

# WHITE PAPER

## Risk Factors for COVID-19 Mortality among Privately Insured Patients

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A Claims Data Analysis

A FAIR Health White Paper in Collaboration with the West Health Institute and  
Marty Makary, MD, MPH, from Johns Hopkins University School of Medicine,  
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## Summary

Previous research has suggested that advanced age, male gender and certain comorbidities are risk factors for COVID-19 mortality. To shed further light on these risk factors in privately insured patients, FAIR Health, in collaboration with the West Health Institute and Marty Makary, MD, MPH, from Johns Hopkins University School of Medicine, undertook an analysis using the nation's largest private healthcare claims database, the FAIR Health National Private Insurance Claims (FH NPIC®) repository. Evaluating all patients in FH NPIC's longitudinal dataset, we identified 467,773 patients diagnosed with COVID-19 from April 1, 2020, through August 31, 2020. We examined relationships between the outcome of mortality (dependent variable) and the following independent variables: age, gender and preexisting comorbidities. The results of this analysis could help inform protocols for vaccine distribution as well as prevention and treatment protocols. Among the findings:

- **Mortality rate.** Of patients diagnosed with COVID-19, 0.59 percent died.
- **Gender.** Males accounted for 60.07 percent of total COVID-19 deaths, females for 39.93 percent.
- **Age.** Patients over age 69 accounted for 4.82 percent of COVID-19 diagnoses but 42.43 percent of total deaths from COVID-19.
- **Developmental disorders.<sup>i</sup>** Across all age groups, COVID-19 patients with developmental disorders (e.g., developmental disorders of speech and language, developmental disorders of scholastic skills, central auditory processing disorders) had the highest odds of dying from COVID-19 (odds ratio [OR]=3.06, 95 percent confidence interval [CI], 1.554-6.008,  $P=0.0105$ ).
- **Cancer.** In patients under age 70, two types of cancer ranked among the top four risk factors for COVID-19 mortality: Lung cancer was number one; leukemia and lymphomas ranked fourth. The results indicate that, in the under-70 age cohort, patients with COVID-19 and lung cancer were nearly seven times more likely to die (OR=6.74, 95 percent CI, 4.711-9.639,  $P<0.0001$ ) than patients who had COVID-19 but not lung cancer. In the same age cohort, COVID-19 patients with leukemia or lymphoma were nearly three times more likely to die (OR=2.89, 95 percent CI, 2.110-3.958,  $P<0.0001$ ) than COVID-19 patients without those malignancies.
- **Intellectual disabilities and related conditions.** Across all age groups, COVID-19 patients with intellectual disabilities and related conditions (e.g., Down syndrome and other chromosomal anomalies; mild, moderate, severe and profound intellectual disabilities; congenital malformations, such as certain disorders that cause microcephaly) had the third highest risk of COVID-19 death (OR=2.75, 95 percent CI, 1.657-4.558,  $P=0.0005$ ). Among COVID-19 patients under age 70, intellectual disabilities and related conditions still had the third highest risk (OR=3.61, 95 percent CI, 1.878-6.930,  $P=0.0007$ ).
- **Chronic kidney disease (CKD) and heart failure.** Across all age groups, the OR for COVID-19 mortality for patients with CKD was 1.85 (95 percent CI, 1.666-2.051,  $P<0.0001$ ); for patients with heart failure, it was 1.58 (95 percent CI, 1.383-1.797,  $P<0.0001$ ).
- **All age groups versus patients under age 70.** The risk of COVID-19 mortality was generally higher for a comorbidity for patients under age 70 than it was for the same comorbidity for patients of all age groups.
- **Lack of comorbidities.** Lack of comorbidities was partially protective against COVID-19 mortality, but not completely. Of COVID-19 patients who died, 83.29 percent had a preexisting comorbidity, while 16.71 percent did not, per the medical claims data.
- **Multiple comorbidities.** As a patient's number of comorbidities increased, so did the odds of dying from COVID-19.

## Introduction

The global outbreak of COVID-19 has resulted in over 48 million cases worldwide, with over 9 million cases and over 230,000 deaths in the United States at the time of this writing.<sup>1</sup> Notwithstanding the wide-

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<sup>i</sup> This category comprises diagnosis codes found in the learning disabilities category of the Chronic Conditions Data Warehouse (CCW).

ranging devastation that the pandemic has wrought, advances in therapeutics and a better overall understanding of how to treat COVID-19 have resulted in a lower COVID-19 mortality rate.<sup>2, 3, 4</sup> Advances in vaccine candidate development have prompted planning regarding vaccine allocation and distribution. Currently, a three-phase vaccine distribution plan developed by the federal government contemplates initially offering a limited number of vaccine doses for high-priority populations; state and local health departments will have the primary responsibility for vaccine distribution.<sup>5</sup> Information about patient populations at risk of COVID-19 mortality would inform protocols for priority in vaccine distribution. Such research also can help inform prevention and treatment protocols for those deemed to be most at risk of COVID-19 mortality.

Previous research has highlighted associations between greater risk of severe COVID-19 illness and death and patient characteristics, including advanced age,<sup>6</sup> male biological sex<sup>7</sup> and specific preexisting comorbidities. In the United States, studies have shown that the most commonly cited comorbidities associated with severe COVID-19 outcomes and mortality are hypertension, obesity, diabetes, cardiovascular disease<sup>8, 9, 10</sup> and chronic kidney disease (CKD)<sup>11</sup>—including among kidney transplant patients.<sup>12</sup> A systematic review found that common comorbidities among 22,753 COVID-19 patients worldwide included cardiovascular disease, hypertension, diabetes, chronic obstructive pulmonary disease (COPD), cancer and CKD, followed by other comorbidities.<sup>13</sup> COVID-19 and cancer comorbidity has been a particular area of concern.<sup>14</sup> Other comorbidities cited as conferring greater risk for worse COVID-19 outcomes include chronic liver disease,<sup>15, 16</sup> as well as conditions that affect pulmonary function, such as COPD, which includes chronic bronchitis and emphysema.<sup>17, 18</sup> A number of comorbidities that are associated with greater risk of severe outcomes in COVID-19 (e.g., heart disease, hypertension, diabetes) also are more prevalent among those with intellectual and developmental disabilities (IDD).<sup>19</sup> IDD has been associated with a higher risk of COVID-19 mortality.<sup>20, 21</sup>

To date, comorbidities have explained the greatest proportion of COVID-19 mortality. However, reports of COVID-19 deaths among those in younger age groups and those with no overt comorbidities also warrant further investigation.<sup>22</sup>

In collaboration with the West Health Institute and Marty Makary, MD, MPH, from Johns Hopkins University School of Medicine, FAIR Health undertook an analysis using the largest private healthcare claims database in the United States, the FAIR Health National Private Insurance Claims (FH NPIC<sup>®</sup>) repository. The study's overarching goal was to generate a set of results using big data analysis in order to inform public health recommendations and policies, particularly those related to protocols for distribution of first-line vaccines or therapeutics. Our primary study objective was to study the risk factors (patient age, gender and preexisting comorbidities) for COVID-19 mortality among privately insured patients.

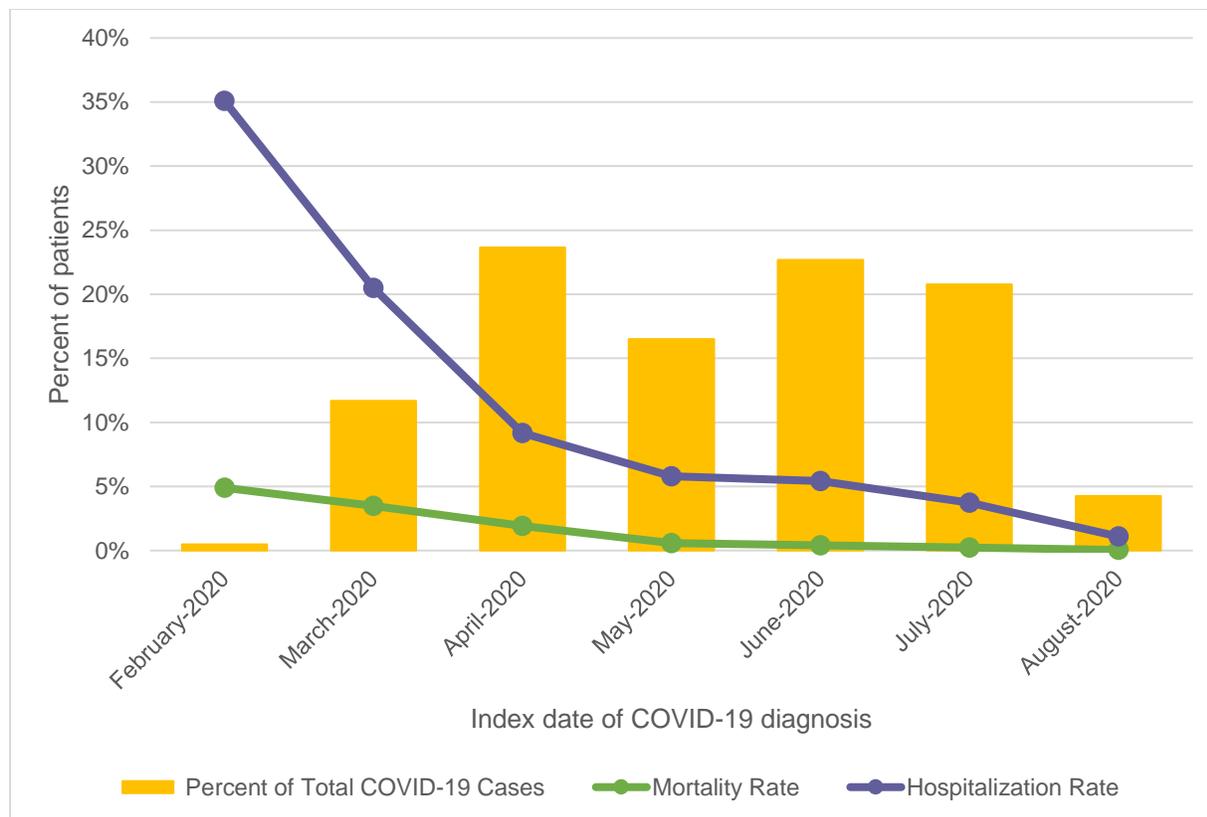
## Methodology

For this analysis, we used a longitudinal claims subset of the FH NPIC<sup>®</sup> database. This subset includes approximately 100 million covered lives. We evaluated all privately insured patients in this longitudinal dataset with a diagnosis of COVID-19 on the earliest claim record in any healthcare setting (including hospitals) from April 1, 2020, through August 31, 2020.<sup>ii</sup> We excluded claims data from February and March 2020 to account for the variation in COVID-19 coding and treatment, and subsequent variance in mortality rates, prior to April 2020.

