

# COVID-19 and the Short-Term Impact on Future U.S. Mortality

## An Expert Opinion Survey



AUGUST | 2022





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### Executive Summary

As results emerged showing the influence of COVID-19 on recent mortality, the Society of Actuaries Research Institute's Mortality and Longevity Strategic Research Program Steering Committee (MLPSC) began to ponder what it means for the future. Was the coronavirus pandemic just a temporary shock to U.S. mortality with mortality quickly returning to prepandemic levels upon its conclusion or a lingering factor in future U.S. mortality from the potential occurrence of new coronavirus variants, post-COVID-19 conditions ("long COVID"), deferral of needed health care treatment, a fatigued health care system and other elements? Only time will provide the answers to these questions.

To gather insights into what the future may hold, a panel of experts of varying backgrounds participated in a survey examining how COVID-19 might affect future U.S. general population mortality. The panel also considered how future U.S. mortality for the life insured, annuitant and pension plan populations might differ from the general U.S. population. Four years were examined: 2022, 2023, 2025 and 2030.

Participants were asked to provide excess mortality estimates. They were instructed to project future mortality for each year studied with and without COVID-19 and compare to mortality for the projected year assuming Covid-19 did not occur (i.e., using 2019 mortality levels as the baseline for expected mortality). No other guidance was given. Therefore, participants may not have responded in a consistent manner in determining excess mortality. Some may have compared projected mortality to 2019 mortality levels. Other respondents may have examined projected mortality relative to 2019 mortality levels with mortality improvement or deterioration for the specific calendar year in question. 2019 and 2020 population mortality data from the CDC WONDER and SOA individual life mortality along with excess mortality sample calculations also may have influenced participant responses. Plans are already underway to include a question with more instruction for determining excess mortality in the next expert opinion survey.

They also provided thoughts on factors influencing their excess mortality estimates and opinions on the potential impact of long COVID on mortality in comparison to 2019 mortality levels.

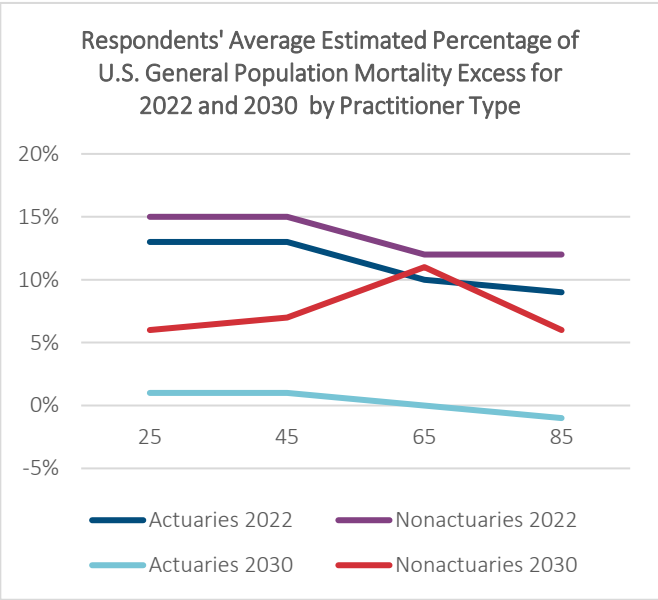
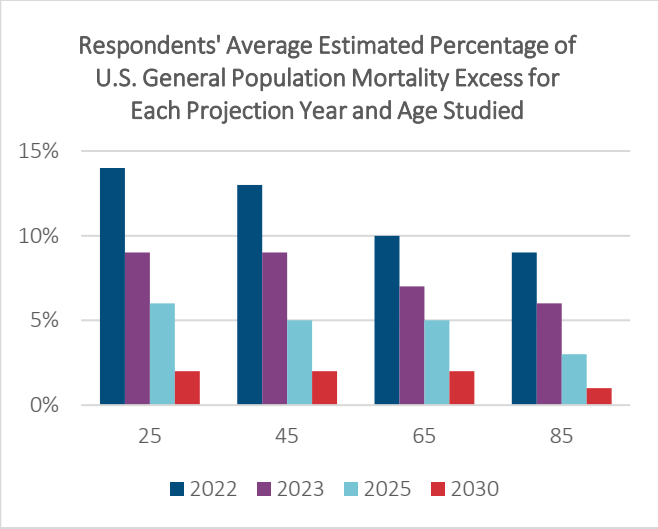
Fifty-nine individuals participated in the survey. Most of the responses focused on the U.S. general population. Results were aggregated and analyzed. Participants had diverse opinions on how COVID-19 will impact future mortality. Unless otherwise noted, the analysis and comments presented in the paper are based on the average excess mortality estimates of the respondents and the most predominant responses selected by the participants. Based on this approach, observations for U.S. general population future mortality follow:

1. **Excess mortality is expected to occur for all years studied with amounts varying by year and age.** Although the largest mortality excess numbers for the U.S. general population are foreseen for 2022, excess mortality is expected to decline each year so that by 2030, excess mortality numbers are nearing expected levels. For 2030, mortality is projected to be 2% higher than expected for all ages except age 85. At this age, 2030 projected mortality is estimated to be 1% higher than expected.

Based on the average of the participants, generally, the amount of mortality excess is anticipated to be highest at the younger ages. For example, for 2022, projected mortality is anticipated to be 14% higher compared to expected levels for age 25, 13% higher for age 45, and 10% higher for ages 65 and 85.

2. **Actuaries and nonactuaries have differing views on excess mortality.**

Approximately, 80% of the respondents were actuaries and 20% were nonactuaries. In comparing the aggregate responses for actuaries to those of nonactuaries, the average estimated excess mortality percentages by actuaries are expected to be lower than excess mortality percentages estimated by nonactuaries. Generally, a widening of the gap between the two groups is also seen as the projection year increases. For 2022, average excess mortality estimates are foreseen to be similar. For example, the average actuarial projected excess mortality level for age 25 is 13% compared to 15% by nonactuaries. By 2030, the difference increased. Actuaries estimate excess mortality at age 25 to be at 1% versus nonactuaries' 6% projection.



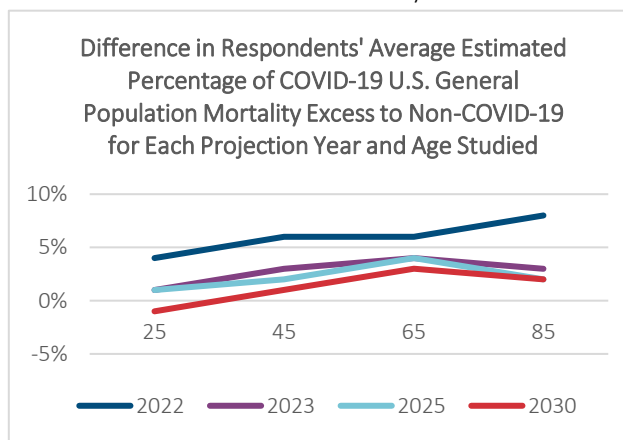
Differing views can partially be explained by looking at what is driving the estimates. For 2022, actuaries anticipate lower virulence of current or future COVID-19 strains, new COVID-19 treatments and change in current or future vaccination or booster rates. Nonactuaries also identified lower virulence of current or future COVID-19 strains and new COVID-19 treatments as top drivers for their 2022 excess mortality projections but also thought the population would exhibit worse mortality due to long COVID. For the 2030 actuarial estimates, the top two drivers are the same as those for 2022. Actuaries also think that the general population as a whole is expected to be healthier than in the past as less healthy individuals die from COVID-19. On the other hand, nonactuaries have new COVID-19 treatments, worse mortality from long COVID and deferral of health care during the pandemic as the top drivers.

**3. Non-COVID-19 causes of death contribute more to total excess mortality than COVID-19 for younger ages. For older ages, COVID-19 is driving excess mortality.**

The differences in respondents' average excess mortality estimates with and without COVID-19 as a cause of death provide insights into how much of the total excess is directly attributable to COVID-19 as a cause of death. For

ages 25 and 45, non-COVID-19 causes are expected to contribute more to total excess mortality than COVID-19 deaths. However, COVID-19 had a larger impact on total excess mortality than non-COVID causes of death at 65 and 85. For example, in 2022, for age 25 the average estimated percentage of excess mortality with COVID-19 is 14%. Respondents' average non-COVID-19 mortality excess is

expected to be 10%. Therefore, the amount of total excess from COVID-19 is expected to be 4%. For age 85, the total excess mortality including COVID is 10% compared to 2% for non-COVID-19 causes of death with 8% expected to be due to COVID-19.



**4. Per the majority of respondents, an annualized mortality deterioration in relation to 2019 levels for all-cause mortality because of long COVID is expected in 2022–2025.**

For 2022, 88% of respondents anticipate an annualized deterioration in all-cause mortality as compared to 2019 mortality levels because of long COVID, with 18% believing the annualized mortality deterioration would be greater than 2.5%. For 2023, 2025 and 2030, the number of respondents contemplating an annualized mortality deterioration for all-cause mortality due to long COVID fell to 81%, 65% and 44%, respectively.

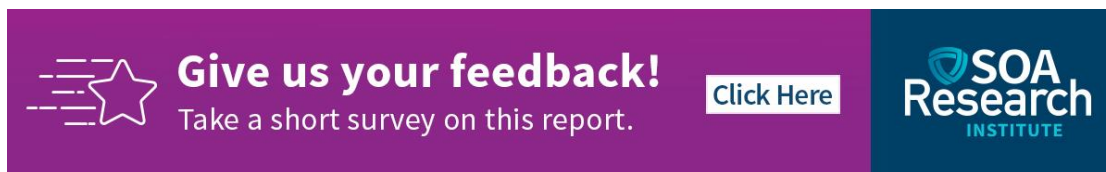
**5. Per the majority of respondents, annualized mortality deterioration in relation to 2019 levels for cardiovascular disorders, cancer and drug overdose causes of death mortality because of long COVID is expected in 2022–2025.**

For cardiovascular disorders, 82% of participants expected there would be an annualized mortality deterioration due to long COVID in 2022. This dropped to 73% for 2023, 62% for 2025 and 42% for 2030. For cancer and drug overdoses, about 65% of the respondents foresee annualized mortality deterioration in 2022 as a result of long COVID with approximately 60% anticipating deterioration in the following year. For 2025 and 2030 the majority expect no change or an annualized mortality improvement for these two causes of death.

**6. Increased immunity in the population due to vaccination, boosters and past infections is expected to have the greatest impact on future all-cause U.S. general population mortality improvement. For future all-cause population mortality deterioration, the top COVID threat is the emergence of a more virulent and lethal COVID-19 variant than existing variants.**

**7. Average excess mortality percentages for the U.S. general population are expected to be higher than for the insured, annuitant and pension plan populations**

Excess mortality estimates for the other insured, annuitant and private and public pension plan populations are generally expected to be lower than that of the U.S. general population and are addressed in Section 2 of the report.



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## Section 1: Introduction

To help actuaries and others model future mortality and mortality improvement, the Society of Actuaries Research Institute's Mortality and Longevity Strategic Research Program Steering Committee (MLPSC) assembled a panel of experts to document and gather opinions and insights into the possible future course of the pandemic, its impact on future mortality, and how their views might change over time. Potential panelists were identified through recommendations from MLPSC members, actuarial volunteers overseeing this project (Project Oversight Group [POG]), SOA staff and an open call for panel members. After a vetting process, individuals were invited to participate. Approximately 90 prospects of varying backgrounds accepted the opportunity, resulting in a panel that was 70% actuaries and 30% nonactuaries.

MLPSC defined the first activity of the expert panel, a survey on expectations for U.S. excess mortality of insured, annuitant, pension and general populations over the short term and delegated the execution of the study to the POG and SOA Research Institute staff. The questionnaire developed, found in Appendix A, included three sections:

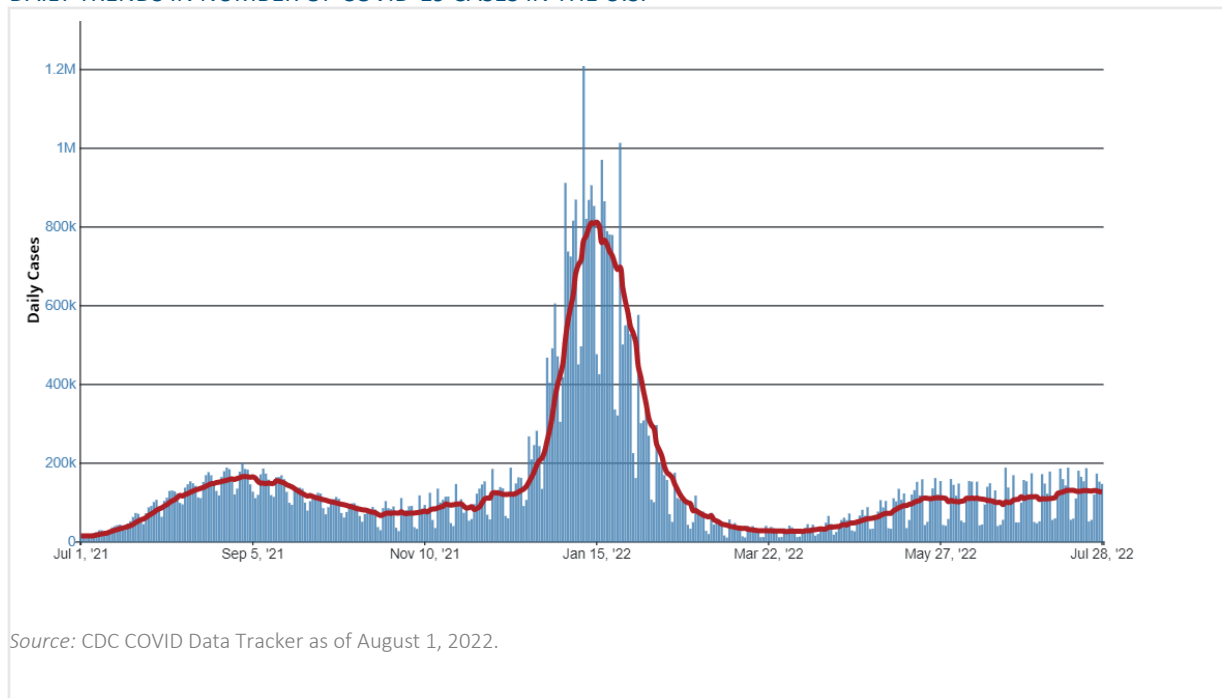
1. **Demographics** captured the characteristics of the respondents including practitioner and employer type, number of years of experience and area of expertise among the four U.S. mortality populations studied: U.S. general population, U.S. life insurance industry, U.S. annuity industry and U.S. private and public pension plans.
2. **Future Changes in U.S. All-Cause Mortality** generated estimates for all-cause excess mortality with and without COVID-19 as a cause of death for each population for 2022, 2023, 2025 and 2030. Four ages were also studied: 25, 45, 65 and 85. In addition to the estimates, respondents provided thoughts on how confident they were in their estimates and factors and mortality changes influencing their estimates from year to year.
3. **COVID-19 and Future Mortality Impacts** collected panelist views on long COVID (post-Covid-19 conditions) and interruptions in the health care system that affect future all-cause mortality and future mortality for six individual causes of death, cardiovascular disorders, cancer, Alzheimer's and other dementias, flu/pneumonia, drug overdoses and accidents excluding drug overdoses. Additionally, respondents identified COVID-19 factors that are most important to future U.S. population all-cause mortality improvement and deterioration.

The online survey was opened to the panel March 11, 2022, and closed March 31. At the time when the survey was released, the U.S. was emerging from the Delta/Omicron wave with falling case counts (Figure 1) and an easing of COVID mitigation strategies such as mandatory masking in many states. This

environment may have factored into the responses. Different perspectives may have been shared by the respondents had the survey been fielded during peak months of a coronavirus wave.

**Figure 1**

**DAILY TRENDS IN NUMBER OF COVID-19 CASES IN THE U.S.**



## Section 2: Results

Access to the individual responses was limited to SOA staff who were responsible for aggregating and analyzing them with the POG providing guidance and peer review. Participants had diverse opinions on how COVID-19 will impact future mortality. Unless otherwise noted, the analysis and comments presented in the paper are based on the average excess mortality estimates of the respondents and the most predominant responses selected by the participants. This section summarizes the expert panel views from the survey.

### 2.1 DEMOGRAPHICS OF EXPERT PANEL SURVEY PARTICIPANTS

Although the entire mortality expert panel was invited to participate, 65% or 59 individuals submitted responses. Of those who responded, 47 were actuaries and 12 were other practitioner types, with academics/demographers being the largest practitioner type represented in the other category with five individuals. Medical professionals, epidemiologists, underwriters and data scientists were among the other practitioner types represented in the survey.

Respondents were generally employed by insurers, reinsurers and consulting firms. However, 26% of the total worked for academic/research institutions, government agencies, banks/investment management/financial services companies, pension plans or international organizations or classified themselves as being self-employed or retired.

Given that respondents were from a group of experts, a high degree of years of experience among the survey participants was expected. Here 97% of the respondents had 10 or more years of experience, with the majority (53%) specifying 25 or more years of experience.



Most of the survey focused on the impact of COVID-19 on future U.S. general population mortality. Yet participants were asked to provide estimates of COVID-19's impact on future excess mortality over the period 2022–2030 based on their indicated area of skill. Table 1 provides the respondents' expertise breakdown, with the majority reporting to have knowledge of U.S. mortality for the life insurance industry insured and/or general populations. Even though 54% of the respondents designated themselves as an expert with the U.S. life insurance industry, not all provided estimates.

Unlike the life insurance population, more excess mortality estimates for the U.S. general population were received than the number of designated experts. In developing the questions, the POG felt the majority of the expert panel members would have a good understanding of U.S. general population mortality. Therefore, all survey participants had the opportunity to weigh in and provide opinions about future U.S. general population mortality except the one individual indicating no expertise in any of the four mortality areas. This respondent did not receive any questions beyond those in the demographics section of the questionnaire.

**Table 1**  
**SURVEY RESPONDENTS' AREA OF EXPERTISE (N = 59)**

Area of Expertise	No. Responding*	Percentage of Respondents* (%)	No. of Excess Mortality Estimates Submitted
U.S. Life Insurance Industry Insured Population Mortality	32	54	29
U.S. Annuity Industry Annuitant Population Mortality	6	10	6
U.S. Private and Public Pension Plan Population Mortality	15	25	15
U.S. General Population Mortality	39	66	56
None of the above	1	2	0

\*Respondents were asked to select all that apply. Therefore, some respondents provided more than one area of expertise.

## 2.2 CHANGES IN FUTURE EXCESS MORTALITY ESTIMATES

Once the skills of the participants were determined, they were asked to provide their opinions on future all-cause excess mortality with and without COVID-19 as a cause of death for ages 25, 45, 65 and 85 and years 2022, 2023, 2025 and 2030. The survey explained that excess mortality with COVID-19 was determined by examining projected mortality, including deaths that are directly or indirectly attributed to COVID-19 for a specific period divided by expected mortality assuming Covid-19 did not occur. Participants were instructed to assume 2019 mortality levels as the baseline for expected mortality.

Non-COVID-19 excess mortality had the same definition as excess mortality with COVID-19 except that projected mortality did not include COVID-19 as a cause of death.

