

2019 Mortality Improvement Survey Report

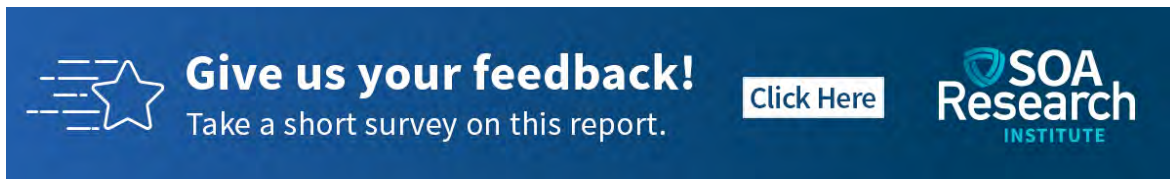






2019 Mortality Improvement Survey Report

AUTHOR Society of Actuaries Research Institute

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2019 Mortality Improvement Survey Report

Introduction

The Committee on Life Insurance Mortality and Underwriting Surveys of the Society of Actuaries, hereinafter referred to as the “Committee,” sent companies a survey in May of 2019 on mortality improvement practices. Note this survey was completed prior to the onset of COVID-19, so that issue was not addressed in this survey.

The Mortality Improvement Survey, henceforth referred to as the “Survey,” was intended for life and annuity insurers and reinsurers in the U.S. and Canada. The purpose of the Survey was to examine mortality improvement practices with respect to life insurance and annuity pricing and financial projections in both the U.S. and Canada. Where appropriate, the report compares U.S. and Canadian practices.

Similar surveys were completed by the Committee in 2001, 2007, 2013 and 2016. While the questions asked were not the same in each of the surveys, where possible, comparisons between the surveys were made.

The report includes sections on:

- Country and Company Information
- Characteristics of Durational Mortality Improvement Assumptions
- Limitations, Data, Resources, Methodologies, Validation and Review
- Opinions on Issues Impacting Durational Mortality Improvement
- Comparison to Generational Mortality Improvement
- Sample Durational Mortality Improvement Rates

Survey Scope

The Survey was completed between the second and third quarters of 2019. Forty-two companies responded; a complete list of participating companies is shown in Appendix A.

The definitions used in this Survey can be found in Appendix B.

The Survey questions can be found in Appendix D.

The Survey Subcommittee would like to thank all of the respondents who participated in this Survey. We also thank those who helped us review this document and offered helpful suggestions and thoughtful comments. Finally, the Survey Subcommittee thanks the Society of Actuaries staff for their help in completing this project, especially Korrel Crawford, Cindy MacDonald and Pete Miller, without whose help this could not have been completed. Shreya Kodati, University of Illinois at Urbana-Champaign college student, also helped analyze the data.

Emerging Risks in Underwriting Survey Subcommittee

Allen M. Klein, FSA, MAAA (Chair)

Connie E. Dewar, FSA, FCIA

Mark Dion, FALU, FLMI

Hannah Lobbezoo (University of Waterloo, intern for Office of the Superintendent of Financial Institutions Canada)

David N. Wylde, FSA, MAAA

SOA Research Liaison: Korrel E. Crawford

Executive Summary

A total of 42 respondents participated in this survey with 35 from the U.S. and 7 from Canada. This was further divided by direct versus reinsurance where 34 of the respondents were direct writers and 8 were reinsurers.

This survey focused on the use of durational and generational mortality improvement. Details regarding assumptions and opinions on mortality improvement in general were asked of the respondents.

Eighty-one percent of respondents indicated using durational mortality improvement assumptions in their life and annuity pricing and/or financial projections. Moreover, of those that used durational mortality improvement assumptions, attained age and gender were the top two characteristics in which assumptions varied.

Respondents were asked to indicate the different limitations when applying durational mortality improvement assumptions. The survey found that the most common lowest and highest attained age to which durational mortality improvement was applied were 0 and about 100, respectively. The lowest and highest durational mortality improvement rate ranged from -0.12% (deterioration) to 2.69% (improvement). The time period the mortality improvement rates were applied ranged from 10 to 125 years, but this varied by life/annuities and pricing/financial projections. The most common time period was 20 years for life; there was no common time period for annuities.

Respondents were also asked to indicate the different data, resources and methodologies used when determining durational mortality assumptions. The primary data sources included population and industry data, while the primary resources used to develop durational mortality improvement assumptions were those internal at the company. The primary internal resource used to develop the mortality improvement assumptions was an (were) actuary(ies). Approximately 50% of the respondents indicated using a standard approach to develop durational mortality improvement assumptions for life, and about 75% indicated using a standard approach for annuities.

About 66% of life respondents and approximately 25% of the annuity respondents indicated that they validate mortality improvement assumptions.

Respondents were asked their opinions on the challenges to setting mortality improvement assumptions. Responses were split among life and annuities, pricing and financial projections. The top challenge to setting mortality improvement assumptions for all four combinations was uncertainty in the magnitude and direction of future trends. The second most common was typically availability of appropriate data.

Respondents were asked their opinions on drivers for mortality improvement and deterioration. Responses were split among life and annuities, short- and long-term. Respondents indicated they thought the top driver of durational mortality improvement was reductions in mortality from cancer. Reductions in mortality from cardiovascular disease was the second most common driver for life respondents, while medical advances was the second most common driver for annuity respondents.

The top drivers of durational mortality deterioration were opioids, obesity, and diabetes for short-term and obesity, antibiotic resistant organisms, and lifestyle behaviors for long-term. Note that this survey was completed before the COVID-19 pandemic.

When comparing generational mortality improvement assumptions to durational mortality improvement assumptions, approximately 60% of respondents indicated they used the same assumptions.

Respondents were asked to provide their companies' durational mortality improvement rates. Regarding durational mortality improvement rates, the general trends were:

- Life were lower than annuities
- Pricing were lower than financial projections
- Short-term were higher than long-term
- U.S. were lower than Canadian
- Direct companies were lower than reinsurers
- Males were higher than females
- Best preferred nonsmoker was higher than best preferred smoker
- Across attained ages, 35, 55, 75, and 95, age 75 was highest and 95 was lowest



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Section 1: Country and Company Information

Forty-two respondents participated in this survey across the United States and Canada. Where possible, responses were split by:

- Country, which includes Canada and the U.S.
- Company type, which includes direct and reinsurer
- Line of business, which includes life and annuities
- Function, which includes pricing and financial projections

1. Indicate for which country/company type you are answering this survey. If you are answering this survey for more than one country or more than one company type, please complete separate surveys for each country/company type.

Country	Direct	Reinsurer
U.S.	30	5
Canada	4	3
Number of Respondents	34	8

Of the 42 participants, 35 (83%) were from the U.S. and 7 (17%) were from Canada. There were 34 (81%) direct insurers and 8 (19%) reinsurers.

2. Indicate if your company is still writing new business.

Writing in 2019	Line of Business			
	Life		Annuities	
Yes	37	90%	22	73%
No	4	10%	8	27%
Number of Respondents	41	100%	30	100%

Seventy-three percent of respondents indicated that they were still writing annuity business in 2019 and 90% of the respondents indicated they were still writing life business in 2019.

Between the U.S. and Canadian respondents, there were differences for those who continued to write new business in 2019. All seven Canadian respondents indicated their companies were writing new life business in 2019, while only 66% of the respondents indicated their companies were writing new annuity business in 2019. For the U.S., 88% of the respondents indicated their companies continued to write new life business, while only 74% of respondents indicated their companies continued to write annuity business into 2019.

By company type, direct respondents were largely in line with the overall data with 88% continuing to write life business and 75% continuing to write annuity business. However, reinsurance respondents were more in line with Canadian results. All reinsurance respondents indicated that they continued to write life business into 2019, and 50% continued to write annuity business.

Section 2: Characteristics of Durational Mortality Improvement Assumptions

Durational mortality improvement describes the process of projecting the current era's mortality into the future. As a cohort proceeds in time from policy year to policy year, the mortality rates applicable in each year may be lower (mortality improvement) or higher (mortality deterioration) than defined by the base mortality table selected for the project. Future lower mortality might be indicated by:

- Medical advances in the treatment of diseases,
- Application of research into the factors affecting the aging process,
- Trends toward healthier lifestyles,
- Changes in the risk selection process, and
- Changes in the underwriting approach.

Durational mortality improvement is a way of keeping the annual expected mortality rate of a cohort up-to-date by applying future trends or expectations for mortality improvement.

The questions answered in sections 2-4 relate to durational mortality improvement.

3a. Did you use durational mortality improvement for life and annuity pricing and/or financial projections?

Using Durational Mortality Improvement	U.S.		Canada	
	Yes	29	83%	5
No	6	17%	2	29%
Number of Respondents	35		7	

In total, 81% of the respondents indicated using durational mortality improvement for life and annuity pricing and financial projections. This percentage is similar to what was seen in prior surveys. Eighty-three percent of the U.S. respondents and 71% of the Canadian respondents indicated using durational mortality improvements. A split by company type indicated that 79% of direct insurers and 88% of reinsurers used durational mortality improvements in their life and annuity pricing and financial projections.

Durational Mortality Improvement	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Yes	29	85%	25	74%	17	50%	20	59%
No	5	15%	9	26%	17	50%	14	41%
Number of Respondents	34	100%	34	100%	34	100%	34	100%

Durational mortality improvements were used more frequently for life than annuities, both for pricing and financial projections. Durational mortality improvements were used for pricing by 85% of the respondents writing life business, but only 50% of the respondents writing annuity business. Durational mortality improvements were used in financial projections by 74% of the respondents writing life business, but only 59% of the respondents writing annuities. This result was consistent between countries.

For both country and company type, durational mortality improvements were used more often for life business in pricing and financial projections than for annuity business.

3b. Indicate by which of the following characteristics your company's durational mortality improvement assumptions varied. Check all that apply.

Characteristics	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Attained Age	24	83%	23	92%	16	94%	19	95%
Gender	22	76%	20	80%	15	88%	17	85%
Duration	15	52%	12	48%	3	18%	3	15%
Smoking Status	12	41%	10	40%	0	0%	0	0%
Product	3	10%	3	12%	2	12%	3	15%
Issued Age	3	10%	3	12%	0	0%	0	0%
Year-of-Birth Cohort	2	7%	2	8%	2	12%	2	10%
Face Amount	2	7%	2	8%	0	0%	0	0%
Risk Class	1	3%	0	0%	0	0%	0	0%
Other*	9	31%	8	32%	6	35%	9	45%
Number of Respondents	29		25		17		20	

Note: Results are sorted by the rank in life pricing

*Other:

- Benefit amount
- Calendar Year (8 life/9 annuities)
- Constant amount applied for 20 years regardless of issue age, gender, etc.
- Generational
- Issue year cohorts are different for older blocks of business than for newer blocks.
- Socioeconomic factors
- UW [underwriting] type

For all four combinations (life and annuities, pricing and financial projections), Attained Age and Gender were the two most commonly used characteristics used to vary durational mortality improvements assumptions. For life business (both pricing and financial projections), the third most commonly used characteristic was Duration. For annuities, the third most common was calendar year.

However, while U.S. and direct respondents were similar with the overall results, there were differences for Canadian and reinsurance respondents:

- For Canadian respondents, while the top two characteristics remained consistent with the overall results, the third most common response was calendar year.
- For reinsurance respondents (life pricing and financial projections), while the top two characteristics remained consistent with the overall results, the third most common response was Smoking Status.

It is interesting to note that, while Attained Age has been a key factor in setting mortality improvement factors in annuities through all of the SOA mortality improvement surveys, about 80% of respondents in this survey indicated using Attained Age, up from about 20% in prior surveys.

3c. Indicate why your company did not use durational mortality improvement assumptions. Check all that apply.

Reason	Life			
	Pricing		Financial Projections	
Difficult	3	38%	3	38%
Limited Experience/Credibility	3	38%	3	38%
To be Conservative	3	38%	3	38%
Not Needed	2	25%	2	25%
Creates Problems with Illustrations	0	0%	0	0%
Not Appropriate	0	0%	0	0%
Other*	1	13%	1	13%
Number of Respondents	8		8	

*Other:

- *Not applicable*

Life respondents who did not use durational mortality improvement had various reasons. Results were consistent across pricing and financial projections. The top three included Difficult to determine assumptions, Limited Experience/Credibility, and To be Conservative.

While these results were consistent for U.S. and direct respondents, Canadian results differed. Canadian respondents indicated the three reasons were To be Conservative, Difficult to determine assumptions, and Not Needed.

For annuities, all but one respondent indicated that durational mortality assumptions were Not Needed.

Section 3: Limitations, Data, Resources, Methodologies, Validation and Review

4. Indicate your company's limits, if any, for application of durational mortality improvement rates. Respondents were asked to express rates as an annual percentage.

The table below shows the results for attained age.

Attained Age	Values	Life		Annuities	
		Pricing	Financial Projections	Pricing	Financial Projections
Minimum Attained Age	Low	0	0	0	0
	Average	10	10	4	3
	High	35	35	20	20
	Most Common	0 (10)	0 (8)	0 (8)	0 (10)
Number of Respondents		17	14	10	12
Maximum Attained Age	Low	89	89	99	99
	Average	101	102	109	111
	High	121	121	150	150
	Most Common	100 (5)	100 (4)	103, 104 (3)	103, 104 (3)
Number of Respondents		22	18	14	16

The most common Minimum Attained Age for both life and annuity respondents to apply durational mortality improvement was zero. This result was consistent for respondents across country and company type.

The lowest Minimum Attained Age was zero across life and annuity respondents, while the highest minimum was age 35 for life and age 20 for annuities. However, while U.S. and direct respondents were consistent with the overall results, there were differences for Canadian and reinsurance respondents:

- For Canada, the Minimum Attained Age was zero for all life respondents while, for annuity respondents, results were consistent with the overall data.
- The reinsurance respondents all used a Minimum Attained Age of zero.

The most common Maximum Attained Age for life respondents was 100 while, for annuities, it was a tie between 103 and 104. However, while U.S. and direct respondents were consistent with the overall results, there were differences for Canadian and reinsurance respondents:

- For Canada, respondents were varied across age groups between 100-105.
- For reinsurers, respondents were varied across age groups between 99-120.

The lowest Maximum Attained Age was 89 for life respondents and 99 for annuity respondents, while the highest maximum was 121 for life and 150 for annuities. However, while U.S. and direct respondents were consistent with the overall results, there were differences for Canadian and reinsurance respondents:

- For Canadian respondents, while the highest Maximum Attained Age remained consistent with the overall results, the lowest Maximum Attained Age was 100 for life and 120 for annuities.
- Reinsurance showed differences in the lowest and highest attained ages. For life, the lowest attained age was 99 and the highest was 120 and, for annuities, 120 was the only result.

Compared to prior surveys, the Maximum Attained Age for which mortality improvements would apply has increased for both life and annuities.

Companies were asked to indicate their limits for durational mortality improvement rates. The responses are summarized in the table below.

Annual Improvement Rate	Values	Life		Annuities	
		Pricing	Financial Projections	Pricing	Financial Projections
Minimum Annual Improvement Rate	Low	0.00%	-0.12%	0.00%	0.00%
	Average	0.14%	0.13%	0.05%	0.12%
	High	0.50%	0.75%	0.30%	0.50%
	Most Common	0% (10)	0% (8)	0% (8)	0% (8)
Number of Respondents		20	17	11	14
Maximum Annual Improvement Rate	Low	0.50%	0.70%	1.00%	1.00%
	Average	1.36%	1.38%	1.44%	1.58%
	High	2.69%	2.69%	1.50%	2.69%
	Most Common	1.00% (7)	1.50% (5)	1.50% (7)	1.50% (7)
Number of Respondents		17	14	8	10

The most common response for the Minimum Annual mortality Improvement Rate across life and annuity respondents was to not assume any mortality improvement (0%). This result was consistent across country and respondent type.

The lowest Minimum Annual mortality Improvement Rate was 0.0% across life and annuities, excluding life financial projections where the rate fell below zero. The highest Minimum Annual mortality Improvement Rate varied across line of business and function. Life pricing and annuity financial projections were 0.50%, annuity pricing was 0.30%, and life financial projections was 0.75%.