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<sup>ii</sup> Claims data for August 2020 exclude any incurred but not reported (IBNR) claims, which can sometimes lag. The August data was about 90 percent complete when retrieved.

Figure 1 shows the considerable difference in mortality and hospitalization rates in February and March 2020 as compared to April 2020 and later. (Unlike the rest of this study, this figure did not exclude data from those two months.) Even though the percentage of COVID-19 cases was lowest in February, the mortality rate (percent of individuals diagnosed with COVID-19 who died) and hospitalization rate were at their highest. Those rates declined in March but were still high compared to the months that followed.



Month	Mortality Rate	Hospitalization Rate	Percent of Total COVID-19 Cases
February-2020	4.9%	35.1%	0.5%
March-2020	3.5%	20.5%	11.7%
April-2020	1.9%	9.2%	23.6%
May-2020	0.6%	5.8%	16.5%
June-2020	0.4%	5.4%	22.7%
July-2020	0.2%	3.7%	20.8%
August-2020	0.0%	1.1%	4.2%

**Figure 1. Percent of total COVID-19 cases with mortality rate and hospitalization rate, February-August 2020**

Using the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes, we identified COVID-19 patients who had the ICD-10 diagnosis code U07.1 (COVID-19) in any of the 24 diagnosis positions on the claim or claim line (12 at the claim level and 12 at the line level). We identified 467,773 privately insured patients diagnosed with COVID-19 from April 1, 2020, through August 31, 2020, in our dataset.

Descriptive statistics were used to calculate demographic factors (age and gender), including means/standard deviations (SD) and percentages. *P* values for descriptive statistics were calculated at

$P < 0.0001$ . We stratified the study population into patient cohorts by gender (male, female)<sup>iii</sup> and by seven age groups: 0 to 18, 19 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, and 70 and over. We computed risk for patients across all age groups and, separately, for patients under 70 years of age.

We examined relationships between the outcome of mortality (dependent variable) and the following independent variables: patient demographics (age, gender) and preexisting comorbidities. The dependent outcome variable, mortality, was counted if a patient's claim line included a discharge status of "expired." This may have resulted in an undercounting in the number of deaths, because to have a discharge of "expired" a patient must be admitted to the morgue or autopsied; there is reason to assume that, using New York City as an example, this was not routinely done at the height of the COVID-19 pandemic.<sup>23</sup>

### Patients with Comorbidities

We used historical data to identify patients' comorbidities, using dates of service with a three-year look-back period: April 1, 2017, to March 31, 2020, through 15 days prior to the index date of the COVID-19 diagnosis. We did so to establish that the comorbidity did, in fact, precede the COVID-19 diagnosis (and did not result from COVID-19). Comorbidities were established using the Centers for Medicare & Medicaid Services (CMS) Chronic Conditions Data Warehouse (CCW)<sup>iv</sup> diagnosis categories, which include common chronic conditions (e.g., diabetes, hypertension) as well as other chronic, potentially disabling conditions.

We attributed a comorbidity to a patient if he or she had at least three claim lines with the diagnosis for a CCW condition within the time period inclusive of April 1, 2017, to March 31, 2020, to fifteen days before the COVID-19 index date. For example, if a patient was first diagnosed with COVID-19 (index date) on April 15, 2020, we evaluated all data from April 1, 2017, to March 31, 2020, and established that there were three claim lines with any one of the ICD-10-CM diagnosis codes found within the 67 CCW condition categories. We evaluated all 24 diagnosis code positions (12 at the claim level and 12 at the line level).

We used random forest models to evaluate all comorbidities of interest and determine the associated predictors of COVID-19 mortality (key comorbidities) for further evaluation. We calculated the relative importance metrics and absolute importance metrics for each of the common comorbidities observed in deceased COVID-19 patients across all age groups. This decision tree model allowed us to determine the associated predictors of COVID-19 mortality.<sup>v</sup> We then narrowed down the list of independent variables for inclusion in the analysis to demographic factors (age and gender) and comorbidities deemed to be associated predictors of COVID-19 mortality. We also ran a logistic regression model to calculate the chi-square test. Chi-square tests were used to test the differences of distribution for the different predictor variables.

Stepwise regression models were used to elucidate which variables might be more highly correlated with COVID-19 mortality. Stepwise regression variables included age, gender and state in which the patient was diagnosed and were adjusted based on these variables. We also computed risk for patients across all age groups and for patients under age 70 to address any age-related confounding results.

We used a stepwise regression and a binary logit model with Fisher's scoring optimization to calculate the odds ratios (ORs) using 95 percent confidence intervals (Wald confidence limits). ORs were adjusted for

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<sup>iii</sup> We could not attribute a gender to approximately 100 patients in the study population due to "unknown" being included in the data field for gender.

<sup>iv</sup> CMS Chronic Conditions Data Warehouse: <https://www2.ccwdata.org/web/guest/condition-categories>.

<sup>v</sup> To calculate the relative importance metric, we used a procedure in SAS (HPSPLIT), which is a high-performance procedure that builds tree-based statistical models for classification and regression. The value it creates is called a relative importance metric; the metric is expressed as a number between 0 and 1 and is calculated in two steps. First, PROC HPSPLIT finds the maximum residual sum of squares (RSS)-based variable importance. Then, for each variable, it calculates the relative variable importance as the RSS-based importance of this variable divided by the maximum RSS-based importance among all the variables.

age, gender and states across all age groups. We used the following input variables: age groups (0 to 18, 19 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, 70 and over) using the age group of 30 to 39 as the reference group, patient gender (male, female) using female as the reference group, state of diagnosis (all 50 states) and CCW conditions. We computed ORs for the entire study population (all age groups) and separately for patients under age 70. This was because our initial data analysis covering patients across all age groups, adjusted for age and gender, revealed that mortality was more highly associated with the patient population of those age 70 and older. Thus, we chose to evaluate the data for patients under 70 years of age, again adjusting for age and gender.

To determine ORs for multiple comorbidities, we ran a count of comorbidities for both the full population and patients under 70 years of age, adjusting for both age and gender, using the same reference groups as previously described. We included only those conditions that were key comorbidities deemed as “important” in our decision tree model and/or comorbidities that had the highest ORs.

## Limitations

This study is subject to certain limitations. The FAIR Health data repository used in this study includes only private insurance claim records, and therefore may not be generalizable to the uninsured or those with public insurance such as Medicaid or traditional Medicare. The database does, however, include data on Medicare Advantage enrollees.

FAIR Health does not obtain data from all private payors or third-party administrators but only those who have elected to participate in FAIR Health’s contractual data contribution program. However, FAIR Health’s longitudinal dataset includes approximately 100 million lives. In addition, as part of the requirements for being certified as a Qualified Entity by CMS, FAIR Health demonstrated to CMS that FAIR Health’s private claims data were statistically representative of the populations in each of the 50 states and the District of Columbia.

As mentioned, we defined mortality by a claim line for a patient with a discharge status of “expired”. This may have resulted in an undercounting in the number of deaths because it required that the patient was admitted to the morgue or autopsied, which, at the height of the COVID-19 pandemic, was not routinely done. The results capture only those for whom claims were submitted through August 31, 2020. These data do not reflect incurred but not reported (IBNR) claims, which sometimes can lag. The analysis did not capture the patient population that was coded for COVID-19 using the B.97 code; this may have resulted in an undercounting of the overall study population for analysis. The CCW Warehouse condition categories do not feature mutually exclusive condition groupings, so multimorbidity and the overlap of conditions must be considered.

# Results

## Overall Mortality Rate

Using the FH NPIC dataset, we identified 467,773 patients with a diagnosis of COVID-19 from April 1, 2020, to August 31, 2020 (the study period). Of those patients, 2,753 died, for a mortality rate of 0.59 percent (figure 2).

