescents. (8)(17)(18)
188 SARS-COV2 vaccination program started in December 2020. By the cutoff date

189 for this analysis in April, less than 1% of the population had been fully vaccinated
190 (11). Since then, this rate has been rapidly increasing, so the expected risks of
191 SARS-COV2 infection in every age strata are expected to decline substantially.

192 **Conclusion**

193 The risk of death from SARS-COV2 infection in children **from Mexico City** is low
194 and is mainly associated with comorbidities. The low risk of direct health injury
195 from SARS-COV2 infection in this age group should be balanced against other
196 prevalent health risks exacerbated by the pandemic mitigating measures. More
197 research should be done regarding the specific factors contributing to death in
198 SARS-COV2 fatal cases to characterize better the vulnerable pediatric population
199 and design policies targeted for them.

200

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202 **Conflicts of interest:** The authors declare no conflicts of interest

203

204 **References**

205

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276 Captions

277 **FIGURE 1. A.** COVID-19 annualized incidence and mortality rates per 1,000,000 people **B.** case-
278 fatality rate, and COVID-19/ 2019 all-cause mortality ratio by age strata

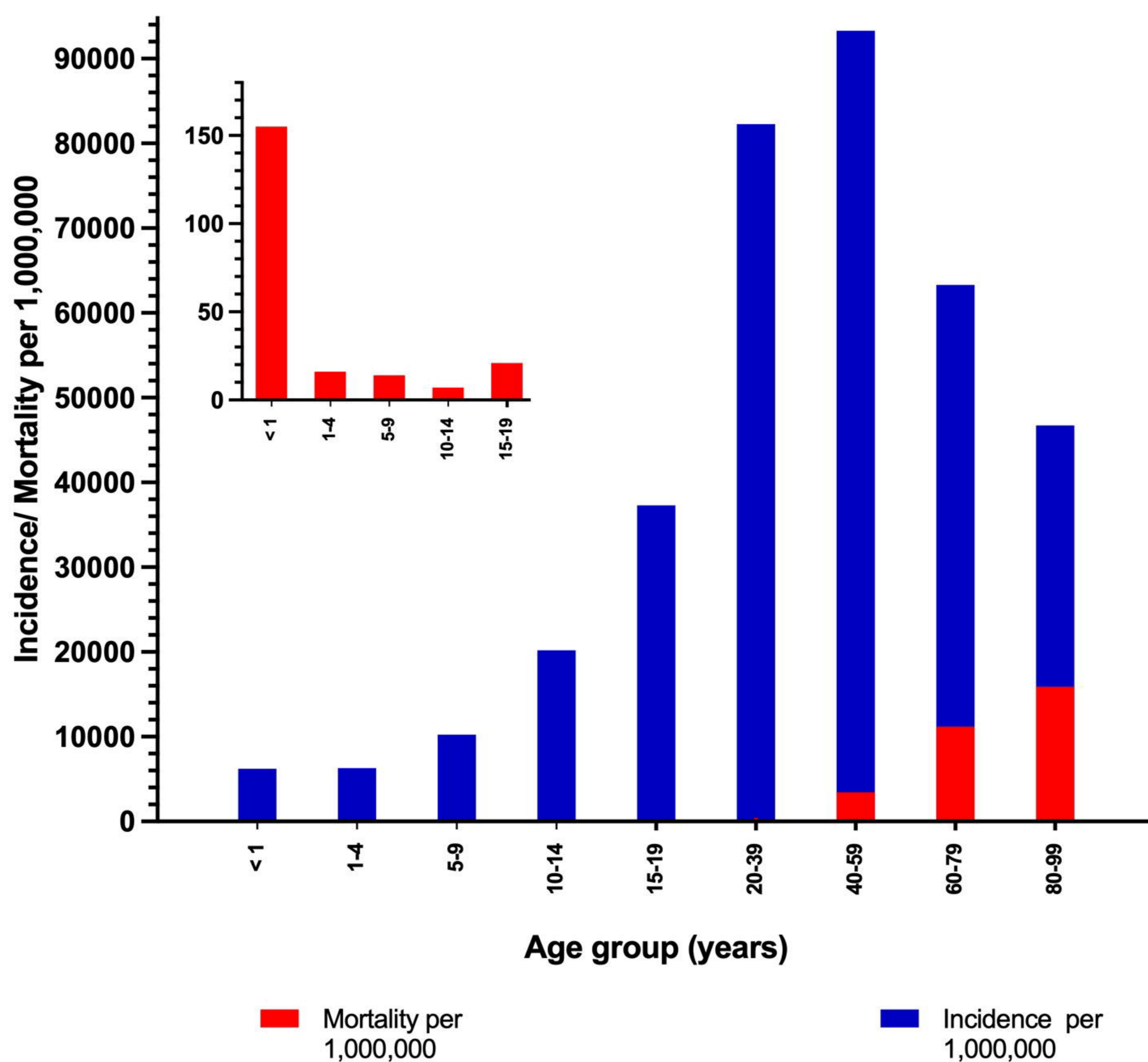
279 **Table 1.** Cases, deaths, and comorbidity frequencies by age group in Mexico City from
280 February 22th to April 18th.