However, while the U.S., direct respondents, and reinsurers were consistent with the overall results, there were differences for Canadian respondents, which differed where the lowest Minimum Annual Improvement was 0.0% and the highest was 0.20%, excluding annuity pricing where no mortality improvement was assumed.

The most common result for the Maximum Annual mortality Improvement Rate for life and annuity respondents was 1.50%, except for life pricing where the most common rate was 1.00%. These results were consistent for both U.S. and direct respondents. However, results differed for Canadian and reinsurance respondents where the rates varied between 1.00%-2.69%.

The lowest Maximum Annual mortality Improvement Rate for life respondents was 0.50% for pricing and 0.70% for financial projections, while the highest maximum rates were 2.69% across pricing and financial projections, except for annuity pricing, which was 1.50%. However, there were differences by country and respondent type:

- For Canadian respondents, no maximum rate was used for annuity pricing.
- Results from reinsurance respondents indicated that the lowest maximum rate for life pricing was 1.00% and 1.50% for financial projections, while the highest maximum rate for financial projections was 1.50%. Reinsurance respondents did not assume any Maximum Annual mortality Improvement Rates for annuity business.

Companies were asked to indicate their maximum number of years for durational mortality improvement. The responses are summarized in the table below.

Maximum Number of Years Values	Life		Annuities	
	Pricing	Financial Projections	Pricing	Financial Projections
Low	15	15	10	20
Average	32	30	61	76
High	125	125	104	125
Most Common	20 (10)	20 (12)	N/A	N/A
Number of Respondents	17	21	6	7

For life respondents, the Most Common maximum number of years of mortality improvement was 20 across pricing and financial projections. Results varied from 15 to 125. For annuity respondents, results varied between 10-104 years for annuity pricing and 20-125 years for financial projections. The Average of the assumptions for life was less than that for annuities for both pricing and financial projections. These results were consistent across country and respondent type.

Compared to prior surveys, results were similar.

5a. Indicate what data your company used for determining durational mortality improvement assumptions. Check all that apply.

Data Type	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Population Data	18	62%	14	54%	8	50%	11	58%
Industry Data	17	59%	15	58%	11	69%	12	63%
Company's Data	12	41%	12	46%	1	6%	2	11%
Government Data	8	28%	7	27%	5	31%	5	26%
Other*	4	14%	5	19%	1	6%	1	5%
Number of Respondents	29		26		16		19	

Note: Results are sorted by the rank in life pricing

*Other:

- Reinsurer data [Life] x2
- Life was just a management decision [Life]
- Consultant recommendation [Life]
- CIA PfAD (Provision for Adverse Deviation) [Life and Annuities]
- Projection scale G2 – industry table [Annuities]

The two most common responses as to the sources of data used for determining durational mortality improvement assumptions for both life and annuity respondents were Population Data and Industry Data, with Population Data being most common for life pricing and Industry Data being most common for life projections and annuities. This result was consistent across country and company type. For reinsurance, Population Data was most common for life financial projections, followed by Company's Data and Government Data.

For life respondents, the third most common source of data was the Company's Data. For annuity respondents, the third most common source of data was Government Data.

5b. Indicate the primary data source(s).

Data Type	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Population Data	13	48%	12	55%	6	38%	10	50%
Industry Data	10	37%	6	27%	8	50%	7	35%
Company's Data	3	11%	2	9%	0	0%	1	5%
Other*	1	4%	2	9%	2	13%	2	10%
Number of Respondents	27		22		16		20	

Note: Results are sorted by the rank in life pricing

*Other:

- Consultant recommendation [Life]
- Management decision [Life]
- Projection scale G2 – industry table [Annuities]
- Industry table [Annuities]
- Actuarial judgement [Annuities]

After indicating what data sources companies used for determining durational mortality improvement assumptions, respondents were asked to indicate their primary data source. Not all respondents who answered 5a answered 5b and vice versa, therefore the total number of respondents is not consistent between questions.

Of the respondents who used data for determining durational mortality improvement assumptions, the most common primary data sources included Population Data, followed by Industry Data. This excluded annuity pricing where Industry Data was the primary source, followed by Population Data. There were several notable differences by country and company type.

Regarding U.S. respondents, responses for life business were similar to the overall data but, for annuity respondents, the two most common primary data sources were Industry Data, followed by Population Data. Interestingly, Canadian respondents almost entirely used Population Data, with life respondents using 89% Population Data and the remainder using Industry Data. One hundred percent of annuity respondents used Population Data.

Data sources used by company type varied. Direct respondents' data sources were consistent with the overall response. However, like Canadian respondents, 83% of life reinsurance respondents and 100% of annuity reinsurance respondents used Population Data as a primary data source.

6a. Indicate what resources your company used to develop the durational mortality improvement assumptions. Check all that apply.

Resource Type	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Internal	25	86%	22	85%	13	68%	15	68%
Reinsurer(s) / Retrocessionaire(s)	9	31%	6	23%	0	0%	0	0%
Consultant(s)	8	28%	7	27%	2	11%	2	9%
Other*	3	10%	3	12%	4	21%	5	23%
Number of Respondents	29		26		19		22	

Note: Results are sorted by the rank in life pricing

*Other:

- SOA Industry study [Life]
- Society of Actuaries [Life]
- CIA [Canadian Institute of Actuaries] Industry scale [Life and Annuities]
- CPP [Canadian Pension Plan] [Life and Annuities]
- Industry Study, Industry developed [Annuities]
- Use industry table [Annuities]

For life, three more respondents answered for pricing than for financial projections while, for annuities, three more companies answered for financial projections than for pricing. The most common resource type used by respondents to develop durational mortality improvement assumptions was Internal resources (85% for life pricing, 86% for life projections, and 68% for annuity pricing and projections). While Internal resources were the most common, there were differences by country and company type.

The second and third most common resources used were Reinsurer(s) / Retrocessionaire(s) and Consultant(s). The number of respondents using these was similar, with the rank order varying between pricing and financial projections.

Differences by country and company type included:

- In the U.S., the second most common resource was Consultant(s) followed by Reinsurer(s) / Retrocessionaire(s). In Canada, the second most common resource was Reinsurer(s) / Retrocessionaire(s) and none selected Consultant(s).
- For direct respondents, Consultant(s) were the second most common resource followed by Reinsurer(s) / Retrocessionaire(s). For reinsurance respondents, the second most common resource was Reinsurer(s) / Retrocessionaire(s) and none selected Consultant(s).

6b. Indicate the primary resource(s).

Resource Type	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Internal	8	67%	7	47%	6	55%	5	63%
Consultant(s)	2	17%	1	7%	0	0%	0	0%
Reinsurer(s) / Retrocessionaire(s)	1	8%	1	7%	0	0%	0	0%
Other*	1	8%	6	40%	0	0%	1	13%
Number of Respondents	12		15		11		8	

Note: Results are sorted by the rank in life pricing

*Other:

- Actuarial judgement [Life]
- CPP [Canadian Pension Plan] [Life]
- Internal [Life]
- Society of Actuaries [Life]
- CIA Industry Scale [Life and Annuities]
- Industry Study, Industry developed [Annuities]
- SOA Industry Study [Annuities]

Not all respondents who answered 6a answered 6b and vice versa, therefore the total number of respondents is not consistent between questions. For life, three fewer respondents answered for pricing than for financial projections while, for annuities, three fewer companies answered for financial projections than for pricing; this is the opposite from the overall resources result.

The most common resource type primarily used by respondents to develop durational mortality improvement assumptions was Internal resources (67% for life pricing, 47% for life projections, 55% for annuity pricing, and 63% for annuity projections).

Results from prior surveys were similar. However, Reinsurer(s) / Retrocessionaire(s) were more heavily relied upon as a source of data for setting mortality improvement assumptions as noted in the 2001 survey compared to more recent surveys.

7a. Indicate the internal resources who were involved with developing the durational mortality improvement assumptions. Check all that apply.

Resource Type	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Actuary(ies)	29	100%	26	100%	16	100%	20	100%
Committee	11	38%	10	38%	7	44%	8	40%
Senior Officer(s)	8	28%	6	23%	6	38%	7	35%
Medical Director(s)	7	24%	8	31%	2	13%	2	10%
Data Scientist(s)	3	10%	4	15%	0	0%	0	0%
Underwriter(s)	2	7%	1	5%	1	6%	1	5%
Other*	1	3%	2	8%	1	6%	1	5%
Number of Respondents	29		26		16		20	

Note: Results are sorted by the rank in life pricing

*Other:

- Risk team
- Peer review committee

The top internal resource used by all four lines of business and functions was Actuary(ies). The second most commonly used internal resource was Committee. The third most common was Senior Officer(s); however, for life projections, Medical Director(s) were the third most common.

7b. Indicate who had the final authority to approve the durational mortality improvement assumptions. Check all that apply.

Final Approver	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Actuary(ies)	19	66%	18	69%	12	75%	14	70%
Committee	13	45%	11	42%	8	50%	9	45%
Senior Officer(s)	8	28%	8	31%	4	25%	5	25%
Data Scientist(s)	0	0%	0	0%	0	0%	0	0%
Medical Director(s)	0	0%	0	0%	0	0%	0	0%
Underwriter(s)	0	0%	0	0%	0	0%	0	0%
Other	0	0%	0	0%	0	0%	0	0%
Number of Respondents	29		26		16		20	

Note: Results are sorted by the rank in life pricing

Not all respondents who answered 7a answered 7b and vice versa, therefore the total number of respondents is not consistent between questions.

Across all four lines of business and functions, the top three final approvers were Actuary(ies), followed by Committee and Senior Officer(s).

There were differences for the reinsurance respondents. For life, Senior Officer(s) were the most common final approver, followed by Committee and Actuary(ies). For annuities, the most common response was Committee.

8a. Indicate if your company used a standard approach to developing durational mortality improvement assumptions. Also, explain your approach in the Explanation section, as there are multiple versions of the standard approaches. If you use a projection scale developed by RPEC (Retirement Plans Experience Committee), which one and how do you use it? Check all that apply.

Approach	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Did not use standard*	13	50%	11	48%	4	29%	4	25%
Standard - CIA MI-2017	3	12%	2	9%	2	14%	3	19%
Standard - RPEC	1	4%	1	4%	1	7%	2	13%
Standard - Lee-Carter	1	4%	1	4%	0	0%	0	0%
Standard - CIA MI-2009	0	0%	0	0%	0	0%	0	0%
Standard - CIA MI-2016	0	0%	0	0%	0	0%	0	0%
Standard – Other**	9	35%	8	35%	7	50%	7	44%
Number of Respondents	26		23		14		16	

Note: Results are sorted by the rank in life pricing

*Did not use standard:

- Based on population mortality with an adjustment for insurance [Life]
- CMI approach used the Human Mortality Database for the population of the United States for the period 1961-2010 [Life]
- Due to the lack of credible mortality improvement experience, the company relied on industry data to determine a mortality improvement assumption. Thus, a conservative mortality improvement assumption was elected to be used in pricing. The company choose to reflect mortality improvement throughout the level term period. [Life]
- Industry Study / Industry developed [Life]
- CPP Scale which is based on cubic interpolation of the Canadian human mortality database. [Life and Annuities]
- It is not obvious what is meant by "standard approach". We use an internal implementation of the APCI model [Life and Annuities] x2
- It's actually not clear if our approach could be viewed as standard. I selected "other" because I wasn't sure if it could be categorized as an option listed. We apply a constant rate of improvement to the projected duration, when the improvement rate varies by attained age & gender, but not extending beyond a maximum defined attained age. [Life and Annuities]
- G2 Mortality Improvement applied year-over-year from an anchor date [Annuities]
- We apply the SOA Scale G2 mortality improvement scale by adjusting mortality rates along the following: $MortalityRate = Multiple \tilde{A} - q \tilde{A} - (1-p)^n$, where p = Mortality improvement for a given attained age and gender and n = number of mortality improvement years (Projection calendar year - Improvement start year) [Annuities]

**Standard - Other:

- Approach based on U.S. general population by age groups [Life]
- Internal [Life] x2
- SOA Research [Life]
- U.S. CMI [Life]
- Cubic Interpolation [Life and Annuities]
- It's actually not clear if our approach could be viewed as standard. I selected "other" because I wasn't sure if it could be categorized as an option listed. We apply a constant rate of improvement to the projected duration, when the improvement rate varies by attained age & gender, but not extending beyond a maximum defined attained age. [Life and Annuities]

- *Comparable to Scale G2 [Annuities]*
- *Industry Study/developed [Annuities]*
- *Scale G-2 [Annuities]*
- *SOA Scale G2 [Annuities]*

This question references various standard approaches. The top response across all categories was “Did not use standard approach,” at 50% for life pricing and 48% for life projections. All other choices represented no more than 29%.

8b. If your company used a variation of a standard approach above, briefly describe the variation used.

Respondents who used a variation of a standard approach were direct and U.S. respondents. No Canadian respondent used a variation of a standard approach. The variations that were used included:

- *U.S. population mortality data from the mortality database where initial mortality improvement rates were set equal to long term rates (i.e. same rate for all calendar years given age) where old age grading begins at age 85 and mortality improvement rate equals 0.2% at age 95. This method differs from CIA MI 2017 where age grading begins at 90 and mortality improvement rates equal at 0.2% at age 100*
- *Constant compound rate of improvement by duration, varying by attained age and gender, not extending beyond a maximum defined attained age*
- *Global Mortality Improvement Experience Projection Techniques from the SOA*
- *RPEC used as a baseline with adjustments at older ages and simplification for modeling limitations*
- *Variation of SOA's scale G2 (annuity projection scale)*
- *Weigh factors with company experience based on credibility theory*
- *Lee-Carter approach with an emphasis on recent year while also maintaining awareness of prior years. Consultant expertise were utilized*

8c. If your company did not use a standard approach, briefly describe the approach used. Also, if your company used a predictive analytics and/or machine learning approach, briefly describe the approach used.

For the respondents who did not use a standard approach, the following approaches were used:

- *CPP [Canadian Pension Plan] Scale based on cubic interpolation of the Canadian human mortality database*
- *Internal implementation of the APCI model*
- *Derived a short-term trend (10-year view) and long-term trend (25-year view). The short term is applied in duration 1. Long term is applied in duration 20. Linearly interpolated between*
- *G2 Mortality Improvement applied year-over-year from an anchor date*
- *SOA Scale G2 mortality improvement scale applied by adjusting mortality rates along the following:*

$$\text{Mortality Rate} = \text{Multiple } \tilde{A} - q\tilde{A} - (1 - p)^n, \text{ where}$$

$$p = \text{Mortality improvement for a given attained age}$$

and

$$n = \text{number of mortality improvement years}$$

$$(\text{Projection calendar year} - \text{Improvement start year})$$

- *Mortality improvement reflected through level term period*

- *CMI approach used for the Human Mortality Database for the population of the United States for the period 1961-2010*
- *TOAMS III mortality improvement assumptions with reasonability assurance given by the Generalized Linear Model*
- *Update assumptions for most recent MP scale on an annual basis*
- *Factors recommended by consultants*
- *Industry data*
- *Based on population mortality with an adjustment for insurance*
- *A time-weighted Lee-Carter model was used for setting U.S. mortality improvement rates. Four models were used for each sex / smoker status cohort using different underlying subpopulations. These subpopulations were derived using a socio-economic proxy variable, educational attainment*

Respondents who used predictive analytics and/or machine learning as an approach included U.S. direct and reinsurance respondents. Their responses are summarized as follows:

- *Actuarial judgment, peer review, approval by senior actuaries*
- *Analysis of U.S. population data, benchmarking against industry*
- *Constant rate of improvement(B) model where weighted linear regression was used by taking the log of both sides:*

$$A/E \text{ Rate} = k(1 - B)^{\text{Period}}$$

- *Industry data used to determine mortality improvement experience*
- *Mortality improvement reflected throughout the level term period*
- *Developed short-term and long-term rates using 20- and 40-year historical average improvements based on population data. Lower rates were adjusted for opiate deaths within insured population*
- *Consultant/industry assumptions*
- *Approach involves reviewing the annual mortality improvement and experience internally each calendar years against consistent expected mortality level and smoothing the historical trend in improvement*
- *TOAMS III mortality improvement assumptions with reasonability assurance given by the Generalized Linear Model*
- *Internally created near term rates based on blending historical experience with greater emphasis on recent data and adjustment for smoker cessation. Near term rates graded into long term estimates based on consultant/industry sources and final rates are adjusted by socioeconomic factor*
- *Annuity 2012 Scale G2 table*
- *Mortality improvement scale from the 2008 VBT*

9a. General population mortality improvements have slowed in recent years. Indicate if your company was aware of this.

