AN INVESTIGATION OF THE MORTALITY OF SOUTH AFRICAN ASSURED LIVES, 1995–1998

By BR O'Malley, RE Dorrington, SC Jurisich, JA Valentini, TM Cohen and BJ Ross

ABSTRACT

This paper outlines the findings of an investigation of the mortality of South African assured lives, covering the period 1995 to 1998. The investigation was carried out by the Continuous Statistical Investigations (CSI) Committee of the Actuarial Society of South Africa (ASSA).

Some of the major findings of the investigation were worsening mortality below age 50, general improvements in mortality above age 50, substantial differences in mortality between the different socio-economic classes and signs of anti-selection below age 50, especially in the better socio-economic classes.

KEYWORDS

Mortality; experience; investigation

CONTACT DETAILS

CSI Committee Convenor, Actuarial Society of South Africa, PO Box 4464, Cape Town, 8000. Tel: (0)21 509-5242; Fax: (0)21 509-0160; E-mail: philentia@assa.org.za

1. INTRODUCTION

1.1 This paper outlines the findings of an investigation of the mortality of South African assured lives, covering the period 1995 to1998. The investigation was carried out by the Continuous Statistical Investigations (CSI) Committee of the Actuarial Society of South Africa (ASSA). The Committee has previously reported the major findings of this investigation (Continuous Statistical Investigations Committee, 2001) but this paper presents the results for publication. The paper is arranged as follows. Section 2 provides a background to the investigations. Sections 3 to 11 discuss the results, considering exposure and deaths, experience over time, males versus females, socio-economic class, smokers versus non-smokers, medical status, duration, province and accelerator riders. Finally, section 12 presents a summary of the main findings and conclusions.

1.2 The CSI Committee in its various forms has produced three standard tables of the mortality of assured lives, SA 85–90 (Dorrington & Rosenberg, 1996), SA 72–77 (Mortality Standing Committee, 1983) and SA 56–62 (Mortality Standing Committee, 1974), and two reports on the trends in assured lives mortality since the most recent standard table for the periods 1991–1994 (Continuous Statistical Investigation Committee, 1996) and 1995–1998 (Continuous Statistical Investigation Committee, 2001). Both reports can be downloaded from the ASSA website at www.assa.org.za.

2. DESCRIPTION OF INVESTIGATION

2.1 This investigation was limited to the experiences of whole-life assurances and endowment assurances. Data relating to retirement annuities (with death cover) and term assurances were collected but were excluded from the analysis since they were considered to represent a different class of lives. Data relating to the following were also excluded from the investigation for various reasons: pure endowment policies, minimum-cover policies, policies with health loadings, policies with extra lives, policies effected by the exercising of options, 'back-to-back' policies and funeral riders. The total exposure for the investigation was approximately 16 500 000 life years giving rise to 87 367 deaths.

2.2 The following companies participated in the investigation: African Life, Fedsure Life, Liberty Life, Metropolitan Life, Momentum Life, Old Mutual and Sanlam. Of these companies, African Life and Momentum Life were first-time participants. Data relating to Southern Life, a company included in the previous investigation, were not included in this investigation as that company merged with Momentum Life but the data were not yet part of this company's system.

2.3 The CSI Committee checked the data for each participating company for reasonableness, and in a few instances data needed to be resubmitted. Insufficient data were provided on cause of death and therefore analysis by this factor has not been possible.

2.4 The investigation used the exact method of calculating the exposed-to-risk for each individual policy and was based on number of policies rather than number of lives. A policy-year rate interval was used, with age nearest birthday and curtate duration at death. This is the same as in previous investigations.

2.5 The progression over time of deaths and exposed-to-risk is illustrated in Table 1. The lower number of deaths and exposure in 1995 is due to several factors. Firstly, one company was unable to supply data for the year. Secondly, most companies seemed to have experienced a drop in claims and exposure for this year, with one showing a significant drop in deaths and exposure due to the exclusion from the current investigation of old-series policies included in previous investigations. These factors, together with the change in composition of contributing companies since the previous investigation, make direct comparisons to previous investigations difficult.

2.6 For the first time data were gathered on socio-economic class as determined at the underwriting stage according to the proxies described below. For the purposes of this investigation, four aggregated socio-economic underwriting classes, namely 'best', 'second-best', 'third-best' and 'worst', were compiled. Income and education are used as proxies for socio-economic class, the aggregated classes being as described in Table 2.

These classifications are discussed more fully in section 6. Note that data were available for only a subset of the policies and thus the exposure is much lower at a total of 4 160 275 males and 2 207 816 females over the four-year period of investigation.

Table 1. Progression of deaths and exposure

Year	Deaths	Exposure	Observed rates
1991	18 159	3 653 569	0,0050
1992	20 643	3 910 302	0,0053
1993	21 880	4 163 407	0,0053
1994	23 023	4 375 428	0,0053
1995	17 728	3 619 147	0,0049
1996	22 270	4 290 824	0,0052
1997	23 182	4 333 931	0,0053
1998	24 187	4 290 848	0,0056

Table 2. Socio-economic classes

Socio-economic class	Income per month (1998 rands)	Minimum education
Best	R15 000	Three-year degree
Second-best	R9 500	Three-year diploma
Third-best	R5 500	Matric (Grade 12)
Worst	R2 500	Standard 8 (Grade 10)

3. ANALYSIS OF EXPOSURE AND DEATHS

3.1 Details of claims and exposure by age-band and sex are given in Table 3. Figures 1 and 2 illustrate this graphically.

3.2 Males contributed about two thirds of the exposure and over 80% of the deaths. Exposure was highest in the age bands 35 to 39 for males and 30 to 34 for females. Below age 15 the experience comprised mainly children's policies (e.g. education plans that provide only a return of premiums on the death of the child) and is therefore not a representative source of mortality information for this age range.

3.3 The number of deaths peaked between ages 45 and 49 for males, and between ages 35 and 39 for females.

Table 3. Claims and exposure

	Males		Females	
Age band	Exposure	Claims	Exposure	Claims
0–4	69 080	148	64 643	119
5–9	101 072	93	95 742	75
10–14	83 462	61	77 223	49
15–19	92 031	161	67 086	76
20–24	483 869	1 566	338 872	369
25–29	1 276 482	4 441	825 761	1 010
30–34	1 693 335	6 512	1 016 181	1 656
35–39	1 766 658	6 942	995 242	1 935
40–44	1 584 462	7 266	787 574	1 897
45–49	1 310 011	7 479	560 420	1 659
50–54	981 976	7 283	374 915	1 523
55–59	666 469	6 973	235 055	1 411
60–64	365 885	5 757	119 891	1 149
65–69	180 404	4 169	58 307	856
70–74	104 663	3 965	33,211	697
75–79	55 234	3 534	17 404	626
80–84	25 080	2 513	7 200	453
85+	15 173	2 407	4 673	537
Total	10 855 345	71 270	5 679 398	16 097

4. EXPERIENCE OVER TIME

4.1 Figure 3 compares the experience for males in this investigation with the ultimate rates of SA 85–90 and the 1991–94 experience. From this comparison it is clear that mortality has worsened for ages below 50, but the improvement in mortality for ages above 50, noted in the 1991–94 experience, appears to have continued. Changes over time may be influenced by a changing mix of business over time, as companies sell a greater proportion of policies to policyholders from emerging markets, though the impact of this over age 50 is unlikely to be very significant. This underlying change in policyholder profile needs to be borne in mind when interpreting all the results of the analysis.

