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SPECIAL REPORT

Pricing Implications of Trends in Population Mortality and Underwriting Effectiveness

Robert J. Pokorski, MD, MBA

Pricing actuaries try to anticipate insured lives mortality rates for decades into the future by considering historic relationships between population and insured lives mortality and trends in population mortality. The degree to which underwriting might decrease insured lives mortality relative to population mortality is of particular importance. A comparison of trends in population and insured mortality is presented to illustrate historic relationships. Two theories for future life expectancy trends are: 1) no foreseeable limit to life expectancy, and 2) life expectancy limited by biological forces. Factors that may increase or decrease the future effectiveness of underwriting are reviewed.

Address: Gen Re LifeHealth Financial Centre, P.O. Box 300, 695 East Main Street, Stamford, CT 06904-0300; e-mail: pokorski@genre.com.

Correspondent: Robert J. Pokorski, MD, MBA; Vice President, Worldwide Medical Research & Development.

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Pricing actuaries try to anticipate insured lives mortality rates for decades in the future. This article will address three important considerations in this process: (1) historic relationships between population and insured lives mortality, (2) trends in population mortality and (3) estimating insured lives mortality, specifically, the degree to which underwriting might decrease insured lives mortality relative to population mortality.

HISTORIC RELATIONSHIPS BETWEEN POPULATION AND INSURED LIVES MORTALITY

Figures 1 and 2 display the ratio of select* to population mortality rates for US males age 35 and 65 at underwriting, respectively, for 1970, 1980 and 1990. Ratios for 1970 represent relationships in the era of ''traditional'' underwriting (physician's exam, physician's statement, urine sample, query of the Medical Information Bureau, and an ECG for larger cases); ratios for 1980 reflect greater underwriting sophistication due to use of cardiovascular risk factors (cholesterol, blood pressure, family history, and smoking status); and ratios for 1990 illustrate still greater sophistication with the advent of preferred underwriting (full-blood profiles for relatively small policy amounts; cotinine, cocaine, and HIV testing; alcohol markers in some cases; and motor vehicle reports to identify applicants with unfavorable driving records).

Given the greater amount and sophistication of underwriting data collected in 1980 and 1990, it might be expected that the decrease in select mortality would exceed the

* Select mortality refers to insured lives mortality that includes the effect of risk ''selection,'' ie, underwriting.

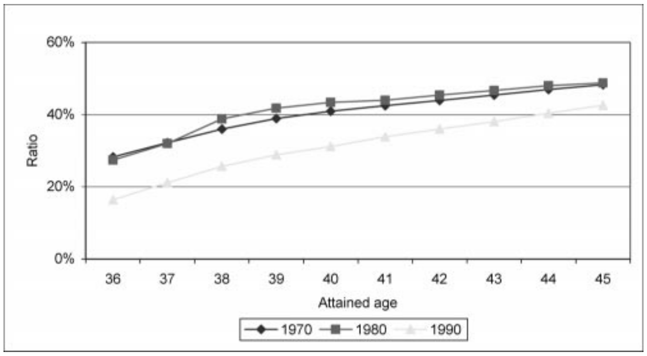

Figure 1. *Ratio of select/population mortality rates, males, issue-age 35. Data sources: SOA Basic Mortality Tables (65–70, 75–80, 85–90, 90–95), US Population Mortality Tables (1970, 1980, 1990).*

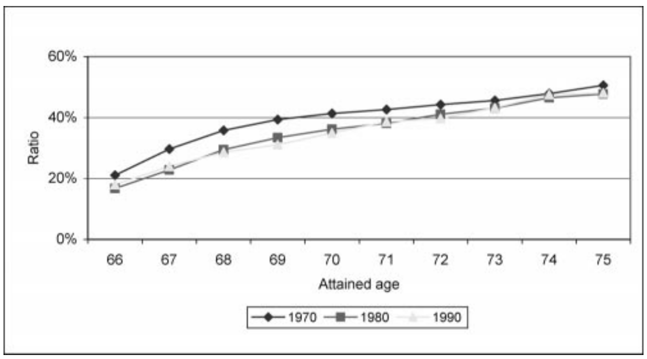

Figure 2. *Ratio of select/population mortality rates, males, issue-age 65. Data sources: SOA Basic Mortality Tables (65–70, 75–80, 85–90, 90–95), US Population Mortality Tables (1970, 1980, 1990).*

decrease in population mortality that occurred during this time, ie, the ratio of select to population mortality would progressively decrease relative to the 1970 ratios. However, the results are mixed.

Age 35 at Underwriting

- 1980—Select to population mortality ratios increased, indicating that improvement in insured lives mortality was less than improvement in population mortality despite acquisition of more underwriting data. A possible explanation is overly aggressive underwriting and pricing.
- 1990—As expected, select to population mortality ratios decreased. The improvement was not solely related to underwriting; AIDS dampened potential improvement in population mortality at young ages.

Age 65 at Underwriting

- 1980—As expected, select to population mortality ratios decreased, but the magnitude of the decrease was relatively small.
- 1990—No significant change from 1980, indicating that acquisition of more underwriting data merely allowed insured lives mortality to match the improvement in population mortality.