All 42 respondents answered this question and indicated that they were aware of the recent slowdown.

9b. If your company was aware of it and made changes to its durational mortality improvement assumptions, indicate the method used. Check all that apply.

Method Used	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Decrease all durational mortality improvement assumptions	4	33%	2	18%	0	0%	2	25%
Decrease a limited number of durational mortality improvement assumptions	2	17%	2	18%	3	75%	4	50%
Extrapolation of the most Recent past experience	1	8%	1	9%	0	0%	0	0%
Other*	6	50%	7	64%	1	25%	2	25%
Number of Respondents	12		11		4		8	

Note: Results are sorted by the rank in life pricing

*Other:

- Applied a cap to the assumptions
- By future projection year
- Choose conservative assumptions
- Do not reflect the most recent past experience
- Update our assumption regularly using the same method
- Weighted recent experience more heavily than older

Of the 42 respondents who were aware of the general population mortality improvement slowdown, 12 life respondents and 8 annuity respondents indicated they made changes to mortality improvement assumptions. However, no more than four respondents indicated any one change due to the slowdown.

10. Indicate whether your company validates durational mortality improvement assumptions.

Response	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Yes	16	64%	15	65%	3	21%	4	25%
No	9	36%	8	35%	11	79%	12	75%
Number of Respondents	25		23		14		16	

For life, approximately 65% of respondents validate durational mortality improvement assumptions across pricing and financial projections. For annuities, at least 75% did not validate durational mortality improvement assumptions across pricing and financial projections.

In general, there was a higher rate of Canadian respondents for life that validate durational mortality improvement assumptions compared to the U.S. Where 75% of Canadian respondents indicated yes for pricing and 67% for financial projections, U.S. respondents indicated 60-65% for pricing and financial projections. Like life, Canadian respondents reported a higher rate of validating durational mortality improvement assumptions. Where 50% of Canadian respondents indicated yes for pricing and financial projections, U.S. respondents indicated 17% for pricing and 21% for financial projections.

Regarding company type for life, reinsurance respondents were more likely to validate durational mortality improvement assumptions compared to direct respondents. While 71% of reinsurance respondents indicated yes to pricing and 80% for financial projections, direct respondents indicated 61% for pricing and financial projections. For annuities, reinsurance respondents were more likely to validate their durational mortality improvement assumptions over direct respondents. Where 100% of reinsurance respondents indicated yes for pricing and financial projections for direct respondents, 15% indicated yes for pricing and 20% for financial projections.

11. Indicate how often your company reviews durational mortality improvement assumptions for possible changes.

Time Period	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Every Year	7	24%	9	33%	5	28%	5	24%
Over 1 Year and up to 3 Years	7	24%	6	22%	2	11%	4	19%
Over 3 Years	3	10%	3	11%	0	0%	1	5%
As Needed	3	10%	3	11%	3	17%	5	24%
As product is priced or repriced	4	14%	1	4%	3	17%	2	10%
As new population mortality data is published	1	3%	1	4%	1	6%	1	5%
Other*	4	14%	4	15%	4	22%	3	14%
Number of Respondents	29		27		18		21	

*Other:

- Every 2 years
- Reviewed as part of product pricing/development process
- When industry table is updated
- New to producing explicit durational mortality improvement factors

Across both life and annuities, respondents indicated Every Year was the most common time interval in which durational mortality improvement was reviewed. For life pricing, Over 1 Year and up to 3 Years was tied as the most common time interval.

For life respondents, the second most common time interval used was Over 1 Year and up to 3 Years.

There were differences by country and company type:

- For U.S. respondents, the most common time interval for pricing was Over 1 Year and up to 3 Years, followed by Every Year. For financial projections, results were consistent with the overall data. For Canadian respondents, the most common choice was Every Year, consistent with the overall results. There was no clear second choice. This result was consistent across pricing and financial projections.
- For company type, direct respondents indicated the most common time interval for pricing was Over 1 Year and up to 3 Years, followed by As product is priced or repriced and Every Year. For financial projections, the results were consistent with the overall data.

For annuity respondents, the second most common time interval to review durational mortality rate improvement assumptions was "Other" for pricing and As Needed for financial projections. This result was consistent for U.S. respondents. Canadian respondents indicated an equal split between "Other," As new population mortality data is published, and Over 3 Years. Results were consistent for direct respondents. Reinsurance respondents listed "Other" as their only response.

Section 4: Opinions on Issues Impacting Durational Mortality Improvement

In this section, we used a weighted ranking system to express the results. For the ranking system, we assumed 3 points for a rank of 1, 2 for a rank of 2, and 1 for a rank of 3. For example, the weighted rank for “Uncertainty of magnitude of future trends” is $11 \times 3 + 10 \times 2 + 4 \times 1 = 57$.

For the analyses in this section, weighted rank will be referred to as “rank.”

12. Rank what you consider to be the top 3 challenges to setting mortality improvement assumptions. Choose your top 3 for each column, with 1 as the top driver.

Life Pricing Challenges	Rank			Weighted Rank
	1	2	3	
Uncertainty of magnitude of future trends	11	10	4	57
Availability of appropriate data	11	4	6	47
Uncertainty in direction of future trends	9	5	3	40
Differences in underwriting over time	3	4	6	23
Determining age/period/cohort effects	0	7	8	22
Limited resources	2	3	5	17
Difficulty in backtesting models	0	2	2	6
Modeling uncertainty	0	1	2	4
Other	0	0	0	0
Number of Respondents	36			

The top three challenges for life pricing were Uncertainty of magnitude of future trends, Availability of appropriate data, and Uncertainty in direction of future trends.

While these results were consistent for the U.S. and direct company respondents, there were differences by country and company type. For Canadian and reinsurance respondents, the top three ranked challenges were Uncertainty in direction of future trends, Uncertainty of magnitude of future trends, and Availability of appropriate data.

Life Financial Projections Challenges	Rank			Weighted Rank
	1	2	3	
Uncertainty of magnitude of future trends	10	11	4	56
Availability of appropriate data	12	2	6	46
Uncertainty in direction of future trends	5	5	3	28
Determining age/period/cohort effects	0	6	7	19
Differences in underwriting over time	3	3	3	18
Limited resources	2	3	4	16
Difficulty in backtesting models	0	1	3	5
Modeling uncertainty	0	1	2	4
Other	0	0	0	0
Number of Respondents	32			

The top three challenges for life financial projections were Uncertainty of magnitude of future trends, Availability of appropriate data, and Uncertainty in direction of future trends. These were the same top three challenges as life pricing, and in the same order.

Note that there were differences by country and company type:

- For U.S. respondents, the top three challenges were Availability of appropriate data, Uncertainty of magnitude of future trends, and Uncertainty in direction of future trends.
- For Canadian respondents, the highest ranked challenge was consistent with the overall data, but this was followed by Uncertainty in direction of future trends and Determining age/period/cohort effects.
- By company type, reinsurance respondents were consistent with the Canadian results.

Annuity Pricing Challenges	Rank			Weighted Rank
	1	2	3	
Uncertainty of magnitude of future trends	5	8	1	32
Determining age/period/cohort effects	3	7	3	26
Availability of appropriate data	6	0	4	22
Uncertainty in direction of future trends	2	0	1	7
Limited resources	1	1	2	7
Modeling uncertainty	0	0	4	4
Differences in underwriting over time	0	1	1	3
Difficulty in backtesting models	0	0	1	1
Other	0	0	0	0
Number of Respondents	17			

The top three challenges for annuity pricing were Uncertainty of magnitude of future trends, Determining age/period/cohort effects, and Availability of appropriate data.

While these results were consistent for U.S. and direct respondents, there were differences for Canadian and reinsurance respondents:

- For Canadian respondents, the second highest ranked challenge was Availability of appropriate data and the third was Modeling uncertainty.
- For reinsurance respondents, the third highest ranked challenge was Modeling uncertainty.

Annuity Financial Projections Challenges	Rank			Weighted Rank
	1	2	3	
Uncertainty of magnitude of future trends	7	8	3	40
Availability of appropriate data	8	0	5	29
Determining age/period/cohort effects	2	7	6	26
Uncertainty in direction of future trends	3	3	1	16
Limited resources	1	2	1	8
Modeling uncertainty	0	0	4	4
Differences in underwriting over time	0	1	0	2
Difficulty in backtesting models	0	0	1	1
Other	0	0	0	0
Number of Respondents	21			

The top three challenges for annuity financial projections were Uncertainty of magnitude of future trends, Availability of appropriate data, and Determining age/period/cohort effects. These were the same three challenges for annuity pricing, however, the second and third ranked challenges were reversed.

While the rankings were consistent for U.S. and direct respondents, the second and third challenges were reversed for Canadian and reinsurance respondents.

13. Rank what you consider to be the top 5 drivers of future mortality improvement for both short term (5-10 years) and long term (20+ years), with 1 as the top driver for each column.

Life: Short-Term (5-10 years) Drivers of Future Mortality Improvement	Rank					Weighted Rank
	1	2	3	4	5	
Reductions in mortality from cancer	16	12	3	2	1	142
Reductions in mortality from cardiovascular disease	8	10	3	0	2	91
Medical advances	6	3	2	6	6	66
Access to health care/medical care	5	1	2	4	2	45
Improvements in health care/medical care	2	1	6	3	4	42
Healthier lifestyle behaviors	1	2	4	4	1	34
Advances in underwriting methodologies	1	3	2	4	2	33
Advances in understanding of genetics	0	3	1	5	1	26
Advances in the understanding of aging	0	0	5	0	4	19
Reductions in mortality from Alzheimer's disease	0	1	2	4	0	18
Number of Respondents	39					

For this and the following tables in this question, only the top ten results are shown.

For life respondents, the top five drivers of short-term future mortality improvement were Reductions in mortality from cancer, Reductions in mortality from cardiovascular disease, Medical advances, Access to health care/medical care, and Improvements in health care/medical care.

Results were consistent across country and company type.

Annuities: Short-Term (5-10 years) Drivers of Future Mortality Improvement	Rank					Weighted Rank
	1	2	3	4	5	
Reductions in mortality from cancer	7	6	1	1	0	64
Reductions in mortality from cardiovascular disease	5	3	2	0	1	44
Access to health care/medical care	3	2	1	3	0	32
Improvements in health care/medical care	1	2	4	2	3	32
Healthier lifestyle behaviors	3	0	4	1	1	30
Medical advances	1	0	2	6	5	28
Changes in government programs/policy	0	3	0	1	0	14
Precision medicine	0	1	2	1	0	12
Technological advances	0	0	1	2	4	11
Reduction in socioeconomic differences	0	0	2	1	3	11
Number of Respondents	21					

For annuity respondents, the top five drivers of short-term future mortality improvement were Reductions in mortality from cancer, Reductions in mortality from cardiovascular disease, Access to health care/medical care, Improvements in health care/medical care, and Healthier lifestyle behaviors.

Compared to life respondents, the first two were the same and two others were the same. For life respondents, Medical advances ranked third (and was not in the top five for annuity respondents) and, for annuity respondents, Healthier lifestyle behaviors ranked fifth (and was not in the top five for life respondents).

While the U.S. respondents were consistent with the overall results, there were differences for Canadian respondents and by company type. Within the top three rankings, the differences were:

- For Canadian respondents, Improvements in health care/medical care ranked second and third was Reductions in mortality from cardiovascular disease.
- For direct respondents, the third most common driver was Improvements in health care/medical care while, for reinsurance respondents, it was Reduction in socioeconomic differences.

Life: Long-Term (20+ years) Drivers of Future Mortality Improvement	Rank					Weighted Rank
	1	2	3	4	5	
Reductions in mortality from cancer	11	7	5	6	0	110
Medical advances	13	0	6	4	2	93
Advances in understanding of genetics	5	9	5	6	1	89
Advances in the understanding of aging	2	6	4	3	8	60
Reductions in mortality from cardiovascular disease	3	7	2	2	2	55
Reductions in mortality from Alzheimer's disease	0	2	4	3	2	28
Improvements in health care/medical care	1	2	2	1	4	25
Healthier lifestyle behaviors	1	0	4	2	3	24
Access to health care/medical care	0	3	2	1	2	22
Precision medicine	1	0	0	4	6	19
Number of Respondents	39					

For life respondents, the top five drivers of long-term future mortality improvement were Reductions in mortality from cancer, Medical advances, Advances in understanding of genetics, Advances in the understanding of aging, and Reductions in mortality from cardiovascular disease.

While the U.S. respondents were consistent with the overall results, there were differences for Canadian respondents and by company type. Within the top three rankings, the differences were:

- For Canadian respondents, the second ranked driver was Advances in understanding of genetics and third was Medical advances.
- Direct respondents had similar results to Canada.
- For reinsurance respondents, the top ranked driver was Medical advances, followed second by Reductions in mortality from cancer, and third by Reductions in mortality from cardiovascular disease.

Annuities: Long-Term (20+ years) Drivers of Future Mortality Improvement	Rank					Weighted Rank
	1	2	3	4	5	
Reductions in mortality from cancer	6	4	2	4	0	60
Medical advances	5	1	5	3	1	51
Advances in understanding of genetics	4	5	1	2	1	48
Advances in the understanding of aging	2	1	3	3	5	34
Healthier lifestyle behaviors	2	0	4	1	2	26
Reductions in mortality from cardiovascular disease	2	2	1	1	1	24
Improvements in health care/medical care	0	3	2	0	4	22
Reductions in mortality from Alzheimer's disease	0	2	0	4	2	18
Precision medicine	1	1	1	1	2	16
Access to health care/medical care	1	1	1	1	0	14
Number of Respondents	23					

For annuity respondents, the top five drivers of long-term future mortality improvement were Reductions in mortality from cancer, Medical advances, Advances in understanding of genetics, Advances in the understanding of aging, and Healthier lifestyle behaviors.

The first four drivers of long-term future mortality improvement were the same as for the life respondents. For annuity respondents, the fifth ranked driver was Healthier lifestyle behaviors while, for life respondents, it was Reductions in mortality from cardiovascular disease.

There were differences by country and company type. Within the top three rankings, the differences were:

- For U.S. respondents, the top ranked driver was Medical advances, followed second by Reductions in mortality from cancer, and third by Advances in understanding of genetics.
- For Canadian respondents, the second ranked driver was Advances in understanding of genetics and the third ranked was Reduction in mortality from Alzheimer's disease.
- For reinsurance respondents, the top ranked driver was Reductions in mortality from cardiovascular disease, followed second by Reductions in mortality from cancer, and third by Reduction in socioeconomic differences.

Mortality improvement choices provided to the survey respondents that did not make the top 10 on any of the four lists include:

- Artificial intelligence/Augmented reality
- Fitness tracking
- Self-driving cars
- Reduction in levels of stress leading to improved mortality
- Other write-in comment: Wellness /Preventive Progress

The prior surveys asked a slightly different question, which was to give the justification for using mortality improvement. The main reasons given were improvements in medicine, technological advances and trends towards healthier lifestyles. One note of interest was that in the 2001 survey, extrapolation from past experience made the list at number 4 but, in 2012, was given as the main justification for using mortality improvement.

14. Rank what you consider to be the top 5 drivers of future mortality deterioration for both short term (5-10 years) and long term (20+ years), with 1 as the top driver for each.

Life: Short-Term (5-10 years)		Rank					Weighted Rank
Drivers of Future Mortality Deterioration	1	2	3	4	5		
Opioids	19	2	8	2	2	133	
Obesity	6	10	4	3	5	93	
Diabetes	4	6	3	3	2	61	
Mental health/depression	0	5	3	4	2	39	
Lifestyle behaviors	2	2	3	4	2	37	
Alzheimer's/dementia	0	3	4	2	2	30	
Changes in government programs/policy	2	2	0	2	3	25	
Socioeconomic inequality	1	1	1	3	5	23	
Suicides	0	1	4	2	1	21	
Antibiotic resistant organisms	0	2	1	4	1	20	
Number of Respondents	39						

For life respondents, the top five drivers of short-term future mortality deterioration were Opioids, Obesity, Diabetes, Mental health/depression, and Lifestyle behaviors.