Figure 1. Number of years of exposure by age

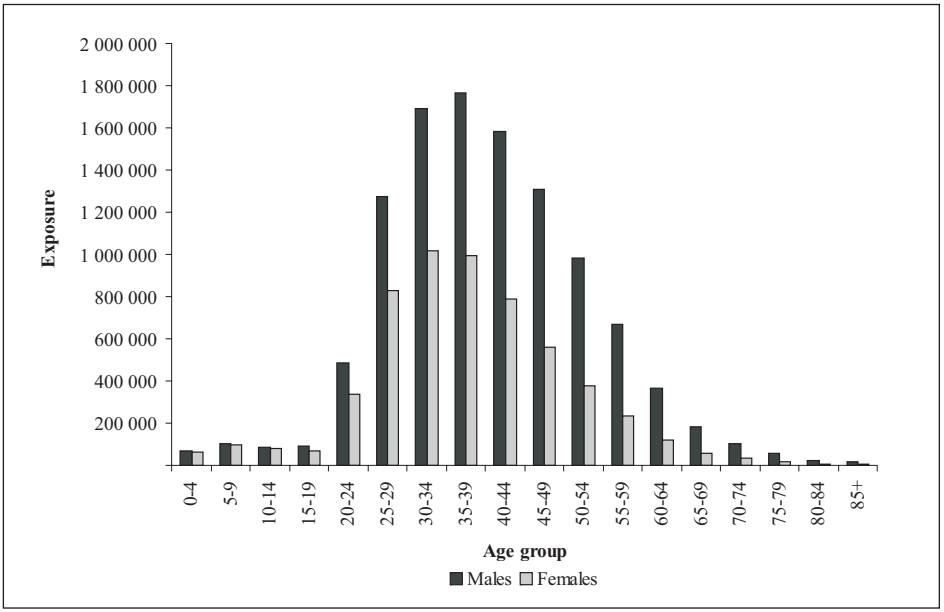


Figure 2. Number of deaths by age

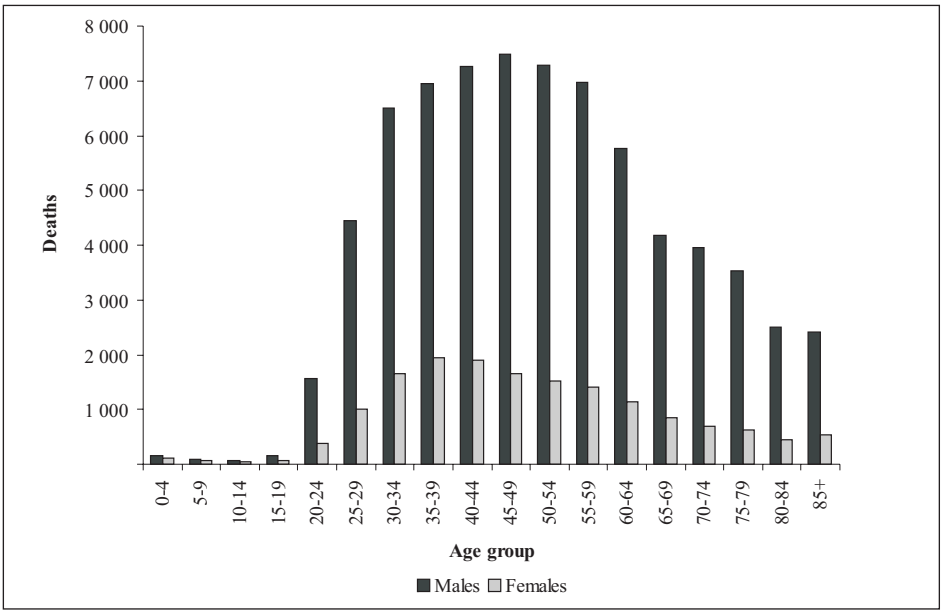


Figure 3. Comparison of male mortality with SA 85–90 and 1991–94 experience

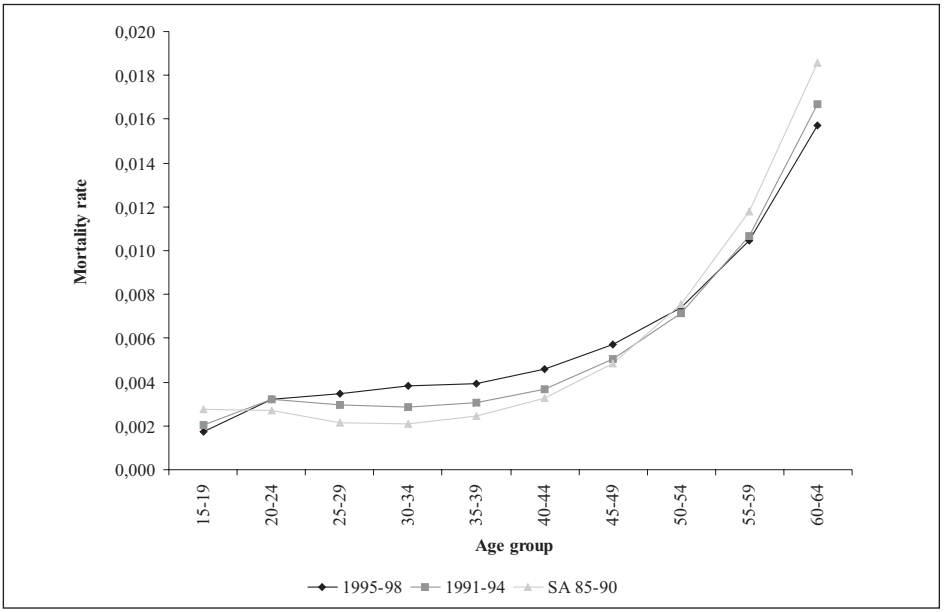


Figure 4. Ratio of male mortality rates to 1995 mortality rates

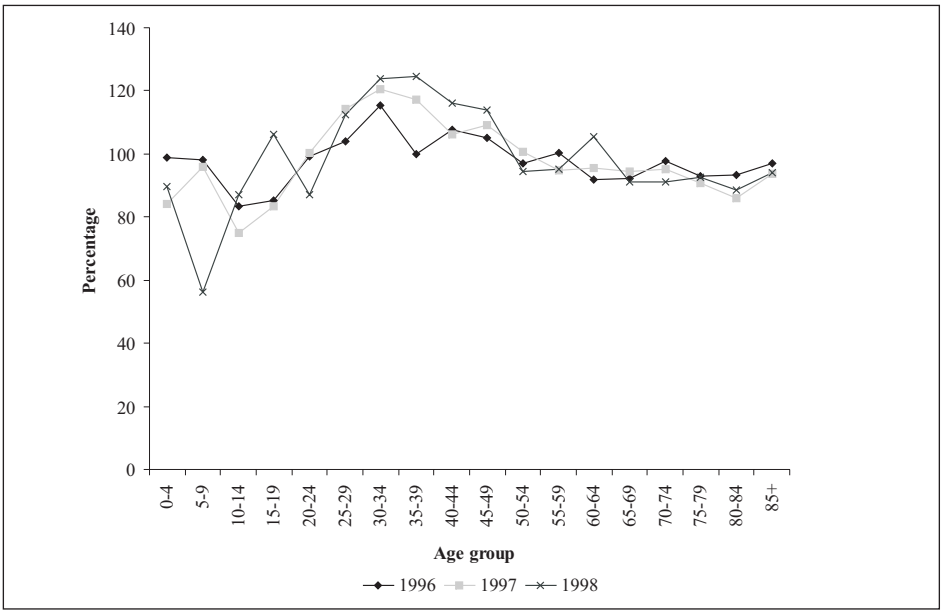
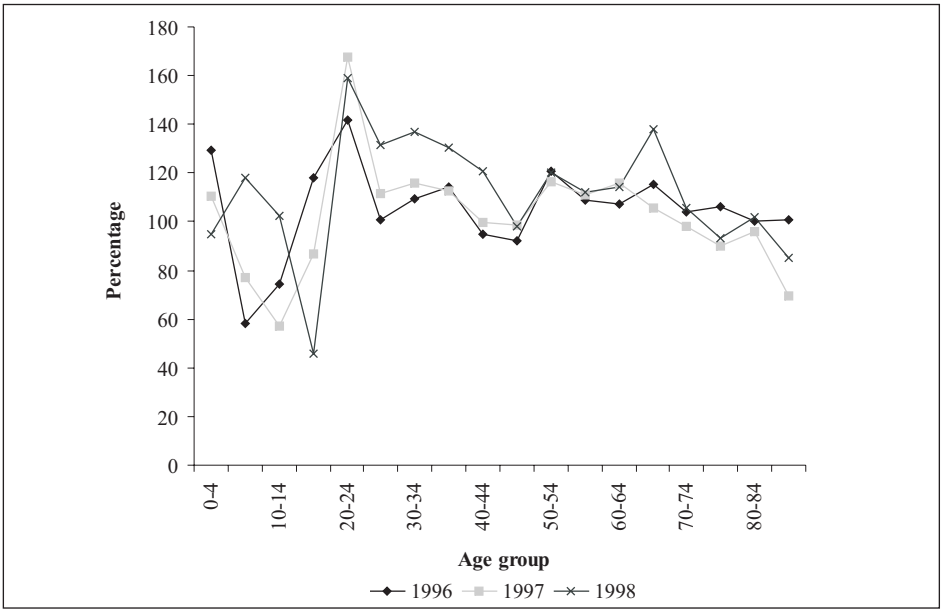


Figure 5. Ratio of female mortality to 1995 mortality rates



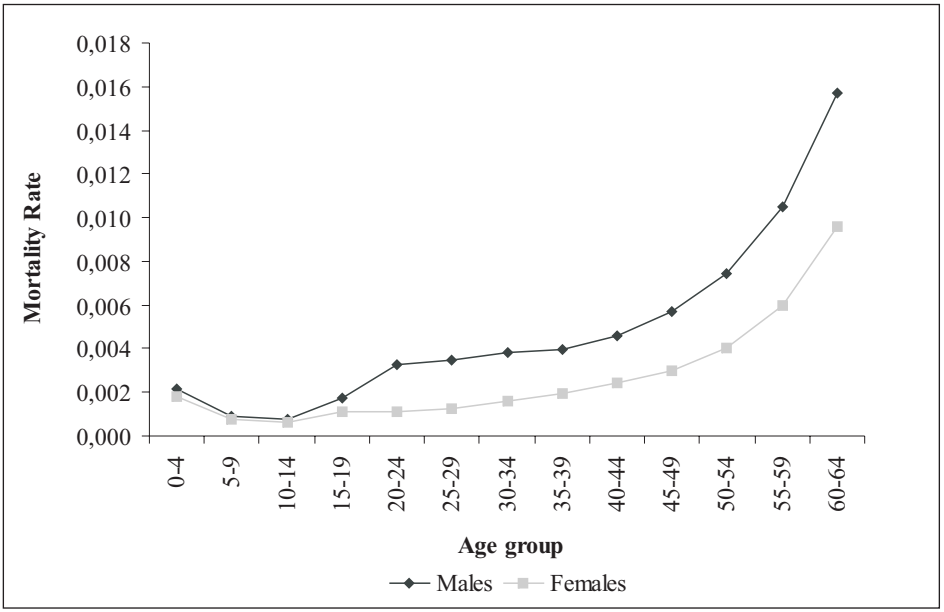
4.2 Figures 4 and 5 illustrate how mortality rates changed over time for males and females separately. The trends are similar for both sexes, although that of females is more erratic because of lower exposure.

4.3 The graphs show generally lighter child mortality in 1996–98 than in 1995 but the data are fairly scanty in this age range. For ages 20 to 49, mortality appears to be worsening. This worsening mortality is probably mainly due to the changing socio-economic mix of policyholders and may also include a worsening mortality due to AIDS. For males over age 50 the mortality in 1996–98 is largely lighter than that in 1995. For females the mortality is higher up to ages in the mid-70s and lower thereafter.

4.4 The worsening at the young adult ages, and in 1998 in the middle ages, is more significant for females than for males. This is off a lower base but may also reflect a more pronounced change of the socio-economic mix than for males.

4.5 An analysis by socio-economic class was performed in an attempt to ascertain whether these trends are due to an underlying change in socio-economic mix. This analysis was constrained by the data available by underwriting class, and the omission of 1995 due to problems with the data discussed in section 2.5. The most notable result of this analysis was that the worst class exhibited strong evidence of worsening mortality over time in the 25 to 39 age range. This may be due, in part at least, to the impact of HIV/AIDS.

Figure 6. Comparison of male and female mortality rates for the period 1995–98



5. COMPARISON OF MALE AND FEMALE MORTALITY

5.1 Figure 6 illustrates male and female mortality experience by age band. While the difference in mortality is small for children, the mortality of men is significantly higher than that of women from age 15 onwards. As has been observed in previous investigations, the accident hump common to most life tables of male mortality is more an accident plateau, reflecting the extremely high proportion of deaths due to non-natural causes (road accidents and violence) in South Africa, particularly amongst young men.