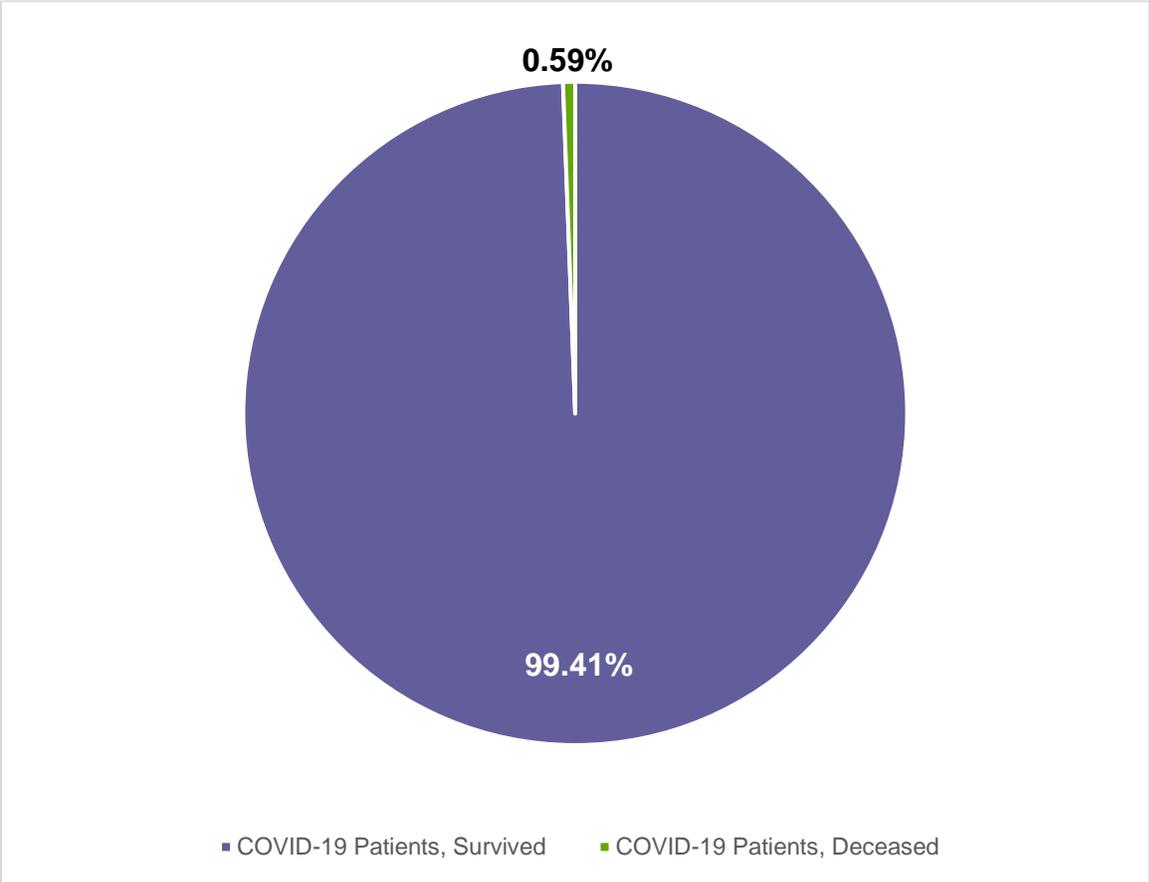


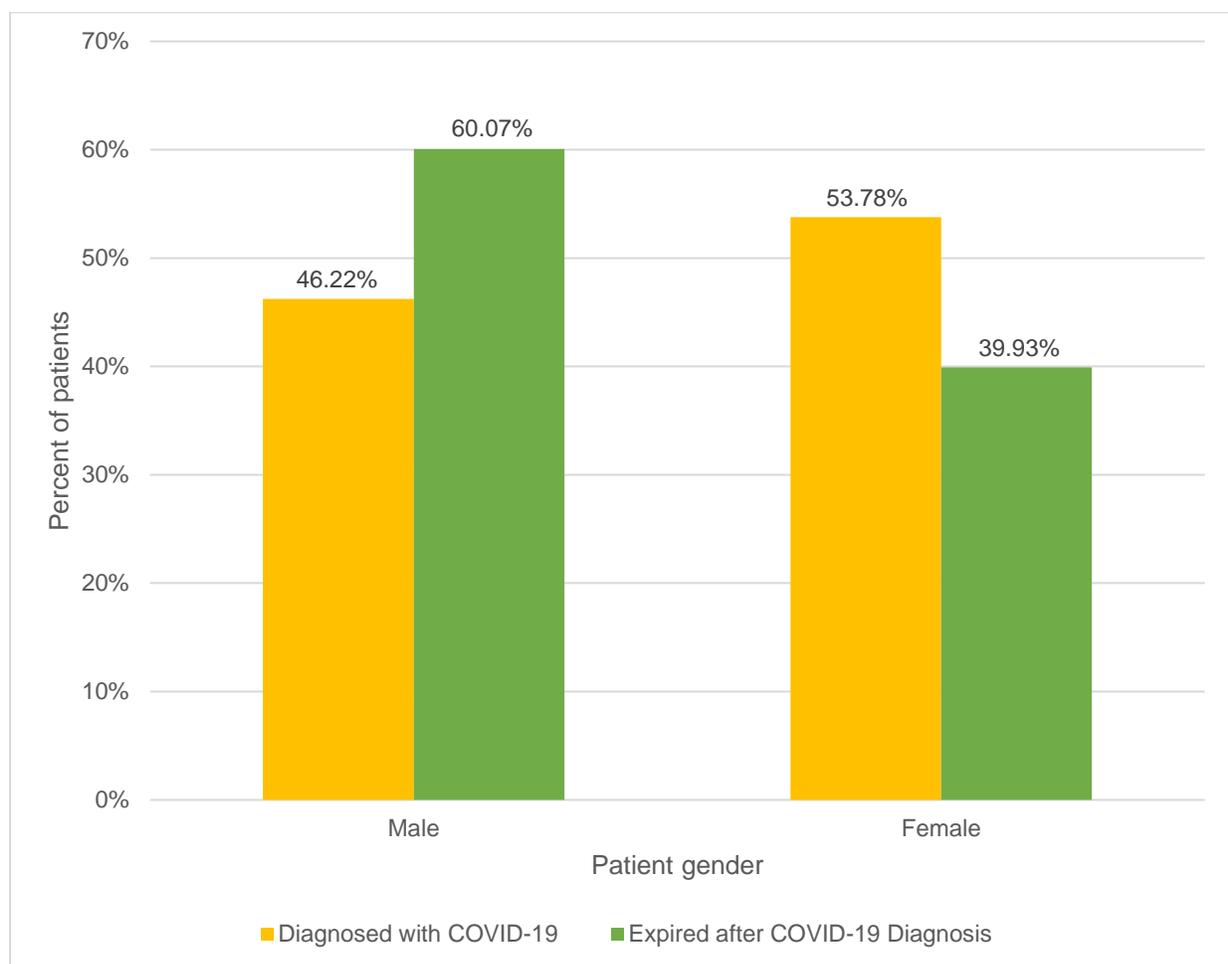
Figure 2. Distribution of COVID-19 patients by mortality, April-August 2020

## Gender

Males were somewhat less likely to be diagnosed with COVID-19, with only 46.22 percent of the total diagnoses attributed to males (figure 3). But in a statistically significant result ( $P < 0.0001$ ), mortality was much more likely to occur among males, with 60.07 percent of total deaths associated with that gender.

According to our analysis, male gender confers a higher risk of COVID-19 mortality across all age groups, both in the entire study population and among those without preexisting comorbidities. Of the entire COVID-19 study population, mortality rates among males was 0.77 percent (as a percentage of all male patients) compared to a female mortality rate of 0.44 percent among all females. The research literature shows that male gender is associated with a higher risk for severe COVID-19 morbidity and mortality.<sup>24</sup>

Gender differences in COVID-19 mortality have been explained by underlying biological factors and have been observed in other types of viral infections<sup>25</sup> and in vaccine efficacy.<sup>26</sup> While a discussion of molecular and genetic determinants that undergird these gender differences is outside the scope of this white paper, Scully et al. offer a summary of this research.<sup>27</sup>



**Figure 3. Distribution of COVID-19 diagnoses and deaths by gender, April-August 2020**

## Age

The age groups with the largest percentages of COVID-19 diagnoses were not necessarily those with the largest percentages of COVID-19 deaths (figure 4). Diagnoses were fairly evenly distributed from age 19 to 59, with lower percentages of diagnoses in individuals 60 and older. But mortality was much higher in those 50 and older, reaching 42.43 percent of all COVID-19 deaths in the age group 70 and over, even though that age group had the lowest share of COVID-19 diagnoses, 4.82 percent.

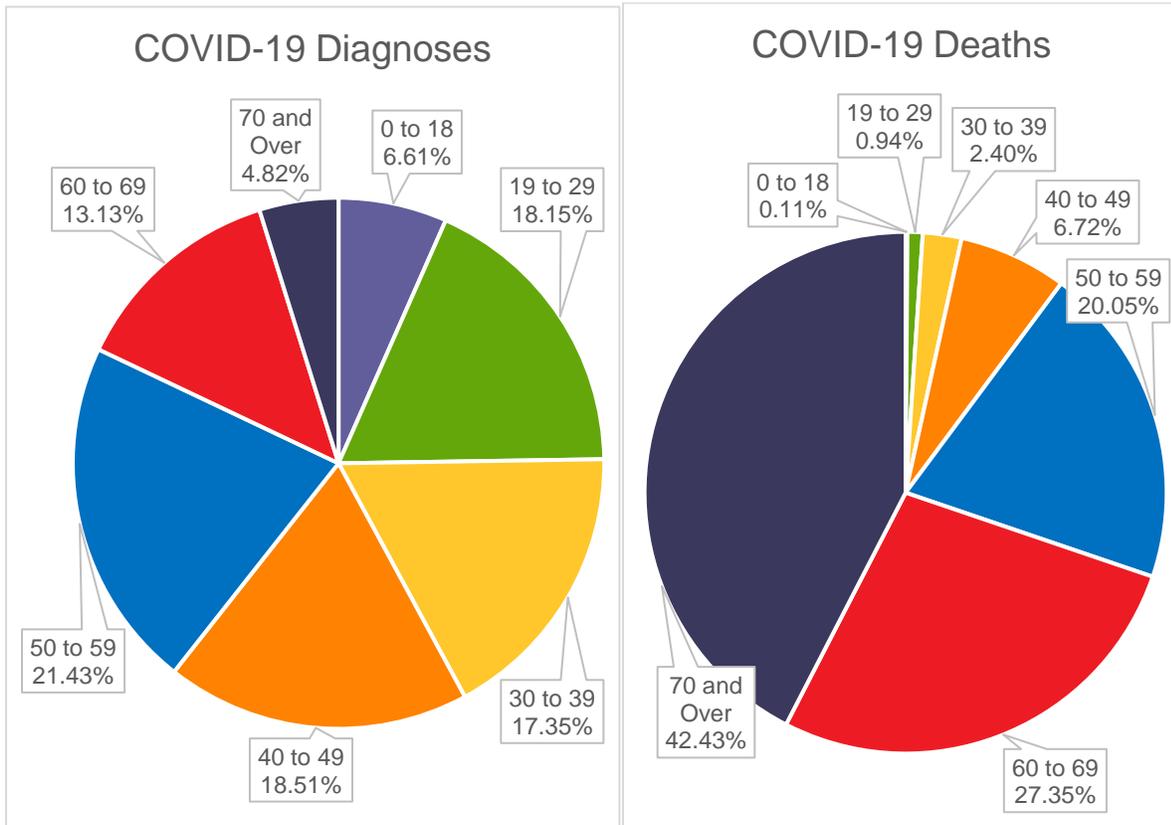
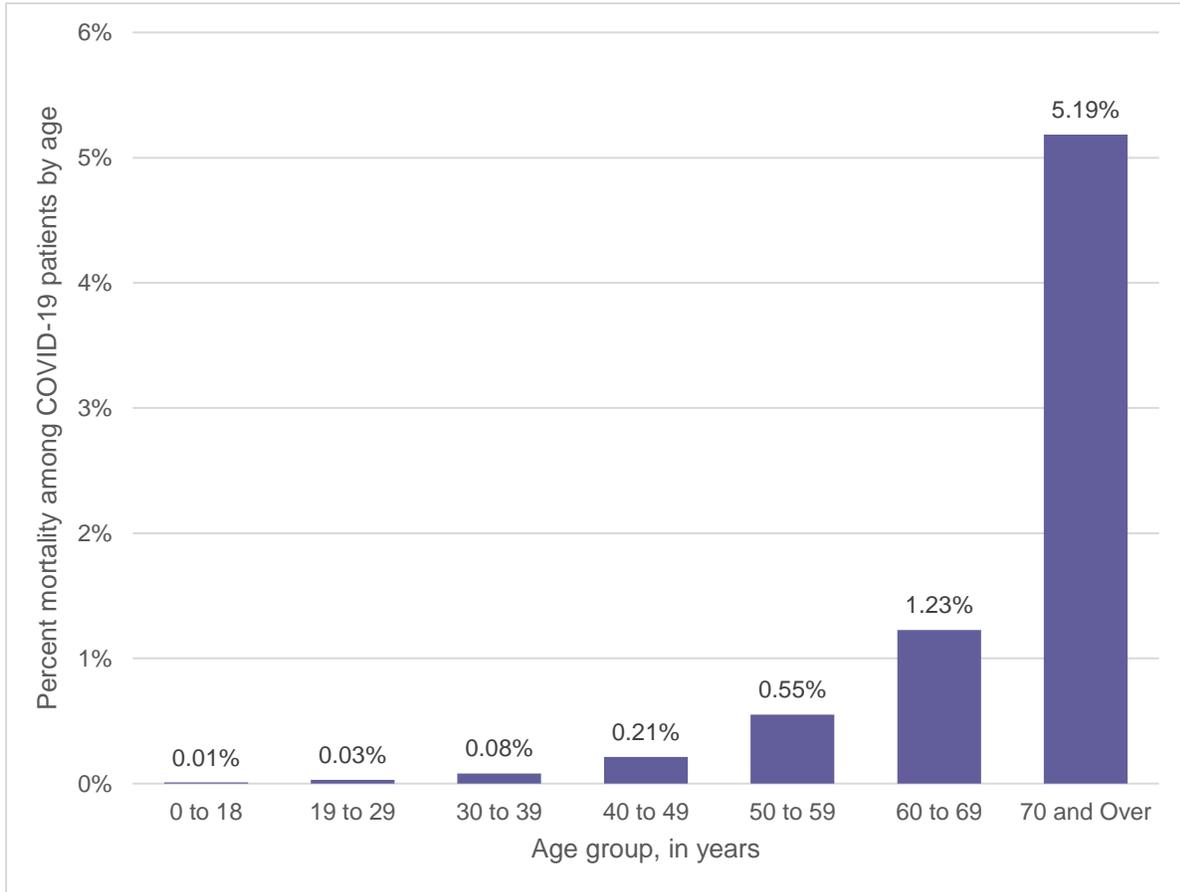