281 **Table 2.** Death risk in SARS-COV2 confirmed cases by comorbidities

	<1 year	1-4 years	5-9 years	10-14 years	15-19 years	20-39 years	40-59 years	60-79 years	80-99 years
Total cases	743	2,741	6,683	14,223	28,042	239,952	232,254	92,846	12,043
Total deaths	16	6	9	5	16	1,488	9,937	16,420	4,106
Share of total deaths	0.05%	0.02%	0.03%	0.02%	0.05%	4.7%	31.1%	51.3%	12.8%
Incidence per 1 million	6,223	6,263	10,250	20,201	37,292	82,278	93,305	63,299	46,721
Mortality per 1 million	155	16	14	7	21	441	3,453	11,195	15,929
Case-fatality rate (%)	2.15	0.22	0.13	0.04	0.06	0.62	4.28	17.69	24.09
COVID-19 / all cause 2019 mortality (%)	1.4	2.8	5.9	3.0	2.5	29.6	62.1	90.8	86
Male sex (%)	53.6	52.1	51.7	50.2	49.6	48.3	47.4	49.9	47.3
Indigenous n (%) ¹	3 (0.4)	9 (0.3)	21 (0.3)	48 (0.3)	88 (0.3)	1003 (0.4)	1230 (0.5)	585 (0.6)	73 (0.6)
Diabetes n (%)	ND ²	4 (0.2)	18 (0.3)	52 (0.4)	120 (0.4)	4536 (1.9)	30153 (13.0)	26379 (28.5)	3227 (26.9)
Inmunosupressed n(%)	13 (1.8)	19 (0.7)	20 (0.3)	42 (0.3)	61 (0.2)	805 (0.3)	1698 (0.7)	1262 (1.4)	188 (1.6)
Systemic Hypertension n (%)	ND	9 (0.3)	8 (0.1)	37 (0.3)	117 (0.4)	6152 (2.6)	35543 (15.3)	34649 (37.4)	5847 (48.8)
Obesity n (%)	48 (6.5)	11 (0.4)	117 (1.8)	448 (3.2)	1085 (3.8)	22693 (9.5)	31633 (13.7)	11719 (12.7)	1002 (8.4)
Chronic Renal Disease n(%)	4 (0.5)	3 (0.1)	14 (0.2)	19 (0.1)	53 (0.2)	899 (0.4)	2038 (0.9)	2200 (2.4)	342 (2.9)
Chronic Obstructive Pulmonary Disease n(%)	4 (0.5)	2 (0.07)	8 (0.1)	10 (0.1)	26 (0.1)	289 (0.12)	1272 (0.6)	2365 (2.6)	870 (7.3)
Asthma n(%)	11 (1.5)	33 (1.2)	159 (2.4)	403 (2.8)	729 (2.6)	5474 (2.3)	4283 (1.8)	1326 (1.4)	144 (1.2)
Smoker n (%)	ND	ND	ND	62 (0.44)	1069 (3.82)	29872 (12.5)	22147 (9.6)	7228 (7.8)	807 (6.7)
Other comorbiditie(s) n (%)	15 (2.0)	36 (1.3)	32 (0.5)	72 (0.5)	112 (0.4)	1732 (0.7)	2743 (1.2)	2078 (2.3)	467 (3.9)
<p>1 Includes all those who self-identified as indigenous or spoke an indigenous language</p> <p>2 No data</p>									

N=629, 518	Lethality if present any comorbidity % (n)	Lethality if no reported comorbidity %(n)	Relative Risk for death if comorbidity present (IC95%)	Attributable risk relative to comorbidity ¹	Adjusted Odds Ratio for Death						
					Male sex	Diabetes	Immunosuppression	Systemic Hipertension	Obesity	Chronic Renal Disease	Other comorbidities
<1 years	5.8% (9/154)	1.2% (7/589)	4.9% (1.9-13.0)	79%	5.3 ²	-	3.2	-	-	-	5.4
1-4 years	2.4 % (3/127)	0.1% (3/2614)	20.6% (4.2-101.0)	96%	0.95	-	-	-	-	-	47.5 ³
5-9 years	0.5% (2/378)	0.1% (7/6296)	4.6% (1.0-22.3)	80%	1.4	-	-	-	5.7	27.12 ²	52.5 ³
10-14 years	0.4% (4/1097)	0.01% (1/13126)	47.9% (5.4-427.8)	98%	2.9	111.2 ³	6.6	-	1.93	-	141.7 ³
15-19 years	0.3% (9/3121)	0.03% (7/24921)	10.3% (3.8-27.6)	90%	1.7	0.9	38.7 ³	0.02	8.8 ³	46.7 ³	4.04
20-39 years	1.3% (808/60904)	0.4% (680/179048)	3.5% (3.2-3.9)	69%	2.7 ³	4.7 ³	1.9 ²	2.7 ³	2.94 ³	9.2 ³	4.5 ³
40-59 years	6.6% (6157/92828)	2.7% (3780/139426)	2.5% (2.4-2.5)	59%	2.7 ³	2.4 ³	1.8 ³	1.7 ³	1.93 ³	4.89 ³	3.0 ³
60-79 years	20.7% (11234/54236)	13.4% (5186/38610)	1.5% (1.5-1.6)	35%	1.9 ³	1.5 ³	1.23 ²	1.2 ³	1.63 ³	2.94 ³	2.9 ³
80-99 years	36.5% (2834/7763)	29.7% (1272/4280)	1.2% (1.2-1.3)	19%	1.8 ³	1.2 ³	1.2	1.2 ³	1.44 ³	1.46 ³	2.2 ³

¹ (Lethality if comorbidity present – Lethality if no comorbidity) / Lethality if comorbidity present. ²P <0.05, ³P<0.001

A**B**