Examples of excess mortality calculations using historical U.S. general population all-cause mortality for 2019 and 2020 from the Centers for Disease Control and Prevention (CDC) were provided (Table 2). An example of historical individual life insurance industry excess mortality from an SOA Research Institute study was also provided (Table 3).

**Table 2**  
**HISTORICAL U.S. GENERAL POPULATION ALL-CAUSE MORTALITY**

Current Age	A 2019 Number of Deaths per 100,000	B 2020 Number of Deaths per 100,000 with COVID-19 Deaths	C = (B/A) – 1 2020 Excess Mortality with COVID-19 Deaths (%)	D 2020 Number of Deaths per 100,000 without COVID- 19 Deaths*	E = (D/A) – 1 2020 Number of Deaths per 100,000 without COVID- 19 Deaths* (%)
25	105	128	22	125	20
45	265	322	22	295	12
65	1,276	1,489	17	1,330	4
84	7,016	8,186	17	7,232	3

Sources: CDC WONDER and SOA Research Institute, *U.S. Population Mortality Observations Updated with 2020 Experience*.

\* COVID-19 causes of death are defined as ICD-10 113 code of GL113-137.

**Table 3**  
**HISTORICAL U.S. INDIVIDUAL LIFE INSURANCE INDUSTRY INSURED POPULATION ALL-CAUSE MORTALITY**

Current Age	A 2019 Number of Deaths per 100,000	B 2020 Number of Deaths per 100,000 with COVID-19 Deaths	C = (B/A) – 1 2020 Excess Mortality with COVID-19 Deaths (%)
25–44	78	90	15
45–64	365	409	12
65–84	2,278	2,563	13
85+	12,181	13,373	10

Source: SOA Research Institute, LIMRA, RGA, TAI, *U.S. Individual Life Covid-19 Mortality Experience Study—Fourth Quarter 2020 Update*.

No other guidance for determining excess mortality was provided. Therefore, participants may not have responded in a consistent manner in determining excess mortality. Some may have compared projected mortality to 2019 mortality levels. Other respondents may have examined projected mortality relative to 2019 mortality levels with mortality improvement or deterioration for the specific calendar year in question. The historical information and excess mortality information provided also may have influenced participant responses. Plans are already underway to include a question with more instruction for determining excess mortality in the next expert opinion survey.

### 2.2.1 EXCESS MORTALITY ESTIMATES WITH AND WITHOUT COVID-19

In examining the average of the excess all-cause mortality estimates submitted as shown in Table 4a and 4b, the average excess mortality estimated values were highest for the U.S. general population followed by the U.S. life insurance industry insured population, U.S. private and public pension plan population, and U.S. annuity industry annuitant population. They also vary by age, with the highest average excess mortality value occurring at age 25. The average excess mortality value generally drops with each subsequent age following the 2020 pattern shown in Table 3.

In looking at the year-by-year estimates, the estimated values declined each year so that by 2030 the projected mortality was near or better than expected mortality levels for all populations. This was especially true for the insured, annuitant and pension populations because the excess mortality estimates showed mortality improvement for all ages in 2030. For the annuity population, the average excess

mortality estimates without COVID-19 as a cause of death wear off sooner, with mortality improvement occurring in 2025.

The excess mortality wearing-off pattern over time for the U.S. general population was different from the insured, annuitant and pension populations. Although the average of the excess mortality estimates showed mortality improvement for the higher ages in 2030, the average excess mortality value remained above zero for U.S. general population ages 25, 45 and 65.

Comparing the average excess mortality estimates with COVID-19 (Table 4a) to the non-COVID-19 average excess mortality estimates (Table 4b), the excess mortality percentages with COVID-19 are generally higher. By subtracting the two, participants' insights into how much of the total average excess mortality estimates is due to COVID-19 can be obtained. Generally, at ages 25 and 45, non-COVID causes contribute the most to total excess mortality estimates, but for ages 65 and 85 COVID-19 has a larger impact.

**Table 4a**  
AVERAGE ALL-CAUSE EXCESS MORTALITY ESTIMATES WITH COVID-19 BY POPULATION AND AGE

U.S. Population (No. of Responses)	Current Age	2022 (%)	2023 (%)	2025 (%)	2030 (%)
<b>Total Respondents</b>					
General (N = 56)	25	14	9	6	2
	45	13	9	5	2
	65	10	7	5	2
	85	9	6	3	1
Life Insurance Industry Insured (N = 29)	25	10	5	2	-1
	45	10	5	2	-1
	65	9	5	1	-1
	85	7	3	1	-1
Annuity Industry Annuitant (N = 6)	25	5	3	0	-1
	45	5	2	0	-2
	65	5	1	-1	-3
	85	6	1	-1	-3
Private and Public Pension Plan (N = 15)	25	8	5	2	-1
	45	7	5	2	-1
	65	6	4	1	-3
	85	6	4	0	-3

**Table 4b**  
AVERAGE ALL-CAUSE EXCESS MORTALITY ESTIMATES WITHOUT COVID-19 AS A CAUSE OF DEATH BY POPULATION AND AGE

U.S. Population (Number of Responses)	Current Age	2022 (%)	2023 (%)	2025 (%)	2030 (%)
<b>Total Respondents</b>					
General (N = 55)	25	10	8	5	3
	45	7	6	3	1
	65	4	3	1	-1
	85	2	1	0	-2
Life Insurance Industry Insured (N = 29)	25	8	5	2	0
	45	5	3	1	-1
	65	3	2	1	-1
	85	2	1	0	-1
Annuity Industry Annuitant	25	3	1	-1	-3
	45	3	1	-2	-4

(N = 6)	65	1	-1	-3	-5
	85	1	-1	-3	-6
Private and Public Pension Plan (N=14)	25	5	3	2	-1
	45	5	3	1	-2
	65	2	1	-1	-4
	85	2	1	-2	-4

The distribution of the submitted excess mortality estimates for each population can be found in box and whisker plots in Appendix B.

Respondents also provided how confident they were in their estimates. Table 5 shows the results. For the general and life insurance industry insured populations, at least 75% of the respondents had a medium or high level of confidence for their excess mortality estimates with COVID-19, which waned to approximately 35% by 2030. In contrast, about 50% of the respondents indicated a medium and high confidence level for the 2022 excess mortality estimates with COVID-19; the confidence level stayed at this level for the private and public pension plan population for all periods but fell to 17% by the end of the period for the annuitant population.

Respondents generally had a lower confidence level for their 2022 excess mortality estimates without COVID-19 as a cause of death than the with COVID-19 estimated values. Respondents indicating a medium or high confidence level were roughly 67% for the general and life insurance industry insured population estimates and 33% for the annuity industry annuitant population estimates. For respondents with expertise in private and public pension plans, confidence levels were higher for the excess mortality estimates without COVID-19 than the with COVID-19 estimates, with 62% indicating a medium or high level of confidence. For the 2030 estimates without COVID-19, respondents' confidence levels were about the same as those for with COVID-19.

**Table 5**  
**PERCENTAGE OF RESPONDENTS BY POPULATION AND LEVEL OF CONFIDENCE FOR ALL-CAUSE EXCESS MORTALITY ESTIMATES**

U.S. Population (No. of Responses)	Level of Confidence	Excess Mortality Estimates with COVID-19			Excess Mortality Estimates without COVID-19 as a Cause of Death		
		2022 (%)	2025 (%)	2030 (%)	2022 (%)	2025 (%)	2030 (%)
General (N = 56)	Low	25	46	63	33	54	61
	Medium	54	50	29	50	41	26
	High	21	4	9	17	6	13
Life Insurance Industry Insured (N = 29)	Low	17	38	66	29	54	64
	Medium	62	62	28	57	46	32
	High	21	0	7	14	0	4
Annuity Industry Annuitant (N = 6)	Low	50	67	83	67	83	83
	Medium	50	33	17	33	17	17
	High	0	0	0	0	0	0
Private and Public Pension Plan (N=15)	Low	47	40	53	38	31	38
	Medium	47	60	27	54	69	31
	High	7	0	20	8	0	31

## 2.2.2 DRIVERS AND FACTORS FOR THE EXCESS MORTALITY ESTIMATES

The survey participants were also asked about their top three drivers for their excess mortality estimates with COVID-19 from the list shown in Table 6. A score was assigned to each response. A driver with a response of rank 1 received a score of 3; a driver with a response of rank 2 received a score of 2; and a driver with a response of rank 3 received a score of 1. Comparing the total scores for each driver, we were able to identify the top drivers among all the respondents, which are the bold numbers in Table 6. Results for the annuitant industry population are very similar to the life insurance insured population. Therefore, they are excluded from the table. All results can be found in Appendix A.

Lower virulence of current or future COVID-19 strains, new COVID-19 treatments and change in the vaccination/booster rate are among the top drivers for the general population estimates for 2022. For the life insurance industry insured population, the top three drivers were generally the same as the general population but included public deferral of health care treatment due to COVID-19 instead of change in the vaccination/booster rate. Better mortality as less healthy individuals die from COVID-19 was one of the top drivers for the pension population excess mortality estimates for 2022 not seen in the other populations. Worse mortality from long COVID also was a top driver for estimates of life insurance industry insured and general populations for years 2023 and 2025.

**Table 6**  
**DRIVER SCORES FOR ALL-CAUSE EXCESS MORTALITY ESTIMATES WITH COVID-19 BY YEAR**

Driver	2022	2023	2025	2030
<b>General Population</b>				
Lower virulence of current or future COVID strains	<b>56</b>	<b>61</b>	<b>60</b>	<b>78</b>
Change in vaccination/booster rate	<b>54</b>	<b>42</b>	32	28
New COVID-19 treatments	<b>54</b>	<b>66</b>	<b>84</b>	<b>81</b>
Higher virulence of current or future COVID strains	52	38	22	16
Public deferral of health care treatment due to COVID-19	28	31	21	11
Worse mortality from long COVID	23	31	<b>37</b>	26
Better mortality as less healthy individuals die from COVID-19	21	20	23	<b>29</b>
Change in public behavior for masking	10	10	3	5
<b>Life Insurance Industry Insured Population</b>				
Lower virulence of current or future COVID strains	<b>28</b>	<b>25</b>	<b>25</b>	<b>27</b>
Public deferral of health care treatment due to COVID-19	<b>28</b>	16	13	7
New COVID-19 treatments	<b>26</b>	<b>41</b>	<b>42</b>	<b>45</b>
Higher virulence of current or future COVID strains	23	14	9	6
Change in vaccination/booster rate	21	18	14	14
Worse mortality from long COVID	18	<b>28</b>	<b>24</b>	12
Better mortality as less healthy individuals die from COVID-19	6	10	18	<b>19</b>
Change in public behavior for masking	4	3	2	7
<b>Private and Public Pension Plan Population</b>				
Change in vaccination/booster rate	<b>20</b>	<b>19</b>	<b>13</b>	11
Lower virulence of current or future COVID strains	<b>12</b>	<b>11</b>	<b>13</b>	<b>13</b>
Better mortality as less healthy individuals die from COVID-19	<b>12</b>	<b>13</b>	<b>13</b>	<b>16</b>
Higher virulence of current or future COVID strains	9	10	5	6

Public deferral of health care treatment due to COVID-19	6	6	2	0
New COVID-19 treatments	5	5	15	17
Worse mortality from long COVID	5	5	1	2
Change in public behavior for masking	2	2	2	2

For the non-COVID-19 excess mortality estimates, participants were asked to provide their top three influential mortality changes impacting their estimates. The mortality changes shown were improvement and deterioration in cardiovascular disorders, cancer, Alzheimer’s and other dementias, drug overdoses, accidents excluding drug overdoses and flu/pneumonia. They could also respond with other mortality changes. Similar to the above, a mortality change with a response of rank 1 received a score of 3; a mortality change with a response of rank 2 received a score of 2; and a mortality change with a response of rank 3 received a score of 1. Comparing the total scores for each mortality change, we were able to identify the top three mortality changes for each population and projection year, which are shown in Table 7. Although we asked about mortality changes for six different causes of death, the top three mortality changes for all populations are expected to be from cardiovascular disorders, cancer, drug overdoses and flu/pneumonia.

For the U.S. general population, the top three changes that the experts indicated drove their responses for 2022 are a deterioration in drug overdoses, a deterioration in cardiovascular disorders and a deterioration in cancer. For 2023, the top two remained the same, and the third most important driver was an improvement in cancer. Moving to 2025 and 2030, the most important driver became an improvement in cancer, and the next two (in different orders between the years) were a deterioration in drug overdoses (as in the earlier years) and an improvement in cardiovascular disorders.

Similar to the general population, respondents indicated drug overdose mortality deterioration as the top factor for the 2022 public and private pension plan population estimates. Cancer and cardiovascular disorders mortality improvement are expected to be also in the top three for this year. By 2023 drug overdose mortality improvement was among the top three mortality changes and remained among the leading factors for 2025 and 2030. In 2030, besides drug overdose mortality improvement, flu/pneumonia mortality improvement and cardiovascular disorder mortality deterioration appeared to have played a role in the average excess mortality estimates.

For the life insurance industry insured population, cardiovascular disorders mortality deterioration is expected to be the top mortality change influencing 2022 estimates followed by cancer mortality deterioration and cardiovascular disorders mortality improvement. For 2023 cancer mortality deterioration moves into the top spot followed by cardiovascular disorders mortality deterioration and cardiovascular disorders and cancer mortality improvement tied for the third position. For the remaining projection years, cancer and cardiovascular disorders mortality improvement and cardiovascular disorders mortality deterioration are the top three factors influencing the excess mortality estimates. The annuity industry annuitant population had similar results to the life insurance industry and can be found in Appendix A.

**Table 7**  
**RESPONDENTS’ TOP THREE MORTALITY CHANGES FOR ALL-CAUSE EXCESS MORTALITY ESTIMATES**  
**WITHOUT COVID-19 AS A CAUSE OF DEATH BY YEAR**

Change in Mortality	2022 Top 3	2023 Top 3	2025 Top 3	2030 Top 3
<b>General Population</b>				

Cardiovascular Disorders Mortality Improvement			3	2
Cardiovascular Disorders Mortality Deterioration	2	2		
Cancer Mortality Improvement		3	1	1
Cancer Mortality Deterioration	3			
Drug Overdoses Mortality Deterioration	1	1	2	3
<b>Life Insurance Industry Insured Population</b>				
Cardiovascular Disorders Mortality Improvement	3	3	2	2
Cardiovascular Disorders Mortality Deterioration	1	2	3	3
Cancer Mortality Improvement		3	1	1
Cancer Mortality Deterioration	2	1		
<b>Private and Public Pension Plan Population</b>				
Cardiovascular Disorders Mortality Improvement	3	2	2	
Cardiovascular Disorders Mortality Deterioration				3
Cancer Mortality Improvement	2	1	1	
Drug Overdoses Mortality Improvement		3	3	1
Drug Overdoses Mortality Deterioration	1			
Flu/Pneumonia Mortality Improvement				2

### 2.2.3 ACTUARIAL EXCESS MORTALITY ESTIMATES COMPARED TO NONACTUARIES' ESTIMATES

Only actuaries provided future excess mortality estimates for the annuity industry annuitant and private and public pension plan populations. However, both actuaries and other practitioner types provided future excess mortality estimates for the general and life insurance industry insured populations. Table 8 shows the average future excess mortality estimates with COVID-19 by practitioner type. Other practitioner types group's excess mortality estimates are larger than those of actuaries, especially for years 2023, 2025 and 2030. The participating nonactuaries believed there would be excess mortality due to COVID-19 in 2023, which ranged from 10% to 15% by age. For 2025 and 2030 the ranges were 7%–13% and 6%–11%, respectively. On the other hand, the participating actuaries' average excess mortality estimates are expected to range from 5% to 9% for 2023, 2% to 5% for 2025 and –1% to 1% for 2030.

For the life insurance industry insured population, for 2022, the actuarial average excess mortality estimates are higher than those for other practitioner types except for age 85. For 2023, the average excess mortality estimates are very similar between the two practitioner groups. For 2025 and 2030, the actuarial excess mortality estimates are nearing or are better than expected mortality levels. Yet the other practitioner types group believes there will be excess mortality at all ages in those years, with 2030 projected mortality being 3% higher than expected levels.

**Table 8**  
**AVERAGE ALL-CAUSE EXCESS MORTALITY ESTIMATES WITH COVID-19 SPLIT BY PRACTITIONER TYPE FOR GENERAL AND LIFE INSURANCE INDUSTRY INSURED POPULATIONS**

U.S. Population (No. of Responses)	Current Age	2022 (%)	2023 (%)	2025 (%)	2030 (%)
<b>Total Respondents</b>					
General (N = 56)	25	14	9	6	2
	45	13	9	5	2
	65	10	7	5	2
	85	10	4	2	0

Life Insurance Industry Insured (N = 29)	25	10	5	2	-1
	45	10	5	2	-1
	65	9	5	1	-1
	85	7	3	1	-1
<b>Actuaries Only</b>					
General (N = 45)	25	13	9	5	1
	45	13	8	4	1
	65	10	5	3	0
	85	9	5	2	-1
Life Insurance Industry Insured (N = 24)	25	11	5	2	-1
	45	10	5	2	-1
	65	9	4	1	-2
	85	7	2	0	-2
<b>Other Practitioner Types Only</b>					
General (N = 11)	25	15	13	9	6
	45	15	14	9	7
	65	12	15	13	11
	85	12	10	7	6
Life Insurance Industry Insured (N = 5)	25	8	5	4	3
	45	8	6	5	3
	65	7	5	2	3
	85	7	4	2	3

Annuitant and pension populations are excluded because only actuaries responded to these questions.

The differences in perspectives between these two groups are highlighted when looking at the top three drivers for the excess mortality estimates (Table 9). For the general population, the top three drivers for the actuarial estimates for 2022–2025 are lower virulence of current or future COVID-19 strains, new COVID-19 treatments and change in the vaccination/booster rate. For 2030, the drivers were similar with better mortality as less healthy individuals die from COVID-19 replacing change in vaccination/booster rate in the leading three drivers.

On the other hand, for the other practitioner types group and general population, we see more variability in the drivers than that for the actuarial estimates. For 2022, the top three drivers for their estimates are change in the vaccination/booster rate, higher virulence of current or future COVID-19 strains and worse mortality from long COVID. For 2023, change in the vaccination/booster rate falls out of the top three and is replaced with new COVID-19 treatments. Then for 2025 and 2030, the top three are worse mortality from long COVID, new COVID-19 treatments and public deferral of health care treatment due to COVID-19. In 2030, lower virulence of current or future COVID-19 strains was also in the top mix because it tied for the third overall driver with public deferral of health care treatment due to COVID-19.