Figure 4. Distribution of COVID-19 diagnoses (left) and deaths (right) by age, April-August 2020

Consistent with earlier findings, the COVID-19 mortality rate in our study population rose sharply with age (figure 5). It is well established from other data that the risk for severe illness, including death, from COVID-19 increases with age.<sup>28, 29</sup> In our data, the mortality rate (the number of patients who died in an age group divided by the total number of COVID-19 cases in that age group) was extremely low for patients 39 years and under: less than a tenth of a percent. In COVID-19 patients aged 40 to 49, it jumped to 0.21 percent, and from there almost exponentially increased. Of those 50 to 59, more than half a percent died; of those 60 to 69, more than one percent died; and of those 70 and over, over five percent died.



**Figure 5. Percent mortality among COVID-19 patients by age, April-August 2020**

## Comorbidities as Risk Factors for COVID-19 Mortality

### Comorbidity Risk Factors in All Age Groups

COVID-19 patients across all age groups had greater odds of dying if they had any of the 15 comorbidities shown in figure 6. All odds ratios (ORs) were statistically significant except for that of endometrial cancer.

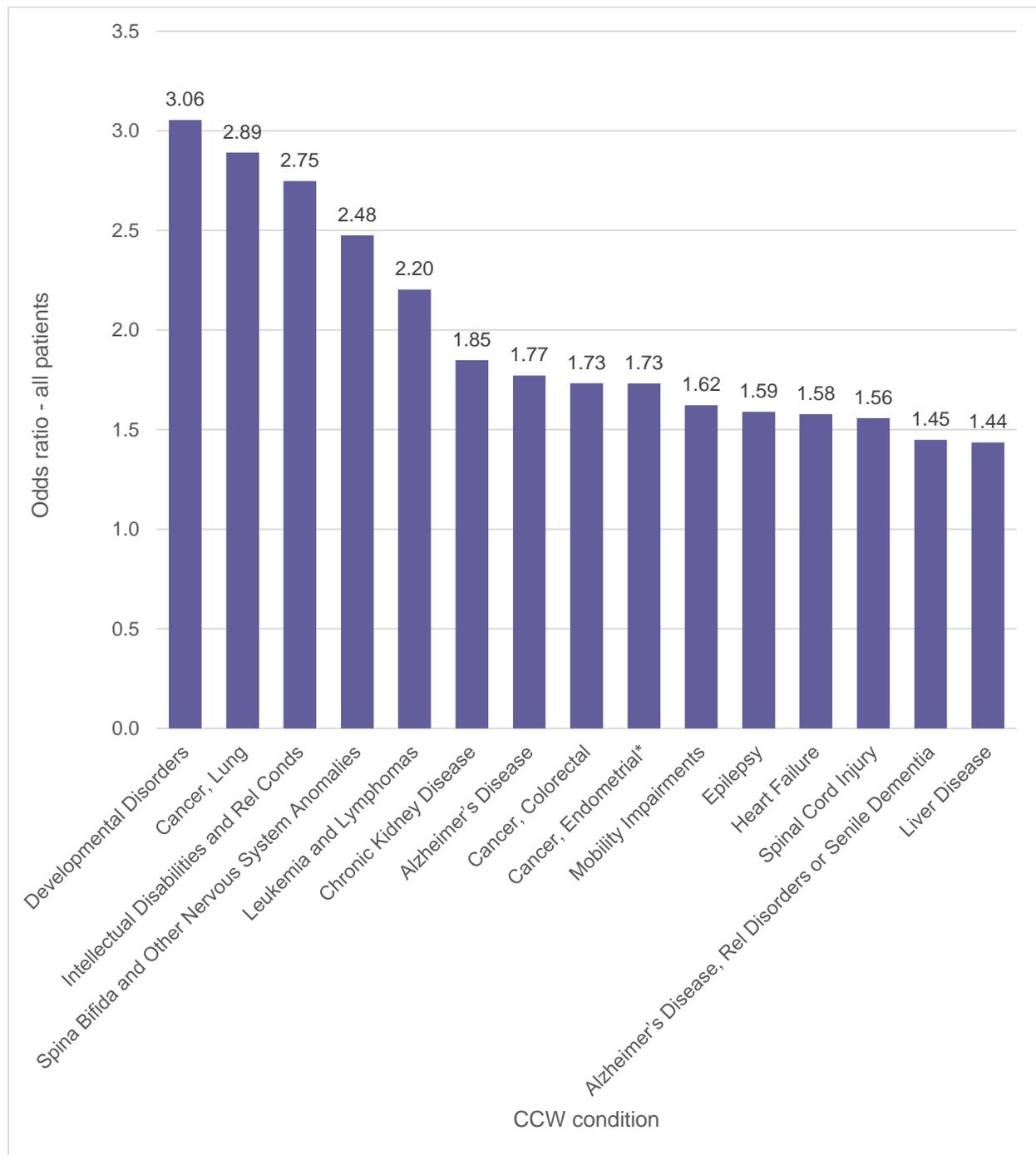


Figure 6. Comorbidity risk factors for COVID-19 mortality, adjusted for age and gender, by odds ratio, all patients, April-August 2020. “Rel” means “Related”; “Conds” means “Conditions.”

\*Endometrial cancer was not statistically significant.

The highest risk came with developmental disorders. With an OR of 3.06, patients with COVID-19 and developmental disorders were 3.06 times more likely to die than patients who had COVID-19 but not developmental disorders (95 percent confidence interval [CI], 1.554-6.008,  $P=0.0105$ ). After developmental disorders, the next four comorbidities, in order of highest to lowest risk, were lung cancer (OR=2.89, 95 percent CI, 2.209-3.784,  $P<0.0001$ ), intellectual disabilities and related conditions (OR=2.75, 95 percent CI, 1.657-4.558,  $P=0.0005$ ), spina bifida and other congenital anomalies of the nervous system (OR=2.48, 95 percent CI, 1.027-5.969,  $P=0.0283$ ) and leukemia and lymphomas (OR=2.20, 95 percent CI, 1.755-2.766,  $P<0.0001$ ).

**Developmental disorders and intellectual disabilities.** Our study highlights the high risk of COVID-19 mortality among those with developmental disorders (e.g., developmental disorders of speech and language, developmental disorders of scholastic skills, central auditory processing disorders), as well as intellectual disabilities and related conditions (e.g., Down syndrome and other chromosomal anomalies; mild, moderate, severe and profound intellectual disabilities; congenital malformations, such as certain disorders that cause microcephaly). (Autism is not included in either category; it is treated as a separate category in the CCW list.)

These findings are consistent with the research literature, which indicate that COVID-19 infections and mortality are higher among those with intellectual and developmental disabilities (IDD).<sup>vi</sup> In a study that collected data from residential group homes across New York State from the start of the pandemic through May 28, 2020, it was found that those with IDD had a higher case rate of COVID-19 (7,841 per 100,000) versus the New York State population overall (1,910 per 100,000).<sup>30</sup> In addition, the mortality rate for people with IDD of 1,175 per 100,000 was substantially higher than the rate of 151 per 100,000 for New York State overall. The nature of group settings, with higher transmissibility of the virus, is purported to be a factor in these results. IDD, like some other comorbidity risk factors shown in figure 6 (e.g., spina bifida, Alzheimer's disease and spinal cord injury) is associated with group homes and other forms of residential housing. Such housing has been identified as a risk factor not only for infection with SARS-CoV-2 (the virus that causes COVID-19) but for severity of COVID-19.<sup>31, 32, 33</sup>

Rates of comorbid respiratory disorders and comorbid endocrine, nutritional and metabolic disorders have been shown to be higher in the IDD patient population than among those without IDD across all age groups.<sup>34</sup> People with IDD often have multiple chronic health conditions,<sup>35</sup> which, as discussed below (figures 14 and 15), increases the odds of dying from COVID-19. In addition, individuals with IDD may not be prioritized for hospital care if they contract SARS-CoV-2.<sup>36, 37</sup>

Economic and social factors also may account for the higher risk of COVID-19 mortality among those with IDD. According to the Bureau of Labor Statistics, workers with disabilities are more likely than those without disabilities to be employed in positions that were deemed to be “essential” during the lockdowns in the United States. In 2019, workers with a disability, compared with those without a disability, were more likely to hold service occupations (20.7 percent, compared with 17 percent), and to hold occupations in production, transportation and material moving (14.5 percent, compared with 11.7 percent).<sup>38</sup> Thus, those with disabilities were less likely than others to have been able to work remotely to protect themselves from exposure to COVID-19. Other aspects of IDD, such as greater reliance on public transport and the need to disinfect mobility aids (e.g., wheelchairs) are also important considerations.<sup>39</sup> For additional commentary on the risks that this patient population faces amid the COVID-19 pandemic, see Constantino et al.<sup>40</sup>

**Cancer.** Among patients of all age groups, 4 of the top 15 age-and-gender adjusted risk factors associated with COVID-19 mortality were cancers: lung cancer, leukemia and lymphomas, colorectal cancer and endometrial cancer. (Endometrial cancer, however, with a  $P$  value of 0.0709 [OR=1.73, 95 percent CI, 0.964-3.112], was not significant.) These results support earlier research indicating that cancer patients who develop COVID-19 have a high mortality risk.<sup>41, 42</sup> That research includes a systematic review and pooled analysis of 52 studies that showed a pooled case mortality rate among patients with cancer and COVID-19 of 25.6 percent.<sup>43</sup> The authors observe that underlying lung cancer

<sup>vi</sup> Developmental disabilities is a term that overlaps with developmental disorders.

and hematological malignancies put COVID-19 patients at greater risk than other cancers, which is supported by our results.

