**Assurances**

# The new mortality tables of the Canadian Institute of Actuaries

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Aller au sommaire du numéro

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Résumé de l'article

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# The new mortality tables of the Canadian Institute of Actuaries

*by*

COLIN E. JACK [1]

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1. The Canadian Institute of Actuaries has recently published new mortality tables for individually insured lives. These tables are known as the CIA 1969-75 (Male) Table and the CIA 1969-75 (Female) Table. As their names indicate they are based on the experience from policy anniversaries in 1969 to those in 1975.

2. The tables are the work of the Mortality Committee of the Institute which, in addition to preparing complete tables from time to time, makes an annual report which compares the most recent information available with the last published table.

3. Twenty-three insurance companies contributed the data concerning business in force and deaths recorded on

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which the new tables are based. Most of these companies do business in Canada and elsewhere but only their Canadian data was used in constructing the tables.

4. While one very large company contributed approximately 20% of the data some contributed less than 1%. Companies generally are glad to contribute to this very useful work, which is of great value to the life insurance industry, but many, particularly small ones, do not have data in form readily adapted to the computer programmes of the Committee.

5. The male table is based on the experience of 25.9 million policy years with a corresponding amount of insurance of $207.0 billion. For the female table the corresponding figures were 9.0 million and $30.1 billion.

6. During the six year period, on the male lives, 134,986 policies for a total sum insured of $661.9 million terminated by death; on female lives the figures were 15,768 and $35.4 million.

**Select and ultimate**

7. Because life insurance policyholders are subject to a selection process — a medical examination or health questionnaire — mortality among a group of policyholders of a particular age who are in their first policy year is found to be less than among a group of policyholders of the same present age who were insured some years ago.

8. Because of this, a mortality table prepared by lumping all policyholders of a certain age together — regardless of how long ago they were insured — would not give a

true or a complete picture and would conceal information of great value to actuaries.

9. As time passes, the effect of selection diminishes and after a certain period, it may be expected that there would be little difference between two groups of the same age, one selected, say, 20 years ago and the other 25 years ago.

10. It has become customary in Canada and the United **101** States to compile statistics for each of the first 15 years of each policy, and to bunch together, by attained age, all policies more than 15 years in force. There is evidence that selection lasts longer than 15 years but its effects after that period are of little significance.

11. For purposes of comparing mortality experience a table with a long select period is desirable. However for actuarial calculations a long period complicates the work; for that reason shorter select periods are frequently adopted. For example the CA 58-64 Male table (Canadian Assured Lives 1958-64) has a select period of only five years. The CA 58-64 Female table was published on an ultimate basis only (excluding the first five years) as there was not enough select experience compiled to give reliable results.

### Smoothing

12. Non-actuaries may find it difficult to believe that a table based on a volume of business of the magnitude mentioned above, may not produce reliable results at every age and duration. However if we stop to think that there are 1065 select groups (71 years, 0-70, times 15 durations) and that the claims during the select period numbered 31,744 for males and 5,392 for females, it will be

seen that the *average number of claims per group* was
30 for males and 5 for females. These are averages; the
numbers in individual groups would vary considerably
from the average; in particular they would be smaller at
young ages, because of the low death rate, and at the
highest ages, because of relatively small numbers of
entrants. A rule of thumb is that a mortality rate based
on fewer than 10 deaths is of relatively little significance;
**102**     thus at certain points the mortality rate based on one
group may not be significant; however the experience of
a number of neigboring groups will be more meaningful.
For this reason a process known as graduation or
smoothing is applied to the crude results to give the final
results; in this process statistical techniques are used
which ensure a high degree of what is known as « close-
ness of fit » to the original data.

## Rates of mortality

13.  Table I shows rates of mortality under the new table for
quinquennial ages attained, in the first year, the sixth
year, the eleventh year, and for the sixteenth and sub-
sequent years combined; rates for males and females are
shown separately.

14.  From Table I the effects of selection are clearly seen;
they are not great at young ages but from age 40 up are
very marked. We also note how much lighter mortality
is among females than among males of the same age. An
interesting feature — observed in all modern mortality
studies — is the « bulge » in the progression of rates for
males in the late teens and early twenties. This is attri-
buted to accidental deaths, mainly on the roads; it exists
also among females but not to the same extent.