**Table 9**  
**DRIVER SCORES FOR ALL-CAUSE EXCESS MORTALITY ESTIMATES WITH COVID-19 BY YEAR**

Driver	2022	2023	2025	2030
<b>Actuaries</b>				
<b>General Population</b>				
Lower virulence of current or future COVID-19 strains	50	58	57	72
New COVID-19 treatments	50	56	73	70
Change in vaccination/booster rate	43	33	29	25
Higher virulence of current or future COVID-19 strains	43	28	18	15
Public deferral of health care treatment due to COVID-19	21	24	15	5
Better mortality as less healthy die from COVID-19	15	16	23	29



Worse mortality from long COVID	14	21	22	18
Change in public behavior for masking	8	7	1	1
<b>Life Insurance Industry Insured Population</b>				
Lower virulence of current or future COVID-19 strains	<b>28</b>	<b>25</b>	<b>25</b>	<b>27</b>
New COVID-19 treatments	<b>25</b>	<b>36</b>	<b>40</b>	<b>41</b>
Change in vaccination/booster rate	<b>21</b>	<b>18</b>	14	14
Higher virulence of current or future COVID-19 strains	19	13	8	5
Public deferral of health care treatment due to COVID-19	15	13	8	3
Worse mortality from long COVID	11	<b>18</b>	15	7
Better mortality as less healthy die from COVID-19	6	8	<b>18</b>	<b>19</b>
Change in public behavior for masking	3	2	2	5
<b>Other Practitioner Types</b>				
<b>General Population</b>				
Change in vaccination/booster rate	<b>11</b>	9	3	3
Higher virulence of current or future COVID -19 strains	<b>9</b>	<b>10</b>	4	1
Worse mortality from long COVID	<b>9</b>	<b>10</b>	<b>15</b>	<b>8</b>
Lower virulence of current or future COVID-19 strains	6	3	3	<b>6</b>
New COVID-19 treatments	4	<b>10</b>	<b>11</b>	<b>11</b>
Change in public behavior for masking	2	3	2	4
Better mortality as less healthy die from COVID-19	6	4	0	0
Public deferral of health care treatment due to COVID	7	7	<b>6</b>	<b>6</b>
<b>Life Insurance Industry Insured Population</b>				
Worse mortality from long COVID	<b>7</b>	<b>8</b>	<b>8</b>	<b>5</b>
Higher virulence of current or future COVID-19 strains	<b>4</b>	1	1	1
Public deferral of health care treatment due to COVID-19	<b>3</b>	<b>3</b>	<b>5</b>	<b>4</b>
New COVID-19 treatments	1	<b>5</b>	<b>2</b>	<b>4</b>
Change in public behavior for masking	1	1	0	2
Lower virulence of current or future COVID-19 strains	0	0	0	0
Change in vaccination/booster rate	0	0	0	0
Better mortality as less healthy die from COVID-19	0	2	0	0

Annuitant and pension populations are excluded because only actuaries responded to these questions.

For the life insurance industry insured population, the top three drivers for the average actuarial estimates with COVID-19 are the same as that for the general population except for years 2023 and 2025. For 2023, the factors are the same as that for the general population except that worse mortality due to long COVID is tied for the third spot with change in the vaccine/booster rate. For 2025, the top two drivers are the same as that for the general population, but better mortality replaces change in vaccination/booster rate for the third spot.

Although they differ from the top drivers for the actuarial estimates, the other practitioner types group's drivers for the life insurance industry insured population are similar to that for the general population. For 2022, the other practitioner types group believes that worse mortality from long COVID, higher virulence of current or future COVID-19 strains, and public deferral of health care due to COVID-19 will be the leading

drivers for the excess mortality estimates. In the following projection years, new COVID-19 treatments replaced higher virulence of current or future COVID-19 strains in the top three.

Non-COVID-19 excess mortality estimates are also examined by practitioner type (Table 10) and exhibit the same patterns as the with COVID-19 estimates for the general population. In this case, the other practitioner types group's excess estimates are higher than the actuarial excess mortality estimates. This is the case too for the life insurance industry. Unlike the excess mortality estimates with COVID-19, actuaries' non-COVID excess mortality estimates are lower than that of the other practitioner types for all projection years.

**Table 10**  
**AVERAGE ALL-CAUSE EXCESS MORTALITY ESTIMATES WITHOUT COVID-19 AS A CAUSE OF DEATH BY POPULATION AND AGE**

U.S. Population (No. of Responses)	Current Age	2022 (%)	2023 (%)	2025 (%)	2030 (%)
<b>Total</b>					
General (N = 55)	25	10	8	5	3
	45	7	6	3	1
	65	4	3	1	-1
	85	2	1	0	-2
Life Insurance Industry Insured (N = 29)	25	8	5	2	0
	45	5	3	1	-1
	65	3	2	1	-1
	85	2	1	0	-1
<b>Actuaries Only</b>					
General (N = 45)	25	9	7	4	1
	45	7	5	2	-1
	65	3	1	0	-3
	85	2	0	-1	-3
Life Insurance Industry Insured (N = 24)	25	7	4	2	-1
	45	5	3	0	-2
	65	2	1	0	-2
	85	1	0	1	-3
<b>Other Practitioner Types Only</b>					
General (N = 10)	25	15	13	12	9
	45	11	10	10	7
	65	11	10	10	9
	85	6	4	3	3
Life Insurance Industry Insured (N = 5)	25	8	8	6	5
	45	7	7	6	5
	65	8	8	6	6
	85	7	7	6	6

Annuitant and pension populations are excluded because only actuaries responded to these questions.

In looking at the changes in mortality driving the non-COVID-19 estimates (Table 11) for the general population in 2022, actuaries expected the top three to be mortality deterioration from cardiovascular disorders, cancer and drug overdoses. For 2023, cancer mortality improvement replaces cancer mortality deterioration in the top three. In 2025, cardiovascular disorders and cancer mortality improvement are included along with mortality deterioration from drug overdoses. By 2030, the participating actuaries believe that mortality improvement from drug overdoses, Alzheimer's and other dementias, cancer and cardiovascular disorders are the top mortality changes influencing their estimates.

The other practitioner types group agreed with the participating actuaries that the top three mortality changes impacting the 2022 non-COVID-19 excess mortality estimates are mortality deterioration from

cardiovascular disorders, cancer and drug overdoses. Whereas the participating actuaries think there will be mortality improvement among the top three mortality changes in future year estimates, the other practitioner types group did not.

For the life insurance industry insured population, participating actuaries include both cardiovascular disorder mortality deterioration and mortality improvement in the top three mortality changes affecting the non-COVID-19 estimates for 2022, 2023 and 2025. Both cancer mortality improvement and mortality deterioration appear in the top three for 2023 and 2025.

Contrary to the participating actuaries, the other practitioner types group's top three mortality changes for the non-COVID-19 excess mortality estimates for the life insurance industry insured population are similar to those for the general population estimates. Mortality deterioration from cardiovascular disorders, cancer, drug overdoses (2022 and 2023 only) and Alzheimer's and other dementias are expected to be in the top three throughout the study period.

**Table 11**  
**RESPONDENTS' TOP THREE MORTALITY CHANGES FOR ALL-CAUSE EXCESS MORTALITY ESTIMATES WITHOUT COVID-19 AS A CAUSE OF DEATH BY PRACTITIONER TYPE AND YEAR**

Change in Mortality	2022 Top 3	2023 Top 3	2025 Top 3	2030 Top 3
<b>Actuaries</b>				
<b>General Population</b>				
Cardiovascular Disorders Mortality Improvement			2	2
Cardiovascular Disorders Mortality Deterioration	2	3		
Cancer Mortality Improvement		1	1	1
Cancer Mortality Deterioration	3			
Drug Overdoses Mortality Improvement				3
Drug Overdoses Mortality Deterioration	1	2	3	
Alzheimer's and Other Dementias Mortality Improvement				3
<b>Life Insurance Industry Insured Population</b>				
Cardiovascular Disorders Mortality Improvement	3	3	2	2
Cardiovascular Disorders Mortality Deterioration	1	2		3
Cancer Mortality Improvement		3	1	1
Cancer Mortality Deterioration	1	1	3	
Alzheimer's and Other Dementias Mortality Improvement				3
<b>Other Practitioner Types</b>				
<b>General Population</b>				
Cardiovascular Disorders Mortality Deterioration	1	2	2	1
Cancer Mortality Deterioration	3	3		3
Drug Overdoses Mortality Deterioration	2	1	1	2
Accidents Excluding Drug Overdoses Mortality Deterioration			3	
<b>Life Insurance Industry Insured Population</b>				
Cardiovascular Disorders Mortality Deterioration	1	1	1	1
Cancer Mortality Deterioration	2	2	2	2
Drug Overdoses Mortality Deterioration	3	3		
Alzheimer's and Other Dementias Mortality Deterioration	3	3	3	3

Annuitant and pension populations are excluded because only actuaries responded to these questions.

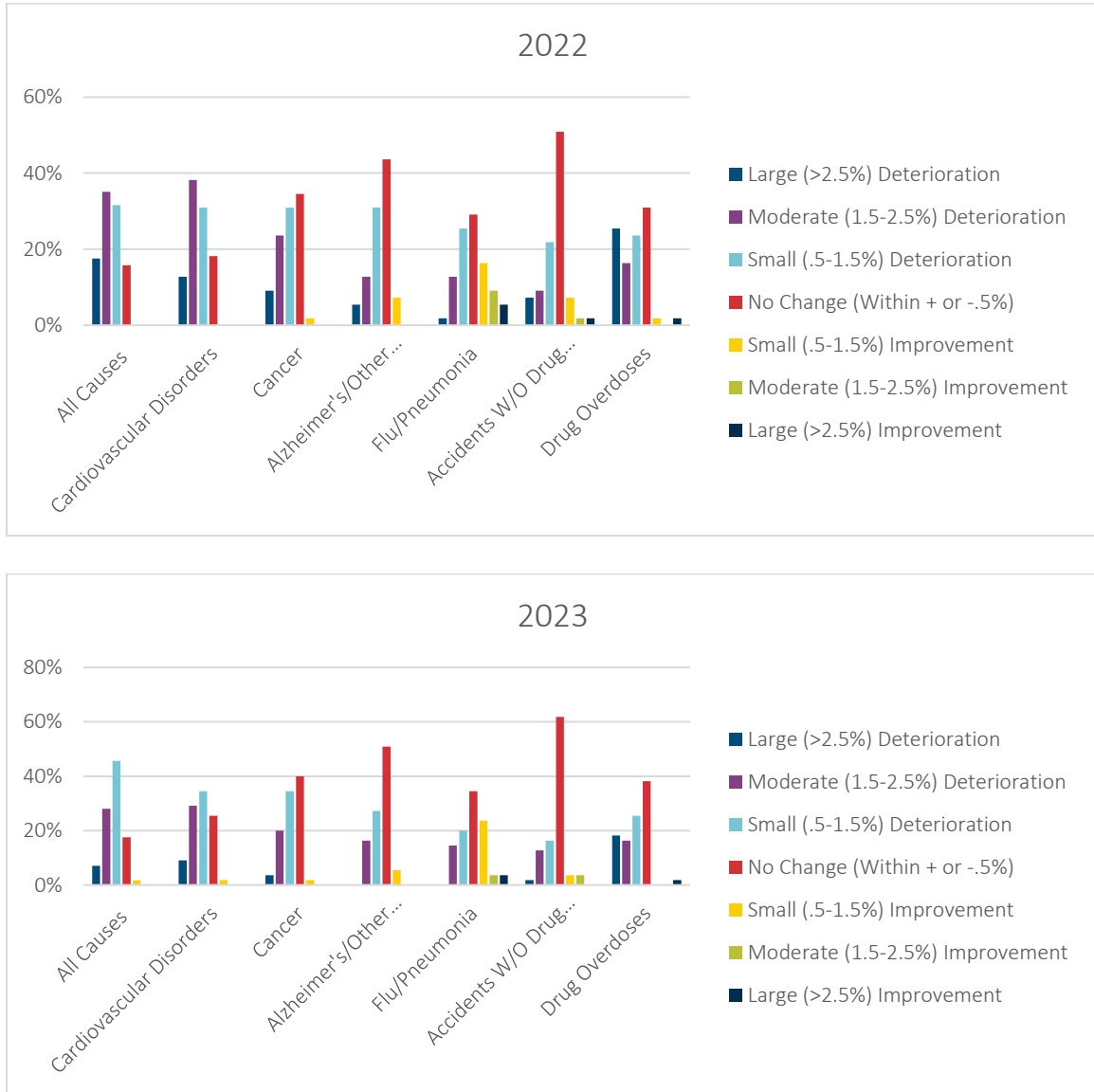
### 2.3 COVID-19 AND FUTURE MORTALITY IMPACTS

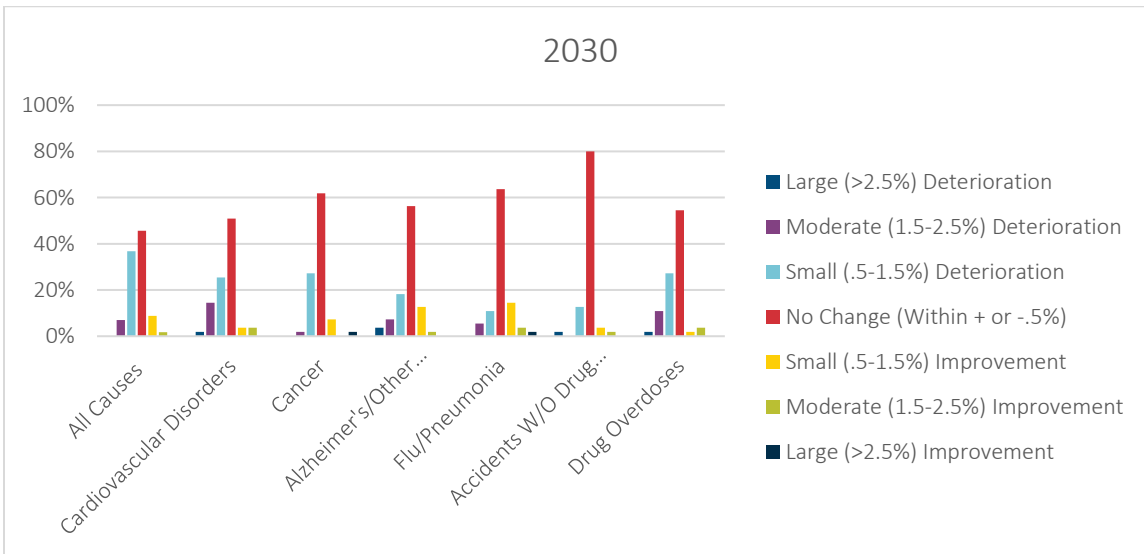
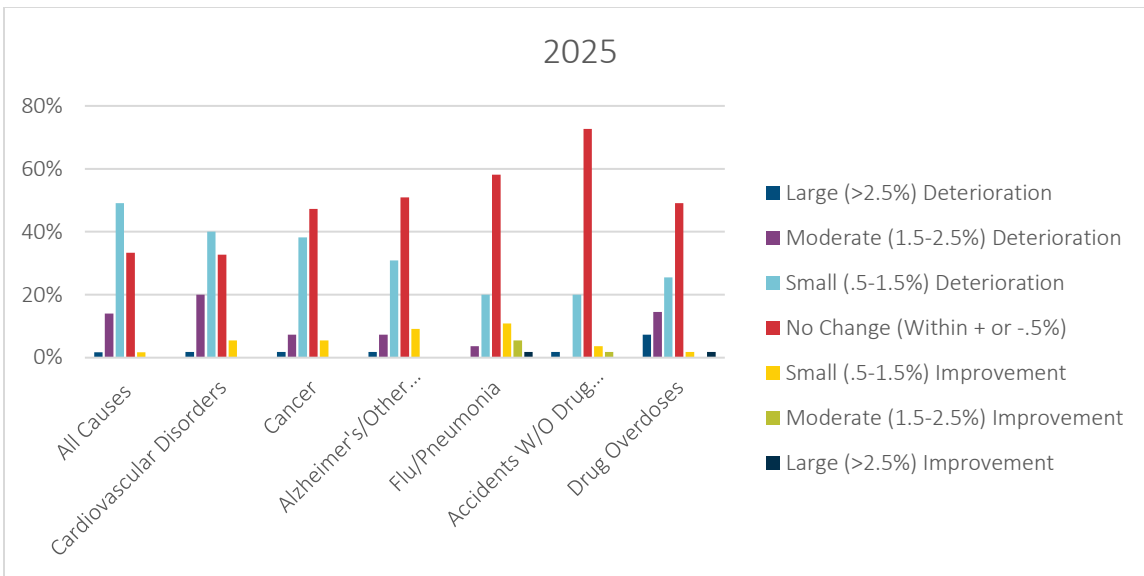
Per the American Medical Association, approximately 10%–30% of patients infected with the virus that causes COVID-19 can experience post-COVID conditions or long COVID, which can last from weeks to years. Because of the novel nature of long COVID, expert panel members were asked to provide their opinions on how long COVID and interruptions in the health care system due to COVID, collectively referred to as long COVID in this report, affect future short-term mortality (2022, 2023, 2025 and 2030) for the U.S. general population.

Participants were asked to provide their thoughts on the annualized mortality impact for the U.S. general population in relation to 2019 mortality levels for each of the four years in the study period. In addition to the impact on all-cause mortality, the annualized mortality impact for six specific causes of death was also examined. The causes of death are the same as those used in Section 2 of the survey: cardiovascular disorders, cancer, Alzheimer's/other dementias, flu/pneumonia, drug overdoses and accidents without drug overdoses. Participants were given six annualized mortality impact levels to select from: large deterioration (>2.5%), moderate deterioration (1.5%–2.5%), small deterioration (0.5%–1.5%), no change (within  $\pm 0.5\%$ ), small improvement (0.5%–1.5%), moderate improvement (1.5%–2.5%) and large improvement (>2.5%).

Figure 2 illustrates the participants' thoughts on the annualized mortality impact of long COVID for all-cause mortality and each by the specific causes of death mortality. In looking at 2022, a little over half of the respondents indicate at least a moderate impact in all-cause mortality and mortality from cardiovascular disorders. Twenty-five percent of the respondents also indicate a large deterioration in mortality due to drug overdoses. For 2023, the impact of long COVID on mortality is expected to ease for all-causes and cardiovascular disorders. This is also true for drug overdoses, but approximately 20% of the respondents still think there will be a large, annualized mortality deterioration due to long COVID. Contrary to drug overdoses, 24% of the respondents also believe there will be a small, annualized improvement in flu/pneumonia mortality representing a 50% increase over 2022. The impact of long COVID is expected to lessen throughout the remaining period so that by 2025 and 2030 at least 73% of the respondents think that long COVID will have a small, annualized mortality deterioration or no change to each cause of death mortality.