A prospective cohort study in the United Kingdom found that patients with hematological malignancies (leukemia, lymphoma, myeloma) had more severe courses of COVID-19 than patients with solid organ tumors such as lung cancer, which was underrepresented in their data.<sup>44</sup> One reason for this difference from our results may be methodological. The UK study compared patients with lung cancer and COVID-19 to patients with cancer but without COVID-19, instead of to COVID-19 patients without lung cancer.

**Spina bifida and other congenital anomalies of the nervous system.** Diagnoses of spina bifida overlap with IDD and other conditions.<sup>45</sup> This may help explain its association with a higher risk of death due to COVID-19.

**Chronic kidney disease (CKD).** Our analysis is consistent with the literature on the increased risk of COVID-19 death in patients with CKD. Across all age groups, the OR for COVID-19 mortality for patients with CKD was 1.85 (95 percent CI, 1.666-2.051,  $P<0.0001$ ). The literature suggests that among patients in long-term care facilities, those who are in renal failure and those with cancer are more likely to die upon contracting COVID-19.<sup>46</sup> Patients undergoing maintenance hemodialysis for renal failure experienced higher mortality rates due to COVID-19 than those without kidney failure.<sup>47</sup> These patients also can be more vulnerable to contracting SARS-CoV-2 if they are being treated through in-center dialysis due to the inability to maintain strict social distancing and self-isolation measures that would protect against exposure.<sup>48</sup> These findings also are echoed by a previous FAIR Health analysis,<sup>49</sup> which showed that the most common comorbidity of patients who were hospitalized with COVID-19 was CKD and kidney failure.

**Alzheimer's disease.** We found that Alzheimer's disease conferred a higher risk of COVID-19 mortality across all age groups (OR=1.77, 95 percent CI, 1.461-2.148,  $P<0.0001$ ).<sup>vii</sup> While this finding may be partly explained by the possibility that patients with Alzheimer's disease may be more likely to live in a residential care facility, other research highlights another potential explanation. According to a study in the United Kingdom, the *ApoE* e4e4 allele (which is associated with higher-risk Alzheimer's disease among those of European ancestry) confers greater risk of COVID-19 mortality, independent of preexisting dementia, cardiovascular disease and type 2 diabetes.<sup>50</sup> This suggests that, in addition to the co-occurrence of Alzheimer's disease with older age and residential care, genetic determinants also may play a role in COVID-19 outcomes. More generally, current literature suggests that underlying biological and genetic factors may be associated with COVID-19 death.<sup>51, 52, 53</sup>

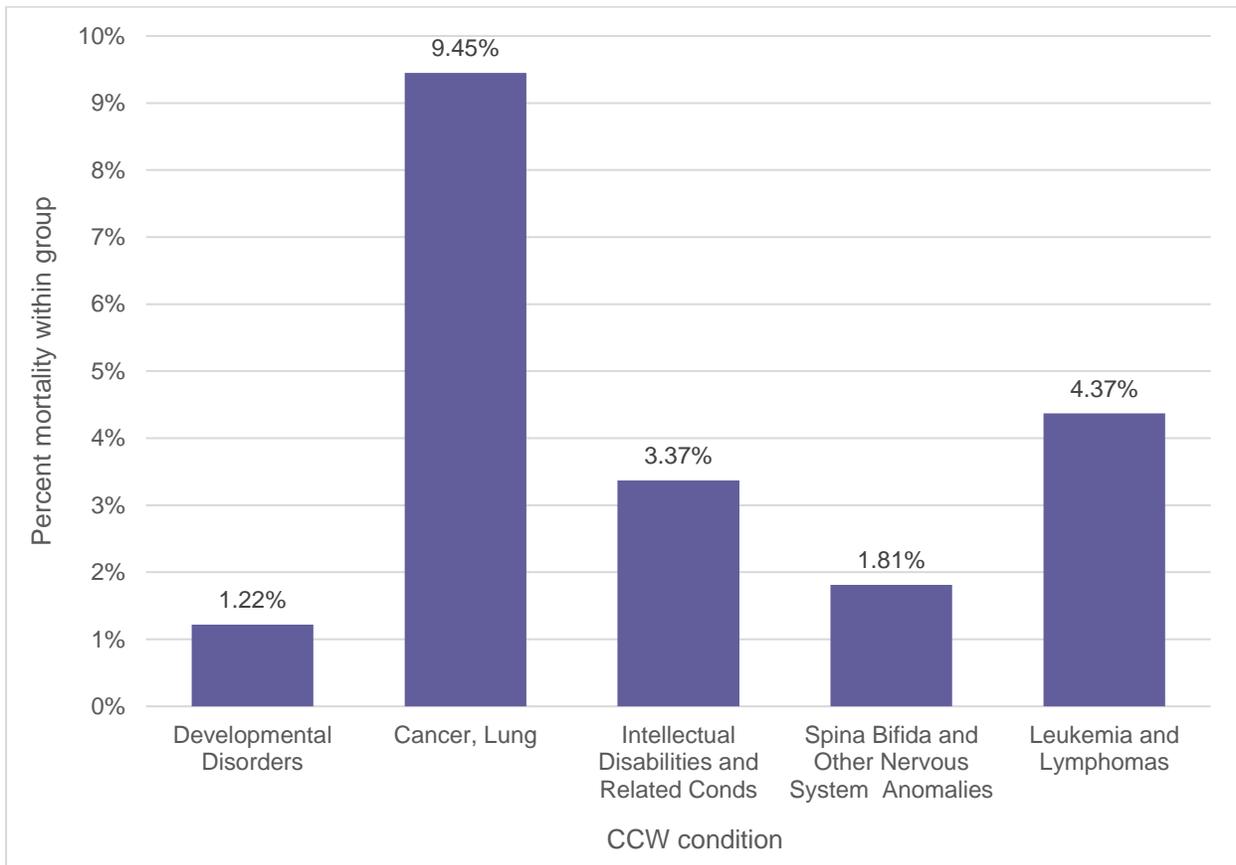
**Heart failure.** Even though heart failure (OR=1.58, 95 percent CI, 1.383-1.797,  $P<0.0001$ ) had a lower OR compared to some other conditions, it is still associated with a higher risk of COVID-19 death. Heart failure has been documented in the literature as being a risk factor for COVID-19 severity and mortality.<sup>54, 55</sup>

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<sup>vii</sup> CCW condition categories group Alzheimer's disease in both the "Alzheimer's disease" category and the "Alzheimer's disease, related dementia and senile dementia" category.

### Mortality Rates across All Age Groups

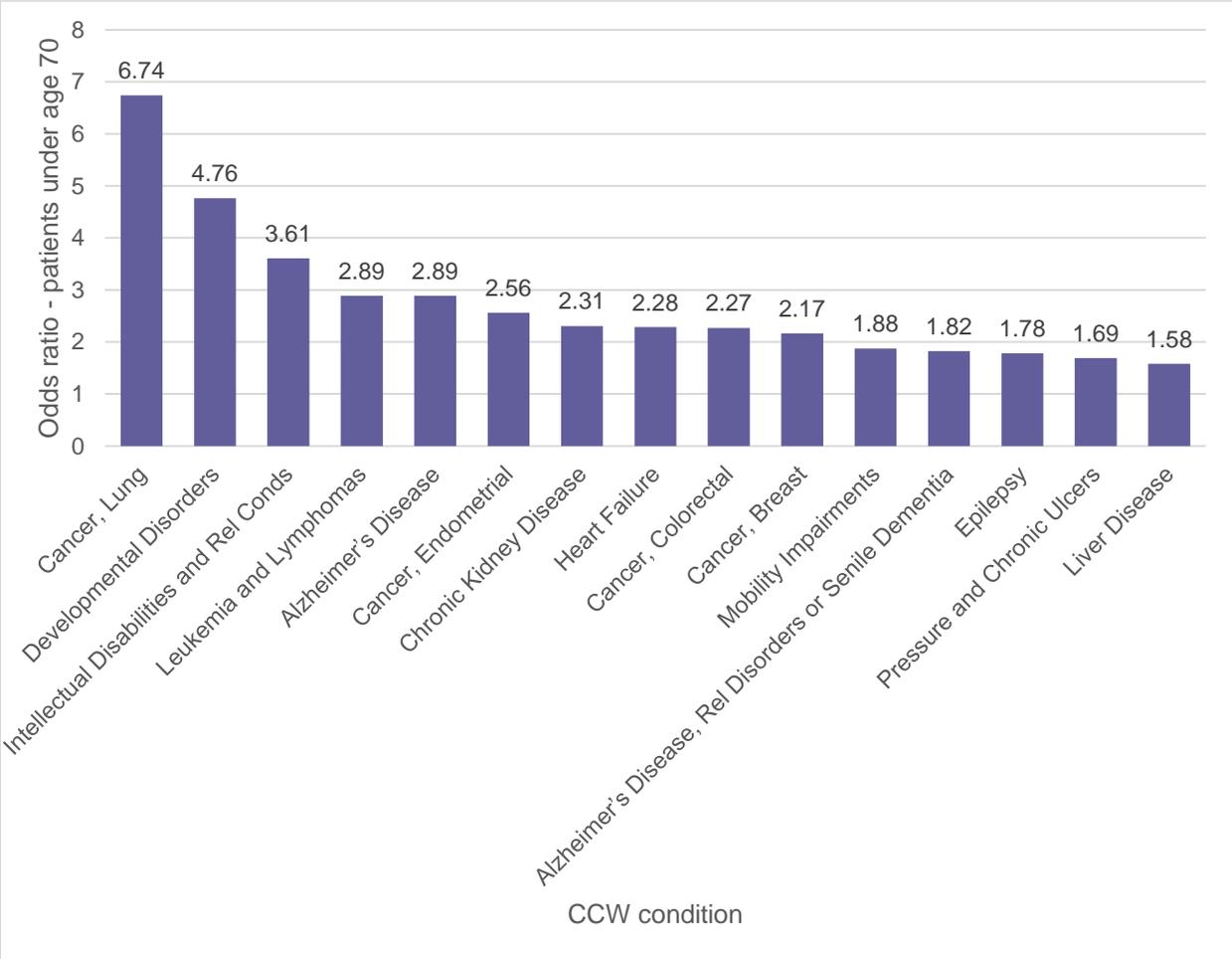
Although developmental disorders had a higher OR than lung cancer, the mortality rate within the group of COVID-19 patients with lung cancer was higher than within the group with developmental disorders. As shown in figure 7, of patients across all age groups who had the top five comorbidities that conferred the greatest risk of dying from COVID-19, 9.45 percent of lung cancer patients died, 4.37 percent of patients with leukemia and lymphomas died and 3.37 percent of those with intellectual disabilities and related conditions died. Of patients with spina bifida and other congenital anomalies of the nervous system, 1.81 percent died. Of patients with developmental disorders, 1.22 percent died.