Annuities: Short-Term (5-10 years)		Rank					Weighted Rank
Drivers of Future Mortality Deterioration	1	2	3	4	5		
Opioids	9	4	3	0	1	71	
Diabetes	3	3	3	3	1	43	
Obesity	1	6	2	0	5	40	
Lifestyle behaviors	2	1	3	1	2	27	
Changes in government programs/policy	1	2	2	1	1	22	
Mental health/depression	0	1	1	5	1	18	
Socioeconomic inequality	2	1	0	1	1	17	
Cardiovascular disease	1	0	3	0	0	14	
Cancer	0	0	2	3	0	12	
Accidents	2	0	0	0	0	10	
Number of Respondents	22						

For annuity respondents, the top five drivers of short-term future mortality deterioration were Opioids, Diabetes, Obesity, Lifestyle behaviors, and Changes in government programs/policy.

Compared to life respondents, the first ranked driver was the same, the second and third were reversed, and Lifestyle behaviors was fourth for annuity respondents and fifth for life respondents. In addition, for life respondents, Mental health/depression ranked fourth (and was not in the top five for annuity respondents) and, for annuity respondents, Changes in government programs/policy ranked fifth (and was not in the top five for life respondents).

There were differences by country and company type:

- For U.S. respondents, the fifth ranked driver was Socioeconomic inequality.
- For Canadian respondents, the top ranked driver was Opioids, followed by Obesity, Diabetes, Changes in government programs/policy, and Catastrophes.
- For reinsurance respondents, the top ranked driver was Opioids, followed by Obesity, Cardiovascular disease, Cancer, and Alzheimer's/dementia.

Life: Long-Term (20+ years) Drivers of Future Mortality Deterioration	Rank					Weighted Rank
	1	2	3	4	5	
Obesity	9	9	5	1	4	102
Antibiotic resistant organisms	7	2	4	2	5	64
Lifestyle behaviors	4	4	3	5	4	59
Mental health/depression	1	4	6	4	4	51
Diabetes	4	3	1	2	3	42
Socioeconomic inequality	2	2	1	5	4	35
Opioids	3	0	3	2	1	29
Pollution	1	1	3	3	2	26
Changes in government programs/policy	2	0	2	4	1	25
Chemicals and hormones in the environment	2	3	0	1	1	25
Number of Respondents	39					

For life respondents, the top five drivers of long-term future mortality deterioration were Obesity, Antibiotic resistant organisms, Lifestyle behaviors, Mental health/depression, and Diabetes.

While U.S. respondents were consistent with the overall results, there were differences in Canadian and company type respondents:

- For Canadian respondents, the second ranked driver was Lifestyle behaviors and third was Antibiotic resistant organisms.
- For direct respondents, the fifth ranked driver was Socioeconomic inequality.
- For reinsurance respondents, the second ranked driver was Diabetes, followed by Mental health/depression, Lifestyle behaviors, and Alzheimer's/dementia.

Annuities: Long-Term (20+ years) Drivers of Future Mortality Deterioration	Rank					Weighted Rank
	1	2	3	4	5	
Obesity	3	5	3	1	4	50
Antibiotic resistant organisms	3	2	3	1	1	35
Lifestyle behaviors	3	2	0	3	4	33
Mental health/depression	0	3	4	2	1	29
Socioeconomic inequality	2	1	1	5	1	28
Diabetes	4	0	0	0	2	22
Opioids	2	0	3	1	0	21
Chemicals and hormones in the environment	1	3	0	0	1	18
Smoking/Vaping	1	1	1	2	0	16
Pollution	0	1	3	1	0	15
Number of Respondents	23					

For annuity respondents, the top five drivers of long-term future mortality deterioration were Obesity, Antibiotic resistant organisms, Lifestyle behaviors, Mental health/depression, and Socioeconomic inequality.

Compared to life respondents, the first four ranked drivers were the same. The fifth for life respondents was Diabetes while, for annuity respondents, it was Socioeconomic inequality.

There were differences by country and company type:

- For U.S. respondents, compared to the overall results, the second and third ranked drivers were reversed, and the fourth and fifth were also reversed.
- For Canadian respondents, the second ranked driver was Opioids, followed by Changes in government programs/policy, Catastrophes, and Diabetes.
- For direct respondents, the top three drivers were consistent with U.S. respondents.
- For reinsurance respondents, the top ranked driver was Diabetes, followed by Obesity, Antibiotic resistant organisms, Lifestyle behaviors, and Mental health/depression.

Mortality deterioration choices provided to the survey respondents that did not make the top 10 on any of the top five lists include:

- Catastrophes
- Epidemics/Pandemics
- Homicides
- Medical Errors
- Smoking/Vaping
- Stress
- Self-driving cars
- Technological changes
- Terrorist Activities

A similar question was asked in prior surveys, but it did not split by short-term and long-term drivers. While opioids was the number one short-term driver today, it was not considered in prior surveys. Obesity, diabetes and resistance to antibiotics were considered the key drivers. Pandemics were also one of the top responses in the prior survey and, while it was included as an option on this survey, it did not make the top ten drivers selected. As a reminder, this survey was conducted prior to the start of the COVID-19 pandemic.

15. General population mortality improvements have slowed in recent years. Indicate if you believe this trend will reverse or continue into the future.

Timeframe	Trend Direction				Number of Respondents
	Continue		Reverse		
Short-Term (5-10 years)	30	75%	10	25%	40
Long-Term (20+ years)	14	35%	26	65%	40

Seventy-five percent of respondents believed that the slowing of mortality improvement would continue in the Short-Term; however, 65% of respondents believed that this trend would reverse in the Long-Term. While U.S., direct and reinsurance respondents showed similar responses, Canadian respondents generally indicated this trend would reverse both Short- and Long-Term.

16. Indicate if you believe there will be improvement or deterioration in cardiovascular and cancer mortality in the near (5-10 years) and long (20+ years) term.

Direction	Cardiovascular				Cancer			
	Short-Term (5-10 years)		Long-Term (20+ years)		Short-Term (5-10 years)		Long-Term (20+ years)	
Large deterioration	0	0%	0	0%	0	0%	0	0%
Moderate deterioration	1	3%	1	3%	1	3%	0	0%
Small deterioration	3	8%	4	10%	2	5%	2	5%
No improvement or deterioration	10	25%	3	8%	4	10%	0	0%
Small improvement	23	58%	21	53%	21	53%	8	20%
Moderate improvement	3	8%	11	28%	9	23%	19	48%
Large improvement	0	0%	0	0%	3	8%	11	28%
Number of Respondents	40		40		40		40	

The most common direction for mortality improvement/deterioration for cardiovascular short- and long-term and cancer short-term was Small improvement. For cancer long-term, the most common response was Moderate improvement. The second most common direction for mortality improvement/deterioration for cardiovascular long-term and cancer short-term was Moderate improvement. For cardiovascular short-term, the second most common response was No improvement or deterioration. For cancer long-term, the second most common response was Large improvement.

There were differences by country and company type:

- U.S. respondents for cancer long-term results differed in that a Small improvement in mortality was second.
- For Canadian respondents for cancer short-term results, there was an even split for the second most common response between a Moderate and Large improvement. For cancer long-term results, the most common response was a Large improvement, followed by a Moderate improvement.
- For direct respondents, for cardiovascular and cancer, results were consistent with U.S. respondents.
- For reinsurance for cardiovascular, respondents indicated that the most common response was Small improvement, followed by No improvement or deterioration and Moderate improvement. This result was the same for both short- and long-term.
- For reinsurance for cancer short-term, the second most common response was an even split between Small and Large improvement. For long-term results, the most common response was Large improvement, followed by Moderate improvement.

17a. Provide your opinion on the following issues related to how changes in smoking habits will impact durational mortality improvement. The purpose of this question is to capture various elements related to smoking habits with the intention of combining the answers to develop a composite view on durational mortality improvement related to smoking. Indicate whether you believe that e-cigarettes or traditional cigarettes will have a higher mortality rate, all other parameters being equal.

Smoking Habits	Responses	
	Traditional cigarettes are slightly higher	15
Traditional cigarettes are substantially higher	12	31%
E-cigarettes and traditional cigarettes are about the same	9	23%
E-cigarettes are slightly higher	3	8%
E-cigarettes are substantially higher	0	0%
Number of Respondents	39	

Almost 70% of the respondents indicated Traditional cigarettes would produce slightly (38%) or substantially (31%) higher mortality than e-cigarettes. Twenty-three percent indicated the mortality was about the same and 8% indicated E-cigarettes would produce slightly higher mortality than traditional cigarettes.

Results differed by country:.

- More U.S. respondents indicated Traditional cigarettes would have a substantially greater impact on mortality improvement than E-cigarettes.
- For Canadian respondents, the second most common response was there would be no difference in the impact in mortality improvement between E-cigarettes and traditional cigarettes.

17b. Compared to today, indicate what you believe the prevalence of e-cigarettes will be over both the short term (5-10 years) and long term (20+ years).

E-Cigarettes	Timeframe			
	Short-Term (5-10 years)		Long-Term (20+ years)	
Large decrease	0	0%	0	0%
Moderate decrease	0	0%	4	10%
Small decrease	2	5%	5	12%
No change	1	2%	3	7%
Small increase	8	19%	15	36%
Moderate increase	21	50%	10	24%
Large increase	8	19%	3	7%
No Answer	2	5%	2	5%
Number of Respondents	42		42	

In the short-term, the most common response was the prevalence of e-cigarettes would experience a Moderate increase (50%), followed by an equal split between a Small and Large increase (19%). In the long-term, the most common response was Small increase (36%), followed by Moderate increase (24%).

There were differences by country and company type:

- For U.S. respondents in the short-term, the second most common result was Large increase.
- For Canadian respondents in the short-term, the second most common response was Small increase. In the long-term, the second most common response was an even split in all categories except Small increase.
- Direct respondents were in line with U.S. results for both short- and long-term time periods.

- Reinsurance respondents did not indicate any notable trends (i.e., responses were varied).

17c. Compared to today, indicate what you believe the prevalence of traditional cigarettes will be over both short term (5-10 years) and long term (20+ years).

Cigarettes	Timeframe			
	Short-Term (5-10 years)		Long-Term (20+ years)	
Large decrease	0	0%	3	7%
Moderate decrease	10	24%	17	40%
Small decrease	20	48%	17	40%
No change	8	19%	1	2%
Small increase	1	2%	2	5%
Moderate increase	1	2%	0	0%
Large increase	0	0%	0	0%
No Answer	2	5%	2	5%
Number of Respondents	42		42	

In the short-term, over 70% of respondents indicated a Small (48%) or Moderate (24%) decrease in the prevalence of traditional cigarettes; in the long-term, slightly more (80%) indicated a Small (40%) or Moderate (40%) decrease.

There were differences by company type:

- For direct respondents, in the short-term, the second most common response was an even split between Moderate decrease and No change in the prevalence of traditional cigarettes. In the long-term, the most common response was that there would be a Moderate decrease in the prevalence of traditional cigarettes, followed by a Small decrease.
- For reinsurance respondents, in the long-term, the most common response was a Small decrease followed by a Moderate decrease.

18. Provide your opinion on whether Accelerated Underwriting programs will impact overall insured mortality (excluding any durational mortality improvement) over both the short (5-10 years) and long term (20+ years).

Impact	Short-Term (5-10 years) Impact		Long-Term (20+ years) Impact	
	#	%	#	%
Substantially lower (-10%+)	0	0%	0	0%
Moderately lower (-5-<-10%)	0	0%	1	3%
Slightly lower (1-<-5%)	1	3%	5	13%
Same (<1% in either direction)	4	10%	8	20%
Slightly higher (1-<5%)	20	50%	19	48%
Moderately higher (5-<10%)	14	35%	7	18%
Substantially higher (10%+)	1	3%	1	3%
Number of Respondents	40		40	

In both the short- and long-term, the most prevalent response (about 50%) was Accelerated Underwriting programs would have a Slightly higher impact on overall insured mortality. The next most prevalent responses differed between short- and long-term; in the short-term, 35% indicated there would be a Moderately higher impact on mortality while, in the long-term, about 20% indicated the Same or a Moderately higher impact.

These results were consistent for both U.S. and direct respondents with key differences being shown for Canadian and reinsurance respondents:

- For short-term, for both Canadian and reinsurance respondents, the most common response was the impact of Accelerated Underwriting programs would make insured mortality Moderately higher, followed by a Slightly higher impact. Further, neither Canadian nor reinsurance respondents indicated that the impact of Accelerated Underwriting programs would lower insured mortality; this compares to a small percentage indicated by overall respondents.
- For long-term, for both Canadian and reinsurance respondents, the most common response was the Same and a Moderately higher impact on insured mortality. Further, they did not believe that the impact of Accelerated Underwriting programs would lower insured mortality; this compares to a small percentage indicated by overall respondents.

Section 5: Comparison to Generational Mortality Improvement

Generational mortality improvement describes the process of bringing historical mortality experience up to the current era. For example, if an actuary has an experience study from an observation period ending several years ago, they might want to trend that experience to account for any mortality improvement from the observation period to the current projection date. This can be accomplished by:

- Updating the entire underlying mortality table by building a new mortality table which considers generational improvement, or
- Simply applying generational mortality improvement factors to the existing underlying mortality table.

The requested information in Section 5 relates to generational mortality improvement.

19. Indicate how your company's generational mortality improvement assumptions compare to its durational mortality improvement assumptions.

Response	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Lower	0	0%	0	0%	0	0%	1	6%
Same	13	57%	14	58%	11	73%	11	61%
Higher	3	13%	4	17%	0	0%	1	6%
Higher and lower, depending on cell	7	30%	6	25%	4	27%	5	28%
Number of Respondents	23		24		15		18	

Across line of business and function, the most common response was that generational mortality improvement assumptions were the Same compared to durational mortality improvement assumptions. Almost 60% of the life respondents and about 60-75% of the annuity respondents indicated this. The second most common response was that assumptions were Higher and lower, depending on cell for both life and annuity respondents, and across pricing and financial projections (25-30% of respondents).

U.S. and direct responses were consistent with the overall data. However, Canadian and reinsurance responses varied and showed no distinct trends.

20. If your company did not use generational mortality improvement, indicate why. Check all that apply.

Response	Life				Annuities			
	Pricing		Financial Projections		Pricing		Financial Projections	
Mortality table already factors in experience	3	33%	3	33%	1	17%	1	14%
Difficult to determine assumptions	2	22%	2	22%	1	17%	1	14%
Limited experience/credibility	2	22%	2	22%	1	17%	1	14%
Do not believe it to be appropriate or needed	1	11%	1	11%	2	33%	3	43%
Creates problems with illustrations	0	0%	0	0%	0	0%	0	0%
To be conservative, company does not use generational mortality improvement	0	0%	0	0%	0	0%	0	0%
Other	1	11%	1	11%	1	17%	1	14%
Number of Respondents	9		9		6		7	

Note: Results are sorted by the rank in life pricing

Of the respondents who did not use generational mortality improvement, the most common reason for life respondents was the Mortality table already factors in experience. For annuity respondents, the most common reason was Do not believe it to be appropriate or needed. Only U.S. and direct respondents answered this question.

Section 6: Sample Durational Mortality Improvement Rates

21. Using the durational mortality assumptions for your company's most prevalent life and annuity products, complete the following tables with annual durational mortality improvement rates as of the end of 2018. Express the rates as a percentage with two decimal places. For example, if the mortality improvement rate was $\frac{3}{4}$ percent, express this as ".75".

For Life and Annuities Pricing, we are looking for short- and long-term rates, however your company defines this. If there is no difference between short- and long-term rates, enter the same rate for both.

For Life Pricing, if your company uses an attained age scale, enter the rates for the gender, risk class, and attained ages shown in the table. If your company uses a select and ultimate scale, enter the ultimate rates for the gender, risk class, and attained ages shown in the table.