The implication is that more underwriting data does not guarantee that improvement in insured lives mortality will exceed improvement in population mortality. For example, insured lives mortality would not be expected to improve relative to population mortality if competition led to overly aggressive underwriting and/or pricing decisions. And, it may be that there are limitations in the ability of underwriting to increase the gap between insured lives and population mortality, particularly if population mortality rates are already low in the socioeconomic group targeted by the insurer (sophisticated underwriting information may merely confirm that risk is low).

TRENDS IN POPULATION MORTALITY

There are two theories for the future of life expectancy (LE): no foreseeable limit to LE, and LE limited by biological forces.

No Foreseeable Limit to Life Expectancy

Advocates of this position cite the statistic that female LE has risen for 160 years at a steady pace of almost 3 months per year from 1840 (Swedish women with a LE of 45 years) to 2002 (Japanese women with a LE of almost 85 years) due to advances in public health, sanitation, nutrition, education, income, and medicine.[1] Before 1950, most of the gain in LE was due to large reductions in mortality rates at younger ages; in the second half of the 20th century, improvements in survival after age 65 propelled the rise in LE. As an example of the degree of improvement, the chance of a 65-year-old Japanese female surviving to 100 soared from less than 1 in 1000 (1950) to 1 in 20 (2002). Accordingly to this line of reasoning, predictions that LE is approaching a ceiling have repeatedly been proven wrong and significant improvements in LE can be expected, although the rate of change is uncertain.

Life Expectancy Limited by Biological Forces

The second theory is that there are inherent limitations to LE due to biological forces.[2,3] This position emphasizes the distinction between aging and age-related diseases: aging is the accumulation of damage to the building blocks of life, whereas age-related diseases are disorders such as heart disease, cancer, stroke, and Alzheimer's disease. Medical interventions target disease processes but have no effect on aging, the result being that there are limits to improvements in LE that could be achieved by preventing or delaying age-related deaths. For example, estimates are that eliminating all Alzheimer's disease deaths would increase LE by only 19 days, and eliminating the 3 leading causes of death at old age (ie, cardiovascular disease, stroke, and cancer) would increase LE by only 15 years.[3] Thus, LE would be limited even under ideal circumstances, such as favorable environment, optimal medical care, and population-wide adoption of healthy habits. These ''ideal circumstances'' are becoming less likely due to environmental issues, difficulty funding public health systems, and the worldwide epidemic of obesity, diabetes mellitus and cardiovascular disease.

Mathematical explanations are also used to support the theory that there are inherent limitations to LE.[2] As LE at birth rises, it becomes less sensitive to changes in mortality rates, a phenomenon known as ''entropy.'' For example, when LE at birth is 50, it takes an estimated 4.1% reduction in total mortality at every age to raise LE 1 year. By contrast, raising LE from 80 to 81 years requires a 9.1% reduction in total mortality at every age. Thus, as LE at birth reaches the 80s, entropy in the life table means that small gains in LE require progressively larger reductions in mortality. Even larger reductions in current levels of total mortality would be required for LE to reach and exceed 85 years. In the United States, 1995 mortality rates would have to decline by more than 50% at every age to reach a LE of 85 (from 1995 levels of 79.0 for females and 72.4 years for males). For the longest-lived subgroup in the world (Japanese women), total mortality at every age would have to drop by 20% to raise LE by 2 years from its current 83 years. Although females in France have enjoyed a LE at birth that has exceeded 80 years since 1987, their 1995 mortality rates would have to decline by more than 26% at every age in order to achieve a LE of 85 years. Eighty-five percent reductions in current levels of total mortality at every age would be required to reach a LE at birth of 100 years in long-lived populations like those of Japan and France. Table 1 shows the year in which LE would reach 85 and 100 in France, Japan and the United States if trends in mortality improvement from 1985–1995 continue in the future.

Table 1. Projected Year When Life Expectancy Would Reach 85 and 100 Years Based on Trends in Mortality Improvement From 1985 to 1995[2]

	85 Years	100 Years
France		
Females	2014	2106
Males	2052	2138
Japan		
Females	2010	2118
Males	2060	2182
United States		
Females	2125	2485
Males	2239	2577

A final argument for inherent limitations to LE was made in a 2002 position paper signed by 52 top aging researchers.[4] Rather than extolling decades of mortality improvement, the authors observed that ''It is almost certainly true that, at least since recorded history, people could have lived as long as those alive today if similar technologies, lifestyles and population sizes had been present.'' Their contention is that medical and public health advances have not affected the aging process but have merely allowed people to reach a LE that has been attainable for thousands of years. The researchers noted that aging (vis-à-vis age-related diseases) is not affected by lifestyle, surgery, vitamins, antioxidants, drugs, hormones, genetic engineering, magnets, light therapy, yoga, telomere manipulation, or caloric restriction (no study has proven caloric restriction will work in humans). With regard to predictive tests and prevention, they stated that ''Any claim that a person's biological or 'real age' can currently be measured, let alone modified, by any means must be regarded as entertainment, not science.''[4]