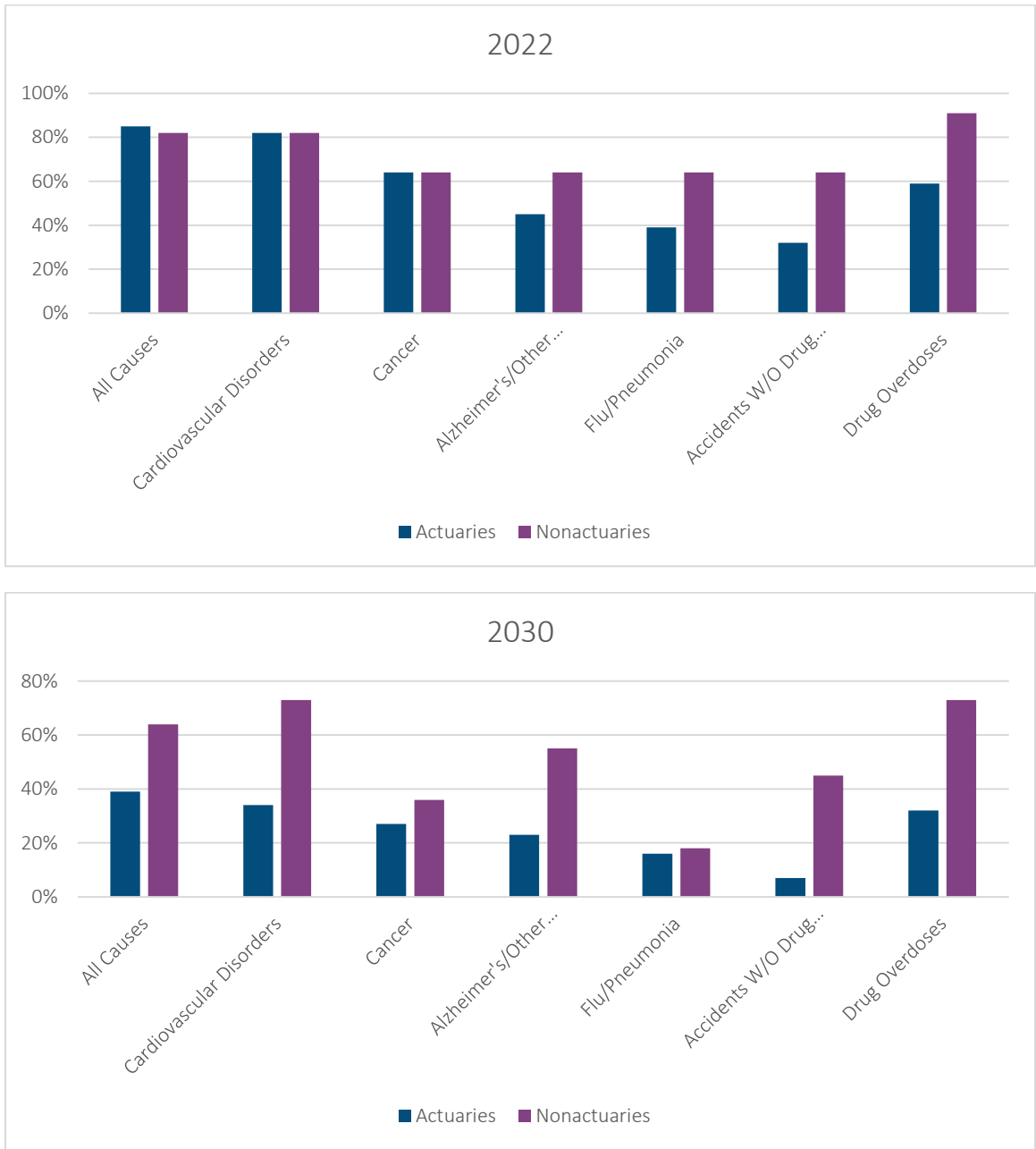
**Figure 2**  
**PERCENTAGE OF RESPONDENTS INDICATING U.S. GENERAL POPULATION ANNUALIZED MORTALITY IMPACT FROM LONG-COVID BY CAUSE AND BY YEAR**





Similar to opinions about excess mortality over the projection periods, differences were found between actuaries and other participating practitioners about the impact of long COVID on future mortality. Figure 3 shows the percentage of respondents expecting a mortality deterioration by practice type. The projection years for 2022 and 2030 are shown. For 2022, roughly the same percentage of actuaries and nonactuaries think there will be annualized mortality deterioration in 2022 for all causes, cardiovascular disorders and cancer mortality. By 2030, the majority of responding actuaries think there will be no change or an improvement in annualized mortality for these three causes, but the majority of nonactuaries still think there will be annualized mortality deterioration for all causes and cardiovascular disorders.

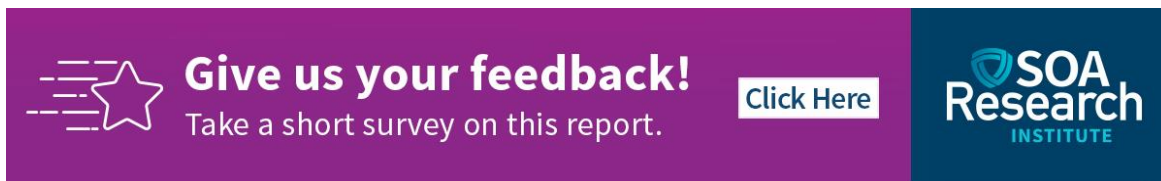
**Figure 3**  
**PERCENTAGE OF RESPONDENTS INDICATING U.S. GENERAL POPULATION ANNUALIZED MORTALITY DETERIORATION FROM LONG-COVID BY CAUSE AND PRACTICE TYPE FOR 2022 AND 2030**





In addition to providing their thoughts about the impact of long COVID on future mortality, the survey concluded by asking the participating panelists for their impressions on what COVID scenario would have the greatest impact on U.S. general population future all-cause mortality improvement and mortality deterioration. For mortality improvement, the top response was increased immunity in the population due to vaccination, boosters and past infections, followed by new medical treatments. For mortality deterioration, the top response was the emergence of a more virulent COVID-19 variant than existing variants, with the second being an unhealthier population than pre-pandemic levels created by long COVID.

### Section 3: Conclusions

Uncertainty remains about the future course of the pandemic. Since the survey was fielded, COVID-19 cases are on the rise in the U.S., with new Omicron subvariants BA.4 and BA.5 becoming the prominent variants. Because of the fluid environment, more research is needed exploring COVID-19 and future mortality. Therefore, planning is already underway for a follow-up expert opinion survey that would further investigate the evolution of the coronavirus and the implications to mortality over the next few years. For example, there has been conflicting information in the media on whether the coronavirus is still a pandemic in the U.S. or has become endemic. This is just one of the areas that will be included in the next survey. If there are COVID-19 topics that you think are important to cover in a future expert opinion survey, please email the author at [rstryker@soa.org](mailto:rstryker@soa.org)



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## Section 4: Acknowledgments

The author's deepest gratitude goes to those without whose efforts this project could not have come to fruition: the volunteers who generously shared their wisdom, insights, advice, guidance and arm's length review of this study prior to publication. Any opinions expressed may not reflect their opinions nor those of their employers. Any errors belong to the author alone.

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## Appendix A: Survey and Responses

# Impact of COVID-19 on Future U.S. Mortality

### Introduction

Since the start of the pandemic, great strides have been made in understanding how COVID-19 has impacted mortality with more and more data becoming available for assessing 2020 and 2021 mortality outcomes. Yet, uncertainty remains about future mortality given the nature of the virus to mutate, public response to COVID-19 mitigation methods, the potential for medical advances to prevent or treat COVID-19 and other factors. This Society of Actuaries Research Institute study seeks your opinions and insights on the impact of COVID-19 on the future mortality for four populations:

1. U.S. General Population
2. U.S. Life Insurance Industry Insured Population
3. U.S. Annuity Industry Annuitant Population
4. U.S. Private and Public Pension Plan Population.

You will not have to respond to the questions for every population. Questions you receive will be based on your indicated area of mortality knowledge.

The survey is composed of three sections in which several future time periods are explored. **As you complete the three sections of the survey, keep in mind that you cannot use the “back” button in your browser to review prior answers. Use the “GO BACK” button at the bottom of each page to navigate back to already answered questions. Upon completion of the survey, you will be provided a printable report of your survey responses.** If you are having challenges entering information in the survey, please clear the browsing history as it may resolve the issue. **Please respond no later than March 31, 2022. A copy of the survey questions can be found here.**

Responses will be kept anonymous and results will be summarized in a report to be published on the SOA website at [www.soa.org](http://www.soa.org).

## Section 1: Demographics

1: Practitioner Type (Please select all that apply.): **Number of responses are included in parentheses.**

- Academic **(6)**
- Actuary **(47)**
- Data scientist **(2)**
- Demographer **(7)**
- Epidemiologist **(3)**
- Medical professional **(5)**
- Regulator **(0)**
- Researcher **(10)**
- Retirement professional **(8)**
- Risk manager **(4)**
- Underwriter **(3)**
- Other **(1)**—Policy analyst

2: Number of years of experience (Please select one.): **Number of responses are included in parentheses.**

- 1–4 **(0)**
- 5–9 **(2)**
- 10–14 **(8)**
- 14–20 **(11)**
- 20–24 **(7)**
- 25+ **(31)**

3: Employer type (Please select one.): **Number of responses are included in parentheses.**

- Academic/Research Institution **(5)**
- Bank/Investment Management/Financial Services Company **(1)**
- Consulting **(16)**
- Insurer **(14)**
- Government Agency **(3)**
- Pension Plan **(1)**
- Rating Agency **(0)**
- Reinsurer **(13)**
- Self-Employed **(1)**
- Retired **(4)**
- Other **(1)**—International Organization

4. Area of Mortality Knowledge (Please select all that apply. Questions received are based on your selection. **Number of responses are in parentheses.**

- U.S. Life Insurance Industry Insured Population Mortality **(32)**
- U.S. Annuity Industry Annuitant Population Mortality **(6)**
- U.S. Private and Public Pension Plan Population Mortality **(15)**
- U.S. General Population Mortality **(39)**
- None of the above—**(1)**

## Section 2 Future Changes in U.S. All-Cause Mortality

In this section we are interested in understanding your thoughts on future changes in all-cause mortality for each of the four populations: U.S. General Population, U.S. Life Insurance Industry Insured Population, U.S. Annuity Industry Annuitant Population, and U.S. Private and Public Pension Plan Population.

Excess mortality will be explored for four future time periods. It is determined by examining projected mortality, including deaths that are directly or indirectly attributed to COVID-19 for a specific period divided by expected mortality assuming COVID-19 did not occur.

The following tables provide historical information for the U.S. General Population (Table 1) and the U.S. Individual Life Insurance Industry Insured Population (Table 2).

**Table 2**  
**HISTORICAL U.S. GENERAL POPULATION ALL-CAUSE MORTALITY**

Current Age	A 2019 No. of Deaths per 100,000	B 2020 No. of Deaths per 100,000 with COVID-19 Deaths	C = (B/A)–1 2020 Excess Mortality with COVID-19 Deaths (%)	D 2020 No. of Deaths per 100,000 without COVID-19 Deaths*	E = (D/A)–1 2020 Excess Mortality without COVID-19 Deaths* (%)
25	105	128	22	125	20
45	265	322	22	295	12
65	1,276	1,489	17	1,330	4
84	7,016	8,186	17	7,232	3

Sources: CDC WONDER and SOA Research Institute, *U.S. Population Mortality Observations Updated with 2020 Experience*.

\* COVID-19 Causes of death are defined as ICD-10 113 code of GL113-137.

**Table 2**  
**HISTORICAL U.S. INDIVIDUAL LIFE INSURANCE INDUSTRY INSURED POPULATION**  
**ALL-CAUSE MORTALITY**

Current Age	A 2019 No. of Deaths per 100,000	B 2020 No. of Deaths per 100,000 with COVID-19 Deaths	C = (B/A)–1 2020 Excess Mortality with COVID-19 Deaths (%)
25–44	78	90	15
45–64	365	409	12
65–84	2,278	2,563	13
85+	12,181	13,373	10

Source: SOA Research Institute, LIMRA, RGA, TAI, *U.S. Individual Life COVID-19 Mortality Experience Study—Fourth Quarter 2020 Update*.

Using the historical information provided above and your knowledge of COVID-19 and the impact on mortality, please provide your thoughts on how much total excess mortality there will be in future years. **In responding to the questions in this section, please assume 2019 mortality levels as your baseline for expected mortality.**

Total excess mortality estimates for four time periods, 2022, 2023, 2025, 2030, and four ages: 25, 45, 65, and 85 are requested.

Two scenarios are also considered for total excess mortality. The first scenario is the current reality in which we are approaching the second anniversary of the COVID-19 pandemic. This scenario is labeled “With COVID-19” and an example of With COVID-19 total excess mortality is column C in the historical information above.

The second scenario examines non-COVID-19 excess mortality and assumes no COVID-19 deaths. This scenario is labeled “Without COVID-19 as a cause of death” and an example of Without Covid-19 as a cause of death total excess mortality is column E in the historical information above.

For both scenarios, you will be asked for your thoughts on what is driving your responses.

Your responses will help us understand your thoughts on the future course of the pandemic and its impact on future mortality.

**All participants will receive U.S. General Population Mortality questions.**

## 1. U.S. GENERAL POPULATION MORTALITY

The following questions relate to **U.S. General Population** mortality.

**1.a.1. Assuming 2019 mortality levels as your baseline for expected mortality**, please indicate the level of excess mortality **With COVID-19** you expect for each of the years and ages listed below. Please express all numbers in decimal form. Here are three examples on how to respond:

From the historical U.S. population all-cause mortality information with COVID-19 deaths provided above, for age 25, the level of excess in 2020 in relation to 2019 mortality levels is 22%.

- If you believe the level of excess mortality will remain at the same level for 2022, for age 25, code the 22% level as “.22”.
- If you believe the excess mortality for age 25 will be reduced, e.g., to a level of 15% excess mortality, code “.15”.
- If you believe that excess mortality for age 25 will go away and there will be mortality improvement of, for example 5%, express the 5% mortality improvement as a negative number, “-.05”.

Please use the “Tab” button on your keyboard to advance from cell to cell.

### AGGREGATION OF RESPONSES FOR TOTAL EXCESS MORTALITY WITH COVID-19 U.S. GENERAL POPULATION

Current Age		Total Excess Mortality with COVID-19			
		2022	2023	2025	2030
25	Min	1%	0%	-4%	-18%
	Max	30%	30%	25%	25%
	Average	14%	9%	6%	2%
	Median	13%	6%	3%	0%
	25th Percentile	10%	5%	1%	0%
	75th Percentile	20%	15%	8%	3%
	No. Responses	55	56	56	56
45	Min	0%	-2%	-6%	-12%
	Max	35%	35%	30%	25%
	Average	13%	9%	5%	2%
	Median	11%	5%	3%	0%
	25th Percentile	8%	4%	1%	0%
	75th Percentile	19%	15%	8%	2%
	No. Responses	55	56	56	56
65	Min	1%	-2%	-6%	-12%
	Max	25%	60%	60%	60%
	Average	10%	7%	5%	2%
	Median	10%	5%	2%	0%
	25th Percentile	6%	2%	0%	0%

	75th Percentile	15%	10%	6%	2%
	No. Responses	55	56	56	55
85	Min	2%	-5%	-6%	-12%
	Max	20%	40%	40%	40%
	Average	9%	6%	3%	1%
	Median	10%	4%	2%	0%
	25th Percentile	5%	2%	0%	-1%
	75th Percentile	14%	10%	5%	2%
	No. Responses	55	55	56	56

**1.a.2** How confident are you in your estimates? For each time period, indicate which word best describes your level of confidence.

#### NUMBER OF RESPONSES FOR EACH CONFIDENCE LEVEL OPTION

Confidence Level	2022 Total Excess Mortality with COVID-19	2025 Total Excess Mortality with COVID-19	2030 Total Excess Mortality with COVID-19
Low	14	26	35
Medium	30	28	16
High	12	2	5

**1.a.3** What are the top 3 COVID-19 drivers influencing your future total excess mortality **With COVID-19** responses? "1" is the most influential COVID-19 driver.

#### NUMBER OF RESPONSES PER DRIVER RANK OPTIONS AND TOTAL SCORES (TS)

Driver	2022	2023	2025	2030
Change in COVID-19 vaccination/booster rates	"1"-12 "2"-7 "3"-4 TS = 54	"1"-9 "2"-5 "3"-5 TS = 42	"1"-2 "2"-10 "3"-6 TS = 32	"1"-2 "2"-8 "3"-6 TS = 28
Higher virulence of current or future COVID-19 strains/variants	"1"-12 "2"-7 "3"-2 TS = 52	"1"-8 "2"-4 "3"-6 TS = 38	"1"-5 "2"-2 "3"-3 TS = 22	"1"-3 "2"-2 "3"-3 TS = 16
Lower virulence of current or future COVID-19 strains/variants	"1"-13 "2"-6 "3"-5 TS = 56	"1"-14 "2"-6 "3"-7 TS = 61	"1"-12 "2"-10 "3"-4 TS = 60	"1"-19 "2"-8 "3"-5 TS = 78

<b>New COVID-19 medical treatments</b>	"1"-5 "2"-13 "3"-13 TS = 54	"1"-7 "2"-19 "3"-7 TS = 66	"1"-11 "2"-21 "3"-9 TS = 84	"1"-9 "2"-21 "3"-12 TS = 81
<b>Change in public behavior for masking</b>	"1"-0 "2"-3 "3"-4 TS = 10	"1"-0 "2"-3 "3"-4 TS = 10	"1"-0 "2"-0 "3"-3 TS = 3	"1"-0 "2"-1 "3"-3 TS = 5
<b>Better mortality occurs as more and more older, less healthy individuals die from COVID-19 leaving a healthier population than pre-pandemic</b>	"1"-3 "2"-2 "3"-8 TS = 21	"1"-2 "2"-2 "3"-10 TS = 20	"1"-4 "2"-1 "3"-9 TS = 23	"1"-5 "2"-3 "3"-8 TS = 29
<b>Worse mortality occurs from long COVID and indirect COVID-19 impacts leaving an unhealthier population than pre-pandemic</b>	"1"-3 "2"-3 "3"-8 TS = 23	"1"-4 "2"-6 "3"-7 TS = 31	"1"-8 "2"-3 "3"-7 TS = 37	"1"-4 "2"-4 "3"-6 TS = 26
<b>Public deferral of health care and treatment due to COVID-19</b>	"1"-2 "2"-8 "3"-6 TS = 28	"1"-5 "2"-5 "3"-6 TS = 31	"1"-2 "2"-4 "3"-7 TS = 21	"1"-1 "2"-2 "3"-4 TS = 11

A score was assigned to each response. A driver with a response of rank 1 received a score of 3; a driver with a response of rank 2 received a score of 2; and a driver with a response of rank 3 received a score of 1. These were summed to produce a total score for each driver option.

Other drivers mentioned by the participants:

Increased immunity to COVID resulting from past infections (partial herd immunity)

Mental health consequences of the pandemic response

Other changes in behavior

Shift in severity of impact to younger ages

Long-term impact of vaccines on future health

Infections by this virulent strain is creating natural immunity in the unvaccinated

Increased use of flu vaccines with COVID boosters

Non-COVID causes of death continue to cause excess mortality at younger ages

Combo of natural immunity and vaccine immunity making more people able to avoid death with infection

COVID no longer is a significant driver of mortality, primarily due to immunity build-up

Persistent refusal to vaccinate/mistrust

COVID isolation "firewall" effect from other mortality drivers wears off

Non-COVID impacts at younger ages

Herd immunity

Immunity level (Booster+prior infection with consideration to waning immunity)



Normal improvements in mortality over time, not specifically related to COVID-19 or associated measures  
 Lower absolute levels of circulating COVID transmission  
 Worsening lifestyle characteristics (e.g., smoking, BMI, alcohol, opioid)  
 Behavior (especially insofar as returns to pre-pandemic levels)  
 Adverse side effects of COVID-19 mitigations for public health (economic disruption, increased mental health issues and drug abuse etc.)  
 Improvement from other causes of death  
 Lack of Federal COVID funding

**1.b.1 Assuming 2019 mortality levels as your baseline for expected mortality**, please indicate the level of excess mortality **Without COVID-19 as a Cause of Death** you expect for each of the years and ages listed below. Please express all numbers in decimal form. Here are three examples on how to respond:

From the U.S. population historical all-cause mortality without COVID-19 deaths information provided above, for age 25, the level of excess for non-COVID-19 causes of deaths in 2020 in relation to 2019 mortality levels is 20%.