5.2 Table 4 shows female mortality as a percentage of male mortality for both the 1991–94 investigation and the 1995–98 investigation. Broadly, female mortality has worsened relative to male mortality, by about 5%.

5.3 It seems likely that these comparisons are influenced by the changing mix of business by socio-economic class for female policyholders. The data available showing underwriting class reflect recent sales patterns, as this classification has only been available since the early 1990s. These data reveal that 72% of the female exposure comes from the lowest two underwriting classes compared with 57% for males. While we can only guess at the relative socio-economic mix in earlier years, this difference in recent sales may have contributed to the current and worsening experience of females relative to males.

Table 4. Female mortality as a percentage of male mortality

Age band	1991–94 (%)	1995–98 (%)
20–24	25	34
25–29	30	35
30–34	43	42
35–39	43	49
40–44	46	53
45–49	47	52
50–54	49	55
55–59	50	57
60–64	50	61
65–69	49	64
70–74	50	55
75–79	54	56
80–84	73	63
85+	35	72

Figure 7. Comparison of male mortality rates by sum assured

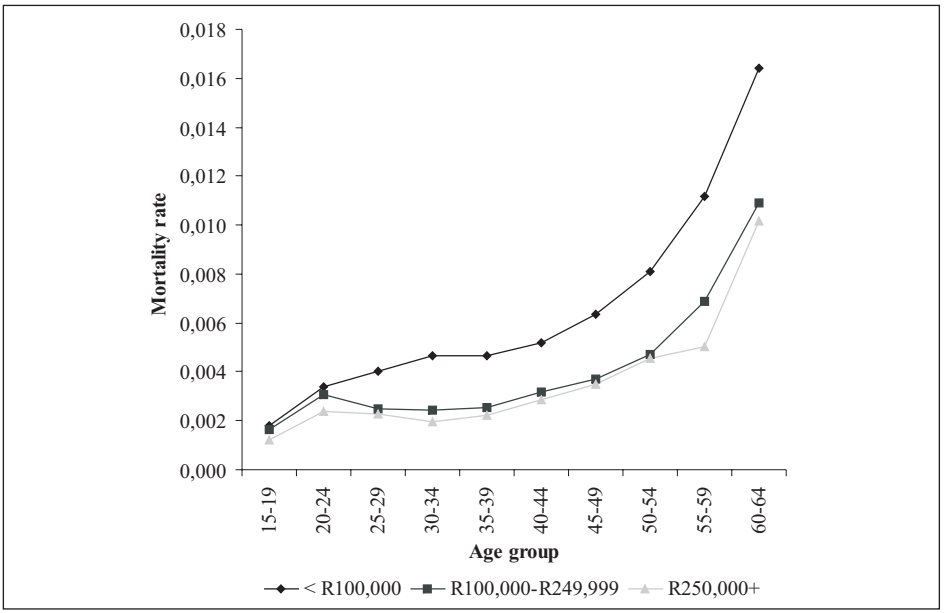
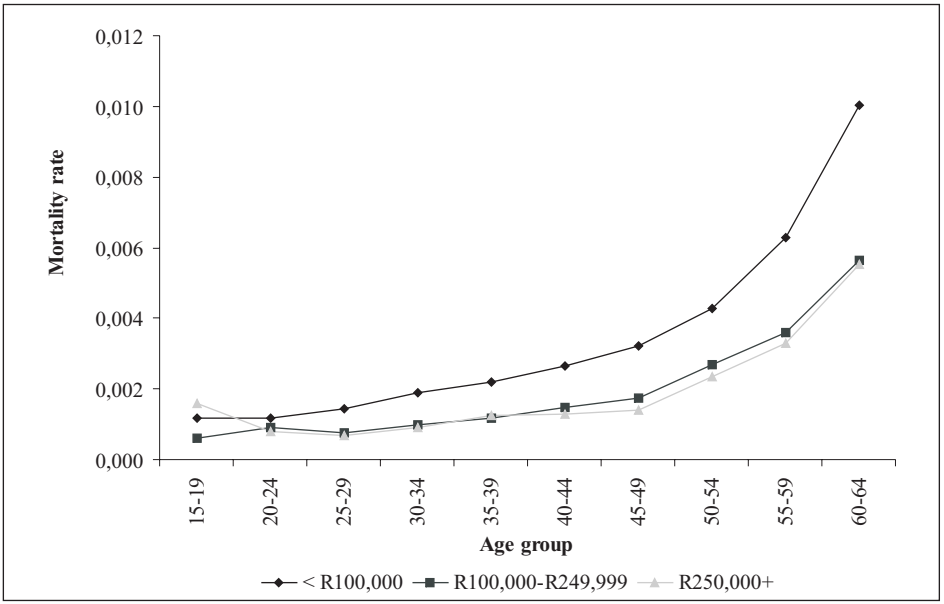


Figure 8. Comparison of female mortality rates by sum assured



6. ANALYSIS BY SOCIO-ECONOMIC CLASS

6.1 ANALYSIS BY SUM-ASSURED BAND

6.1.1 In previous investigations, the proxy for socio-economic class was the level of sum assured. In this investigation, three sum-assured bands were used (below R100 000, between R100 000 and R249 999, and R250 000 and above) where previously only two had been used to distinguish between different socio-economic classes.

6.1.2 Figures 7 and 8 show how the experience differs across the three sum-assured bands. These figures show a markedly higher mortality in the lowest sum-assured band, than in the two higher sum-assured bands. However, these comparisons underestimate the socio-economic differential since it was not possible to remove the effect of inflation (thus leading to old, formerly 'high'-sum-assured policies, now being included with the low sums assured). This effect is probably more marked in the middle band and higher ages, suggesting that the upper two bands give a better picture of the socio-economic impact on mortality. As this method is limited it was decided to investigate the differential further by considering underwriting class.

6.2 ANALYSIS BY UNDERWRITING CLASS

6.2.1 In the early 1990s, life companies, recognising the heterogeneity of the mortality of South African assured lives, modified underwriting to include socio-economic class. The best and most usable proxies for socio-economic class were believed to be income and education. This was supported by the existence of a number of

international studies that showed the strong influence of both of these factors on mortality. Thus, at the time of this study, a significant amount of life assurance business had been written on this basis, making it possible, for the first time, to analyse the experience by underwriting class.

6.2.2 Unfortunately, life offices did not use the same set of underwriting classes. Differences included both the number of classes used and the income and education thresholds. In addition, several offices had, over time, used more than one set of underwriting classes, as they refined the selection process. These differences had to be accommodated.

6.2.3 The various underwriting classes currently in use were therefore compared and a new, independent set was constructed for the purposes of this analysis. Certain principles guided this process. Firstly, the new 'best' class should be defined in such a way as to be representative of the majority of offices' best class of life. Secondly, the new 'worst' class of life should represent the majority of offices' worst underwriting class. Thirdly, the number of underwriting classes should be determined taking into account the size of the exposure and the desire to ensure statistical significance. Finally, it was recognised that having too many classes would vastly increase the complexity of the exercise, without adding much value, in that all such classes would be bounded by the best and worst classes. After some experimentation four underwriting classes were defined.

6.2.4 The next step involved mapping contributing offices' underwriting classes onto the new set. The principles outlined above were adhered to stringently, and as a result some offices' best classes were found to have too low an entry threshold, and were thus mapped to the new second-best class. Similarly, those offices' worst classes that had too high an exit threshold were allocated to the second-worst class, which in a four-class system is also the third-best class. At the end of the process, roughly 10% of the exposure was mapped to the best class, with 25% to the worst class. The middle two classes were roughly equal in size for the males, at a third of the exposure each. For females the third-best class was double the size of the second-best, showing the differing relative socio-economic exposure. For both sexes, the middle two classes were more heterogeneous than the two extreme classes, but no further refinement was practical. This needs to be borne in mind when interpreting the results of the analysis.

6.2.5 All data where underwriting class was unspecified have been excluded from this analysis. Figures 9 and 10 (and Table A1 in Appendix A) show the ratio of the mortality rates for the various underwriting classes as a percentage of the best class for males and females separately.

6.2.6 Figures 9 and 10 show that mortality rates for the worst underwriting class are clearly higher than the rest. This probably reflects wide socio-economic differences between the worst class and the other classes, but could also be due in part to the impact of AIDS. The best and second-best underwriting classes are quite close to each other and the third-best class is clearly higher. These figures illustrate statistically significant differences in mortality amongst the different socio-economic classes. The pattern for females is similar to that for males, except that the differences between the best, second-best and third-best classes are not as pronounced. Note that exposure beyond