**Figure 7. Percent mortality within group of patients with comorbidity and COVID-19, all patients, April-August 2020**

Comorbidity Risk Factors under Age 70

Among COVID-19 patients under 70 years of age, the top 15 comorbidity risk factors by OR (figure 8) were similar to those among all age groups, but with differences in ORs and in a few comorbidities. Only the list for all age groups included spina bifida and other congenital anomalies of the nervous system, and spinal cord injury (OR=1.56, 95 percent CI, 1.157-2.097,  $P=0.0061$ ). Only the list for patients under 70 included breast cancer (OR=2.17, 95 percent CI, 1.554-3.014,  $P<0.0001$ ) and pressure and chronic ulcers (OR=1.69, 95 percent CI, 1.301-2.195,  $P<0.0001$ ). In the list for patients under 70, all ORs in the top 15 were statistically significant.



**Figure 8. Comorbidity risk factors for COVID-19 mortality, adjusted for age and gender, by odds ratio, patients under age 70, April-August 2020**

COVID-19 patients under age 70 had the highest odds of dying if they had the following top five comorbidities: lung cancer (OR=6.74; 95 percent CI, 4.711-9.639,  $P<0.0001$ ), developmental disorders (OR= 4.76; 95 percent CI, 1.858-12.216,  $P=0.0003$ ), intellectual disabilities and related conditions (OR=3.61, 95 percent CI, 1.878-6.930,  $P=0.0007$ ), leukemia and lymphomas (OR= 2.89; 95 percent CI, 2.110-3.958,  $P<0.0001$ ), and Alzheimer’s disease (OR=2.89; 95 percent CI, 1.277- 6.524,  $P=0.0082$ ).

The risk of COVID-19 mortality was generally higher for a comorbidity for patients under age 70 than it was for the same comorbidity for patients of all ages. For example, in the under-70 age cohort, patients with COVID-19 and lung cancer were nearly seven times more likely to die (OR=6.74) than patients who had COVID-19 but not lung cancer. But in the all-age-groups cohort, the OR was only 2.89. That the ORs were smaller in the all-age-groups cohort is likely due to the inclusion in that cohort of patients age 70 and

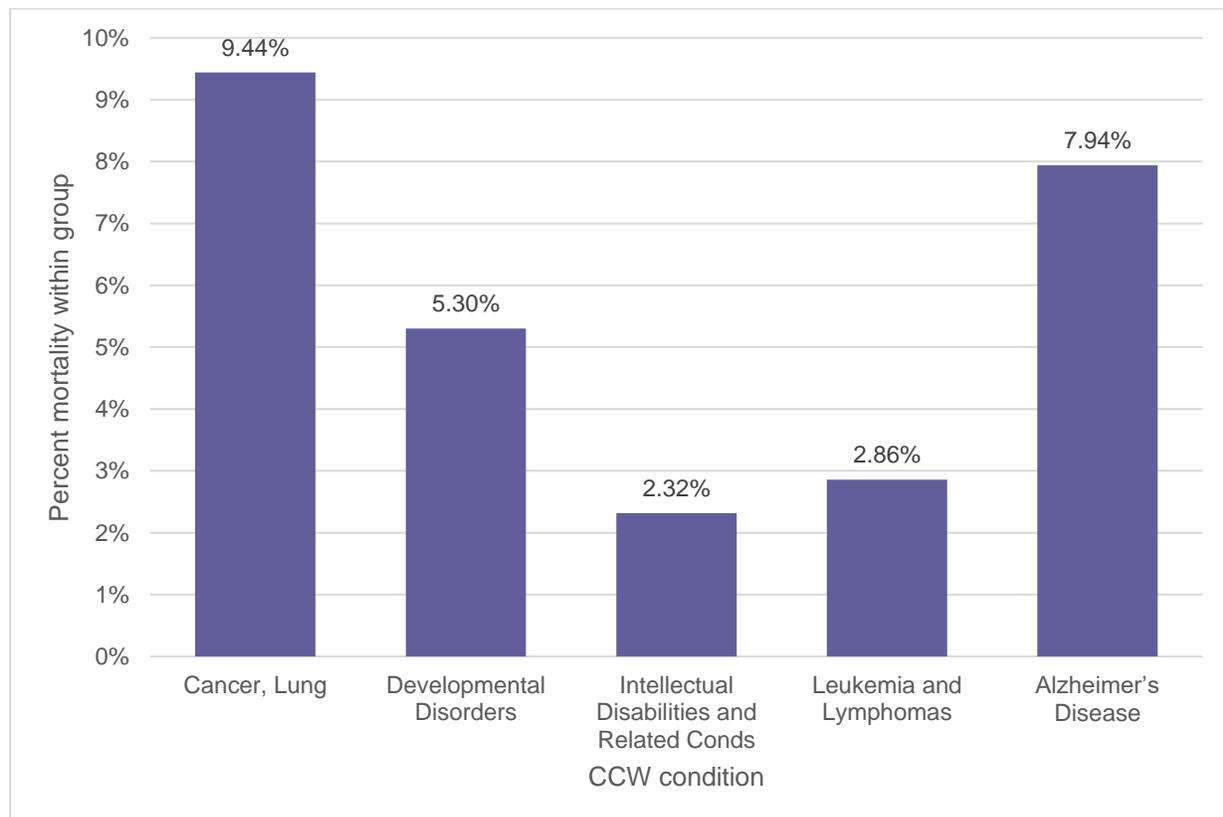
over, who have a higher probability of dying regardless of whether they have the comorbidity in question (holding all other variables constant). A condition such as lung cancer does not have as big an impact on mortality on those age 70 and over as it does on those under 70.

Among patients under age 70, 5 of the top 15 risk factors associated with COVID-19 mortality were cancers: lung cancer, leukemia and lymphomas, endometrial cancer, colorectal cancer and breast cancer. Endometrial cancer (OR=2.56, 95 percent CI, 1.218-5.387,  $P=0.0111$ ) was significant for patients under age 70.

Lung cancer and developmental disorders switched positions in the list of risk factors in the two age cohorts: Developmental disorders was first and lung cancer second in the all-age-groups cohort, but their positions were reversed in the under-70 cohort. Intellectual disabilities and related conditions, however, remained in third place in both cohorts.

### *Mortality Rates under Age 70*

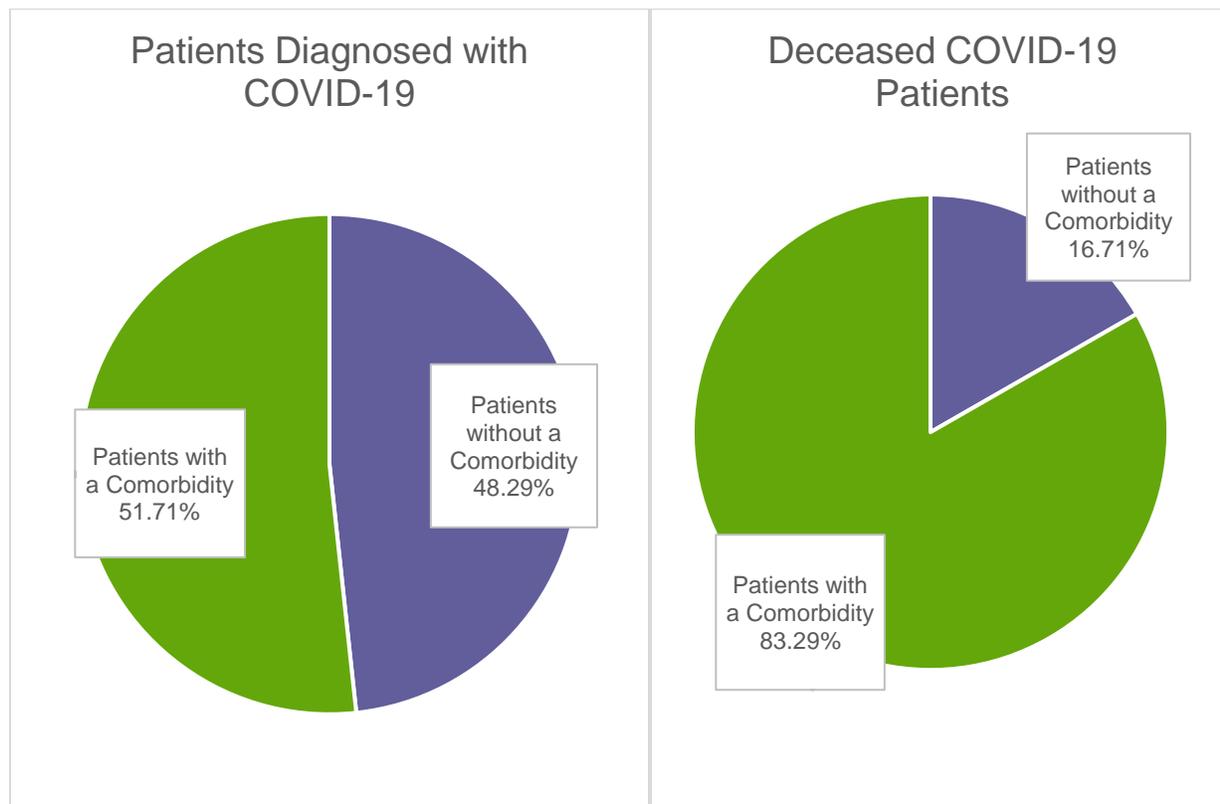
As shown in figure 9, of COVID-19 patients under age 70 who had the top five comorbidities that conferred the greatest risk of dying from COVID-19, 9.44 percent of lung cancer patients died, 7.94 percent of patients with Alzheimer's disease died and 5.30 percent of those with developmental disorders died. Of patients with leukemia and lymphomas, 2.86 percent died; of those with intellectual disabilities and related conditions, 2.32 percent died.