- If you believe the level of excess mortality will remain at the same level for 2022, code the 20% level as “.20”.
- If you believe the excess mortality will be reduced, e.g., to a level of 15% excess mortality, code “.15”.
- If you believe that excess mortality will go away and there will be mortality improvement of, for example 5%, express the 5% mortality improvement as a negative number, “-.05”.

#### AGGREGATION OF RESPONSES FOR TOTAL EXCESS MORTALITY WITHOUT COVID-19 AS A CAUSE OF DEATH U.S. GENERAL POPULATION

Total Excess Mortality without COVID-19 as a Cause of Death					
Current Age		2022	2023	2025	2030
25	Min	-1%	-1%	-5%	-10%
	Max	30%	28%	24%	23%
	Average	10%	8%	5%	3%
	Median	10%	5%	2%	0%
	25th Percentile	3%	2%	0%	0%
	75th Percentile	15%	15%	9%	5%
	No. Responses	54	55	55	54
45	Min	-4%	-5%	-7%	-19%
	Max	33%	33%	25%	22%
	Average	7%	6%	3%	1%
	Median	7%	4%	2%	0%
	25th Percentile	3%	2%	0%	0%
	75th Percentile	10%	10%	5%	3%
	No. Responses	54	55	55	54

65	Min	-4%	-5%	-7%	-19%
	Max	50%	50%	50%	50%
	Average	4%	3%	1%	-1%
	Median	3%	1%	0%	0%
	25th Percentile	1%	0%	-1%	-4%
	75th Percentile	5%	3%	2%	0%
	No. Responses	54	55	55	54
85	Min	-10%	-8%	-6%	-17%
	Max	20%	20%	20%	20%
	Average	2%	1%	0%	-2%
	Median	2%	1%	0%	0%
	25th Percentile	1%	0%	-2%	-5%
	75th Percentile	3%	2%	1%	0%
	No. Responses	54	55	55	54

**1.b.2** How confident are you in your estimates? For each time period, indicate which word best describes your level of confidence.

#### NUMBER OF RESPONSES FOR EACH CONFIDENCE LEVEL OPTION

Confidence Level	2022 Total Excess Mortality without COVID-19 as a Cause of Death	2025 Total Excess Mortality without COVID-19 as a Cause of Death	2030 Total Excess Mortality without COVID-19 as a Cause of Death
Low	18	29	33
Medium	27	22	14
High	9	3	7

**1.b.3** What are the top 3 influential mortality changes impacting your future total excess mortality **Without COVID-19 as a Cause of Death** responses in 1.b.1? "1" is the most influential change.

#### NUMBER OF RESPONSES PER MORTALITY CHANGE RANK OPTION AND TOTAL SCORES (TS)

Change in Mortality from	2022	2023	2025	2030
<b>Cardiovascular Disorders Mortality Improvement</b>	"1"-3 "2"-5 "3"-5 TS = 24	"1"-3 "2"-7 "3"-7 TS = 30	"1"-5 "2"-11 "3"-6 TS = 43	"1"-5 "2"-14 "3"-9 TS = 52
<b>Cardiovascular Disorders Mortality Deterioration</b>	"1"-13 "2"-5 "3"-6 TS = 55	"1"-12 "2"-5 "3"-4 TS = 50	"1"-7 "2"-7 "3"-2 TS = 37	"1"-7 "2"-3 "3"-1 TS = 28

<b>Cancer Mortality Improvement</b>	"1"-6 "2"-3 "3"-2 TS = 26	"1"-10 "2"-6 "3"-2 TS = 44	"1"-14 "2"-6 "3"-2 TS = 56	"1"-17 "2"-10 "3"-3 TS = 74
<b>Cancer Mortality Deterioration</b>	"1"-5 "2"-11 "3"-5 TS = 42	"1"-5 "2"-9 "3"-3 TS = 36	"1"-5 "2"-4 "3"-2 TS = 25	"1"-1 "2"-4 "3"-0 TS = 11
<b>Alzheimer's and Other Dementias Mortality Improvement</b>	"1"-1 "2"-1 "3"-4 TS = 9	"1"-1 "2"-1 "3"-5 TS = 10	"1"-0 "2"-2 "3"-8 TS = 12	"1"-3 "2"-4 "3"-7 TS = 24
<b>Alzheimer's and Other Dementias Mortality Deterioration</b>	"1"-0 "2"-1 "3"-3 TS = 5	"1"-0 "2"-1 "3"-4 TS = 6	"1"-0 "2"-1 "3"-4 TS = 6	"1"-1 "2"-1 "3"-2 TS = 24
<b>Accidents Excluding Drug Overdoses Mortality Improvement</b>	"1"-2 "2"-2 "3"-3 TS = 13	"1"-1 "2"-3 "3"-3 TS = 12	"1"-1 "2"-3 "3"-3 TS = 12	"1"-1 "2"-2 "3"-4 TS = 11
<b>Accidents Excluding Drug Overdoses Mortality Deterioration</b>	"1"-4 "2"-5 "3"-5 TS = 27	"1"-4 "2"-6 "3"-2 TS = 26	"1"-1 "2"-6 "3"-2 TS = 12	"1"-6 "2"-3 "3"-7 TS = 31
<b>Drug Overdoses Mortality Improvement</b>	"1"-2 "2"-2 "3"-2 TS = 12	"1"-3 "2"-1 "3"-3 TS = 14	"1"-5 "2"-1 "3"-6 TS = 23	"1"-5 "2"-0 "3"-7 TS = 22
<b>Drug Overdoses Mortality Deterioration</b>	"1"-10 "2"-12 "3"-9 TS = 63	"1"-11 "2"-8 "3"-12 TS = 61	"1"-10 "2"-5 "3"-9 TS = 49	"1"-1 "2"-3 "3"-3 TS = 12
<b>Flu/Pneumonia Mortality Improvement</b>	"1"-0 "2"-4 "3"-2 TS = 10	"1"-0 "2"-5 "3"-1 TS = 11	"1"-1 "2"-3 "3"-2 TS = 11	"1"-1 "2"-3 "3"-3 TS = 12
<b>Flu/Pneumonia Mortality Deterioration</b>	"1"-2 "2"-0 "3"-0 TS = 6	"1"-1 "2"-0 "3"-1 TS = 4	"1"-1 "2"-0 "3"-1 TS = 4	"1"-1 "2"-0 "3"-1 TS = 4

A score was assigned to each response. A mortality change with a response of rank 1 received a score of 3; a mortality change with a response of rank 2 received a score of 2; and a mortality change with a response of rank 3 received a score of 1. These were summed to produce a total score for each mortality change option.

Other influencers of mortality mentioned by the participants:

Return to normalcy

Cardiovascular mortality stagnation  
 Cancer mortality stagnation  
 Chronic disease improvement  
 Murder, suicide etc.  
 Mental health issues  
 Treatment delay due to COVID  
 "Thinning the herd" better selection  
 Healthier population post-COVID  
 Better awareness of personal hygiene; cleaning hands and surfaces; avoiding crowds

**1.c** Additional comments about future excess mortality: \_\_\_\_\_

Responses:

I believe that long COVID will impact, cancer incidence, treatment, as well as depression and alienation which come from the lock downs causing overall higher mortality for the next few years. 2030 is too far to see. New COVID itself will not be a factor because of the impact of therapeutic treatments, as well as the disease already culling the most vulnerable.

The trends in external COD for ages under 45 is striking and it seems to be accelerated under the pandemic in 2020 and 2021. I'm projecting that will slow over time, but I'm somewhat doubtful.

It is difficult to know the effects of Long COVID on future mortality. This is a huge question mark. Is COVID killing off those with pre-existing conditions at higher rates than healthy individuals? Of course. Without knowledge of the effect of Long COVID on healthier individuals, my default is to assume it is a push between a healthier population and mortality effects of Long COVID. I do think COVID at least in the near term will still have the effect of influenza seasonally—perhaps around 50,000 deaths annually.

In 10 years, excess COVID mortality will be mostly gone, but complications due to pandemic response will cause more excess mental health related mortality

Cancer is driving improvement; heart disease is driving deterioration. Those are the big two.

Too speculative regarding excess mortality in 2020. It has to be COVID-related whether classified or not.

I think that in the short and medium term, what happens with regard to drug overdoses is going to determine in large part the level of mortality below age 65 and COVID will have very limited impact; by contrast, at 65 and above, long COVID and its impact on cardiovascular diseases and cancer (due for instance to delayed screening and care during the pandemic) will be the main factors influencing mortality trends in the immediate future.

My forecast of mortality is not optimistic, because current data show that mortality in 2022 has no tendency to decline. I would not separate COVID and non-COVID mortality taking into account that cause-of-death data are notoriously inaccurate.

The impact of COVID on excess mortality is very difficult to untangle due to inconsistencies in reporting of COVID deaths and the impact of COVID on other causes of death.

Lots of unknowns due to the impact of mRNA vaccines, autoimmune deficiency, and possible future variants (better or worse?). However, should also see some overall improvements due to reduction in population with co-morbidities.

Younger age MI [mortality improvement] is highly dependent on social improvement regarding drug overdoses. Low confidence because both improvement and disimprovement are plausible and of greater magnitude than improvements in medical care.

Projected mortality entered is generally in sync with current mortality improvement projections, which are based on historical improvement information. This includes the worsening improvements at the younger ages. Top 3 reasons given are a guess.

The questions above appear to imply that masking is the only significant COVID vector. As social isolation ends there will be greater exposure both to COVID and other risks such as accidents as more people are out and about, with or without wearing masks. The overall impact of that will decline with age.

A large issue with excess mortality trends is the uncertainty and how much is being driven by public policy choices. I'm going to admit to very large error bars on my guesses above, which are partly driven by my preliminary numbers I'm seeing from 2021, and making stabs at 2022, plus thinking through some scenarios for near term and longer-term. I think it's good to put down some baseline guesses right now, and for us to adjust as we get better data, but to realize how much forecasts will (or will not) be affected by public policy.

I believe all conditions that worsen due to deferred care will result in excess mortality in the next 3-5 years.

2023 will likely be a heavy flu year, with higher ages disproportionately affected.

Flu vs. COVID kill many of the same people, so there could be an offset that persists indefinitely. No question asks about contagiousness vs. severity of future strains. With high levels of prior infection, any model should consider both vaccines and existing levels of immunity from prior infection (waning immunity taken into account). Immunity at both sterilizing and functional levels would need to be considered. Could we already be starting to move to an overall level of immunity where vaccination really only matters for older or at risk groups, and these groups keep getting a booster periodically so a situation much like the flu was before 2020? 1.b.3 was difficult for me in the sense that the dynamic is different for younger ages (crash cars and take drugs) vs. older (Cardio, cancer) in terms of dominance.

## 2. U.S. LIFE INSURANCE INDUSTRY INSURED POPULATION MORTALITY

The following questions relate to **U.S. Life Insurance Industry Insured Population** mortality.

**2.a.1 Assuming 2019 mortality levels as your baseline for expected mortality**, please indicate the level of excess mortality **With COVID-19** you expect for each of the years and ages listed below. Please express all numbers in decimal form. Here are three examples on how to respond:

No historical U.S. life insurance industry insured population mortality information is provided. In this example U.S. individual life insurance industry historical mortality with COVID-19 information is used. From the U.S. individual life insurance industry historical information provided above, for ages 25–44, the level of excess in 2020 in relation to 2019 mortality levels, is 15%.

- If you believe the U.S. life insurance industry insured population level of excess mortality, for age 25, will remain at the same level for 2022 as the U.S. individual life insurance industry 25–44 historical information for 2020, code the 15% level as “.15”.
- If you believe the excess mortality will be reduced, e.g., to a level of 10% excess mortality, code “.10”.

- If you believe that excess mortality will go away and there will be mortality improvement of, for example 5%, express the 5% mortality improvement as a negative number, “-.05”.

#### AGGREGATION OF RESPONSES FOR TOTAL EXCESS MORTALITY WITH COVID-19 U.S. LIFE INSURANCE INDUSTRY INSURED POPULATION

Current Age		Total Excess Mortality with COVID-19			
		2022	2023	2025	2030
25	Min	0%	-1%	-5%	-20%
	Max	25%	15%	12%	12%
	Average	10%	5%	2%	-1%
	Median	10%	5%	2%	0%
	25th Percentile	7%	2%	0%	0%
	75th Percentile	12%	10%	4%	1%
	No. Responses	29	29	29	29
45	Min	0%	-1%	-5%	-20%
	Max	30%	25%	15%	10%
	Average	10%	5%	2%	-1%
	Median	10%	4%	1%	0%
	25th Percentile	6%	2%	0%	0%
	75th Percentile	10%	6%	3%	1%
	No. Responses	29	29	29	29
65	Min	0%	-1%	-10%	-20%
	Max	25%	15%	10%	10%
	Average	9%	4%	1%	-1%
	Median	7%	3%	1%	0%
	25th Percentile	5%	1%	0%	0%
	75th Percentile	10%	5%	3%	1%
	No. Responses	29	29	29	29
85	Min	0%	-5%	-10%	-15%
	Max	15%	10%	10%	10%
	Average	7%	3%	1%	-1%
	Median	6%	3%	1%	0%
	25th Percentile	5%	1%	-1%	-2%
	75th Percentile	9%	5%	2%	1%
	No. Responses	29	29	29	29

2.a.2 How confident are you in your estimates? For each time period, indicate which word best describes your level of confidence.

#### NUMBER OF RESPONSES FOR EACH CONFIDENCE LEVEL OPTION

Confidence Level	2022 Total Excess Mortality with COVID-19	2025 Total Excess Mortality with COVID-19	2030 Total Excess Mortality with COVID-19
Low	5	11	19
Medium	18	18	8
High	6	0	2

2.a.3 What are the top 3 COVID-19 drivers influencing your future total excess mortality **With COVID-19** responses? "1" is the most influential driver.

#### NUMBER OF RESPONSES PER DRIVER RANK OPTIONS AND TOTAL SCORES (TS)

Driver	2022	2023	2025	2030
Change in COVID-19 vaccination/booster rates	"1"-6 "2"-1 "3"-1 TS = 21	"1"-3 "2"-3 "3"-3 TS = 18	"1"-2 "2"-3 "3"-2 TS = 14	"1"-2 "2"-3 "3"-2 TS = 14
Higher virulence of current or future COVID-19 strains/variants	"1"-6 "2"-2 "3"-1 TS = 23	"1"-3 "2"-1 "3"-3 TS = 14	"1"-2 "2"-1 "3"-1 TS = 9	"1"-1 "2"-1 "3"-1 TS = 6
Lower virulence of current or future COVID-19 strains/variants	"1"-6 "2"-4 "3"-2 TS = 28	"1"-4 "2"-5 "3"-3 TS = 25	"1"-3 "2"-6 "3"-4 TS = 25	"1"-6 "2"-3 "3"-3 TS = 27
New COVID-19 medical treatments	"1"-2 "2"-7 "3"-6 TS = 26	"1"-7 "2"-7 "3"-6 TS = 41	"1"-8 "2"-6 "3"-6 TS = 42	"1"-7 "2"-11 "3"-2 TS = 45
Change in public behavior for masking	"1"-0 "2"-0 "3"-4 TS = 4	"1"-0 "2"-0 "3"-3 TS = 3	"1"-0 "2"-0 "3"-2 TS = 42	"1"-0 "2"-1 "3"-5 TS = 7
Better mortality occurs as more and more older, less healthy individuals die from COVID-19 leaving a healthier population than pre-pandemic	"1"-0 "2"-1 "3"-4 TS = 6	"1"-1 "2"-2 "3"-3 TS = 10	"1"-3 "2"-2 "3"-5 TS = 18	"1"-4 "2"-1 "3"-5 TS = 19
Worse mortality occurs from long COVID and indirect COVID-19 impacts leaving an	"1"-2 "2"-4 "3"-4 TS = 18	"1"-4 "2"-6 "3"-4 TS = 28	"1"-3 "2"-6 "3"-3 TS = 24	"1"-1 "2"-4 "3"-1 TS = 12

unhealthier population than pre-pandemic				
Public deferral of health care and treatment due to COVID-19	"1"-2	"1"-3	"1"-3	"1"-2
	"2"-5	"2"-3	"2"-2	"2"-0
	"3"-2	"3"-1	"3"-0	"3"-1
	TS = 18	TS = 16	TS = 13	TS = 7

A score was assigned to each response. A driver with a response of rank 1 received a score of 3; a driver with a response of rank 2 received a score of 2; and a driver with a response of rank 3 received a score of 1. These were summed to produce a total score for each driver option.

Other drivers mentioned: Improvement in general vaccine; non-COVID-19 Causes of death continues to cause excess mortality at the younger ages; natural and passive immunity; herd immunity; overall level of immunity in the U.S. from infection and prior vaccination; behavior returns to prepandemic levels; worsening lifestyle characteristics will adversely impact mortality; and lack of federal funding for COVID-19.

**2.b.1 Assuming 2019 mortality levels as your baseline for expected mortality**, please indicate the level of excess mortality **Without COVID-19 as a Cause of Death** you expect for each of the years and ages listed below. Please express all numbers in decimal form. Here are three examples on how to respond:

No historical U.S. life insurance industry insured population mortality information is provided. In this example, U.S. population historical mortality information **Without COVID-19** deaths is used. From the historical information provided above, for age 25, the level of excess mortality for non-COVID-19 causes of death in 2020 in relation to 2019 mortality levels is 20%.

- If you believe the U.S. life insurance industry insured population level of excess mortality **Without COVID-19 as a Cause of Death** will remain at the same level for 2022 as the U.S. population historical mortality without COVID-19 deaths information in 2020, code the 20% level as ".20".
- If you believe the excess mortality will be reduced, e.g., to a level of 15% excess mortality, code ".15".
- If you believe that excess mortality will go away and there will be mortality improvement of, for example 5%, express the 5% mortality improvement as a negative number, "-.05".

#### AGGREGATION OF RESPONSES FOR TOTAL EXCESS MORTALITY WITHOUT COVID-19 AS A CAUSE OF DEATH U.S. LIFE INSURANCE INDUSTRY INSURED POPULATION

Total Excess Mortality without COVID-19 as a Cause of Death					
Current Age		2022	2023	2025	2030
25	Min	0%	-3%	-6%	-21%
	Max	20%	20%	20%	20%
	Average	8%	5%	2%	0%
	Median	8%	3%	1%	0%
	25th Percentile	1%	1%	0%	-1%
	75th Percentile	10%	7%	3%	2%
	No. Responses	29	29	29	29
45	Min	0%	-3%	-6%	-21%
	Max	20%	20%	20%	20%



	Average	5%	3%	1%	-1%
	Median	4%	2%	1%	0%
	25th Percentile	1%	0%	0%	-1%
	75th Percentile	6%	5%	1%	1%
	No. Responses	29	29	29	29
65	Min	-1%	-3%	-6%	-21%
	Max	20%	20%	20%	20%
	Average	3%	2%	1%	-1%
	Median	2%	1%	0%	0%
	25th Percentile	1%	0%	-1%	-1%
	75th Percentile	4%	3%	1%	0%
	No. Responses	29	29	29	29
85	Min	-10%	-8%	-6%	-16%
	Max	20%	20%	20%	20%
	Average	2%	1%	0%	-1%
	Median	1%	0%	0%	0%
	25th Percentile	0%	-1%	-1%	-3%
	75th Percentile	3%	1%	1%	0%
	No. of responses	29	29	29	29

**2.b.2** How confident are you in your estimates? For each time period, indicate which word best describes your level of confidence.