Figure 9. Mortality as a percentage of the best class: males

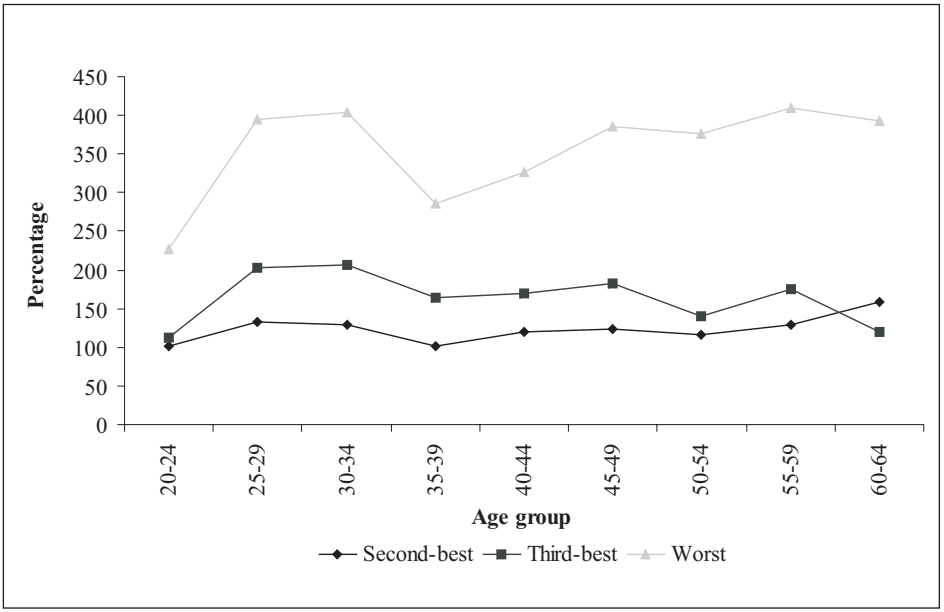
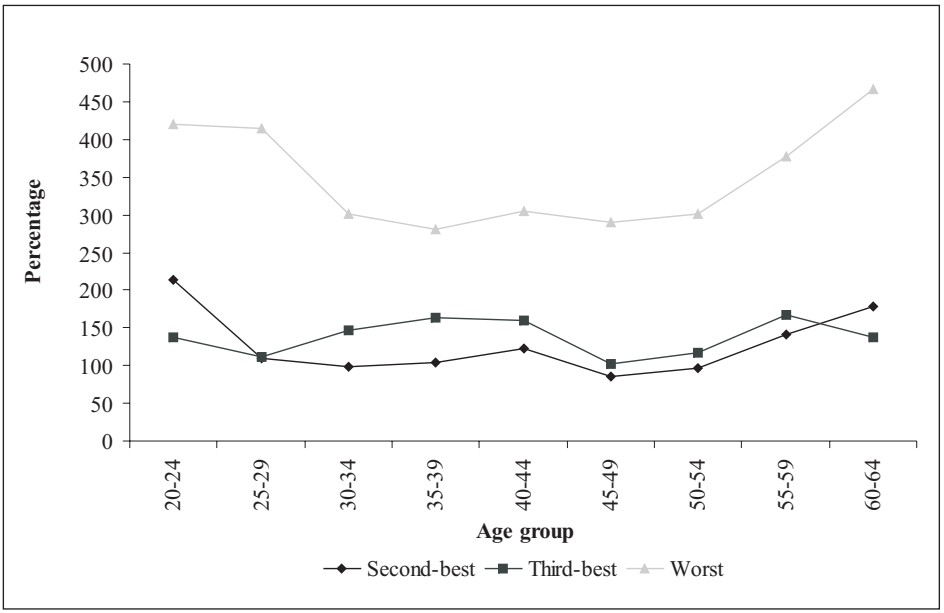


Figure 10. Mortality as a percentage of the best class: females



age 70 is scant as a natural consequence of the relatively new socio-economic underwriting approach, and thus comparison is confined to ages below 65.

6.2.7 Figures 11 and 12 compare the mortality rates by underwriting class for males with SA 85–90. SA 85–90 (light) was the experience of the traditional assured-lives markets at the time, and SA 85–90 (heavy) represented that of the emerging markets (Dorrington & Rosenberg, 1996). The former probably comprises mainly the best and second-best classes, and the latter mainly the third-best and worst classes. Again, the better experience of the best and second-best classes compared with SA 85–90 (light) is very evident above age 40.

6.2.8 Figure 12 shows the ratio of the mortality rates of the best class of males to SA 85–90 (light), and the ratio of the mortality of the worst class of males to SA 85–90 (heavy). The mortality of the worst class of males is consistently heavier than SA 85–90 (heavy) across all ages, while that of the best class of males is slightly heavier than SA 85–90 (light) at the younger ages, but significantly lighter above age 40. As illustrated in Figure 11, the shape of the curve for the worst class is similar to SA 85–90 (heavy), and Figure 12 shows that it can be broadly expressed as about 140% of SA 85–90 (heavy). The experience for the best class cannot easily be expressed as a percentage of SA 85–90 (light).

7. ANALYSIS BY SMOKING STATUS

7.1 Figures 13 and 14 (and Tables B1 and B2 in Appendix B) compare the ratio of smoker to non-smoker mortality in South Africa with that found for the same period in the United Kingdom. The excess smoker mortality increases with age below age 65 for males. The extra mortality for female smokers is not as high as for males, and shows no clear trend with age.

7.2 Male smoker mortality rates were on average 140% of those of non-smokers. In the UK for the 1995–98 period the equivalent ratio was 189% (Continuous Mortality Investigation Bureau, 2000). For females the ratio of smoker to non-smoker mortality rates was on average 128%. In the UK this ratio averaged 216% over the same period. The ratios of all-age smoker to non-smoker mortality rates were influenced by low levels of exposure at the older ages.

7.3 Figure 15 and 16 and Tables B3 and B4 in Appendix B show this ratio by underwriting class. (Because underwriting class was unspecified for some data, the ‘all’ category differs from the ‘SA’ curve in Figures 13 and 14 in that it refers to all data with a specified underwriting class.).

7.4 Figures 17 and 18 compare male mortality rates for smokers and non-smokers for the best and worst underwriting classes in turn. In the best class, there is a marked difference in experience, with smoker mortality often more than double that of non-smokers. In the worst class, smoker mortality is consistently heavier but the difference is not as significant as for the other classes because of heavier underlying mortality.

Figure 11. Comparison of male mortality rates by socio-economic class with SA 85–90 light and heavy

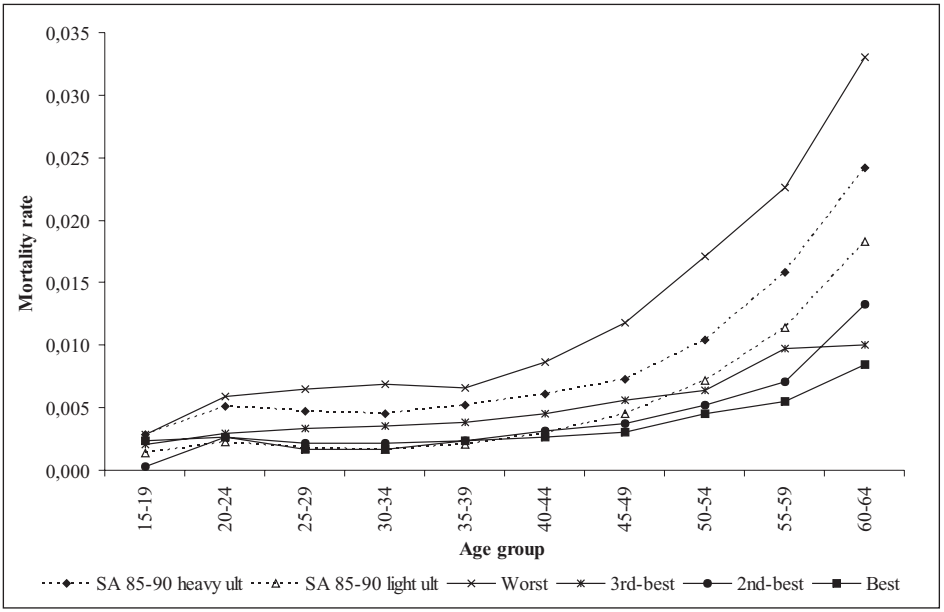


Figure 12. Comparison of male best and worst class mortality with that of SA 85–90 light and heavy respectively