**Figure 9. Percent mortality within group of patients with comorbidity and COVID-19, patients under age 70, April-August 2020**

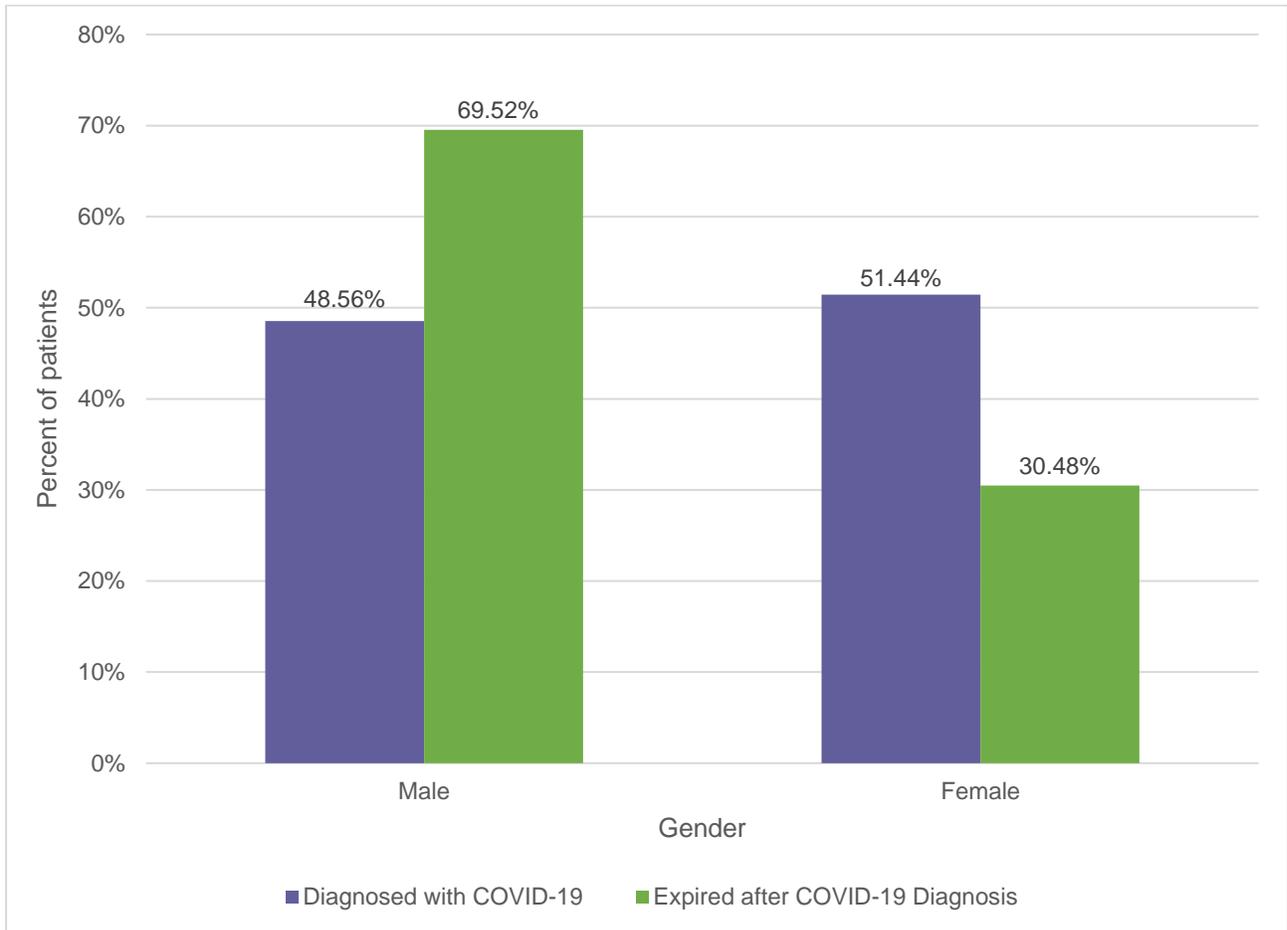
### COVID-19 Patients with No Comorbidities

About half (51.71 percent) of all patients who were diagnosed with COVID-19 had a preexisting comorbidity; the remainder (48.29 percent) did not (figure 10). But although the two groups were roughly evenly divided among patients diagnosed with COVID-19, their division was very different among COVID-19 patients who died. Of deceased COVID-19 patients, 83.29 percent had a preexisting comorbidity, while 16.71 percent did not, per the medical claims data.



**Figure 10. Distribution of patients with and without a comorbidity among all patients diagnosed with COVID-19 (left) and all deceased COVID-19 patients (right), April-August 2020**

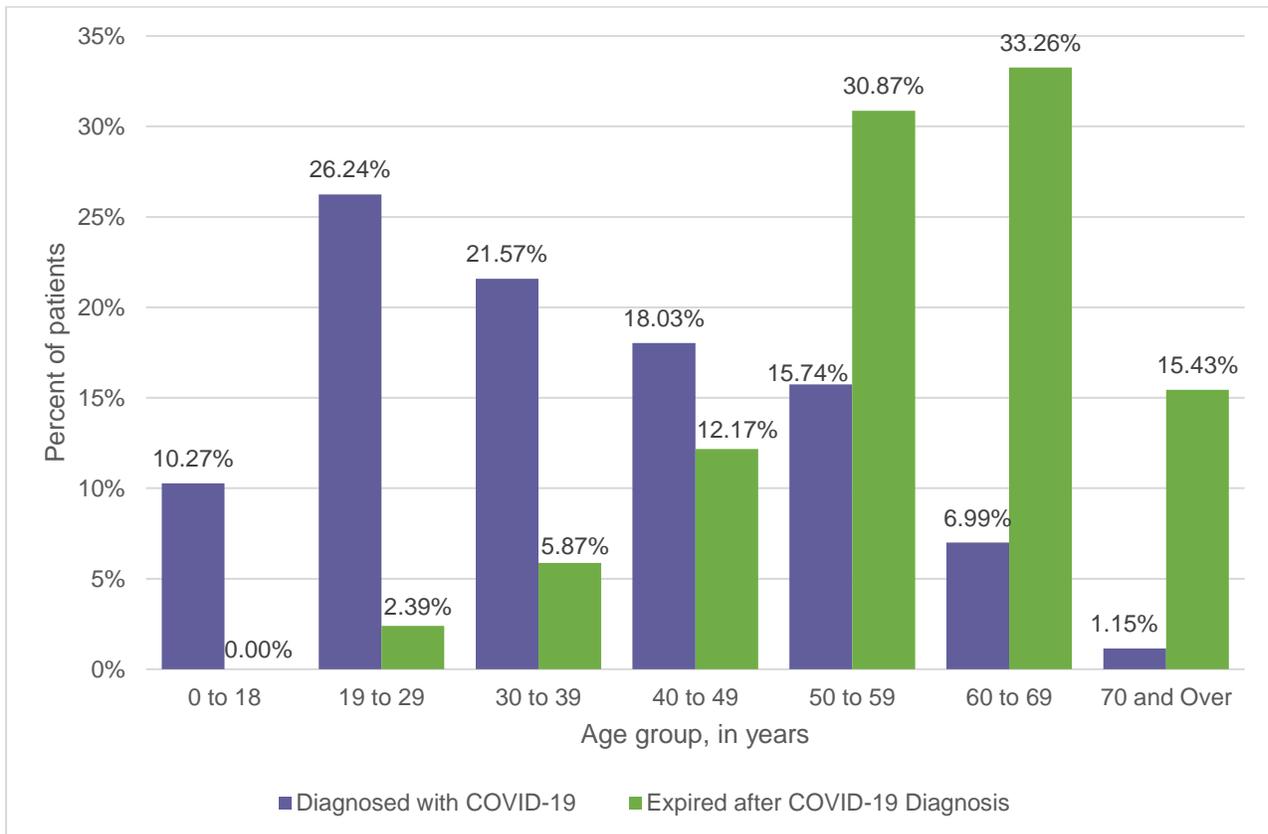
Males and females were about equally likely to be diagnosed as COVID-19 patients without comorbidities (figure 11). Males accounted for 48.56 percent of this population, females 51.44 percent. Mortality, however, was more than twice as high in males with no comorbidities as in females with no comorbidities. Of the deaths in COVID-19 patients without comorbidities, males accounted for 69.52 percent and females for 30.48 percent—indicating that male gender was a risk factor for COVID-19 mortality independent of comorbidities.



**Figure 11. Distribution of COVID-19 diagnoses and deaths by gender among patients with no comorbidities, April-August 2020**

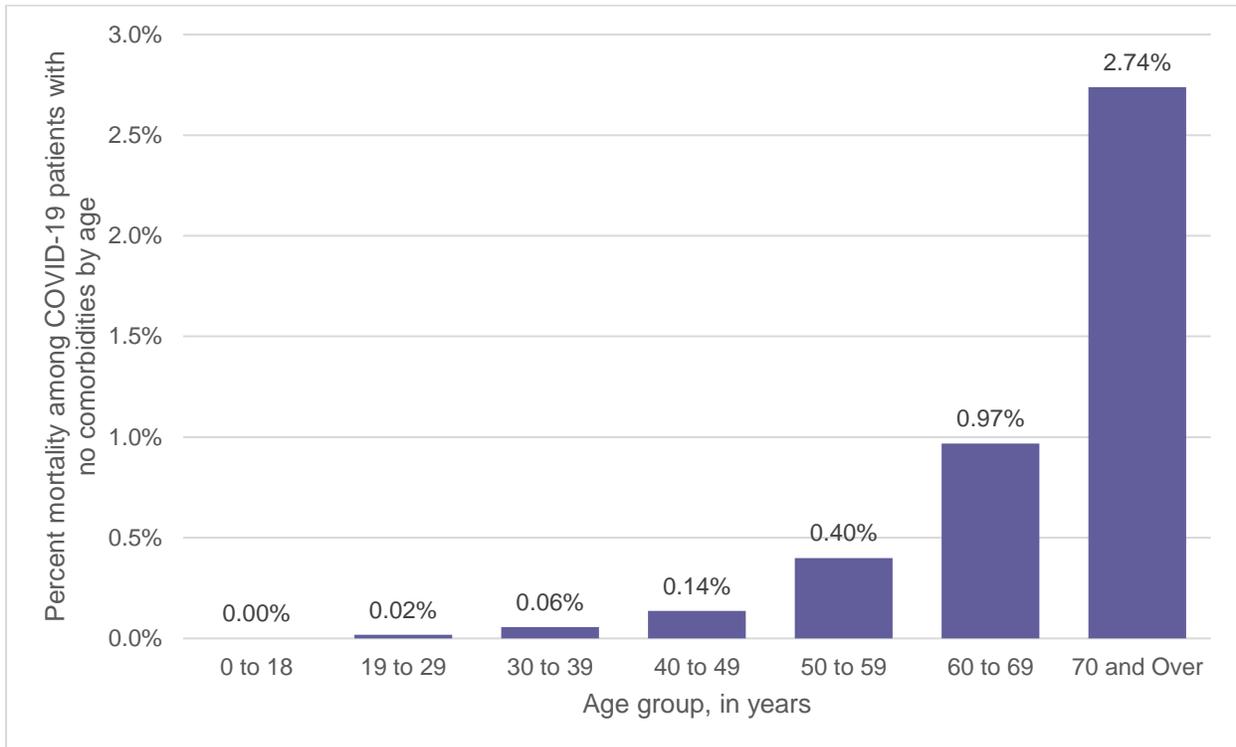
Within the COVID-19 population, the age distribution of individuals without a comorbidity (figure 12) skewed much younger than that of all patients diagnosed with COVID-19 (figure 4). Among those without a comorbidity, the largest age group (26.24 percent) was 19 to 29; among all COVID-19 patients, the largest age group (21.43 percent) was 50 to 59.