#### NUMBER OF RESPONSES FOR EACH CONFIDENCE LEVEL OPTION

Confidence Level	2022 Total Excess Mortality without COVID-19 as a Cause of Death	2025 Total Excess Mortality without COVID-19 as a Cause of Death	2030 Total Excess Mortality without COVID-19 as a Cause of Death
Low	8	15	18
Medium	16	13	9
High	4	0	1

2.b.3 What are the top 3 influential mortality changes impacting your future total excess mortality **Without COVID-19 as a Cause of Death** responses in 2.b.1? “1” is the most influential change.

**NUMBER OF RESPONSES PER MORTALITY CHANGE RANK OPTION AND TOTAL SCORES (TS)**

Change in Mortality from	2022	2023	2025	2030
<b>Cardiovascular Disorders Mortality Improvement</b>	“1”-5 “2”-2 “3”-0 TS = 19	“1”-5 “2”-5 “3”-0 TS = 25	“1”-5 “2”-5 “3”-2 TS = 27	“1”-4 “2”-5 “3”-3 TS = 25
<b>Cardiovascular Disorders Mortality Deterioration</b>	“1”-8 “2”-4 “3”-2 TS = 34	“1”-6 “2”-5 “3”-2 TS = 30	“1”-4 “2”-6 “3”-0 TS = 24	“1”-3 “2”-3 “3”-1 TS = 16
<b>Cancer Mortality Improvement</b>	“1”-3 “2”-4 “3”-0 TS = 17	“1”-5 “2”-5 “3”-0 TS = 25	“1”-6 “2”-6 “3”-0 TS = 30	“1”-8 “2”-6 “3”-1 TS = 37
<b>Cancer Mortality Deterioration</b>	“1”-6 “2”-6 “3”-2 TS = 32	“1”-6 “2”-6 “3”-2 TS = 32	“1”-5 “2”-3 “3”-1 TS = 22	“1”-2 “2”-2 “3”-0 TS = 10
<b>Alzheimer’s and Other Dementias Mortality Improvement</b>	“1”-0 “2”-1 “3”-2 TS = 4	“1”-0 “2”-1 “3”-4 TS = 6	“1”-0 “2”-1 “3”-4 TS = 6	“1”-2 “2”-2 “3”-3 TS = 13
<b>Alzheimer’s and Other Dementias Mortality Deterioration</b>	“1”-1 “2”-1 “3”-2 TS = 7	“1”-1 “2”-1 “3”-1 TS = 6	“1”-2 “2”-0 “3”-2 TS = 8	“1”-2 “2”-2 “3”-3 TS = 13
<b>Accidents Excluding Drug Overdoses Mortality Improvement</b>	“1”-0 “2”-0 “3”-1 TS = 1	“1”-0 “2”-0 “3”-1 TS = 1	“1”-0 “2”-1 “3”-2 TS = 4	“1”-0 “2”-1 “3”-3 TS = 5
<b>Accidents Excluding Drug Overdoses Mortality Deterioration</b>	“1”-1 “2”-2 “3”-4 TS = 11	“1”-2 “2”-1 “3”-3 TS = 11	“1”-0 “2”-1 “3”-2 TS = 4	“1”-0 “2”-1 “3”-1 TS = 3
<b>Drug Overdoses Mortality Improvement</b>	“1”-0 “2”-1 “3”-2 TS = 4	“1”-1 “2”-0 “3”-3 TS = 6	“1”-1 “2”-0 “3”-2 TS = 5	“1”-1 “2”-1 “3”-3 TS = 8
<b>Drug Overdoses Mortality Deterioration</b>	“1”-3 “2”-2 “3”-5 TS = 18	“1”-1 “2”-3 “3”-6 TS = 15	“1”-1 “2”-1 “3”-6 TS = 11	“1”-1 “2”-1 “3”-5 TS = 10

<b>Flu/Pneumonia Mortality Improvement</b>	"1"-0 "2"-1 "3"-1 TS = 3	"1"-1 "2"-0 "3"-1 TS = 4	"1"-1 "2"-0 "3"-1 TS = 4	"1"-1 "2"-0 "3"-1 TS = 4
<b>Flu/Pneumonia Mortality Deterioration</b>	"1"-0 "2"-0 "3"-0 TS = 0	"1"-0 "2"-0 "3"-0 TS = 0	"1"-1 "2"-0 "3"-0 TS = 3	"1"-1 "2"-1 "3"-0 TS = 5

A score was assigned to each response. A mortality change with a response of rank 1 received a score of 3; a mortality change with a response of rank 2 received a score of 2; and a mortality change with a response of rank 3 received a score of 1. These were summed to produce a total score for each mortality change option.

Other influential mortality changes mentioned: Reversion to normalcy, cardiovascular stagnation, murder, suicide, mortality displacement, long-term work from home causes more sedentary behavior so more heart disease, diabetes, depression suicide and obesity.

2.c Additional comments about future excess mortality: \_\_\_\_\_

Impact of overdose deaths is mitigated by underwriting, reducing the influence of this factor relative to the general population.

I expect all causes of death due to medical care deferrals (e.g., diabetes) will increase in the next 3-5 years and beyond.

COVID-19 vs. Flu will offset to some degree long term.

### 3. U.S. ANNUITY INDUSTRY ANNUITANT POPULATION MORTALITY

The following questions relate to **U.S. Annuity Industry Annuitant Population** mortality.

**3.a.1 Assuming 2019 mortality levels as your baseline for expected mortality**, please indicate the level of excess mortality **With COVID-19** you expect for each of the years and ages listed below. Please express all numbers in decimal form. Here are three examples on how to respond:

No historical U.S. annuity industry annuitant population mortality information is provided. In this example, U.S. population historical mortality with COVID-19 information is used. From the U.S. population industry historical mortality with COVID-19 information above, for age 25, the level of excess in 2020 in relation to 2019 mortality levels is 22%.

- If you believe the U.S. annuity industry annuitant population level of excess mortality with COVID-19 will remain at the same level for 2022 as the U.S. population historical information in 2020, code the 22% level as ".22".
- If you believe the excess mortality will be reduced, e.g., to a level of 15% excess mortality, code ".15".
- If you believe that excess mortality will go away and there will be mortality improvement of, for example 5%, express the 5% mortality improvement as a negative number, "-.05".

AGGREGATION OF RESPONSES FOR TOTAL EXCESS MORTALITY WITH COVID-19 U.S. ANNUITY INDUSTRY  
ANNUITANT POPULATION

Current Age		Total Excess Mortality with COVID-19			
		2022	2023	2025	2030
25	Min	2%	1%	-2%	-5%
	Max	7%	5%	2%	2%
	Average	5%	3%	0%	-1%
	Median	5%	3%	0%	0%
	25th Percentile	4%	2%	0%	-4%
	75th Percentile	5%	3%	1%	0%
	No. Responses	6	6	6	6
45	Min	3%	0%	-2%	-5%
	Max	6%	3%	2%	2%
	Average	5%	2%	0%	-2%
	Median	5%	2%	0%	-3%
	25th Percentile	5%	1%	0%	-5%
	75th Percentile	5%	3%	1%	0%
	No. Responses	6	6	6	6
65	Min	0%	0%	-5%	-10%
	Max	10%	3%	1%	1%
	Average	5%	1%	-1%	-3%
	Median	5%	1%	-1%	-3%
	25th Percentile	4%	1%	-3%	-5%
	75th Percentile	5%	2%	0%	0%
	No. Responses	6	6	6	6
85	Min	0%	-5%	-5%	-10%
	Max	15%	3%	1%	1%
	Average	6%	1%	-1%	-3%
	Median	5%	1%	-1%	-3%
	25th Percentile	4%	1%	-3%	-5%
	75th Percentile	5%	2%	0%	0%
	No. Responses	6	6	6	6

3.a.2 How confident are you in your estimates? For each time period, indicate which word best describes your level of confidence.

#### NUMBER OF RESPONSES FOR EACH CONFIDENCE LEVEL OPTION

Confidence Level	2022 Total Excess Mortality with COVID-19	2025 Total Excess Mortality with COVID-19	2030 Total Excess Mortality with COVID-19
Low	3	4	5
Medium	3	2	1
High	0	0	0

3.a.3 What are the top 3 COVID-19 drivers influencing your future total excess mortality **With COVID-19** responses? "1" is the most influential driver.

#### NUMBER OF RESPONSES PER DRIVER RANK OPTIONS AND TOTAL SCORES (TS)

Driver	2022	2023	2025	2030
Change in COVID-19 vaccination/booster rates	"1"-2 "2"-0 "3"-1 TS = 7	"1"-2 "2"-0 "3"-0 TS = 6	"1"-1 "2"-0 "3"-0 TS = 3	"1"-2 "2"-0 "3"-1 TS = 7
Higher virulence of current or future COVID-19 strains/variants	"1"-0 "2"-0 "3"-0 TS = 0	"1"-0 "2"-0 "3"-0 TS = 0	"1"-0 "2"-0 "3"-0 TS = 0	"1"-0 "2"-1 "3"-0 TS = 2
Lower virulence of current or future COVID-19 strains/variants	"1"-3 "2"-1 "3"-0 TS = 11	"1"-1 "2"-1 "3"-0 TS = 5	"1"-1 "2"-2 "3"-0 TS = 7	"1"-0 "2"-1 "3"-1 TS = 3
New COVID-19 medical treatments	"1"-1 "2"-2 "3"-0 TS = 7	"1"-1 "2"-2 "3"-1 TS = 8	"1"-2 "2"-2 "3"-1 TS = 11	"1"-1 "2"-2 "3"-1 TS = 8
Change in public behavior for masking	"1"-0 "2"-1 "3"-0 TS = 2	"1"-0 "2"-1 "3"-0 TS = 2	"1"-0 "2"-0 "3"-0 TS = 0	"1"-0 "2"-0 "3"-0 TS = 0
Better mortality occurs as more and more older, less healthy individuals die from COVID-19 leaving a healthier population than pre-pandemic	"1"-0 "2"-0 "3"-1 TS = 1	"1"-0 "2"-0 "3"-2 TS = 2	"1"-1 "2"-1 "3"-2 TS = 7	"1"-3 "2"-0 "3"-0 TS = 9

Worse mortality occurs from long COVID and indirect COVID-19 impacts leaving an unhealthier population than pre-pandemic	"1"-0 "2"-1 "3"-1 TS = 3	"1"-0 "2"-2 "3"-0 TS = 4	"1"-1 "2"-1 "3"-0 TS = 5	"1"-0 "2"-1 "3"-0 TS = 2
Public deferral of health care and treatment due to COVID-19	"1"-0 "2"-1 "3"-2 TS = 4	"1"-1 "2"-0 "3"-2 TS = 5	"1"-0 "2"-1 "3"-0 TS = 2	"1"-0 "2"-0 "3"-0 TS = 0

A score was assigned to each response. A driver with a response of rank 1 received a score of 3; a driver with a response of rank 2 received a score of 2; and a driver with a response of rank 3 received a score of 1. These were summed to produce a total score for each driver option.

No other drivers were mentioned.

**3.b.1 Assuming 2019 mortality levels as your baseline for expected mortality**, please indicate the level of excess mortality **Without COVID-19 as a Cause of Death** you expect for each of the years and ages listed below. Please express all numbers in decimal form. Here are three examples on how to respond:

No historical U.S. annuity industry annuitant population mortality information is provided. In this example, U.S. population historical mortality information **Without COVID-19** deaths is used. From the historical information provided above, for age 25, the level of excess mortality for non-COVID-19 causes of death in 2020 in relation to 2019 mortality levels is 20%.

- If you believe the level of excess for U.S. annuity industry annuitant population mortality **Without COVID-19 as a cause of death** will remain at the same level for 2022 as the U.S. population historical mortality without COVID-19 deaths in 2020, code the 20% level as ".20".
- If you believe the excess mortality will be reduced, e.g., to a level of 15% excess mortality, code ".15".
- If you believe that excess mortality will go away and there will be mortality improvement of, for example 5%, express the 5% mortality improvement as a negative number, "-.05".

#### AGGREGATION OF RESPONSES FOR TOTAL EXCESS MORTALITY WITHOUT COVID-19 AS A CAUSE OF DEATH U.S. ANNUITY INDUSTRY ANNUITANT POPULATION

Total Excess Mortality without COVID-19 as a Cause of Death					
Current Age		2022	2023	2025	2030
25	Min	0%	0%	-2%	-5%
	Max	7%	3%	2%	2%
	Average	3%	1%	-1%	-3%
	Median	2%	1%	-1%	-5%
	25th Percentile	1%	0%	-2%	-5%
	75th Percentile	5%	2%	0%	-1%
	No. Responses	6	6	6	6
45	Min	0%	0%	-5%	-7%

	Max	5%	2%	1%	1%
	Average	3%	1%	-2%	-4%
	Median	3%	1%	-2%	-5%
	25th Percentile	1%	0%	-2%	-5%
	75th Percentile	5%	1%	0%	-1%
	No. Responses	6	6	6	6
65	Min	0%	-5%	-6%	-12%
	Max	3%	1%	0%	0%
	Average	1%	-1%	-3%	-5%
	Median	1%	-1%	-3%	-5%
	25th Percentile	0%	-2%	-5%	-9%
	75th Percentile	2%	0%	-1%	-1%
	No. Responses	6	6	6	6
85	Min	0%	-5%	-6%	-12%
	Max	3%	1%	0%	0%
	Average	1%	-1%	-3%	-6%
	Median	1%	-1%	-3%	-8%
	25th Percentile	0%	-2%	-5%	-10%
	75th Percentile	2%	0%	-1%	-1%
	No. Responses	6	6	6	6

**3.b.2** How confident are you in your estimates? For each time period, indicate which word best describes your level of confidence.

#### NUMBER OF RESPONSES FOR EACH CONFIDENCE LEVEL OPTION

Confidence Level	2022 Total Excess Mortality without COVID-19 as a Cause of Death	2025 Total Excess Mortality without COVID-19 as a Cause of Death	2030 Total Excess Mortality without COVID-19 as a Cause of Death
Low	4	5	5
Medium	2	1	1
High	0	0	0

3.b.3 What are the top 3 influential mortality changes impacting your future total excess mortality **Without COVID-19 as a Cause of Death** responses in 3.b.1? “1” is the most influential change.

**NUMBER OF RESPONSES PER MORTALITY CHANGE RANK OPTION AND TOTAL SCORES (TS)**

Change in Mortality from	2022	2023	2025	2030
<b>Cardiovascular Disorders Mortality Improvement</b>	“1”-1 “2”-0 “3”-0 TS = 3	“1”-1 “2”-1 “3”-1 TS = 6	“1”-0 “2”-3 “3”-1 TS = 7	“1”-0 “2”-3 “3”-1 TS = 7
<b>Cardiovascular Disorders Mortality Deterioration</b>	“1”-0 “2”-2 “3”-2 TS = 6	“1”-0 “2”-2 “3”-0 TS = 4	“1”-0 “2”-0 “3”-1 TS = 1	“1”-0 “2”-1 “3”-1 TS = 1
<b>Cancer Mortality Improvement</b>	“1”-0 “2”-1 “3”-0 TS = 2	“1”-1 “2”-1 “3”-1 TS = 6	“1”-4 “2”-0 “3”-0 TS = 12	“1”-3 “2”-0 “3”-1 TS = 10
<b>Cancer Mortality Deterioration</b>	“1”-2 “2”-1 “3”-0 TS = 8	“1”-2 “2”-0 “3”-0 TS = 6	“1”-1 “2”-0 “3”-0 TS = 3	“1”-0 “2”-1 “3”-0 TS = 2
<b>Alzheimer’s and Other Dementias Mortality Improvement</b>	“1”-0 “2”-0 “3”-1 TS = 1	“1”-0 “2”-0 “3”-1 TS = 1	“1”-0 “2”-0 “3”-1 TS = 1	“1”-1 “2”-0 “3”-0 TS = 3
<b>Alzheimer’s and Other Dementias Mortality Deterioration</b>	“1”-0 “2”-0 “3”-2 TS = 2	“1”-0 “2”-0 “3”-2 TS = 2	“1”-0 “2”-1 “3”-1 TS = 3	“1”-1 “2”-0 “3”-1 TS = 4
<b>Accidents Excluding Drug Overdoses Mortality Improvement</b>	“1”-0 “2”-1 “3”-0 TS = 2	“1”-0 “2”-0 “3”-0 TS = 0	“1”-0 “2”-0 “3”-0 TS = 0	“1”-0 “2”-0 “3”-0 TS = 0
<b>Accidents Excluding Drug Overdoses Mortality Deterioration</b>	“1”-0 “2”-0 “3”-0 TS = 0	“1”-0 “2”-0 “3”-0 TS = 0	“1”-0 “2”-0 “3”-0 TS = 0	“1”-0 “2”-0 “3”-0 TS = 0
<b>Drug Overdoses Mortality Improvement</b>	“1”-0 “2”-0 “3”-0 TS = 0	“1”-0 “2”-0 “3”-0 TS = 0	“1”-0 “2”-0 “3”-1 TS = 1	“1”-0 “2”-0 “3”-1 TS = 1
<b>Drug Overdoses Mortality Deterioration</b>	“1”-1 “2”-0 “3”-0 TS = 3	“1”-1 “2”-0 “3”-0 TS = 3	“1”-0 “2”-0 “3”-0 TS = 0	“1”-0 “2”-0 “3”-0 TS = 0



Flu/Pneumonia Mortality Improvement	"1"-0	"1"-0	"1"-0	"1"-0
	"2"-0	"2"-1	"2"-1	"2"-1
	"3"-0	"3"-0	"3"-0	"3"-0
	TS = 0	TS = 2	TS = 2	TS = 2
Flu/Pneumonia Mortality Improvement	"1"-1	"1"-0	"1"-0	"1"-0
	"2"-0	"2"-0	"2"-0	"2"-0
	"3"-0	"3"-0	"3"-0	"3"-0
	TS = 3	TS = 0	TS = 0	TS = 0

A score was assigned to each response. A mortality change with a response of rank 1 received a score of 3; a mortality change with a response of rank 2 received a score of 2; and a mortality change with a response of rank 3 received a score of 1. These were summed to produce a total score for each mortality change option.

No other influential mortality changes mentioned.

**3.c** Additional comments about future excess mortality: \_\_\_\_\_

The impact will vary tremendously on type of annuity and market, e.g., structured settlements with high numbers of injured and immuno-compromised individuals will fare worse than other types of annuities. Group annuities that serve education and medical markets may have different results than individual annuities, particularly non-qualified products.

#### 4. U.S. PUBLIC AND PRIVATE PENSION PLAN POPULATION MORTALITY

The following questions relate to **U.S. Public and Private Pension Plan Population** mortality.