For Annuities Pricing, enter the rates for the gender and attained ages shown in the table.

For Financial Projections, enter the rates for Projection years 1 and 21.

The data requested was:

- Life
 - Pricing, Financial Projections
 - Short-term, Long-term
 - Male, Female
 - Best Preferred Nonsmoker, Residual Standard Nonsmoker, Best Preferred Smoker
 - Attained Ages 35, 55, 75, 95
- Annuities
 - Pricing, Financial Projections
 - Short-term, Long-term
 - Male, Female
 - Attained Ages 35, 55, 75, 95

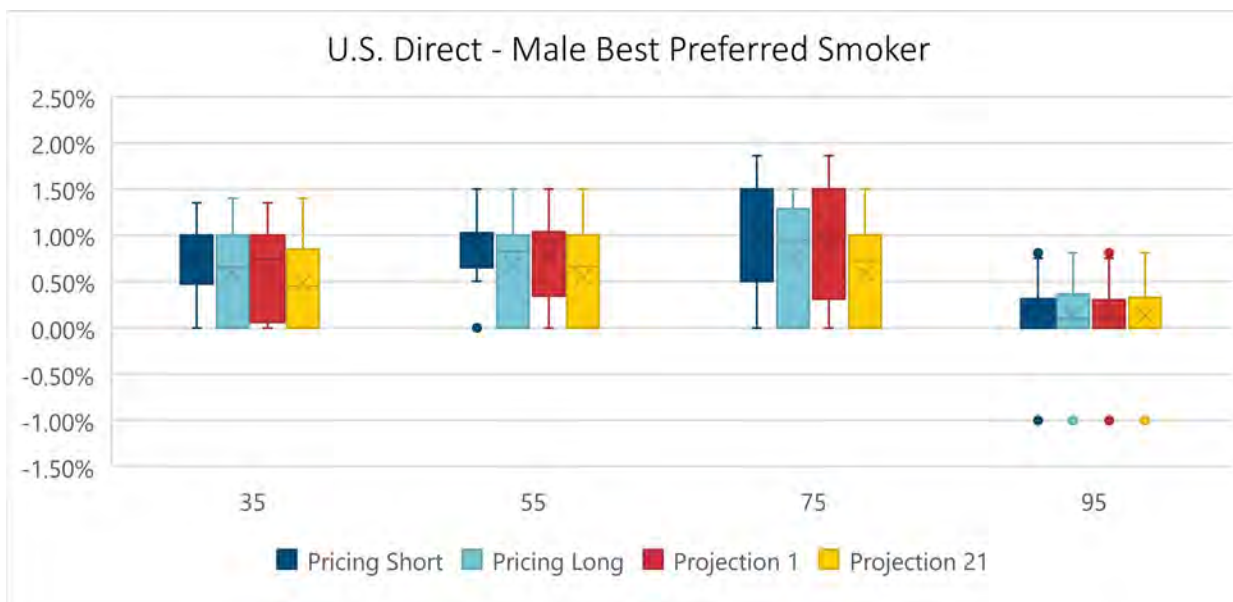
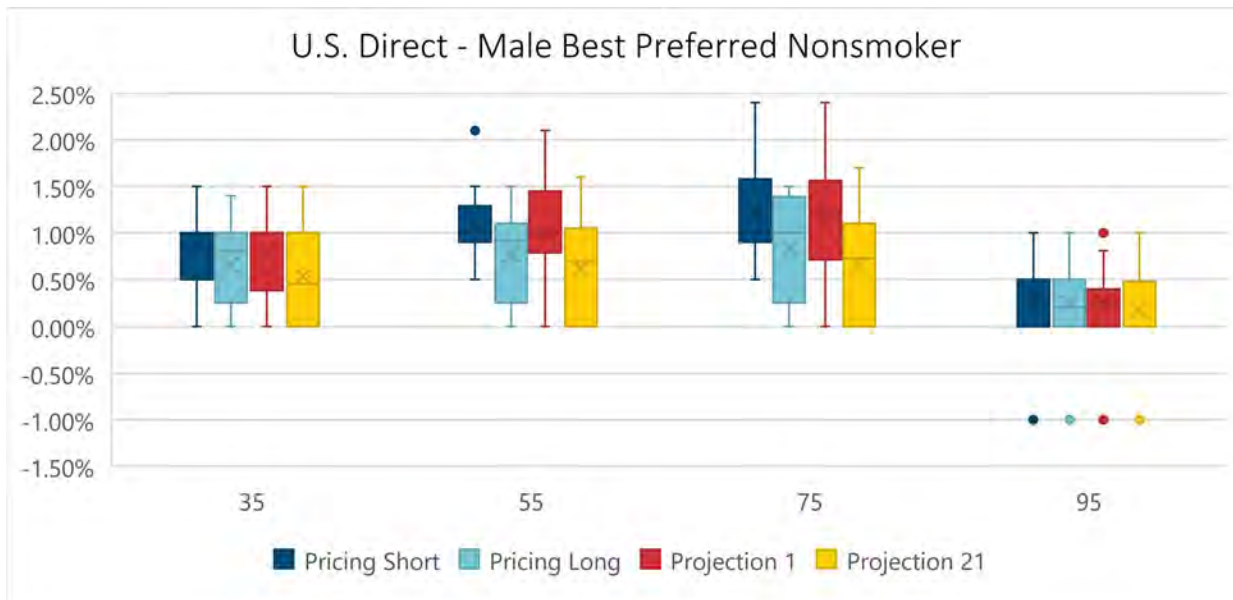
To represent this data, 'box and whisker' graphs were used. The following details an explanation of these graphs:

- X represents the average
- Lines represent maximum, median and minimum
- Boxes show from the top of the second quartile to the bottom of the third quartile.
- Dots are 'outliers' or any values that lie more than one and a half times the length of the box from either end of the box.

The following sections are split between company type, with details pertaining to line of business within each section.

The following graphs present U.S. data only as there were not sufficient responses to show Canadian data separately. Where U.S. and Canadian results differed, this has been noted in the analysis. Life results were split between direct insurers and reinsurers, and then further by gender and risk class. Annuity results were split by gender only. For all of the graphs, pricing (short- and long-term) and projection for years 1 and 21 are shown for attained ages 35, 55, 75, 95. Graphs for the residual standard risk class are shown in Appendix C.

LIFE – DIRECT COMPANIES

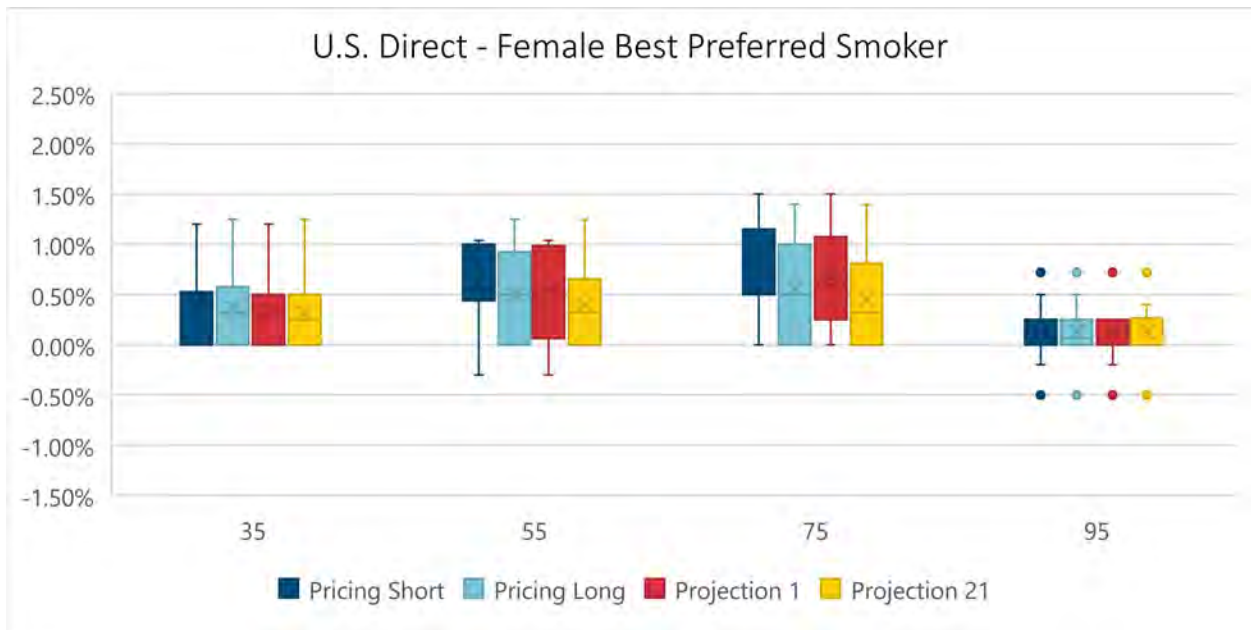
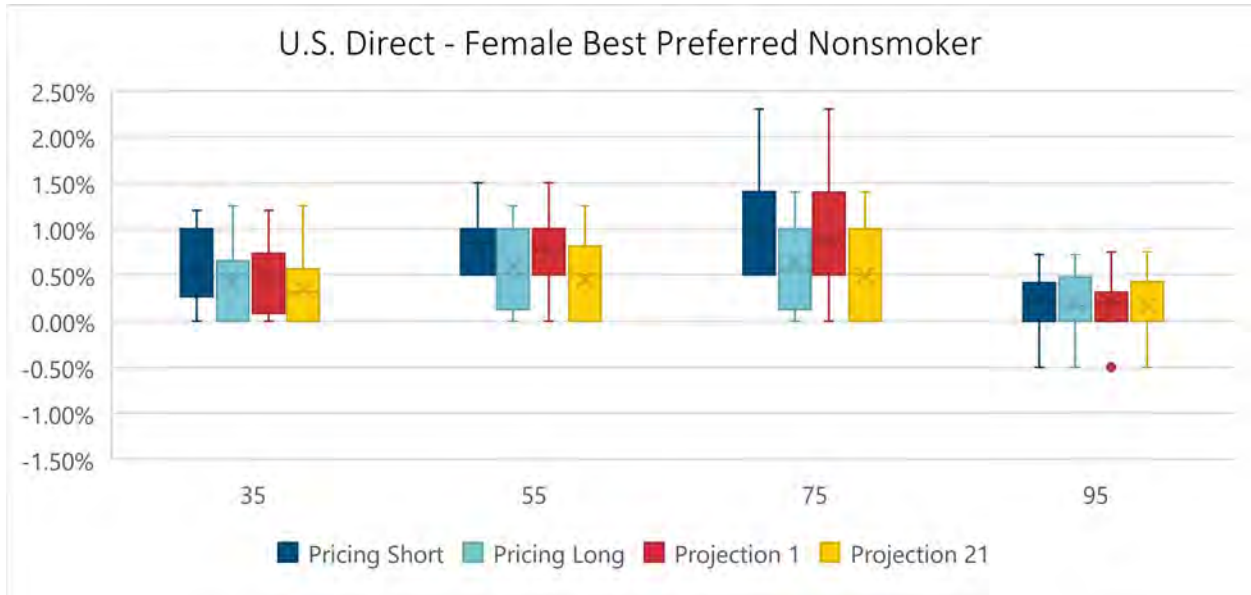


In general, short-term mortality improvement rates were higher than the longer-term rates for both pricing and financial projections, for ages 35, 55, and 75. Higher mortality improvement rates were reported for the middle ages, 55 and 75, compared to ages 35 and 95, with age 75 being the highest and age 95 the lowest.

The range of short-term mortality improvement rates were the narrowest for ages 35 and 55. Another observation is age 95 had the most outliers.

Over 75% of the respondents did not vary mortality improvement rates by risk class. For respondents who indicated a variance in mortality improvement rates:

- The differences were for long-term pricing and financial projections.
- The preferred nonsmoker risk class had the highest mortality improvement rates, followed by residual nonsmoker, and then preferred smoker.

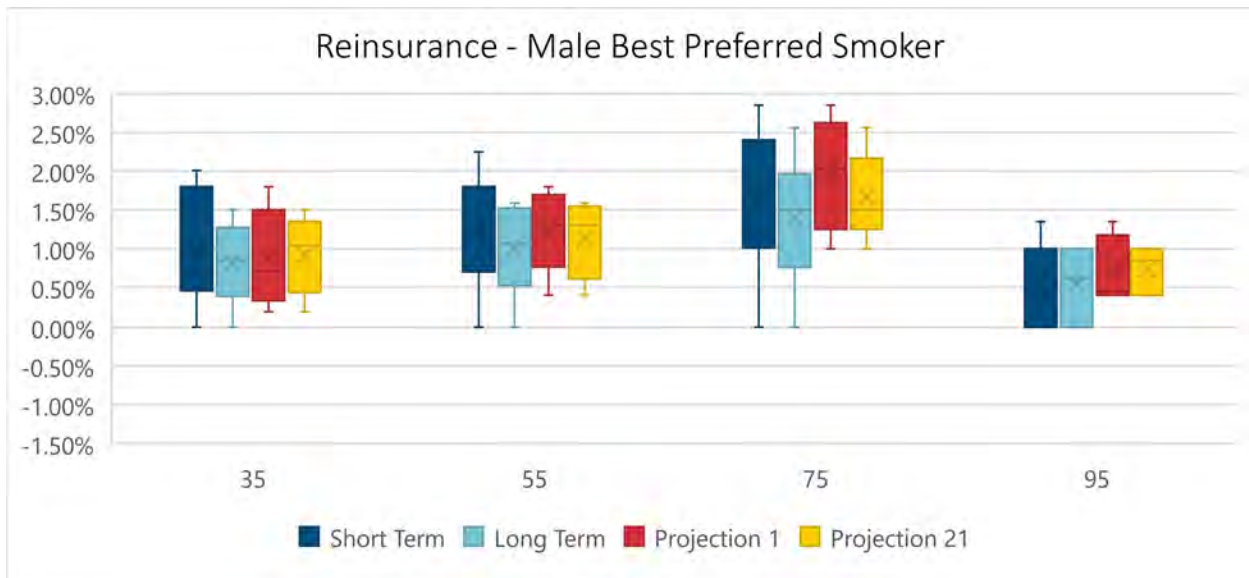
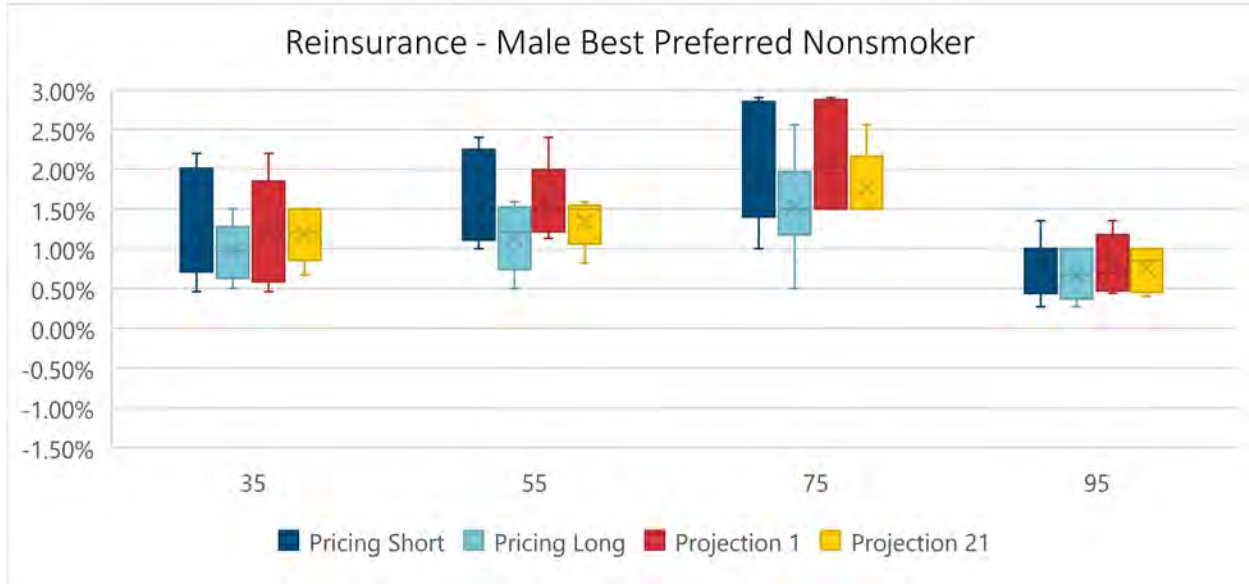


The pattern by age and short- and long-term pricing and financial projections for nonsmokers and smokers was similar between males and females. However, the female mortality improvement rates were typically lower than those for males. The difference in mortality improvement rates between males and females was highest for age 35.