Even among COVID-19 patients with no comorbidities, mortality remained associated with older age, just as it did in the total COVID-19 population. Among those without a comorbidity who died, the largest age group (33.26 percent) was 60 to 69 (figure 12); among all COVID-19 patients who died, the largest age group (42.43 percent) was 70 and over (figure 4).



**Figure 12. Distribution of COVID-19 diagnoses and deaths by age among patients with no comorbidities, April-August 2020**

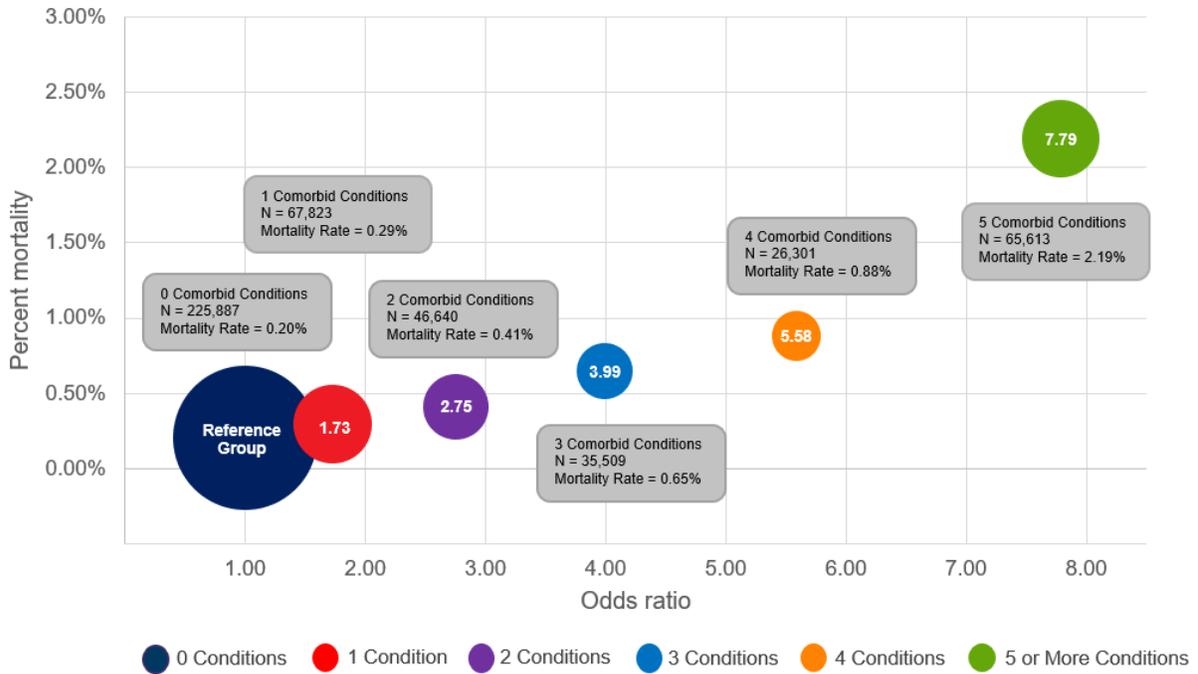
Similar to the total population of COVID-19 patients (figure 5), the population of COVID-19 patients with no comorbidities showed escalating mortality rates with age (figure 13). Among patients with no comorbidities, the youngest age group, 0 to 18, had 0.00 percent mortality (no deaths), compared to 0.01 percent mortality in the same age group among all patients. Among patients with no comorbidities, the oldest age group, 70 and over, had the greatest mortality rate, 2.74 percent, compared to 5.19 percent in that age group among all patients.



**Figure 13. Percent mortality among COVID-19 patients with no comorbidities by age, April-August 2020**

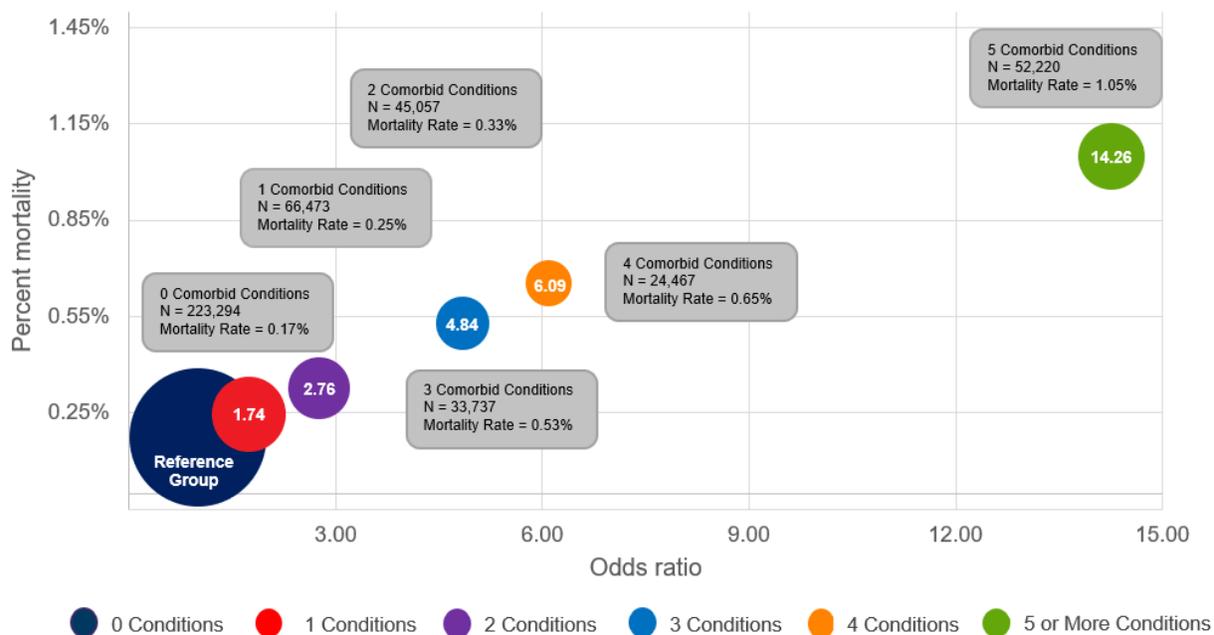
## Number of Comorbidities and Risk of COVID-19 Mortality

Across all age groups, the risk of COVID-19 death increased significantly as a patient's number of comorbidities increased (figure 14). Compared to patients with no comorbidities (the reference group), patients with a single condition had an OR of 1.73 (95 percent CI, 1.533-1.949,  $P < 0.0001$ ). Patients with five or more conditions had nearly eight times greater risk of COVID-19 death (OR=7.79, 95 percent CI, 6.798-8.920,  $P < 0.0001$ ) than those with no comorbidities.



**Figure 14. Mortality rates and odds ratios for mortality risk by number of comorbid conditions, all COVID-19 patients, April-August 2020**

In the population of COVID-19 patients under age 70, the risk of COVID-19 death increased significantly with a patient's number of comorbidities (figure 15), as it did in the population of patients of all age groups (figure 14). But under age 70, patients with five comorbidities had greatly increased odds of dying (OR=14.26, 95 percent CI, 11.616-17.495,  $P<0.0001$ ) compared to patients with five comorbidities in the population of all ages (OR=7.79).



**Figure 15. Mortality rates and odds ratios for mortality risk by number of comorbid conditions, COVID-19 patients under age 70, April-August 2020**

## Conclusion

While consistent with previous research showing that advanced age, male gender and certain comorbidities are risk factors for COVID-19 mortality, the present study adds details on the impact of COVID-19 on the privately insured population. In particular, our results show that developmental disorders, as well as intellectual disabilities and related conditions, are important risk factors for COVID-19 mortality, as are lung cancer and leukemia and lymphomas. The risk of COVID-19 mortality is generally higher for a comorbidity for patients under age 70 than it is for the same comorbidity for patients of all age groups. As a patient's number of comorbidities increase, so do the odds of dying from COVID-19. Lack of chronic conditions is partially protective against COVID-19, but not completely.

The goal of this study was to produce results that could inform public health recommendations and policies, particularly those related to protocols for distribution of first-line vaccines or therapeutics, as well as prevention and treatment protocols for patients most at risk of COVID-19 mortality. In addition, FAIR Health hopes that the study will provide data and insights to assist other researchers and healthcare stakeholders.

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## About FAIR Health

FAIR Health is a national, independent nonprofit organization dedicated to bringing transparency to healthcare costs and health insurance information through data products, consumer resources and health systems research support. FAIR Health qualifies as a public charity under section 501(c)(3) of the tax code. FAIR Health possesses the nation's largest collection of private healthcare claims data, which includes over 32 billion claim records contributed by payors and administrators. FAIR Health licenses its privately billed data and data products—including benchmark modules, data visualizations, custom analytics and market indices—to commercial insurers and self-insurers, employers, providers, hospitals and healthcare systems, government agencies, researchers and others. Certified by the Centers for Medicare & Medicaid Services (CMS) as a national Qualified Entity, FAIR Health also receives data representing the experience of all individuals enrolled in traditional Medicare Parts A, B and D; FAIR Health includes among the private claims data in its database, data on Medicare Advantage enrollees. FAIR Health can produce insightful analytic reports and data products based on combined Medicare and commercial claims data for government, providers, payors and other authorized users. FAIR Health's free, award-winning, national consumer websites are [fairhealthconsumer.org](https://fairhealthconsumer.org) and [fairhealthconsumidor.org](https://fairhealthconsumidor.org). For more information on FAIR Health, visit [fairhealth.org](https://fairhealth.org).

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