**4.a.1 Assuming 2019 mortality levels as your baseline for expected mortality**, please indicate the level of excess mortality **With COVID-19** you expect for each of the years and ages listed below. Please express all numbers in decimal form. Here are three examples on how to respond:

No historical U.S. public and private pension plan population mortality information is provided. In this example, U.S. population historical mortality with COVID-19 information is used. From the U.S. population industry historical mortality with COVID-19 information above, for age 25, the level of excess in 2020 in relation to 2019 mortality levels is 22%.

- If you believe the U.S. public and private pension plan population level of excess mortality with COVID-19 will remain at the same level for 2022 as the U.S. population historical information in 2020, code the 22% level as ".22".
- If you believe the excess mortality will be reduced, e.g., to a level of 15% excess mortality, code ".15".
- If you believe that excess mortality will go away and there will be mortality improvement of, for example 5%, express the 5% mortality improvement as a negative number, "-.05".

AGGREGATION OF RESPONSES FOR TOTAL EXCESS MORTALITY WITH COVID-19 U.S. PUBLIC AND PRIVATE PENSION PLAN POPULATION

Current Age		Total Excess Mortality with COVID-19			
		2022	2023	2025	2030
25	Min	1%	-1%	-3%	-6%
	Max	16%	14%	10%	3%
	Average	8%	5%	2%	-1%
	Median	8%	5%	1%	0%
	25th Percentile	5%	3%	0%	-2%
	75th Percentile	11%	9%	5%	1%
	No. Responses	15	15	15	14
45	Min	0%	0%	-6%	-12%
	Max	15%	12%	8%	5%
	Average	7%	5%	2%	-1%
	Median	6%	5%	1%	0%
	25th Percentile	5%	3%	0%	-3%
	75th Percentile	11%	8%	5%	1%
	No. Responses	15	15	15	14
65	Min	0%	-1%	-6%	-12%
	Max	13%	11%	7%	1%
	Average	6%	4%	1%	-3%
	Median	5%	3%	1%	-1%
	25th Percentile	4%	2%	-1%	-6%
	75th Percentile	9%	5%	3%	0%
	No. Responses	15	15	15	14
85	Min	0%	-1%	-6%	-12%
	Max	12%	9%	5%	1%
	Average	6%	4%	0%	-3%
	Median	6%	3%	0%	-2%
	25th Percentile	4%	2%	0%	-5%
	75th Percentile	10%	5%	2%	0%
	No. Responses	15	15	15	14

4.a.2 How confident are you in your estimates? For each time period, indicate which word best describes your level of confidence.

#### NUMBER OF RESPONSES FOR EACH CONFIDENCE LEVEL OPTION

Confidence Level	2022 Total Excess Mortality with COVID-19	2025 Total Excess Mortality with COVID-19	2030 Total Excess Mortality with COVID-19
Low	7	6	8
Medium	7	9	4
High	1	0	3

4.a.3 What are the top 3 COVID-19 drivers influencing your future total excess mortality **With COVID-19** responses? "1" is the most influential driver.

#### NUMBER OF RESPONSES PER DRIVER RANK OPTIONS AND TOTAL SCORES (TS)

Driver	2022	2023	2025	2030
Change in COVID-19 vaccination/booster rates	"1"-5 "2"-2 "3"-1 TS = 20	"1"-4 "2"-3 "3"-1 TS = 19	"1"-2 "2"-3 "3"-1 TS = 13	"1"-2 "2"-2 "3"-1 TS = 11
Higher virulence of current or future COVID-19 strains/variants	"1"-1 "2"-3 "3"-0 TS = 9	"1"-2 "2"-2 "3"-0 TS = 10	"1"-1 "2"-1 "3"-0 TS = 5	"1"-2 "2"-0 "3"-0 TS = 6
Lower virulence of current or future COVID-19 strains/variants	"1"-3 "2"-1 "3"-1 TS = 12	"1"-2 "2"-1 "3"-0 TS = 11	"1"-1 "2"-3 "3"-4 TS = 13	"1"-1 "2"-3 "3"-4 TS = 13
New COVID-19 medical treatments	"1"-0 "2"-1 "3"-1 TS = 5	"1"-0 "2"-1 "3"-3 TS = 5	"1"-2 "2"-3 "3"-3 TS = 15	"1"-2 "2"-4 "3"-3 TS = 17
Change in public behavior for masking	"1"-0 "2"-1 "3"-0 TS = 2	"1"-0 "2"-1 "3"-0 TS = 2	"1"-0 "2"-1 "3"-0 TS = 2	"1"-0 "2"-1 "3"-0 TS = 2
Better mortality occurs as more and more older, less healthy individuals die from COVID-19 leaving a healthier population than pre-pandemic	"1"-2 "2"-2 "3"-2 TS = 12	"1"-2 "2"-2 "3"-3 TS = 13	"1"-3 "2"-1 "3"-2 TS = 13	"1"-4 "2"-1 "3"-2 TS = 16
Worse mortality occurs from long COVID and	"1"-1	"1"-1	"1"-0	"1"-0

indirect COVID-19 impacts leaving an unhealthier population than pre-pandemic	"2"-1 "3"-0 TS = 5	"2"-1 "3"-0 TS = 5	"2"-0 "3"-1 TS = 1	"2"-0 "3"-2 TS = 2
Public deferral of health care and treatment due to COVID-19	"1"-0 "2"-1 "3"-4 TS = 6	"1"-0 "2"-1 "3"-4 TS = 6	"1"-0 "2"-1 "3"-0 TS = 2	"1"-0 "2"-0 "3"-0 TS = 0

A score was assigned to each response. A driver with a response of rank 1 received a score of 3; a driver with a response of rank 2 received a score of 2; and a driver with a response of rank 3 received a score of 1. These were summed to produce a total score for each driver option.

Other drivers mentioned by respondents: Increased immunity to COVID resulting from past infections (partial herd immunity; normal improvements in mortality over time, not specifically related to COVID-19 or associated measures; adverse side effects of COVID-19 mitigations for public health (economic disruption, increasing mental health issues, drug abuse etc.; mental health issues; long-term impact of vaccines/boosters on future health; COVID no longer significant driver of mortality, primarily due to immunity build-up; persistent refusal to vaccinate or mistrust; covered pension participants as a whole exhibit better mortality than the population.

**4.b.1 Assuming 2019 mortality levels as your baseline for expected mortality**, please indicate the level of excess mortality **Without COVID-19 as a Cause of Death** you expect for each of the years and ages listed below. Please express all numbers in decimal form. Here are three examples on how to respond:

No historical U.S. public and private pension plan population mortality information is provided. In this example, U.S. population historical mortality information **Without COVID-19** deaths is used. From the historical information provided above, for age 25, the level of excess mortality for non-COVID-19 causes of death in 2020 in relation to 2019 mortality levels is 20%.

- If you believe the U.S. public and private pension plan population level of excess mortality **Without COVID-19 as a cause of death** will remain at the same level for 2022 as the U.S. population historical information without COVID-19 deaths in 2020, code the 20% level as ".20".
- If you believe the excess mortality will be reduced, e.g., to a level of 15% excess mortality, code ".15".
- If you believe that excess mortality will go away and there will be mortality improvement of, for example 5%, express the 5% mortality improvement as a negative number, "-.05".

#### AGGREGATION OF RESPONSES FOR TOTAL EXCESS MORTALITY WITHOUT COVID-19 AS A CAUSE OF DEATH U.S. PUBLIC PENSION PLAN POPULATION

Total Excess Mortality without COVID-19 as a Cause of Death					
Current Age		2022	2023	2025	2030
25	Min	0%	-1%	-3%	-8%
	Max	16%	14%	10%	3%
	Average	5%	3%	2%	-1%
	Median	4%	2%	0%	0%
	25th Percentile	2%	1%	-1%	-2%

	75th Percentile	8%	5%	4%	0%
	No. Responses	14	14	14	13
45	Min	0%	-1%	-6%	-12%
	Max	15%	12%	8%	4%
	Average	5%	3%	1%	-2%
	Median	3%	2%	0%	0%
	25th Percentile	2%	1%	-1%	-3%
	75th Percentile	5%	4%	3%	0%
	No. Responses	14	14	13	13
65	Min	-1%	-1%	-6%	-12%
	Max	13%	11%	7%	0%
	Average	2%	1%	-1%	-4%
	Median	1%	1%	-1%	-4%
	25th Percentile	0%	-1%	-3%	-5%
	75th Percentile	2%	1%	0%	0%
	No. Responses	14	13	13	13
85	Min	-3%	-3%	-6%	-12%
	Max	10%	8%	4%	0%
	Average	2%	1%	-2%	-4%
	Median	1%	1%	-1%	-3%
	25th Percentile	0%	-1%	-3%	-5%
	75th Percentile	2%	1%	0%	0%
	No. Responses	13	13	13	13

**4.b.2** How confident are you in your estimates? For each time period, indicate which word best describes your level of confidence.

#### NUMBER OF RESPONSES FOR EACH CONFIDENCE LEVEL OPTION

Confidence Level	2022 Total Excess Mortality without COVID-19 as a Cause of Death	2025 Total Excess Mortality without COVID-19 as a Cause of Death	2030 Total Excess Mortality without COVID-19 as a Cause of Death
Low	5	4	5
Medium	7	9	4
High	1	0	4

4.b.3 What are the top 3 influential mortality changes impacting your future total excess mortality **Without COVID-19 as a Cause of Death** responses in 4.b.1? “1” is the most influential change.

**NUMBER OF RESPONSES PER MORTALITY CHANGE RANK OPTION AND TOTAL SCORES (TS)**

Change in Mortality from	2022	2023	2025	2030
<b>Cardiovascular Disorders Mortality Improvement</b>	“1”-1 “2”-1 “3”-3 TS = 8	“1”-2 “2”-2 “3”-3 TS = 13	“1”-2 “2”-2 “3”-3 TS = 13	“1”-0 “2”-0 “3”-2 TS = 2
<b>Cardiovascular Disorders Mortality Deterioration</b>	“1”-1 “2”-1 “3”-0 TS = 5	“1”-1 “2”-0 “3”-0 TS = 3	“1”-1 “2”-0 “3”-0 TS = 3	“1”-1 “2”-0 “3”-2 TS = 5
<b>Cancer Mortality Improvement</b>	“1”-3 “2”-1 “3”-0 TS = 11	“1”-3 “2”-3 “3”-1 TS = 16	“1”-3 “2”-4 “3”-1 TS = 18	“1”-0 “2”-3 “3”-0 TS = 6
<b>Cancer Mortality Deterioration</b>	“1”-0 “2”-2 “3”-0 TS = 4	“1”-0 “2”-1 “3”-0 TS = 2	“1”-0 “2”-1 “3”-0 TS = 2	“1”-1 “2”-0 “3”-2 TS = 5
<b>Alzheimer’s and Other Dementias Mortality Improvement</b>	“1”-1 “2”-1 “3”-1 TS = 6	“1”-0 “2”-1 “3”-2 TS = 4	“1”-0 “2”-1 “3”-2 TS = 4	“1”-0 “2”-1 “3”-0 TS = 2
<b>Alzheimer’s and Other Dementias Mortality Deterioration</b>	“1”-0 “2”-1 “3”-0 TS = 2	“1”-0 “2”-1 “3”-0 TS = 2	“1”-1 “2”-0 “3”-0 TS = 3	“1”-0 “2”-0 “3”-1 TS = 1
<b>Accidents Excluding Drug Overdoses Mortality Improvement</b>	“1”-0 “2”-0 “3”-1 TS = 1	“1”-0 “2”-1 “3”-1 TS = 3	“1”-0 “2”-1 “3”-1 TS = 3	“1”-0 “2”-1 “3”-0 TS = 2
<b>Accidents Excluding Drug Overdoses Mortality Deterioration</b>	“1”-0 “2”-1 “3”-1 TS = 3	“1”-0 “2”-0 “3”-1 TS = 1	“1”-0 “2”-0 “3”-0 TS = 0	“1”-1 “2”-1 “3”-0 TS = 5
<b>Drug Overdoses Mortality Improvement</b>	“1”-1 “2”-1 “3”-0 TS = 5	“1”-3 “2”-0 “3”-1 TS = 10	“1”-3 “2”-0 “3”-1 TS = 10	“1”-3 “2”-1 “3”-2 TS = 13
<b>Drug Overdoses Mortality Deterioration</b>	“1”-3 “2”-1 “3”-1 TS = 12	“1”-1 “2”-0 “3”-1 TS = 4	“1”-1 “2”-0 “3”-1 TS = 4	“1”-0 “2”-2 “3”-1 TS = 5

<b>Flu/Pneumonia Mortality Improvement</b>	"1"-0 "2"-3 "3"-1 TS = 7	"1"-0 "2"-3 "3"-0 TS = 6	"1"-0 "2"-3 "3"-0 TS = 6	"1"-3 "2"-1 "3"-0 TS = 11
<b>Flu/Pneumonia Mortality Improvement</b>	"1"-1 "2"-0 "3"-1 TS = 4	"1"-0 "2"-0 "3"-1 TS = 1	"1"-0 "2"-0 "3"-1 TS = 1	"1"-0 "2"-0 "3"-0 TS = 0

A score was assigned to each response. A mortality change with a response of rank 1 received a score of 3; a mortality change with a response of rank 2 received a score of 2; and a mortality change with a response of rank 3 received a score of 1. These were summed to produce a total score for each mortality change option.

Other influential factors mentioned: mental health issues; long-term impact of vaccines/boosters on future health; better awareness of personal hygiene.

**4.c** Additional comments about future excess mortality: \_\_\_\_\_

Responses:

While it depends somewhat on the nature of the work. I think the pension population is less impacted by COVID due to the ability to telework and the demand for employees. There will be an impact due to long COVID—but as a percentage less than the general population.

Our pension members have done a little better than the general population, however improvements have been trending down for the last 10 years. So many unknown variables come into play with the forecast for the next 10 years, future variants good or bad could have a significant impact on the COVID mortality, while the impact of the mRNA experiment could also have some long-term implications on people's health.

Projected mortality entered is generally in sync with current mortality improvement projections, which are based on historical improvement information. This includes the worsening improvements at the younger ages. Top 3 reasons given are a guess.

I am not an expert in the specific causes of death outside COVID-19 (since pension plans don't need to worry about why).

## Section 3 COVID-19 and Future Mortality Impacts

The following questions relate to **U.S. General Population** mortality.

1. In comparison to 2019 mortality levels, how do you think Long-COVID in survivors and interruptions in the healthcare system will affect future **all-cause mortality**? For each time period, please select the expression that best describes your opinion of the future **all-cause of death annualized mortality impact from Long-COVID and interruptions in the healthcare system**.

All-Cause Mortality Annualized Impact	2022 (%)	2023 (%)	2025 (%)	2030 (%)
Large (>2.5%) Deterioration	18	7	2	0
Moderate (1.5%–2.5%) Deterioration	35	28	14	7
Small (0.5%–1.5%) Deterioration	32	46	49	37
No Change (Within $\pm 0.5\%$ )	16	18	33	46
Small (0.5%–1.5%) Improvement	0	2	2	9
Moderate (1.5%–2.5%) Improvement	0	0	0	2
Large (>2.5%) Improvement	0	0	0	0
I don't know	0	0	0	0



2. In comparison to 2019 mortality levels, how do you think Long-COVID in survivors and interruptions in the healthcare system will affect future **cause of death mortality** for the following conditions? For each time period, please select the expression that best describes your opinion of the future cause of death annualized mortality impact due to Long-COVID and interruptions in the health care system.

a. Cardiovascular Disorders (Heart Disease and Stroke)

Cause of Death Mortality Annualized Impact	2022 (%)	2023 (%)	2025 (%)	2030 (%)
Large (>2.5%) Deterioration	13	9	2	2
Moderate (1.5%–2.5%) Deterioration	38	29	20	15
Small (0.5%–1.5%) Deterioration	31	35	40	25
No Change (Within $\pm 0.5\%$ )	18	25	33	51
Small (0.5%–1.5%) Improvement	0	2	5	4
Moderate (1.5%–2.5%) Improvement	0	0	0	4
Large (>2.5%) Improvement	0	0	0	0
I don't know	0	0	0	0

## b. Cancer

Cause of Death Mortality Annualized Impact	2022 (%)	2023 (%)	2025 (%)	2030 (%)
Large (>2.5%) Deterioration	9	4	2	0
Moderate (1.5%–2.5%) Deterioration	24	20	7	2
Small (0.5%–1.5%) Deterioration	31	35	38	27
No Change (Within $\pm 0.5\%$ )	35	40	47	62
Small (0.5%–1.5%) Improvement	2	2	5	7
Moderate (1.5%–2.5%) Improvement	0	0	0	0
Large (>2.5%) Improvement	0	0	0	2
I don't know	0	0	0	0

## c. Alzheimer's and Other Dementias

Cause of Death Mortality Annualized Impact	2022 (%)	2023 (%)	2025 (%)	2030 (%)
Large (>2.5%) Deterioration	5	0	2	4
Moderate (1.5%–2.5%) Deterioration	13	16	7	7
Small (0.5%–1.5%) Deterioration	31	27	31	18
No Change (Within $\pm 0.5\%$ )	44	51	51	56
Small (0.5%–1.5%) Improvement	7	5	9	13
Moderate (1.5%–2.5%) Improvement	0	0	0	2
Large (>2.5%) Improvement	0	0	0	0
I don't know	0	0	0	0

## d. Flu/Pneumonia

Cause of Death Mortality Annualized Impact	2022 (%)	2023 (%)	2025 (%)	2030 (%)
Large (>2.5%) Deterioration	2	0	0	0
Moderate (1.5%–2.5%) Deterioration	13	15	4	5
Small (0.5%–1.5%) Deterioration	25	20	20	11
No Change (Within $\pm 0.5\%$ )	29	35	58	64
Small (0.5%–1.5%) Improvement	16	24	11	15
Moderate (1.5%–2.5%) Improvement	9	4	5	4
Large (>2.5%) Improvement	5	4	2	2
I don't know	0	0	0	0

## e. Accidents Excluding Drug Overdoses

Cause of Death Mortality Annualized Impact	2022 (%)	2023 (%)	2025 (%)	2030 (%)
Large (>2.5%) Deterioration	7	2	2	2
Moderate (1.5%–2.5%) Deterioration	9	13	0	0
Small (0.5%–1.5%) Deterioration	22	16	20	13
No Change (Within $\pm 0.5\%$ )	51	62	73	80
Small (0.5%–1.5%) Improvement	7	4	4	4
Moderate (1.5%–2.5%) Improvement	2	4	2	2
Large (>2.5%) Improvement	2	0	0	0
I don't know	0	0	0	0

**f. Drug Overdoses**

Cause of Death Mortality Annualized Impact	2022 (%)	2023 (%)	2025 (%)	2030 (%)
Large (>2.5%) Deterioration	25	18	7	2
Moderate (1.5%–2.5%) Deterioration	16	16	15	11
Small (0.5%–1.5%) Deterioration	24	25	25	27
No Change (Within $\pm 0.5\%$ )	31	38	49	55
Small (0.5%–1.5%) Improvement	2	0	2	2
Moderate (1.5%–2.5%) Improvement	0	0	0	4
Large (>2.5%) Improvement	2	2	2	0
I don't know	0	0	0	0

**Comments on any other causes:**

Increased mental health issues (for example, more suicides and homicides).

I am not sure, if we can easily identify all of the shades of long COVID. While there are some obvious cases, there may be a larger undetected group.