## Comparisons with other tables

15. The new table is compared with the 1958-64 Table and with the Canadian population table based on deaths of 1970-72 inclusive and on the 1971 Census. Table II gives the comparison for male lives; Table III for females.

16. The comparisons are based on (i) rates of mortality, i.e. deaths per thousand and (ii) *expectation of life*, or *average future lifetime*, a statistic which reflects mortality at all ages greater than that for which it is calculated.

*103*

## Tables

17. Many interesting points will be noted from an examination of Table II:

   a) Mortality for males at young adult ages was slightly higher in 1969-75 than in 1958-64 at least during the select period. Comparison of the ultimate rates is not completely valid because of the different select periods. The new table having a select period of 15 years, the ultimate rates are based on lives insured, on average, perhaps 20 years ago; the older table having a select period of only five years, the average period since issue would be much shorter. Thus with no improvement or worsening of underlying mortality the ultimate new rates for the table would be somewhat higher than the older one.

   b) At higher ages, mortality is definitely lighter under the new than under the older table.

   c) Both insurance tables show definitely lighter mortality than the population table. At age zero this is accounted for by the fact the population figures include all deaths from the moment of birth; insurance com-

panies generally accept babies only after the first week of life. Of the deaths in the first year of life, a very high proportion occur during the first week, and even during the first day.

d) One might expect that ultimate rates would be higher than for the population on the grounds that so many newly selected lives are not included in the ultimate experience but do form part of the population.

104

That this is not the case is no doubt due to the fact that insured lives are not representative of the entire population, not only because of selection on medical grounds, but because insurance is sold mainly to the more favoured socio-economic groups. This is probably accentuated by the fact that the insurance tables are based on amounts of insurance thus weighting the results in favour of these more favoured groups.

e) Expectations of life are longest for the new table, and shortest for the population table. The expectation for select lives is not much greater than for ultimate lives at young ages, for the select period is a relatively short part of the average future lifetime. From middle age on, the difference is considerable.

18. Looking at Table III we may note once more that mortality among females is much lighter than among males. Most of the comments made above concerning Table II apply equally to Table III. It may be noted however that at older ages the mortality for 1958-64 is higher than for population table. This may be due to the fact that the average date of the population table is about nine years later than the average date of the insurance experience.

It may however simply indicate that the insurance figures, which were based on rather scanty data, are not reliable.

### The future

19. At young ages, mortality has increased a little. This may mean that mortality at these ages has been brought down to an irreducible minimum. At older ages, the improvements are probably mainly accounted for by better treatment of heart and other circulatory diseases and of cancers. It is to be hoped that there is still room for even further reductions in deaths from these causes.

*105*

20. There are some who fear that increased use of nuclear energy, atmospheric pollution, greater consumption of alcohol and drugs, the changed lifestyle of women, and less stability in society may lead to higher mortality in future. On the other hand, factors which lead to an optimistic outlook are better nutrition, medical and dental care, and wider knowledge of the hazards of smoking.

21. The new table will have some effect on premium for non-participating insurance and on dividends for participating policies. However actuaries have known that mortality has been improving both from results in their own companies and from the annual reports of the Institute; this knowledge has already reflected in premium rates and dividends since the publication of the 1958-64 table.

TABLE I

Death per thousand per annum

CIA 1969-75

| Attained Age | MALES Insurance year | | | | FEMALES Insurance year | | | |
|---|---|---|---|---|---|---|---|---|
| | First | Sixth | Eleventh | Sixteenth and up | First | Sixth | Eleventh | Sixteenth and up |
| 0 | 2.27 | — | — | — | 1.62 | — | — | — |
| 10 | .32 | .32 | — | — | .21 | .21 | — | — |
| 20 | 1.20 | 1.46 | 1.49 | 1.49 | .36 | .57 | .57 | .57 |
| 30 | .63 | .86 | .94 | 1.22 | .41 | .55 | .57 | .67 |
| 40 | 1.21 | 1.64 | 1.82 | 1.96 | .98 | 1.15 | 1.30 | 1.41 |
| 50 | 2.83 | 3.94 | 4.82 | 5.32 | 1.66 | 2.67 | 3.09 | 3.48 |
| 60 | 5.41 | 9.17 | 11.53 | 14.32 | 2.92 | 4.62 | 6.78 | 8.52 |
| 70 | 10.99 | 21.01 | 26.17 | 36.97 | 5.95 | 8.62 | 13.10 | 19.33 |
| 80 | — | — | 49.21 | 83.61 | — | — | 41.31 | 57.75 |
| 90 | — | — | — | 187.41 | — | — | — | 154.23 |