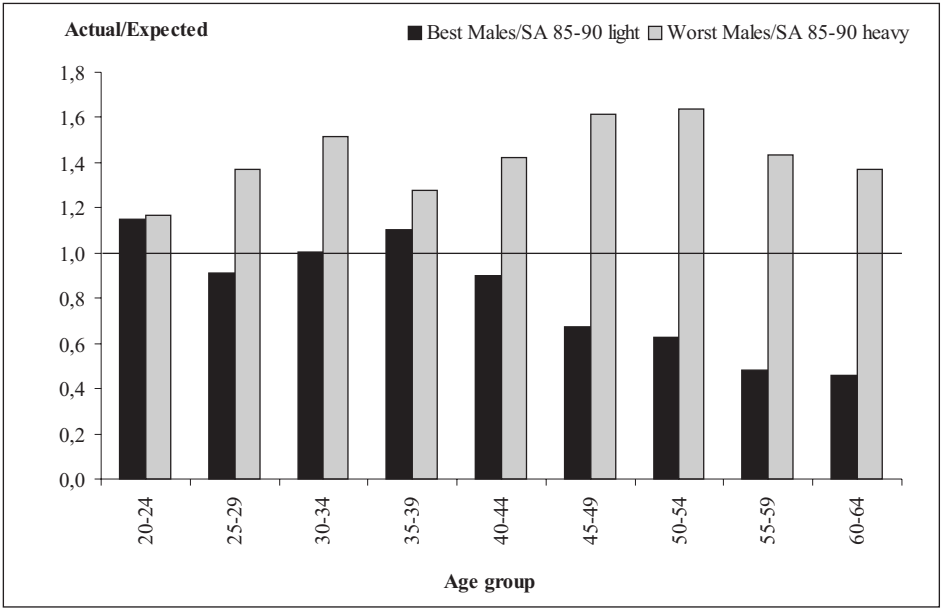


Figure 13. Male smokers as a percentage of non-smokers

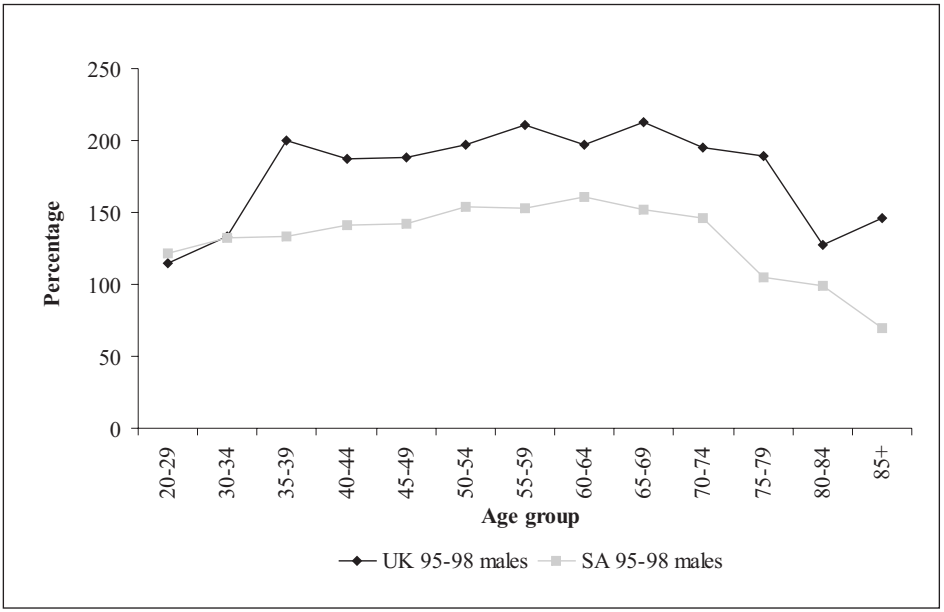


Figure 14. Female smokers as a percentage of non-smokers

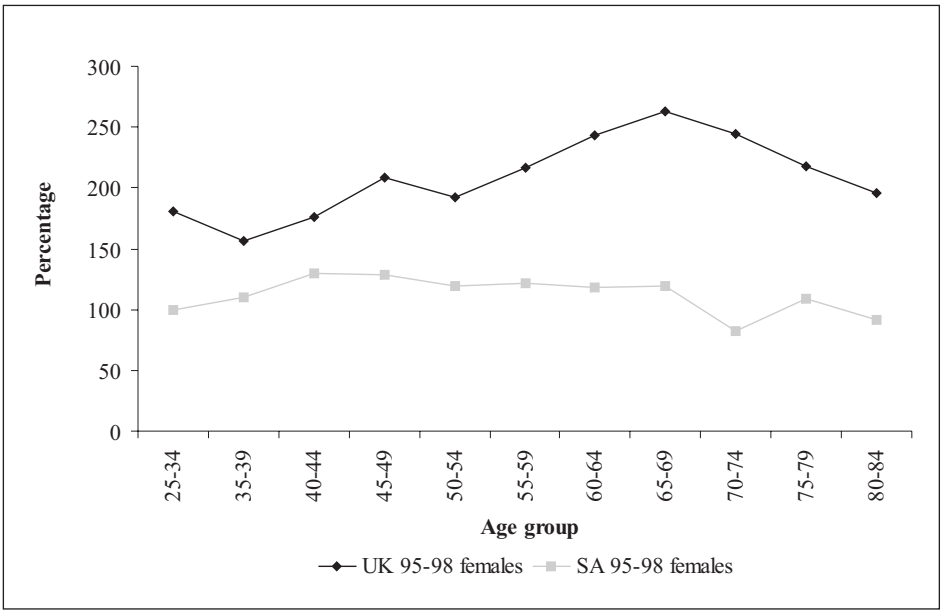


Figure 15. Male smokers as a percentage of non-smokers by socio-economic class

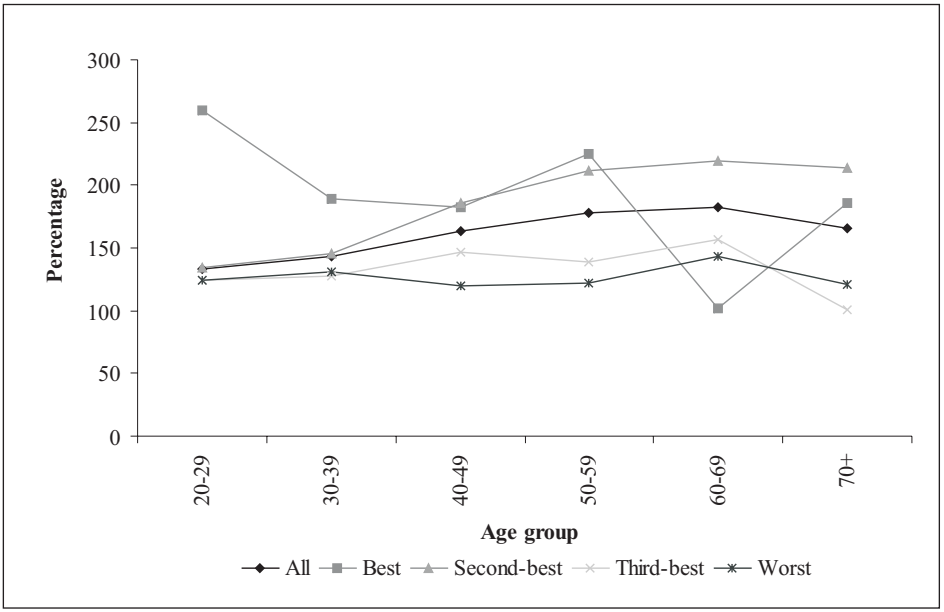


Figure 16. Female smokers as a percentage of non-smokers by socio-economic class

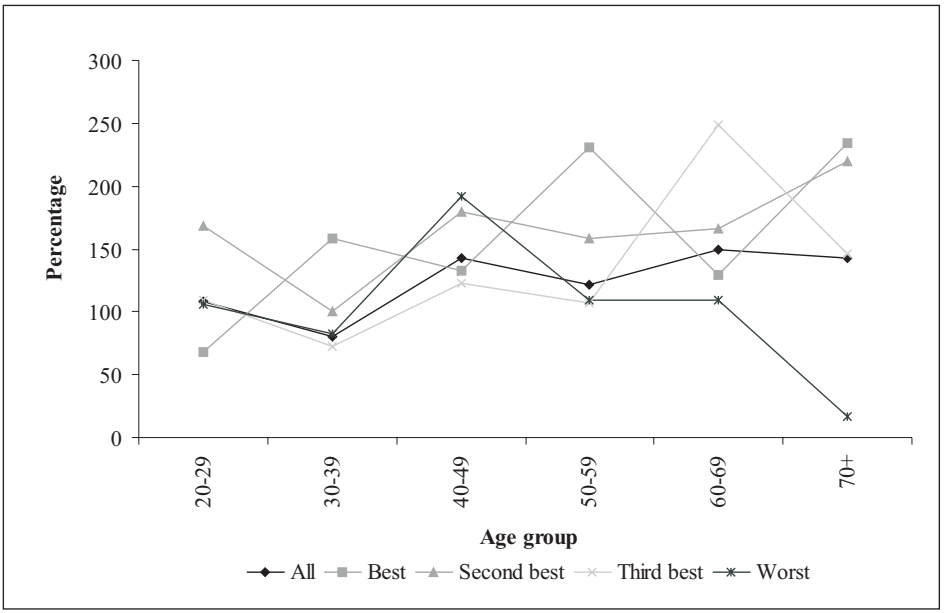


Figure 17. Comparison of male smoker and non-smoker mortality rates in the best socio-economic class

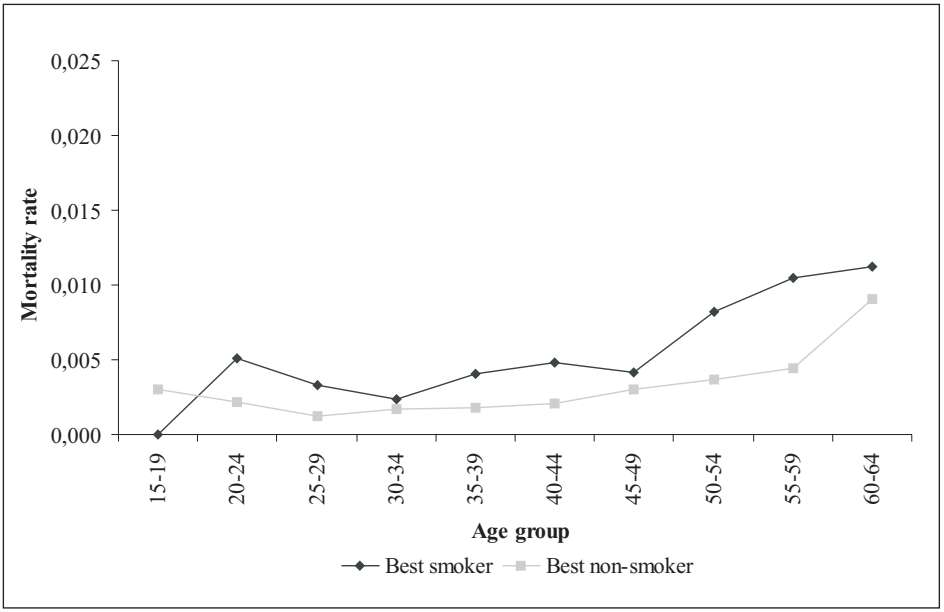
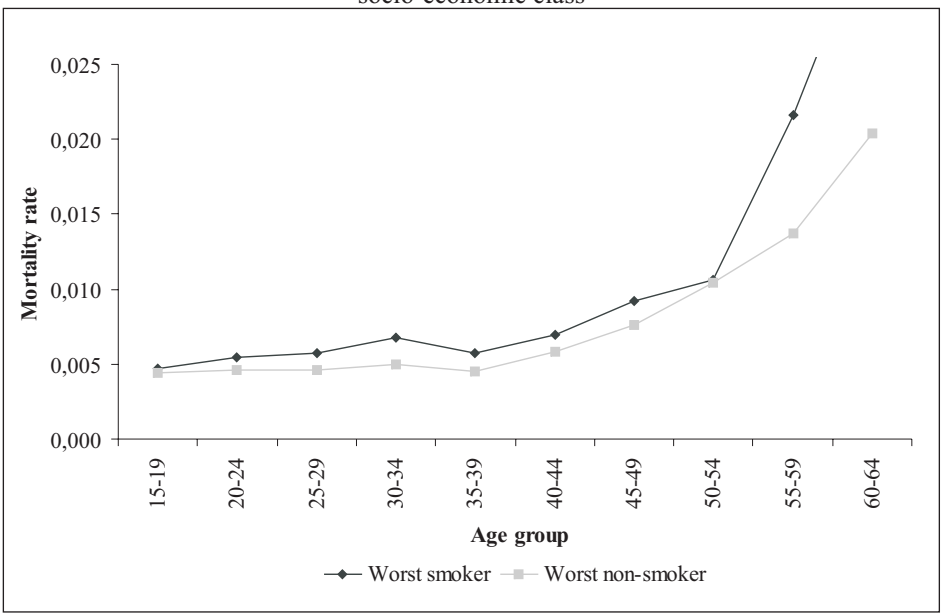


Figure 18. Comparison of smoker and non-smoker mortality rates in the worst socio-economic class



7.5 From this it is apparent that the excess of smoker mortality versus non-smoker mortality decreases as one moves from best underwriting class to worst. This reflects the higher non-smoking-related mortality in the worst underwriting class. The extra smoker mortality in the better South African underwriting classes is not dissimilar to the UK experience.