It is possible that acute respiratory diseases experience some excess mortality in 2022 and 2023 due to misclassified COVID.

More prominent in near term in kidney disease, liver disease and diabetes.

Alcohol related deaths might show a moderate deterioration in 2022, 2023, and 2025, with a return to no change in 2030.

I only have a rough impression of effects of long COVID and don't really have an opinion on how it will affect particular causes of death.

I think the long COVID impact will primarily be in related causes -- drug overdoses in self-medication-relationship, and then respiratory & cardiovascular causes. There may be improvements in other causes.... because people who would have died of those causes died younger of something else instead. There may be displacement/replacement effects.

Long COVID is not likely to be measurable as it's likely that cause of death will be recorded as cardiovascular disease or some other cause. We're more likely to see increases in the normal primary causes that are due to long COVID but will be undistinguishable from normal causes.

Diabetes and liver conditions will likely also have moderate deterioration due to COVID-19 disruptions.

Assume you mean % change per cause of death as opposed to % change in overall level of mortality.

3. Please rank the top 3 COVID-19 scenarios shown below that have the greatest impact on **U.S. General Population** future all-cause mortality **improvement**. In your ranking, please assume "1" is the most impactful.

#### NUMBER OF RESPONSES PER MORTALITY CHANGE RANK OPTION AND TOTAL SCORES

Scenario	Rank 1	Rank 2	Rank 3	Total Score
New medical treatments for COVID-19	12	14	18	82
More medical professionals and hospitals than currently to care for and treat COVID-19 patients	1	2	12	19
Healthier population than pre-pandemic levels as more and more individuals die from COVID-19	6	10	17	55
Increased immunity in the population due to vaccination/boosters/past infections	36	15	4	142
More public adherence to COVID-19 mitigation strategies such as mask wearing and vaccines than current levels	3	6	4	25
I don't know	0	0	0	0

Other scenarios mentioned by the respondents: evolution of COVID-19 to cause less severe cases on average over time; application of mRNA and other technologies to other causes of death including cancer; Improved vaccines; I really don't think people are more likely to listen to the CDC—why I'm pushing

adherence to the bottom; pushing adherence to bottom on purpose; I think we will see deterioration of adherence, sorry.

4. Please rank the top 3 COVID-19 scenarios below that have the most impact on **U.S. General Population** future all-cause mortality **deterioration**. In your ranking, please assume “1” is the most impactful.

Scenario	Rank 1	Rank 2	Rank 3	Total Score
Emergence of a more virulent COVID-19 variant than existing variants	31	7	8	115
Unhealthier population created by long COVID	8	10	11	55
An overwhelmed medical system due to shortage of hospital beds, medical supplies or medical professionals to care and treat for COVID-19 patients	5	16	13	60
Unhealthier population than pre-pandemic levels as more and more individuals battle long COVID	3	8	8	33
Less public adherence to mitigation strategies such as mask wearing and vaccines than current levels	4	13	13	51
I don't know	0	0	0	0

Other scenarios mentioned: mental health issues: long-term impact of mRNA on future health; lifestyle changes adversely impacting mortality (e.g., smoking, alcohol, weight, drugs); greater exposure to all forms of mortality risks as isolation and social distancing end; delayed monitoring and maintenance of existing or anticipated conditions; bad trends in external causes—alcohol, drugs, motor vehicle accidents—higher risk at younger ages; unhealthier population due to deferred physical care; drug overdoses; unhealthier population than pre-pandemic levels as more people work from home more often and permanently;

unhealthier population due to mental health deterioration; worse health due to underutilization for non-COVID health problems—kidney problems, diabetes, cancer—capacity, but underused.

#### 5. Additional comments about COVID-19 and its impact to future mortal

Responses:

I worry about the backlash on preventive care in general and vaccination (including the influenza) that could be brought about by the politization of COVID-19 vaccination and other mitigation strategies, on future mortality trends.

The two "unhealthier population" options sound the same so I chose one of them.

Won't know the impact of this experimental vaccine on future health for a number of years.

It is unrealistic to assign 100% of medical staff shortages to COVID. I have heard repeatedly from health care providers that many are leaving due to overall dissatisfaction with health care administrators. A similar exodus took place in the mid-1990s. COVID aggravates this but is far from the sole cause. This in turn will have a deleterious effect upon health care delivery.

I think worse mortality won't come directly from COVID, actually—I know that's not what this question is about, but I think it's ancillary effects that will have larger and longer-lasting impact.

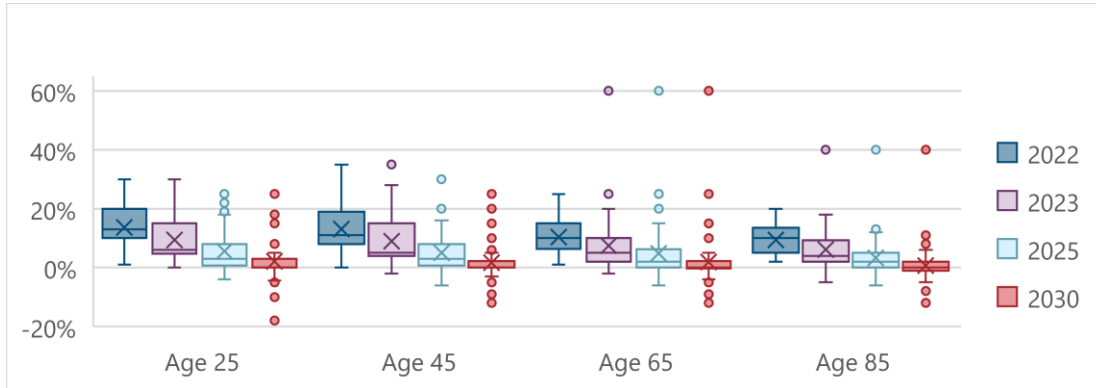
I believe the disruption to the healthcare system will take at least 3-5 years to restore to 2019 levels of operation and functionality. The accelerating mental health deterioration will also have an adverse impact on mortality over the next 10 years.

## Appendix B: Distribution of Excess Mortality Estimates

For each of the populations, opinions varied among the participating experts. Figures 4–11 are box and whisker plots showing the distribution of the submitted excess mortality estimates with and without COVID-19 as a cause of death. The bottom, middle and top lines of the boxes represent the 25th percentile, median and 75th percentile, respectively. The “X” are the averages from Tables 4a and 4b and data points that are “outliers” are also shown.

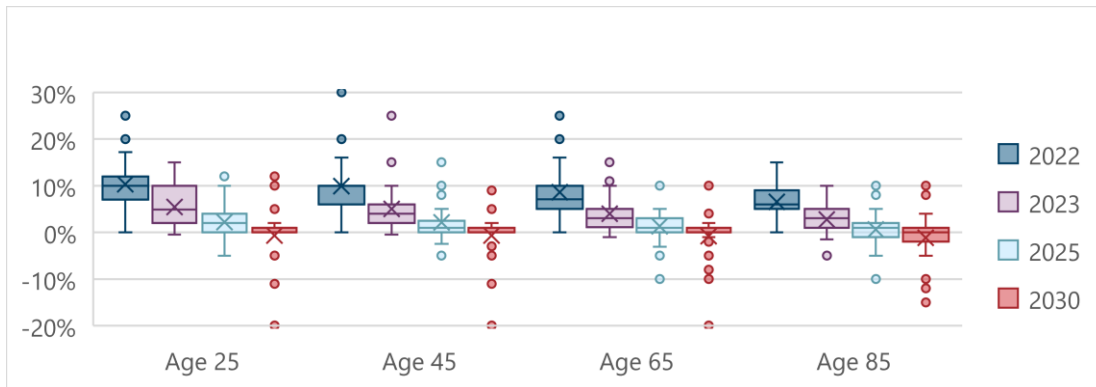
**Figure 4**

U.S. GENERAL POPULATION FUTURE EXCESS MORTALITY ESTIMATES WITH COVID-19 BY AGE (N = 56)



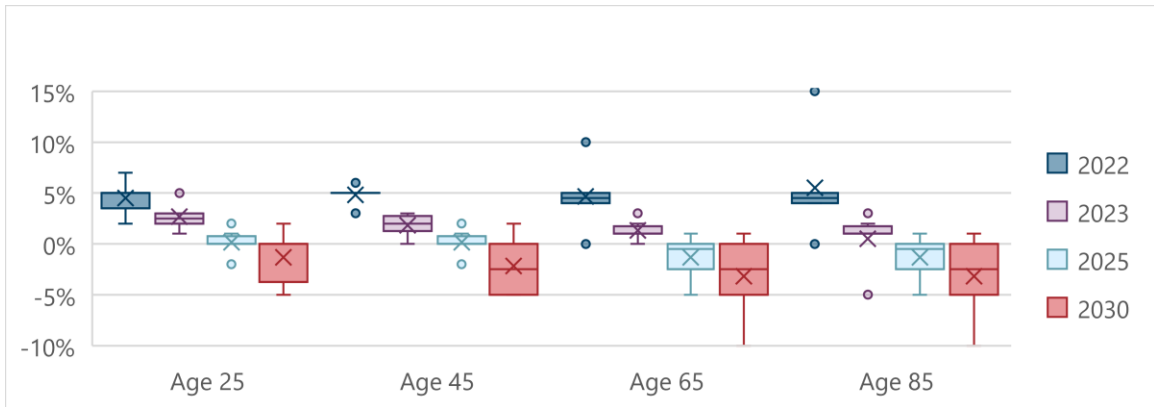
**Figure 5**

U.S. LIFE INSURANCE INDUSTRY INSURED POPULATION FUTURE EXCESS MORTALITY ESTIMATES WITH COVID-19 BY AGE (N = 29)

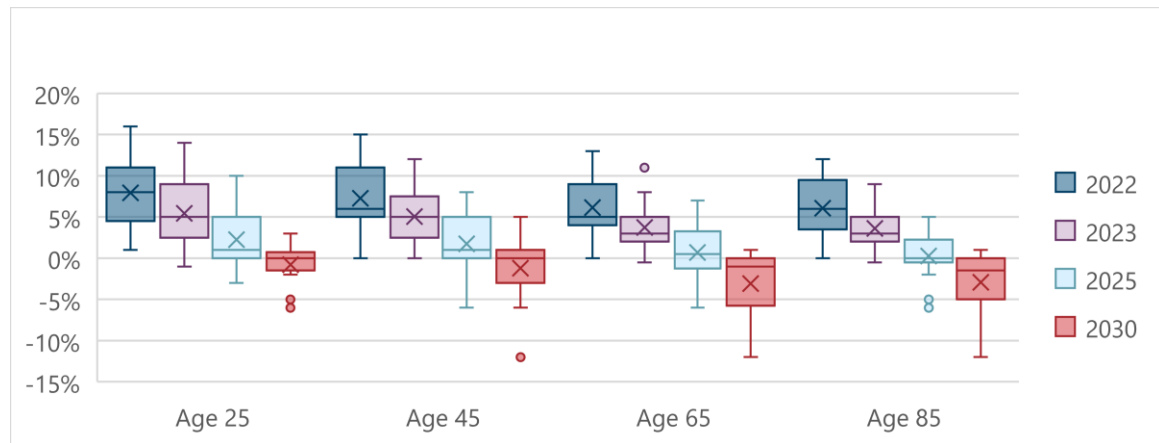




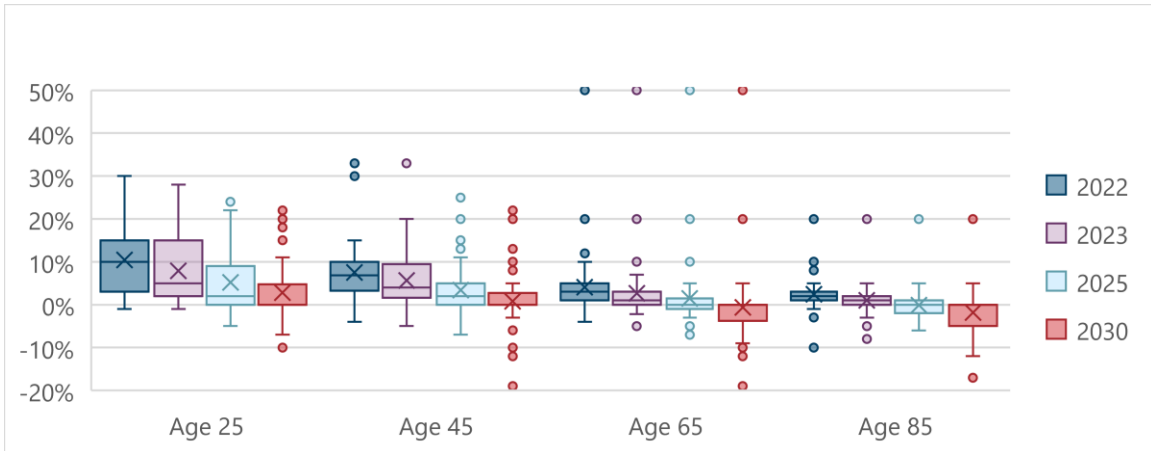
**Figure 6**  
 U.S. ANNUITY INDUSTRY ANNUITANT POPULATION FUTURE EXCESS MORTALITY ESTIMATES WITH COVID-19 BY AGE (N = 6)



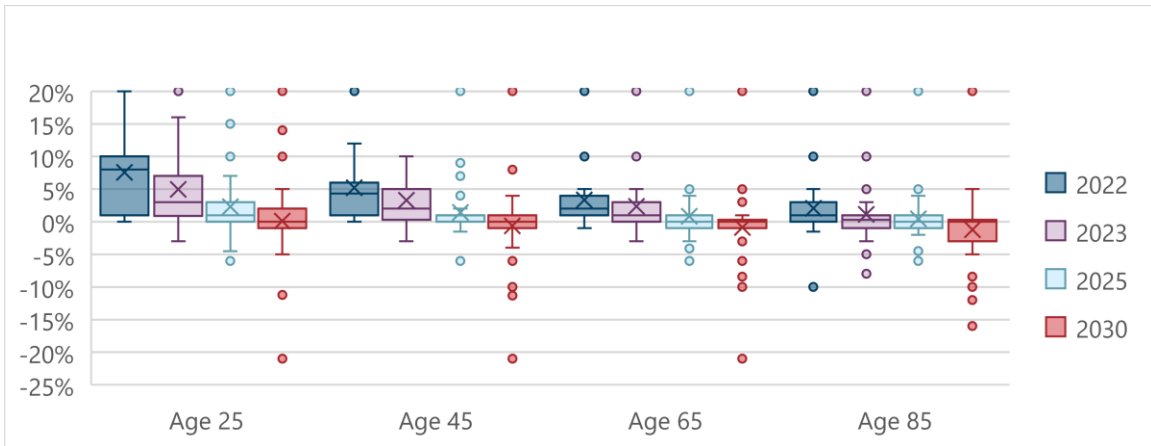
**Figure 7**  
 U.S. PRIVATE AND PUBLIC PENSION PLAN POPULATION FUTURE EXCESS MORTALITY ESTIMATES WITH COVID-19 BY AGE (N = 15)



**Figure 8**  
 U.S. GENERAL POPULATION FUTURE EXCESS MORTALITY ESTIMATES WITHOUT COVID-19 AS A CAUSE OF DEATH BY AGE (N = 55)

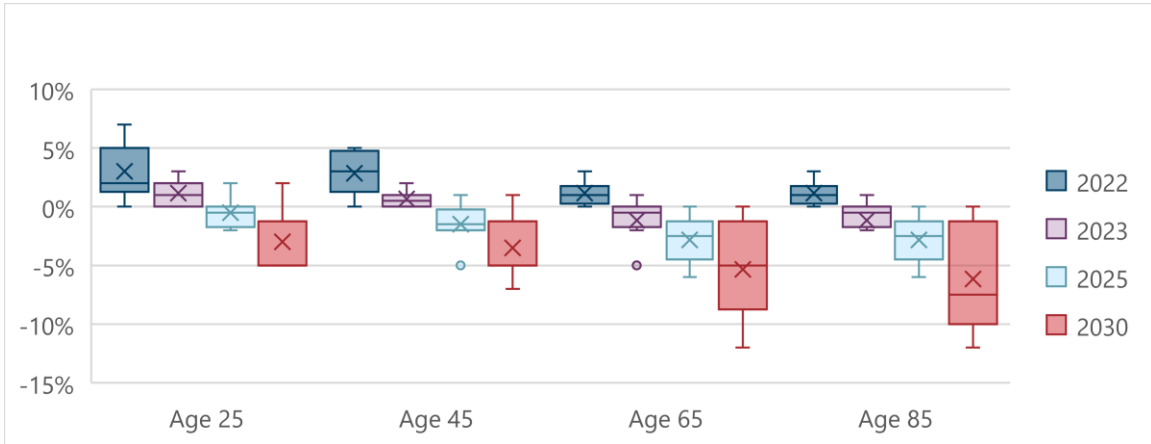


**Figure 9**  
 U.S. LIFE INSURANCE INDUSTRY INSURED POPULATION FUTURE EXCESS MORTALITY ESTIMATES WITHOUT COVID-19 AS A CAUSE OF DEATH BY AGE (N = 29)



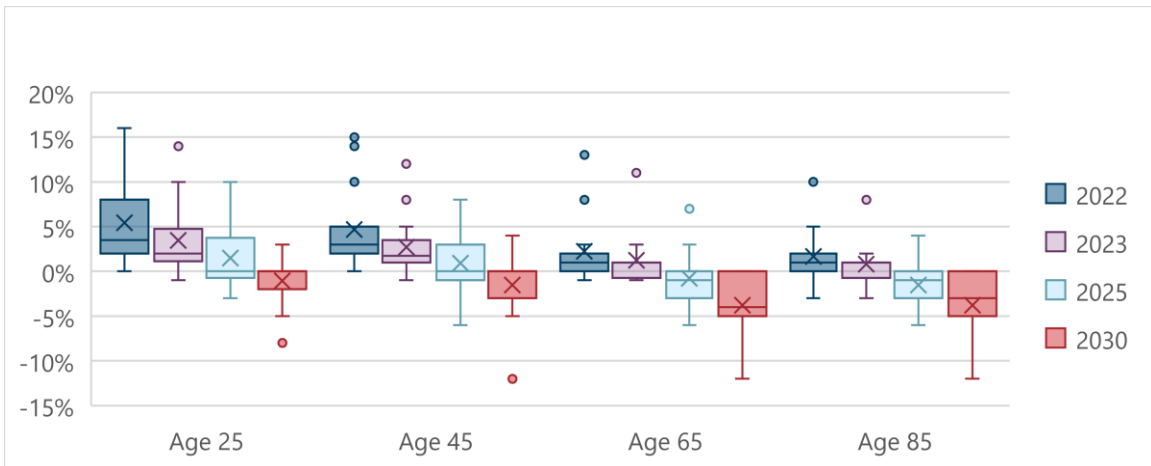
**Figure 10**

U.S. ANNUITY INDUSTRY ANNUITANT POPULATION FUTURE EXCESS MORTALITY ESTIMATES WITHOUT COVID-19 AS A CAUSE OF DEATH BY AGE (N = 6)



**Figure 11**

U.S. PRIVATE AND PUBLIC PENSION PLAN POPULATION FUTURE EXCESS MORTALITY ESTIMATES WITHOUT COVID-19 AS A CAUSE OF DEATH BY AGE (N = 14)



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