There were some differences for Canadian direct companies:

- The majority of Canadian respondents did not vary mortality improvement rates by gender.
- In almost all cases, Canadian respondents generally assumed higher mortality improvement rates compared to the U.S. respondents, with the greatest difference being at ages 35 and 95. Prior surveys also noted that Canadian insurers assumed higher mortality improvement rates than their U.S. counterparts.

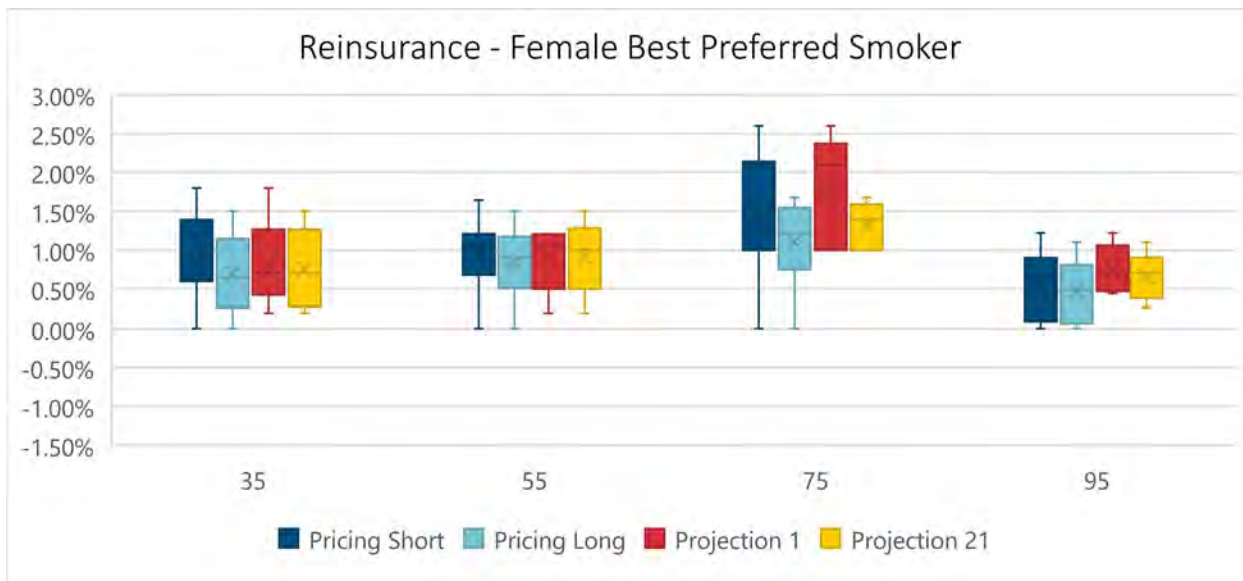
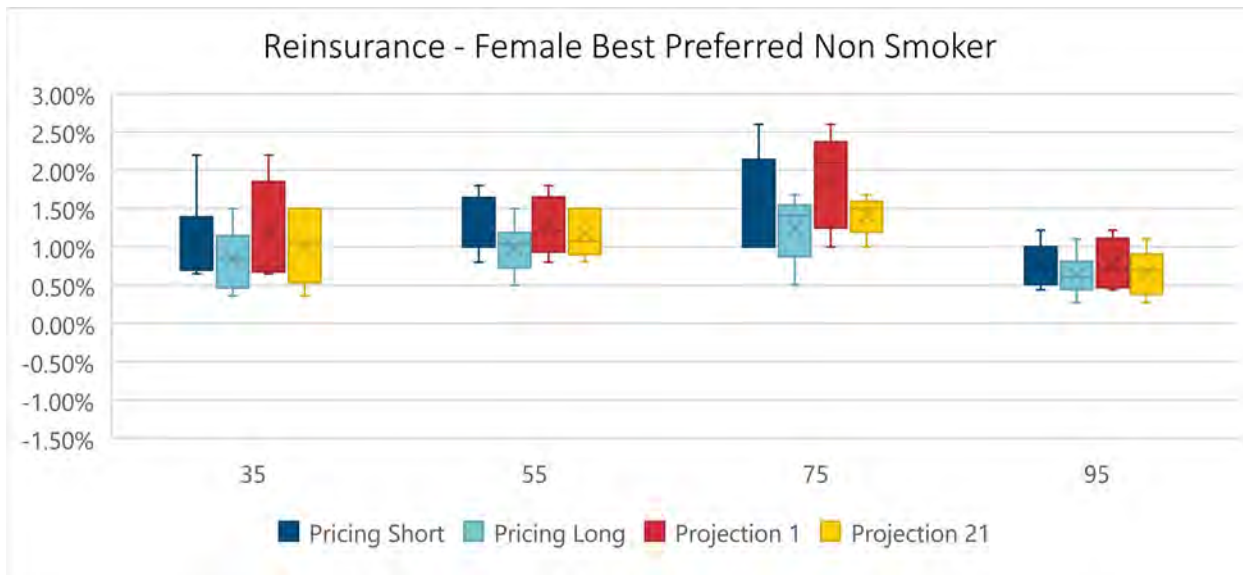
LIFE – REINSURERS



The majority (>60%) of reinsurance respondents did not vary mortality improvement rates by risk class. This compares to 75% of direct respondents.

For reinsurance respondents who did vary mortality improvement rates by risk class, they did not vary the mortality improvement rates by nonsmoker risk classes. The respondents did vary between nonsmoker and smoker risk classes and nonsmoker mortality improvement rates were higher than for smoker.

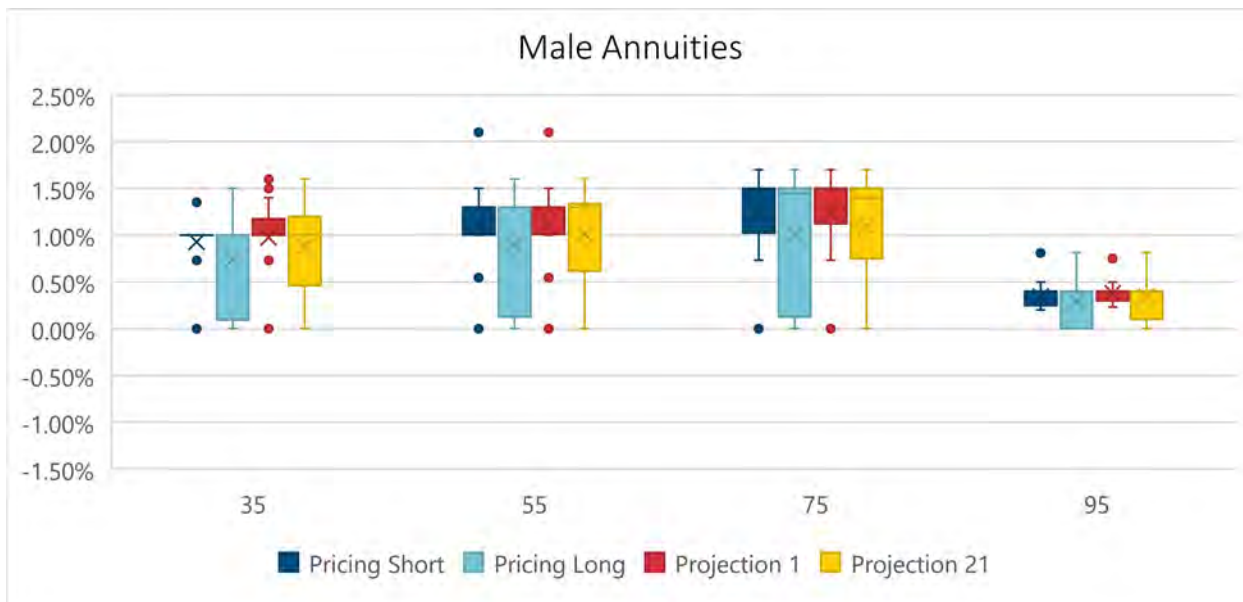
Reinsurance respondents reported higher mortality improvement rates at age 75 than at the other ages. Compared to direct respondents, mortality improvement rates for reinsurance respondents were generally higher.



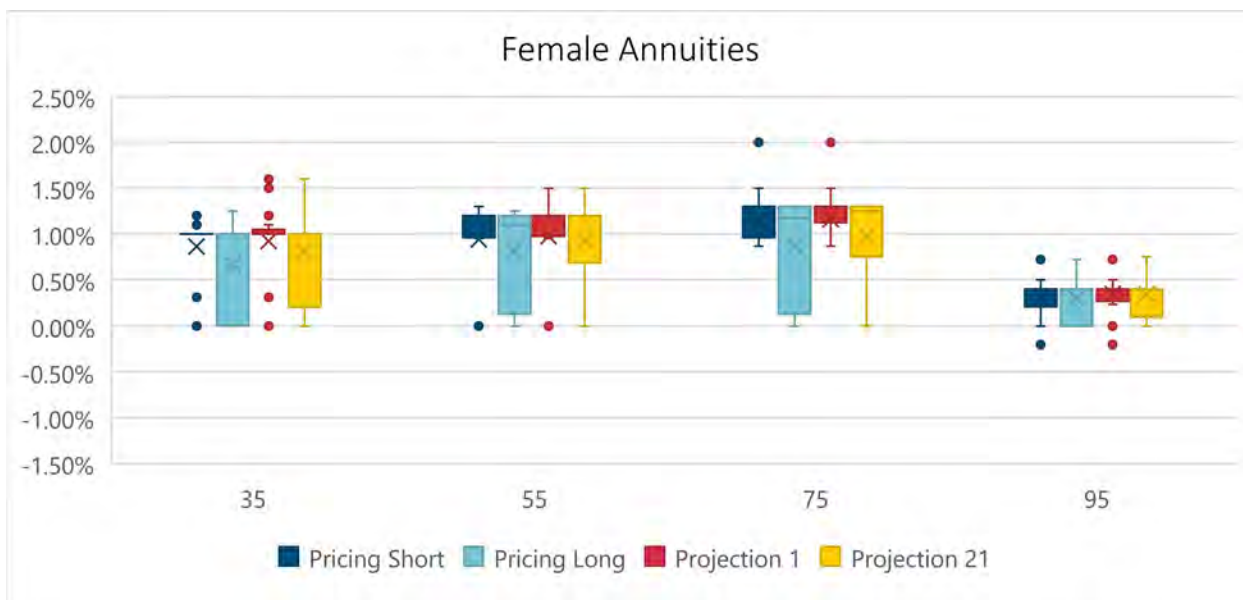
For reinsurance respondents, for all ages and risk classes, female mortality improvement rates were generally lower than for males. Similar to males, female mortality improvement rates were generally highest for age 75.

Canadian reinsurance respondents generally reported higher mortality improvement rates, for both males and females, compared to the U.S. respondents. The only exception was for financial projection year 1, where Canadian respondents assumed lower mortality improvement rates.

ANNUITIES



For annuities, male mortality improvement rates were highest at age 75 and lowest at 95. Age 75 also had the widest range of mortality improvement rates. Within each age group, pricing long-term had the widest range of mortality improvement rates.



For annuities, female mortality improvement rates were generally less than for males. For females, ages 55 and 75 generally had higher mortality improvement rates than for ages 35 and 95.

When compared to life mortality improvement rates for direct companies, annuity mortality improvement rates were generally higher.

The tables below show the average, median, and 25th and 75th percentile mortality improvement assumptions for males and females, respectively. Results were for U.S. direct companies and reinsurers combined, and include all risk classes for Life. Only U.S. companies were used to be more consistent with the graphs above. As noted above, Canadian mortality improvement rates were generally higher than those in the U.S.

Male Attained Age	Values	Life		Annuities	
		Pricing	Financial Projections	Pricing	Financial Projections
Short term for Pricing and Year 1 for Financial Projections					
35	Average	0.81%	0.74%	0.90%	0.95%
	Median	1.00%	1.00%	1.00%	1.00%
	25 th Percentile	0.50%	0.39%	0.87%	0.93%
	75 th Percentile	1.00%	1.00%	1.00%	1.09%
55	Average	1.01%	0.97%	1.10%	1.12%
	Median	1.00%	1.00%	1.30%	1.30%
	25 th Percentile	0.90%	0.75%	1.01%	1.02%
	75 th Percentile	1.13%	1.30%	1.30%	1.30%
75	Average	1.19%	1.14%	1.28%	1.29%
	Median	1.01%	1.40%	1.50%	1.50%
	25 th Percentile	0.90%	0.73%	1.05%	1.19%
	75 th Percentile	1.50%	1.50%	1.50%	1.50%
95	Average	0.30%	0.27%	0.35%	0.38%
	Median	0.26%	0.25%	0.40%	0.40%
	25 th Percentile	0.00%	0.00%	0.27%	0.30%
	75 th Percentile	0.50%	0.44%	0.40%	0.41%
Long term for Pricing and Year 21 for Financial Projections					
35	Average	0.66%	0.58%	0.73%	0.87%
	Median	0.75%	0.67%	1.00%	1.00%
	25 th Percentile	0.50%	0.00%	0.19%	0.50%
	75 th Percentile	1.00%	1.00%	1.00%	1.10%
55	Average	0.77%	0.66%	0.89%	1.00%
	Median	0.90%	0.75%	1.30%	1.30%
	25 th Percentile	0.50%	0.00%	0.25%	0.67%
	75 th Percentile	1.11%	1.20%	1.30%	1.32%
75	Average	0.89%	0.76%	1.05%	1.13%
	Median	1.00%	0.80%	1.50%	1.45%
	25 th Percentile	0.50%	0.00%	0.25%	0.88%
	75 th Percentile	1.40%	1.40%	1.50%	1.50%
95	Average	0.26%	0.23%	0.30%	0.35%
	Median	0.22%	0.02%	0.40%	0.40%
	25 th Percentile	0.00%	0.00%	0.00%	0.15%
	75 th Percentile	0.50%	0.50%	0.40%	0.40%
Number of Respondents		23	23	17	18

For males, across all four line of business/function combinations, the average mortality improvement rates for short term ranged from 0.74% to 0.95% for age 35, 0.97% to 1.12% for age 55, 1.14% to 1.29% for age 75, and 0.27% to 0.38% for age 95. In all cases, the lowest end of the range was for life projections and the highest was for annuities financial projections, both more conservative than the pricing mortality improvement rates for their respective lines of business. The averages for the long-term mortality improvement rates were lower, ranging from 0.58% to 0.87% for age 35, 0.66% to 1.00% for age 55, 0.76% to 1.13% for age 75, and 0.23% to 0.35% for age 95. Again, the average mortality improvement rate for life financial projections was lowest and annuities financial projections was highest.