8. ANALYSIS BY MEDICAL STATUS

8.1 Figure 19 shows the male mortality rate by medical status (where 'medical status' refers to whether or not the policyholder was subject to any form of medical underwriting). One company did not provide data by medical status and was therefore excluded from this analysis. As expected, mortality rates for medically underwritten lives are lower than for non-medically underwritten lives. However, rather than reflecting the medical selection effect, this may be primarily due to class selection whereby the classes that have higher sums assured (and lighter mortality) are more likely to be subject to medical underwriting. The erratic pattern for medically underwritten lives at the younger ages is due to the low number of medically underwritten lives at these ages.

8.2 Figures 20 and 21 show this comparison for policies in their first year (duration 0) and for policies in force for four years (duration 4), to try and isolate the effect of medical selection without the distortions introduced by the heterogeneity of data at the higher durations (ultimate rates) due to the use of differing underwriting limits in the past. The

Figure 19. Comparison of male mortality by medical and non-medical underwriting

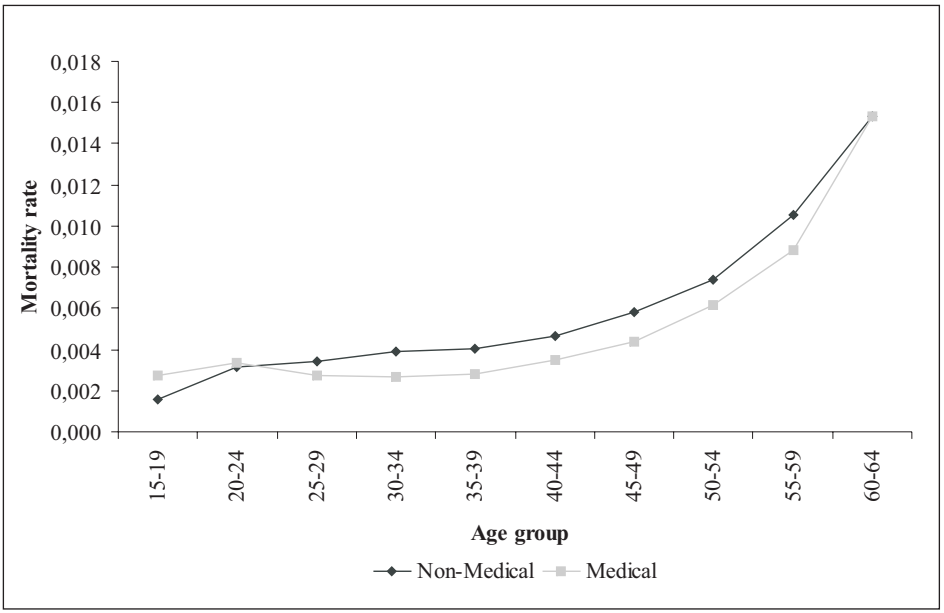


Figure 20. Comparison of male mortality by medical and non-medical underwriting, duration 0

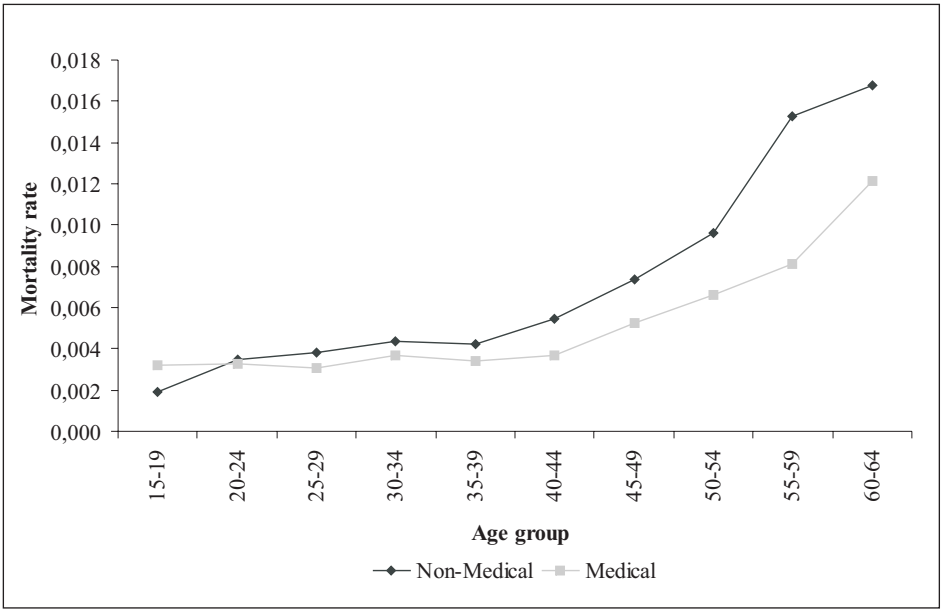
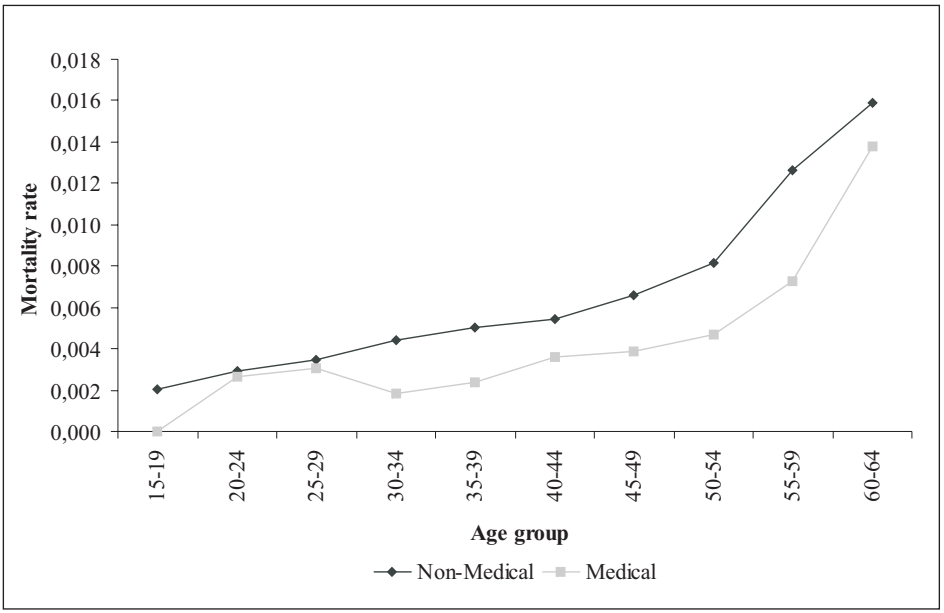


Figure 21. Comparison of male mortality rates by medical and non-medical underwriting, duration 4



result is counter-intuitive; showing a wider gap between medical and non-medical lives between ages 30 and 54 at duration four. This may suggest that medicals are not stringent enough to prevent anti-selection at these ages.

9. ANALYSIS BY DURATION

9.1 Figure 22 shows male mortality rates for duration zero, duration two and durations five and above. Contrary to expectation, the ultimate rates are lower than the select rates. This anomalous pattern of rates by duration has been noted in all previous investigations (from SA56–62 onwards) but not to this extent. The differences at younger ages possibly reflect the underlying socio-economic differences rather than apparent reverse selection. Higher proportions of new policies are now sold in the emerging markets (with lower socio-economic levels) than in the past at the younger ages, but this does not explain the difference at older ages where the traditional markets are still dominant.

9.2 Figures 23 and 24 consider the same comparison separately for medical and non-medical lives. The first graph shows that the experience of medical lives between ages 25 and 39 (where exposure is high) supports the suggestion in section 8.2 that medicals may not be stringent enough to prevent anti-selection at the younger ages. However, above age 55 the effect of selection is as would be expected, which may be due to more stringent medical requirements at the older ages or the fact that medicals are more effective at older ages due to the lower proportion of deaths due to unnatural causes at these ages.