# TABLE II
## Male lives

| AGE | Deaths per thousand | | | | | Expectation of Life in years | | | | |
| | Insured Lives | | | | Population | Insured Lives | | | | Population |
| | 1969-75 | | 1958-64 | | 1970-72 | 1969-75 | | 1958-64 | | 1970-72 |
| | Select | Ultimate | Select | Ultimate | — | Select | Ultimate | Select | Ultimate | — |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2.27 | — | 3.36 | — | 20.02 | 73.4 | — | 72.7 | — | 69.3 |
| 10 | 0.32 | — | 0.32 | 0.32 | 0.39 | 63.9 | — | 63.2 | 63.2 | 61.2 |
| 20 | 1.20 | 1.49 | 1.06 | 1.10 | 1.78 | 54.5 | 54.3 | 53.6 | 53.6 | 51.7 |
| 30 | 0.63 | 1.22 | 0.65 | 0.89 | 1.52 | 45.2 | 45.0 | 44.1 | 44.1 | 42.5 |
| 40 | 1.21 | 1.96 | 1.19 | 1.91 | 2.91 | 35.8 | 35.6 | 34.7 | 34.6 | 33.2 |
| 50 | 2.83 | 5.32 | 3.12 | 5.90 | 7.61 | 27.4 | 26.5 | 25.9 | 25.6 | 24.5 |
| 60 | 5.41 | 14.32 | 7.22 | 15.88 | 19.18 | 20.3 | 18.5 | 18.2 | 17.5 | 17.0 |
| 70 | 10.99 | 36.97 | 16.58 | 41.54 | 44.36 | 15.0 | 11.9 | 12.4 | 11.1 | 10.9 |
| 80 | — | 83.61 | — | 94.12 | 97.01 | — | 7.0 | — | 6.5 | 6.4 |
| 90 | — | 187.41 | — | 206.36 | 209.77 | — | 3.8 | — | 3.5 | 3.4 |

## TABLE III

### Female lives

|  | Deaths per thousand | | | | Expectation of Life in years | | | |
|---|---|---|---|---|---|---|---|---|
| AGE | Insured Lives | | | Population | Insured Lives | | | Population |
|  | 1969-75 | | 1958-64 | 1970-72 | 1969-75 | | 1958-64 | 1970-72 |
|  | Select | Ultimate | Ultimate | — | Select | Ultimate | Ultimate | — |
| 0 | 1.62 | — | 2.61 | 15.44 | 79.1 | — | 78.2 | 76.4 |
| 10 | 0.21 | — | 0.25 | 0.28 | 69.5 | — | 68.7 | 67.9 |
| 20 | 0.36 | 0.57 | 0.39 | 0.57 | 59.8 | 59.7 | 58.9 | 58.2 |
| 30 | 0.41 | 0.67 | 0.58 | 0.77 | 50.1 | 50.0 | 49.1 | 48.5 |
| 40 | 0.98 | 1.41 | 1.33 | 1.73 | 40.6 | 40.4 | 39.5 | 39.0 |
| 50 | 1.66 | 3.48 | 3.53 | 4.03 | 31.9 | 31.2 | 30.2 | 29.9 |
| 60 | 2.92 | 8.52 | 7.89 | 9.31 | 24.1 | 22.5 | 21.5 | 21.4 |
| 70 | 5.95 | 19.33 | 21.70 | 23.37 | 17.0 | 14.8 | 13.6 | 13.8 |
| 80 | — | 57.75 | 70.34 | 65.14 | — | 8.4 | 7.6 | 7.9 |
| 90 | — | 154.23 | 175.32 | 171.37 | — | 4.4 | 3.9 | 4.0 |

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