Female Attained Age	Values	Life		Annuities	
		Pricing	Financial Projections	Pricing	Financial Projections
Short term for Pricing and Year 1 for Financial Projections					
35	Average	0.55%	0.48%	0.85%	0.91%
	Median	0.50%	0.50%	1.00%	1.00%
	25 th Percentile	0.30%	0.10%	0.83%	0.91%
	75 th Percentile	0.99%	0.70%	1.00%	1.03%
55	Average	0.77%	0.71%	0.95%	0.99%
	Median	0.80%	0.79%	1.20%	1.20%
	25 th Percentile	0.50%	0.50%	0.98%	0.99%
	75 th Percentile	1.00%	1.00%	1.20%	1.20%
75	Average	0.97%	0.91%	1.19%	1.21%
	Median	1.00%	1.00%	1.30%	1.30%
	25 th Percentile	0.50%	0.50%	0.98%	1.19%
	75 th Percentile	1.40%	1.39%	1.34%	1.32%
95	Average	0.25%	0.22%	0.32%	0.35%
	Median	0.23%	0.20%	0.40%	0.40%
	25 th Percentile	0.00%	0.00%	0.22%	0.28%
	75 th Percentile	0.50%	0.44%	0.40%	0.41%
Long term for Pricing and Year 21 for Financial Projections					
35	Average	0.44%	0.39%	0.65%	0.78%
	Median	0.50%	0.36%	1.00%	1.00%
	25 th Percentile	0.00%	0.00%	0.01%	0.28%
	75 th Percentile	0.67%	0.70%	1.00%	1.00%
55	Average	0.60%	0.51%	0.82%	0.94%
	Median	0.50%	0.50%	1.00%	1.20%
	25 th Percentile	0.25%	0.00%	0.25%	0.78%
	75 th Percentile	1.00%	1.00%	1.20%	1.20%
75	Average	0.69%	0.59%	0.90%	0.99%
	Median	0.60%	0.50%	1.25%	1.28%
	25 th Percentile	0.25%	0.00%	0.25%	0.88%
	75 th Percentile	1.00%	1.00%	1.30%	1.30%
95	Average	0.23%	0.22%	0.29%	0.34%
	Median	0.20%	0.02%	0.40%	0.40%
	25 th Percentile	0.00%	0.00%	0.00%	0.15%
	75 th Percentile	0.50%	0.50%	0.40%	0.40%
Number of Respondents		23	23	17	18

Females followed the same pattern as males, but the mortality improvement rates were lower.

For females, across all four line of business/function combinations, the average mortality improvement rates for short term ranged from 0.48% to 0.91% for age 35, 0.71% to 0.99% for age 55, 0.91% to 1.21% for age 75, and 0.22% to 0.35% for age 95. In all cases, the lowest end of the range was for life projections and the highest was for annuities financial projections, both more conservative than the pricing mortality improvement rates for their respective lines of business. The averages range for the long-term mortality improvement rates were lower, ranging from 0.39% to 0.78% for age 35, 0.51% to 0.94% for age 55, 0.59% to 0.99% for age 75, and 0.22% to 0.34% for age 95. Again, the average mortality improvement rate for life financial projections was lowest and annuities financial projections was highest.



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Appendix A: List of Participating Companies

American Family Life Ins Co
American National Insurance Company
Amica Life Insurance Company
Fidelity & Guaranty Life Ins Co
Gen Re
Gerber Life
ivari Canada
Jackson National Life Insurance
Kansas City Life Insurance Company
Knights of Columbus
Legal & General America
London Life Reinsurance Company
Manulife/John Hancock
MassMutual
Metlife
Munich Re U.S. Life
Munich Re Canada
Northwestern Mutual
Optimum Re (U.S.)
Optimum Re (Canada)
Oxford Life Insurance Company
Pacific Life
Pacific Life Re - Canada
Penn Mutual
Primerica (U.S.)
Primerica (Canada)
Principal Financial Group
Protective Life Insurance Group
Prudential Financial
SCOR
Securian Financial
Sun Life Financial (U.S.)
Sun Life Financial (Canada)
Talcott Resolution
The Nassau Companies of New York
Thrivent Financial
Torchmark Corp (U.S.)
Torchmark Corp (Canada)
Transamerica
United of Omaha Insurance Company
Vantis Life Insurance Company
Vantis Life Insurance Company of New York

Appendix B: Definitions

For the purposes of this survey, the following definitions were used:

Accelerated underwriting: This is used with a fully underwritten product. For applicants who meet specific company-defined guidelines, requirements such as examinations, blood, and urine could be waived. These guidelines could include predictive models or scores.

Annuities: Includes all individual immediate and deferred annuity products.

Catastrophes: Includes natural and man-made catastrophes.

Durational mortality improvement: Durational mortality improvement describes the process of projecting the current era's mortality into the future. As a cohort proceeds in time from policy year to policy year, the mortality rates applicable in each year may be lower than defined by the base mortality table selected for the project. Durational mortality improvement is a way of keeping the annual mortality rate of a cohort up-to-date by applying future trends or expectations for mortality improvement.

Financial projections: Estimates of future financial outcomes for a company. The outcomes are used to develop projections for profit and loss statements, balance sheets, and other cash flow forecasts using best estimate assumptions for mortality, lapse, and other relevant financial elements, over short- and/or long-term horizons.

Generational mortality improvement: Generational mortality improvement describes the process of bringing historical mortality experience up to the current era. For example, if an actuary has an experience study from an observation period ending several years ago, they might want to trend that experience to account for any mortality improvement from the observation period to the current projection date.

Life: Includes all individual fully underwritten term and permanent life insurance products.

Lifestyle behaviors: Includes behaviors such as diet, exercise, smoking, alcohol consumption, and drug use.

Opioids: Includes both prescribed and street drugs.

Pollution: Includes air, water, and land.

Projection models:

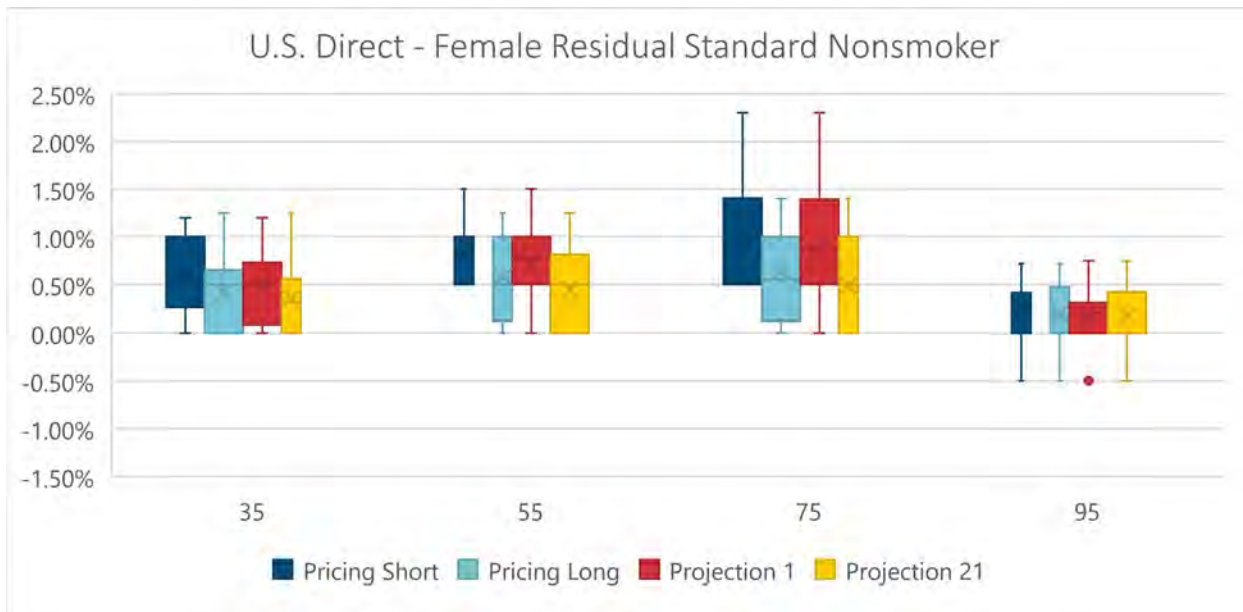
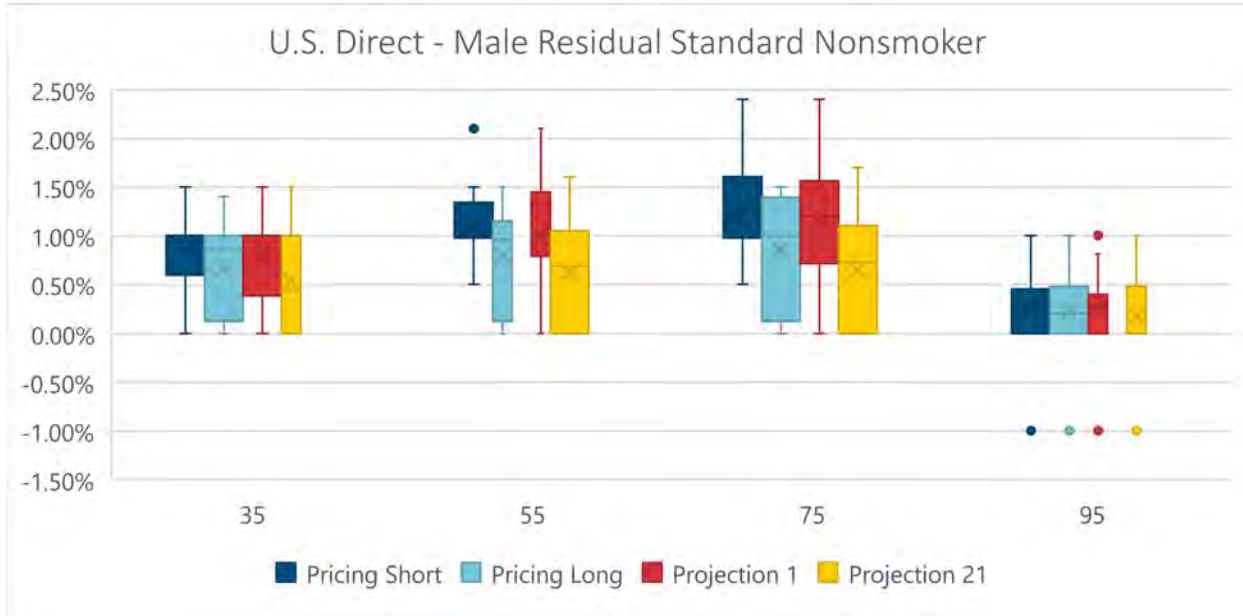
- **CIA:** Canadian Institute of Actuaries. The CIA has developed at least two projection models.
- **CMI:** Continuous Mortality Investigations. These projection models were developed in the UK and are used in a number of countries. There are at least two CMI projection models.
- **RPEC:** Retirement Plans Experience Committee of the SOA. Starting in 2014, RPEC has released annual updated mortality improvement scales, each based on the underlying RPEC_2014 model.

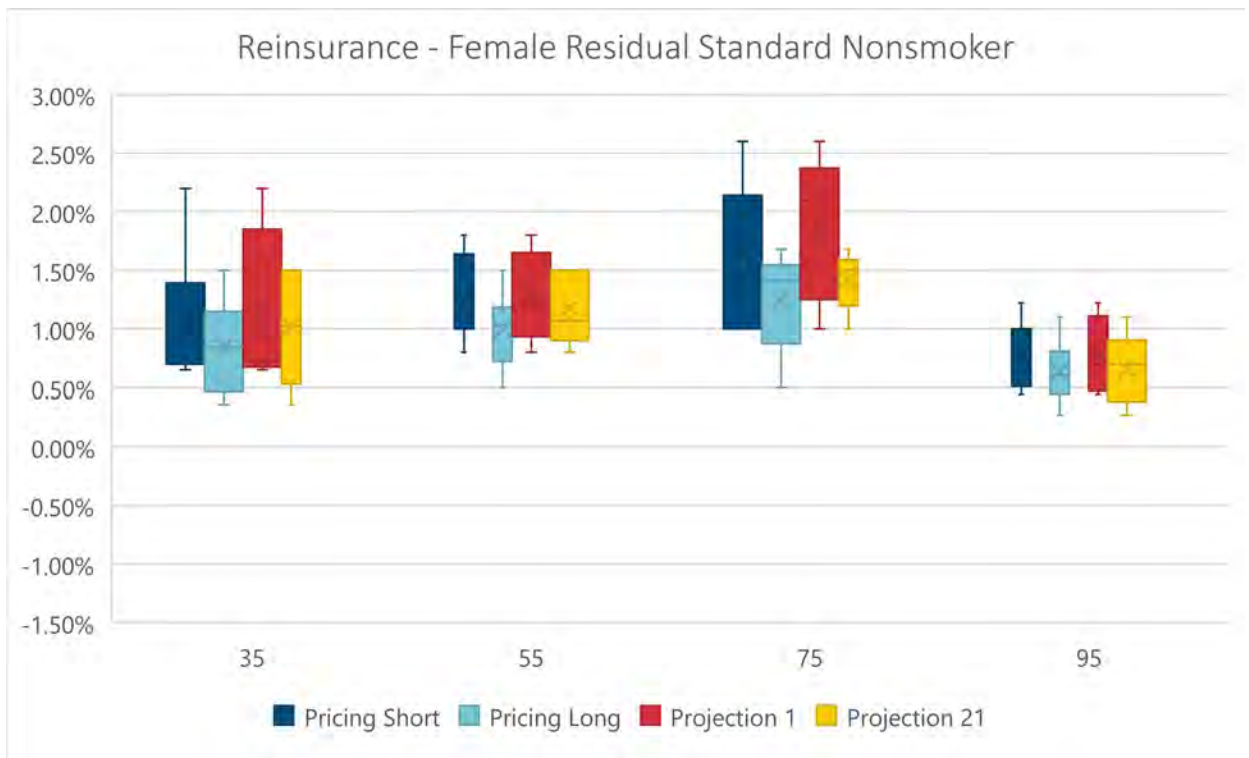
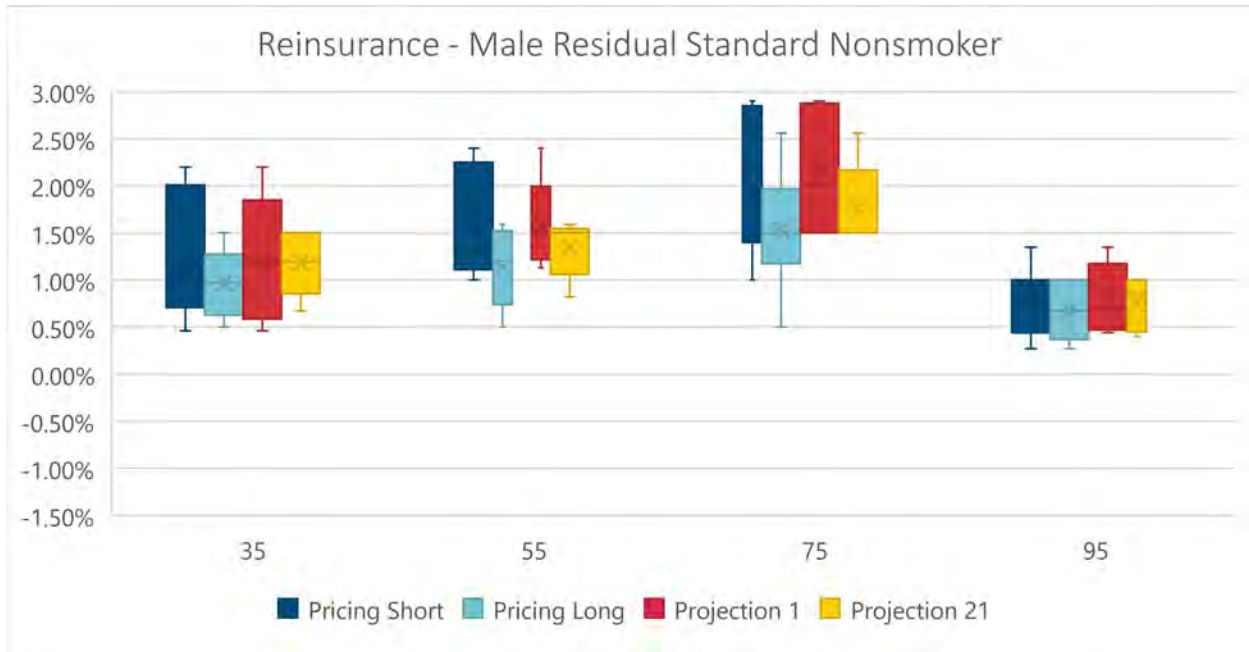
Smoking/vaping: Includes all forms and uses of tobacco, nicotine, and marijuana-based products.

Socioeconomic inequality: Includes education and income levels, access to medical care, exposure to environmental hazards, and geographical differences.

Appendix C: Additional Graphs

The following graphs show U.S. direct insurers and reinsurer data, split by males and females, for the residual standard nonsmoker risk class. Results are shown for pricing (short and long term) and projection for years 1 and 21, and for attained ages 35, 55, 75, 95.