Figure 22. Male mortality rates by duration

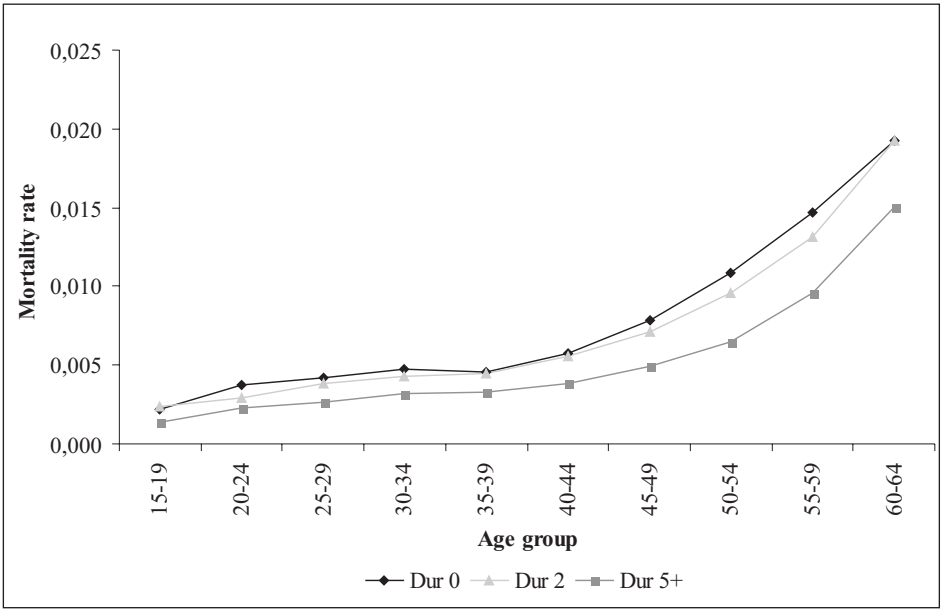


Figure 23. Male mortality by duration for those subject to medical underwriting

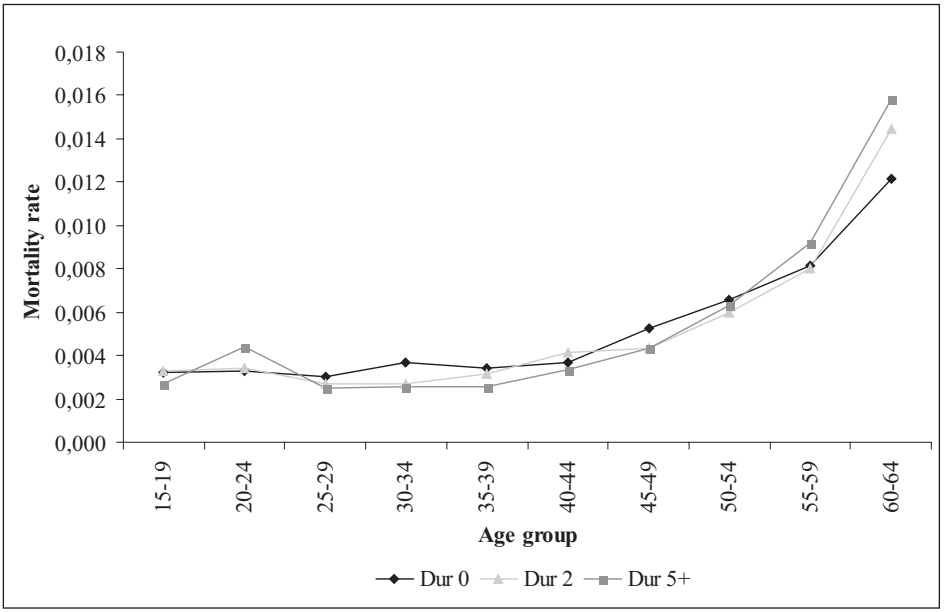
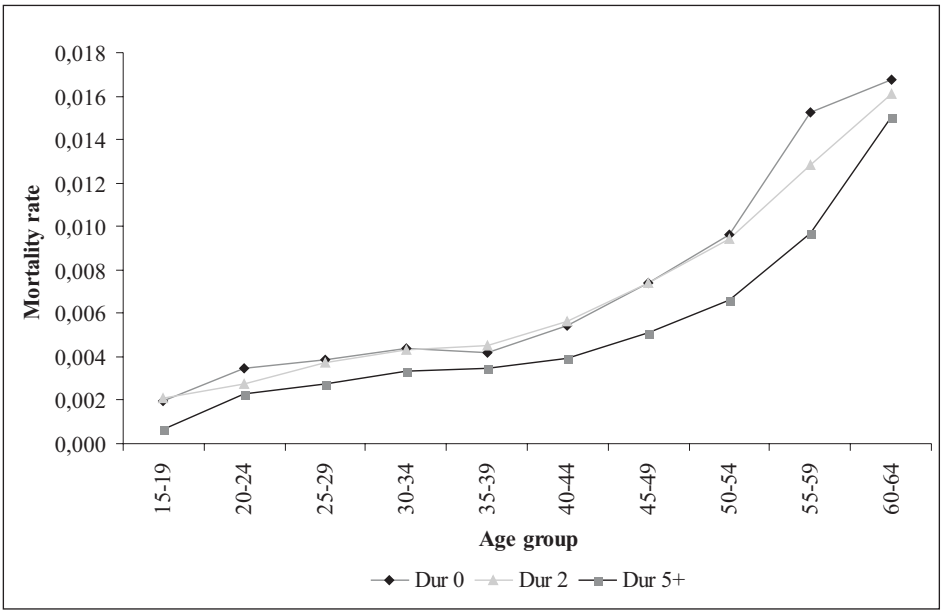


Figure 24. Male mortality for those not subject to medical underwriting



9.3 Figure 24 is similar to Figure 22, but a reason for non-medical experience improving with duration could be the changing mix of business by socio-economic class in recent years. At the older ages where the socio-economic effect is still small, however, there is possible anti-selection.

9.4 Figures 25 and 26 show results for males in the best and worst underwriting classes respectively. Figure 25, showing the best underwriting class, provides further evidence of anti-selection below age 50. However, this feature is not as strong in the emerging-market business as shown in Figure 26.

10. ANALYSIS BY PROVINCE

10.1 Figures 27 and 28 (and Tables C1 and C2 in Appendix C) show mortality rates by province for males and females respectively. For males, KwaZulu-Natal generally has the highest mortality rates, with Free State counter-intuitively the second-highest. Northern Cape is also high but exposure is very low for this province. Thereafter follow Eastern Cape, Northern Province (Limpopo) and Mpumalanga and North-West and Gauteng. The Western Cape is the lowest, with Gauteng tending towards Western Cape rates at older ages. The picture for females is fairly similar to that of males.

10.2 On the face of it, it is tempting to assume that this is consistent with studies showing a high prevalence of HIV in KwaZulu-Natal at the one extreme compared with a low prevalence of HIV in the Western Cape at the other extreme. However, to a large extent this difference probably reflects socio-economic differences between the two provinces.

10.3 Once the underwriting class is taken into account, unspecified data form about 50% of this category. Because of low exposure at many ages, it is difficult to draw any firm conclusions. Inspection of the second-best underwriting class showed little evidence to support the hypothesis that this was due to higher levels of AIDS in the central and eastern provinces of South Africa. Examination of the worst class shows KwaZulu-Natal to be much higher and the Western Cape generally lower than the others at most ages. This is probably attributable to socio-economic variations within this underwriting class.

10.4 The overall conclusion of the provincial analysis is that there is little evidence of higher AIDS deaths in the central and eastern provinces, and that the primary reason for the variances is probably socio-economic.

11. ANALYSIS BY ACCELERATOR RIDER

11.1 An accelerator rider is a rider benefit that accelerates the payment of the underlying (usually death) benefit on the occurrence of the event (usually disability or dread disease) covered by the rider. Payment of a benefit under the rider reduces the mortality benefit by the same amount.