Credible Estimate of Improvement in Population Mortality

Pricing actuaries generally assume that historic trends in population mortality will continue. One estimate of the degree of improvement was offered at a 2001 Society of Actuaries longevity meeting by aging expert Dr. Jay Olshansky, who suggested that population mortality would decrease about 1% per year for the foreseeable future.[5] This estimate assumes no significant disruptions in mortality trends. Though unlikely, the probability of slower rates of improvement or even deterioration in mortality is not zero. Listed below are events that could cause major disruptions in population mortality:

- Antibiotic resistance, followed by a resurgence of infectious and parasitic diseases that were responsible for much of the mortality early in the 20th century
- New infectious diseases, such as virulent strains of influenza or pandemics (eg, a new AIDS-like disease that affects much of the insurance buying populace)
- War and terrorism
- Pollution
- Natural disasters, eg, earthquakes, asteroids, and hurricanes (a category 4 or 5 hurricane that struck the city of New Orleans in the United States could cause 100,000 deaths[6])
- Decline in the quality of public health systems or in the percentage of people with health insurance, leading to a broad-based deterioration in mortality
- Changing patterns of disease, eg, the obesity pandemic is spawning a diabetes pandemic which could mitigate expected improvements in cardiovascular mortality

ESTIMATING INSURED LIVES MORTALITY

Effectiveness of Underwriting

Insured lives mortality is less than population mortality because of underwriting and other basic elements of policy design that limit adverse selection. For pricing actuaries, the question is ''How effective will underwriting be in the future?'' Inherent in this question is acknowledgment that the degree to which underwriting might decrease insured lives mortality relative to population mortality depends on government policy, social mores, insurer practices, and tests used for risk classification.

One possibility is that improved underwriting might increase the gap between population and insured lives mortality rates. This situation could occur because of major improvements in the predictive ability of cardiovascular risk factors, tumor markers, or tests for biological age. However, there are no tests on the horizon that have the potential to effect such a major improvement in insured lives mortality.

The other possibility—which may be even more likely because of consumer activism, greater willingness of the government to regulate risk classification practices, and intense industry competition—is that underwriting might be less effective, and the gap between population and insured lives mortality rates could decrease. Factors that could lead to a relative decrease in the impact of underwriting include:

- Consumer demands for greater privacy, with reduced ability to access underwriting data from all sources
- Government restrictions on factors used to classify risks, such as prohibiting use of family history or genetic information
- Competitive pressures to speed the issue of new policies, raise testing limits, and reduce data acquisition costs, resulting in fewer underwriting requirements and increased mortality
- The industry trend to a less experienced underwriting workforce

If underwriting becomes less effective in the future, relative improvement in insured lives mortality could merely match or possibly even lag behind improvement in population mortality. In this instance, pricing actuaries would use trends in population mortality as an indicator of likely improvement in insured lives mortality. For example, if estimates were that population mortality rate would decrease about 1% per year, similar (or in some cases, even lower) estimates might be made for insured lives mortality rates.

Socioeconomic Class

Another issue to consider is the effect of socioeconomic class. Mortality improvements are generally greater for higher socioeconomic classes (often targeted by insurers), and insured lives mortality rates would improve for this reason alone even if no underwriting were done (eg, improvement in mortality rates for non-underwritten annuity products). Demographic (J. Vaupel, personal communication, November 2002) and aging (S.J. Olshansky, personal communication November 2002) experts suggest that mortality improvement for higher socioeconomic groups will either equal or slightly exceed rates projected for the entire population. Regardless of the theoretical relationship between socioeconomic class and insured lives mortality, Figures 1 and 2 indicate that insured lives mortality rates have not shown continuous improvement relative to population mortality rates, even though the socioeconomic status of insured lives improved during this time. For some periods, relative improvement in insured lives mortality simply matched (Figure 2, 1990 compared to 1980) or even lagged behind (Figure 1, 1980 compared to 1970) improvement in population mortality.

CONCLUSIONS

There are conflicting opinions regarding the future of LE, but the more persuasive argument is that LE is limited by biological forces. Unless the aging process itself can be brought under control, mortality trends from 1985 to 1995 imply that future gains in LE will be measured in days or months rather than years. LE could actually decline for some populations because of the re-emergence of infectious diseases, social and political unrest, or natural disasters.[2]

For countries that have already achieved a high LE, population mortality might decrease about 1% per year for the foreseeable future.

More detailed underwriting data does not guarantee that improvement in insured lives mortality will exceed improvement in population mortality, particularly in the context of overly aggressive underwriting and/or pricing, and if population mortality rates are already low in the socioeconomic group targeted by the insurer.

The effectiveness of underwriting could increase or decrease in the future depending on privacy issues, government policy, insurer practices, and tests used for risk classification. If underwriting becomes less effective, relative improvement in insured lives mortality could merely match or possibly even lag behind improvement in population mortality.

Enhanced socioeconomic status per se does not necessarily result in improved insured lives mortality relative to what occurs in the general population. Other factors, especially underwriting, play an important role.

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