Appendix D: Mortality Improvement Survey

Section 1 – Country and Company Information

1. Indicate for which country/company type you are answering this survey. **If you are answering this survey for more than one country or more than one company type, please complete separate surveys for each country/company type.**

	Direct Company	Reinsurer	N/A
Canada			
UK			
U.S.			

Additional Comments:

2a. Indicate the total number of policies in force at the end of 2018.

Life
Annuities

There will be a number of questions that ask for responses to both life and annuities. Respond to those questions with answers for the lines of business you have chosen above.

2b. Indicate if your company is still writing new business.

	Yes	No	N/A
Life			
Annuities			

Additional Comments:

Section 2 – Characteristics of Durational Mortality Improvement Assumptions

Durational mortality improvement describes the process of projecting the current era’s mortality into the future. As a cohort proceeds in time from policy year to policy year, the mortality rates applicable in each year may be lower than defined by the base mortality table selected for the project. Future lower mortality might be indicated by:

- Medical advances in the treatment of diseases,
- Application of research into the factors affecting the aging process, and
- Trends toward healthier lifestyles.

Durational mortality improvement is a way of keeping the annual mortality rate of a cohort up-to-date by applying future trends or expectations for mortality improvement.

The requested information in Sections 2-4 relates to durational mortality improvement.

3a. Did you use durational mortality improvement for life and annuity pricing and/or financial projections?

Yes, answer 3b for each category you use it for

No, answer 3c for each category you do not use it for

3b. Indicate by which of the following characteristics your company’s durational mortality improvement assumptions varied. Check all that apply.

	Yes	No	N/A
Attained age			
Issue age			
Duration			
Face amount			
Gender			
Product			
Smoking status			
Risk class			
Year-of-birth cohort			
Other1			
Other2			
Other3			
Did not use durational mortality improvement			

3c. Indicate why your company did not use durational mortality improvement assumptions. Check all that apply.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Did not believe it to be appropriate				
Did not believe it to be needed				
Limited experience/credibility				
To be conservative				
Difficult to determine assumptions				
Creates problems with illustrations				
Other1				
Other2				
Other3				
Used durational mortality improvement				

Additional Comments:

Section 3 – Limitations, Data, Resources, Methodologies, Validation and Review

4. Indicate your company's limits, if any, for application of durational mortality improvement rates. Express rates as an annual percentage. For example, if the maximum rate is 2½ percent, express this as "2.5." If there is no limit, indicate "N" for none.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Minimum attained age				
Maximum attained age				
Maximum number of years				
Minimum annual improvement rate				
Maximum annual improvement rate				
Other1				
Other2				
Other3				

Additional Comments:

5a. Indicate what data your company used for determining durational mortality improvement assumptions. Check all that apply.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Population data				
Industry data				
Government data				
Your company's data				
Other1				
Other2				
Other3				

5b. Indicate the primary data source(s).

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Population data				
Industry data				
Government data				
Your company's data				
Other				

Additional Comments:

6a. Indicate what resources your company used to develop the durational mortality improvement assumptions. Check all that apply.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Internal				
Consultant(s)				
Reinsurer(s)/Retrocessionaire(s)				
Other1				
Other2				
Other3				

6b. Indicate the primary resource(s).

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Internal				
Consultant(s)				
Reinsurer(s)/Retrocessionaire(s)				
Other				

Additional Comments:

7a. Indicate the internal resources who were involved with developing the durational mortality improvement assumptions. Check all that apply.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Actuary(ies)				
Data scientist(s)				
Medical Director(s)				
Underwriter(s)				
Senior Officer(s)				
Committee				
Other1				
Other2				
Other3				

7b. Indicate who had the final authority to approve the durational mortality improvement assumptions. Check all that apply.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Actuary(ies)				
Data scientist(s)				
Medical Director(s)				
Underwriter(s)				
Senior Officer(s)				
Committee				
Other1				
Other2				
Other3				

Additional Comments:

8a. Indicate if your company used a standard approach to developing durational mortality improvement assumptions. Also, explain your approach in the Explanation section, as there are multiple versions of the standard approaches. If you use a projection scale developed by RPEC, which one and how do you use it? Check all that apply.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
CIA MI-2017				
CMI_2009				
CMI_2016				
RPEC				
Lee-Carter				
Other				
Did not use a standard approach				

Explanation:

8b. If your company used a variation of a standard approach above, briefly describe the variation used.

8c. If your company did not use a standard approach, briefly describe the approach used. Also, if your company used a predictive analytics and/or machine learning approach, briefly describe the approach used.

Additional Comments:

9a. General population mortality improvements have slowed in recent years. Indicate if your company was aware of this.

- Yes
- No
- Don't know

9b. If your company was aware of it and made changes to its durational mortality improvement assumptions, indicate the method used. Check all that apply.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Extrapolation of only the most recent past experience				
Decrease all durational mortality improvement assumptions				
Decrease a limited number of durational mortality improvement assumptions				
Other1				
Other2				
Other3				
Not applicable (no change was made)				

Additional Comments:

10. Indicate whether your company validates durational mortality improvement assumptions.

	Yes	No	N/A
Pricing – Life			
Pricing – Annuities			
Financial Projections – Life			
Financial Projections – Annuities			

Additional Comments:

11. Indicate how often your company reviews durational mortality improvement assumptions for possible changes.

	Every year	Over 1 year and up to 3 years	Over 3 years	As product is priced or repriced	As new population mortality data is published	As new insured mortality data is published	As needed	Other	N/A
Pricing – Life									
Pricing – Annuities									
Financial Projections – Life									
Financial Projections – Annuities									

Additional Comments:

Section 4 – Opinions on Issues Impacting Durational Mortality Improvement

We are looking for your personal opinions on the questions in this section. Feel free to seek the advice of others, but the answers to these questions may or may not reflect your company’s practices.

12. Rank what you consider to be the top 3 challenges to setting mortality improvement assumptions. Choose your top 3 for each column, with 1 as the top driver.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Availability of appropriate data				
Uncertainty in direction of future trends				
Uncertainty of magnitude of future trends				
Limited resources				
Modeling uncertainty				
Difficulty in backtesting models				
Differences in underwriting over time				
Determining age/period/cohort effects				
Other				

Additional Comments:

13. Rank what you consider to be the top 5 drivers of future mortality improvement for both short term (5-10 years) and long term (20+ years), with 1 as the top driver for each column.

	Short-Term (5-10 yrs) – Life	Short-Term (5-10 yrs) - Annuities	Long-Term (20+ yrs) – Life	Long-Term (20+ yrs) - Annuities
Advances in the understanding of aging				
Reductions in mortality from Alzheimer’s disease				
Artificial intelligence/Augmented reality				
Reductions in mortality from cancer				
Reductions in mortality from cardiovascular disease				
Fitness tracking				
Advances in understanding of genetics				
Changes in government programs/policy				
Access to health care/medical care				
Improvements in health care/medical care				
Healthier lifestyle behaviors				
Medical advances				
Precision medicine				
Self-driving cars				
Reduction in socioeconomic differences				
Reduction in levels of stress leading to improved mortality				
Technological advances				
Advances in underwriting methodologies				
Other1				
Other2				
Other3				

Additional Comments:

14. Rank what you consider to be the top 5 drivers of future mortality deterioration for both short term (5-10 years) and long term (20+ years), with 1 as the top driver for each column.

	Short-Term (5-10 yrs) – Life	Short-Term (5-10 yrs) - Annuities	Long-Term (20+ yrs) – Life	Long-Term (20+ yrs) - Annuities
Accidents				
Opioids				
Antibiotic resistant organisms				
Catastrophes				
Chemicals and hormones in the environment				
Pollution				
Cardiovascular disease				
Cancer				
Diabetes				
Epidemics/Pandemics				
Changes in government programs/policy				
Homicides				
Lifestyle behaviors				
Medical errors				
Mental health/depression				
Alzheimer’s/dementia				
Obesity				
Stress				
Self-driving cars				
Smoking/Vaping				
Suicides				
Socioeconomic inequality				
Technological changes				
Terrorist attacks				
Other1				
Other2				
Other3				

Additional Comments:

15. General population mortality improvements have slowed in recent years. Indicate if you believe this trend will reverse or continue into the future.

	Reverse	Continue
Short-Term (5-10 yrs)		
Long-Term (20+ yrs)		

Additional Comments:

16. Indicate if you believe there will be improvement or deterioration in cardiovascular and cancer mortality in the near (5-10 years) and long (20+ years) term.

	Large deterioration	Moderate deterioration	Small deterioration	No improvement or deterioration	Small improvement	Moderate improvement	Large improvement
Short-Term (5-10 yrs) – Cardiovascular							
Short-Term (5-10 yrs) – Cancer							
Long-Term (20+ yrs) – Cardiovascular							
Long-Term (20+ yrs) - Cancer							

Additional Comments:

17a. Provide your opinion on the following issues related to how changes in smoking habits will impact durational mortality improvement. The purpose of this question is to capture various elements related to smoking habits with the intention of combining the answers to develop a composite view on durational mortality improvement related to smoking. Indicate whether you believe that e-cigarettes or traditional cigarettes will have a higher mortality rate, all other parameters being equal.

E-cigarettes and traditional cigarettes are about the same

E-cigarettes are slightly higher

E-cigarettes are substantially higher

Traditional cigarettes are slightly higher

Traditional cigarettes are substantially higher

17b. Compared to today, indicate what you believe the prevalence of e-cigarettes will be over both the short term (5-10 years) and long term (20+ years).

	Large decrease	Moderate decrease	Small decrease	No change	Small increase	Moderate increase	Large increase
Short-Term (5-10 yrs)							
Long-Term (20+ yrs)							

17c. Compared to today, indicate what you believe the prevalence of traditional cigarettes will be over both short term (5-10 years) and long term (20+ years).

	Large decrease	Moderate decrease	Small decrease	No change	Small increase	Moderate increase	Large increase
Short-Term (5-10 yrs)							
Long-Term (20+ yrs)							

Additional Comments:

18. Provide your opinion on whether Accelerated Underwriting programs will impact overall insured mortality (excluding any durational mortality improvement) over both the short (5-10 years) and long term (20+ years).

	Substantially lower (10%+)	Moderately lower (5- <10%)	Slightly lower (1-<5%)	Same (<1% in either direction)	Slightly higher (1-<5%)	Moderately higher (5- <10%)	Substantially higher (10%+)
Short-Term (5-10 yrs)							
Long-Term (20+ yrs)							

Additional Comments:

Section 5 – Comparison to Generational Mortality Improvement

Generational mortality improvement describes the process of bringing historical mortality experience up to the current era. For example, if an actuary has an experience study from an observation period ending several years ago, they might want to trend that experience to account for any mortality improvement from the observation period to the current projection date. This can be accomplished by:

- Updating the entire underlying mortality table by building a new mortality table which considers generational improvement, or
- Simply applying generational mortality improvement factors to the existing underlying mortality table.

The requested information in Section 5 relates to generational mortality improvement.

19. Indicate how your company's generational mortality improvement assumptions compare to its durational mortality improvement assumptions.

	Same	Higher	Lower	Higher and lower, depending on cell	Did not use generational mortality improvement	N/A
Pricing – Life						
Pricing – Annuities						
Financial Projections – Life						
Financial Projections – Annuities						

Additional Comments:

20. If your company did not use generational mortality improvement, indicate why. Check all that apply.

	Pricing - Life	Pricing - Annuities	Financial Projections – Life	Financial Projections - Annuities
Do not believe it to be appropriate or needed				
Mortality table already factors in experience				
Limited experience/credibility				
To be conservative, company does not use generational mortality improvement				
Difficult to determine assumptions				
Creates problems with illustrations				
Other1				
Other2				
Other3				
Not applicable - use generational mortality improvement.				

Additional Comments:

Section 6 – Sample Durational Mortality Improvement Rates

21. Using the durational mortality assumptions for your company’s most prevalent life and annuity products, complete the following tables with annual durational mortality improvement rates as of the end of 2018. Express the rates as a percentage with two decimal places. For example, if the mortality improvement rate was $\frac{3}{4}$ percent, express this as “.75”.

For Life and Annuities Pricing, we are looking for short- and long-term rates, however your company defines this. If there is no difference between short- and long-term rates, enter the same rate for both.

For Life Pricing, if your company uses an attained age scale, enter the rates for the gender, risk class, and attained ages shown in the table. If your company uses a select and ultimate scale, enter the ultimate rates for the gender, risk class, and attained ages shown in the table.

For Annuities Pricing, enter the rates for the gender and attained ages shown in the table.

For Financial Projections, enter the rates for Projection years 1 and 21.

Male, Best preferred nonsmoker risk class

	Life – Pricing – Short-Term	Life - Pricing - Long-Term	Life - Financial Projections - Year 1	Life - Financial Projections - Year 21
Attained age 35				
Attained age 55				
Attained age 75				
Attained age 95				

Male, Residual standard nonsmoker risk class

	Life – Pricing – Short-Term	Life - Pricing - Long-Term	Life - Financial Projections - Year 1	Life - Financial Projections - Year 21
Attained age 35				
Attained age 55				
Attained age 75				
Attained age 95				

Male, Best preferred smoker risk class

	Life – Pricing – Short-Term	Life - Pricing - Long-Term	Life - Financial Projections - Year 1	Life - Financial Projections - Year 21
Attained age 35				
Attained age 55				
Attained age 75				
Attained age 95				

Female, Best preferred nonsmoker risk class

	Life – Pricing – Short-Term	Life - Pricing - Long-Term	Life - Financial Projections - Year 1	Life - Financial Projections - Year 21
Attained age 35				
Attained age 55				
Attained age 75				
Attained age 95				

Female, Residual standard nonsmoker risk class

	Life – Pricing – Short-Term	Life - Pricing - Long-Term	Life - Financial Projections - Year 1	Life - Financial Projections - Year 21
Attained age 35				
Attained age 55				
Attained age 75				
Attained age 95				

Female, Best preferred smoker risk class

	Life – Pricing – Short-Term	Life - Pricing - Long-Term	Life - Financial Projections - Year 1	Life - Financial Projections - Year 21
Attained age 35				
Attained age 55				
Attained age 75				
Attained age 95				

Male

	Life – Pricing – Short-Term	Life - Pricing - Long-Term	Life - Financial Projections - Year 1	Life - Financial Projections - Year 21
Attained age 35				
Attained age 55				
Attained age 75				
Attained age 95				

Female

	Life – Pricing – Short-Term	Life - Pricing - Long-Term	Life - Financial Projections - Year 1	Life - Financial Projections - Year 21
Attained age 35				
Attained age 55				
Attained age 75				
Attained age 95				

Additional Comments:

About The Society of Actuaries Research Institute

Serving as the research arm of the Society of Actuaries (SOA), the SOA Research Institute provides objective, data-driven research bringing together tried and true practices and future-focused approaches to address societal challenges and your business needs. The Institute provides trusted knowledge, extensive experience and new technologies to help effectively identify, predict and manage risks.

Representing the thousands of actuaries who help conduct critical research, the SOA Research Institute provides clarity and solutions on risks and societal challenges. The Institute connects actuaries, academics, employers, the insurance industry, regulators, research partners, foundations and research institutions, sponsors and non-governmental organizations, building an effective network which provides support, knowledge and expertise regarding the management of risk to benefit the industry and the public.

Managed by experienced actuaries and research experts from a broad range of industries, the SOA Research Institute creates, funds, develops and distributes research to elevate actuaries as leaders in measuring and managing risk. These efforts include studies, essay collections, webcasts, research papers, survey reports, and original research on topics impacting society.

Harnessing its peer-reviewed research, leading-edge technologies, new data tools and innovative practices, the Institute seeks to understand the underlying causes of risk and the possible outcomes. The Institute develops objective research spanning a variety of topics with its [strategic research programs](#): aging and retirement; actuarial innovation and technology; mortality and longevity; diversity, equity and inclusion; health care cost trends; and catastrophe and climate risk. The Institute has a large volume of [topical research available](#), including an expanding collection of international and market-specific research, experience studies, models and timely research.

Society of Actuaries Research Institute
475 N. Martingale Road, Suite 600
Schaumburg, Illinois 60173
www.SOA.org