Figure 25. Male mortality by duration for the best socio-economic class

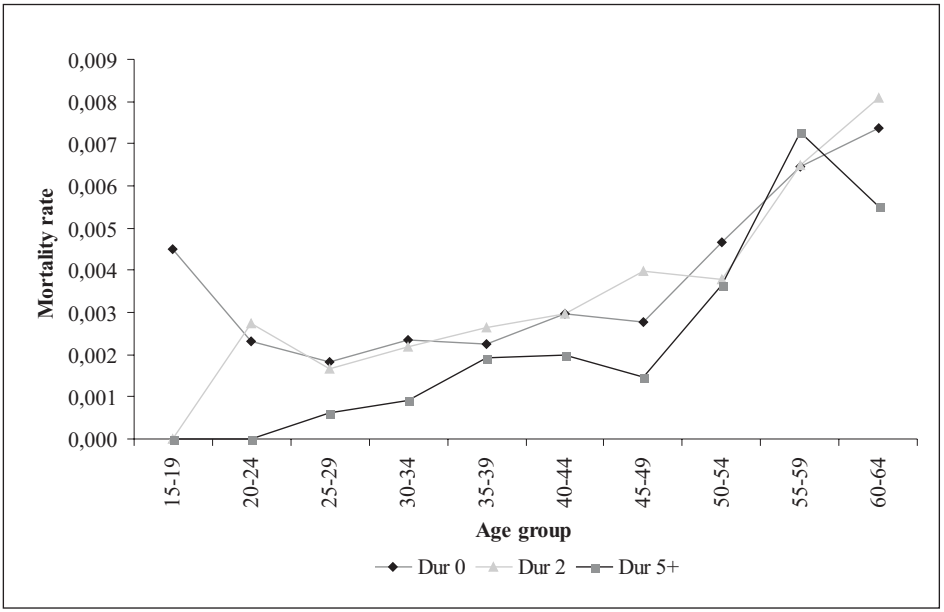


Figure 26. Male mortality by duration for the worst underwriting class

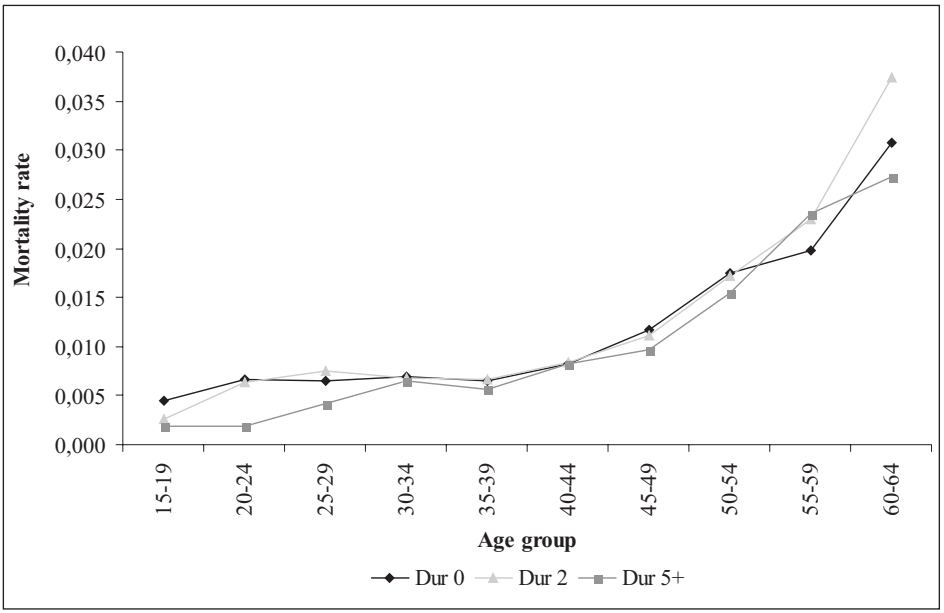


Figure 27. Male mortality rates by province

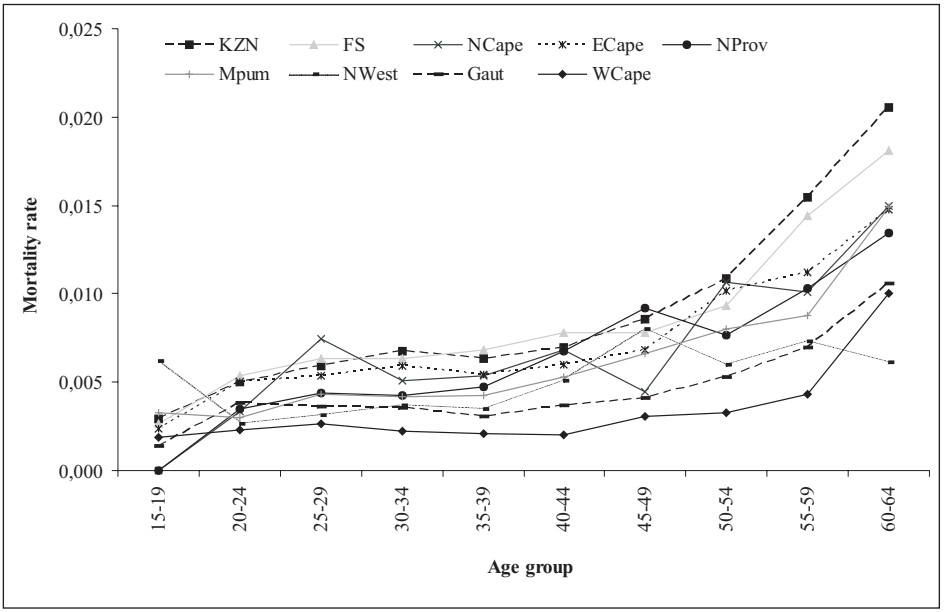
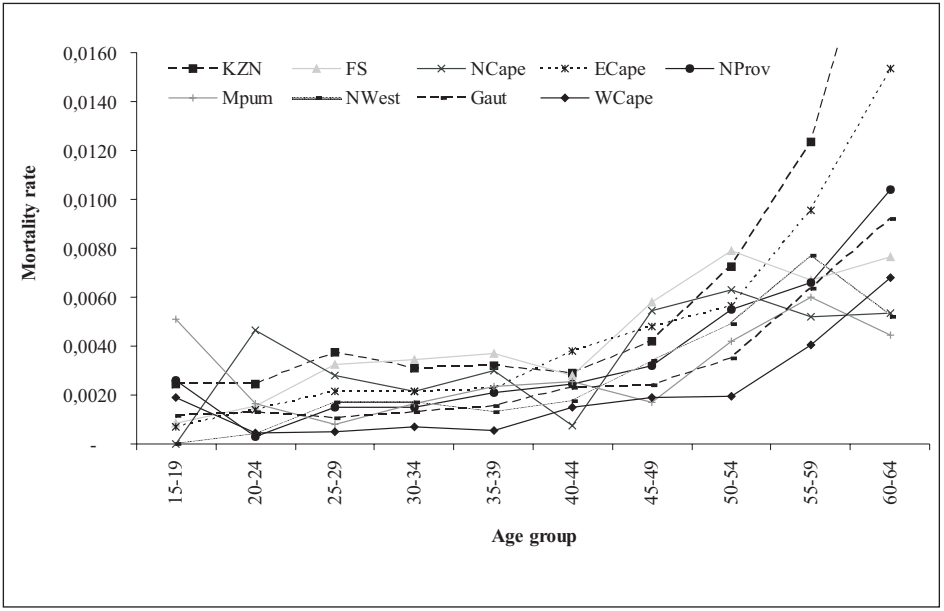


Figure 28. Female mortality rates by province



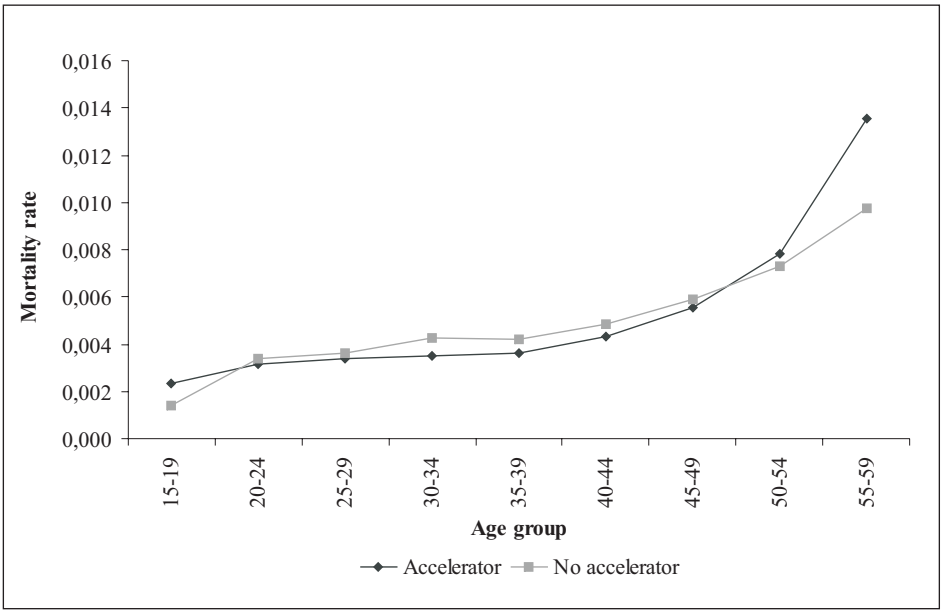
11.2 For the purpose of this analysis, policies with full accelerator benefits were compared with policies with partial or no accelerator benefits.

11.3 Figure 29 confirms the picture shown in the 1991–94 investigation, namely that the mortality rates of policies without full accelerator benefits are generally higher than those with such benefits. These benefits result in an acceleration of payment of the death benefit and cessation of the policy if the policyholder is disabled or suffers a dread disease. This removes the policy from the exposure before death, resulting in lighter experience. Accelerator benefits also tend to be sold to higher socio-economic classes and the experience may also reflect this. However, comparison of rates by underwriting class suggests that the relationship holds in all but the second-best class (where the rates are roughly similar).

12. SUMMARY AND CONCLUSIONS

12.1 Below age 50, aggregate mortality appeared to have worsened during the investigation period, but this may have been due in part to the changing socio-economic mix of policyholders. This also appeared to be the case within each underwriting class, which was probably the result of deaths due to AIDS, but could possibly indicate changes of socio-economic mix within underwriting classes. There was a general improvement in mortality above age 50, in line with international trends.

Figure 29. Male mortality rates for those with 'accelerator' rider and those without



12.2 Female mortality increased relative to that of males, possibly due to increased sales in the female middle-income markets.

12.3 There was a substantial difference in mortality between the different socio-economic classes, (particularly between the worst and the next-worst socio-economic classes) reflecting underlying socio-economic differences. Mortality rates of the worst class were about three times those of the best class.

12.4 Smoker mortality was 140% of non-smoker mortality for males. For females the ratio was around 128%. That these figures are lower than international norms reflects in part the high levels of mortality from other causes, particularly in the lower South African socio-economic classes. Male smoker mortality in the higher socio-economic classes was between about 170% and 200% of non-smoker mortality, which is closer to the 189% experienced in the UK over the same period.

12.5 Anti-selection appeared to be present below age 50, especially in the better socio-economic classes, suggesting possibly that underwriting may not be stringent and effective enough in this age range.

12.6 Mortality was significantly different between the nine provinces of South Africa, with KwaZulu-Natal generally highest and the Western Cape generally lowest. This was probably due mainly to socio-economic factors, but could reflect some effect of HIV/AIDS on mortality.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the work done by Hilton O'Connor and the help of the other members of the CSI Committee, namely Judy Faure, John Graham, Gustav Jenkins, Mike McDougall, Richard Montgomery, Gerhard Potgieter, Johan Potgieter, Nimol Rajkumar, Salmien Symeonides, Colin van Zijl, Philip van Zyl and Frans Vergeest.

REFERENCES

Continuous Mortality Investigation Bureau (2000). The mortality of smokers and non-smokers 1995–1998. *CMIR* 19, 101–18

Continuous Statistical Investigation Committee (1996). Mortality investigation 1991–1994. *Transactions of the Actuarial Society of South Africa* **11(1)**, 146–80

Continuous Statistical Investigation Committee (unpublished). Report of the Continuous Statistical Investigations Committee: Assured lives mortality investigation 1995–1998. Actuarial Society of South Africa, http://www.assa.org.za/default.asp?id=1000000024

Dorrington, R.E. & Rosenberg, S.B. (1996). Graduation of the 1985–90 assured life mortality experience. *Transactions of the Actuarial Society of South Africa* **11(1)**, 91–144

Mortality Standing Committee (1983). 1981 Report of the Mortality Standing Committee: Graduation of the 1972–77 white male data. *Transactions of the Actuarial Society of South Africa* **V(II)**, 6–30

Mortality Standing Committee (1974). The graduation of SA (1956–62) assured lives mortality. *Transactions of the Actuarial Society of South Africa* **II(II)**, 221–37

APPENDIX A
MORTALITY BY UNDERWRITING CLASS

Table A1. Mortality as a percentage of best-class mortality

Age band	Males (%)			Females (%)		
	Second-best	Third-best	Worst	Second-best	Third-best	Worst
20–24	101	113	227	213	138	421
25–29	133	203	394	109	111	414
30–34	129	206	404	98	147	302
35–39	102	164	285	104	163	281
40–44	119	169	327	122	159	304
45–49	124	182	386	85	103	290
50–54	116	141	377	97	118	302
55–59	129	176	410	141	168	378
60–64	158	119	392	178	138	466

APPENDIX B
SMOKERS AS A PERCENTAGE OF NON-SMOKERS

Table B1. Male smoker mortality as a percentage of non-smoker mortality

Age band	UK 95–98 males (%)	SA 95–98 males (%)
20–29	115	122
30–34	133	132
35–39	200	133
40–44	187	141
45–49	188	142
50–54	197	154
55–59	211	153
60–64	197	161
65–69	213	152
70–74	195	146
75–79	189	105
80–84	127	99
Average	189	133

Table B2. Female smoker mortality as a percentage of non-smoker mortality

Age band	UK 95–98 females (%)	SA 95–98 females (%)
25–34	181	100
35–39	156	110
40–44	176	130
45–49	209	128
50–54	192	119
55–59	217	122
60–64	243	118
65–69	263	119
70–74	244	82
75–79	218	109
80–84	196	91
Average	216	110

The age-bands that the UK data relate to are actually one year older than has been indicated above. The above age-bands are used for illustrative purposes.

Table B3. Male smokers as a percentage of non-smokers by underwriting class

Age band	All (%)	Best (%)	Second-best (%)	Third-best (%)	Worst (%)
20–29	133	259	135	124	124
30–39	143	189	146	128	131
40–49	163	182	185	147	119
50–59	178	225	211	139	122
60–69	183	102	220	156	144
70+	166	185	214	101	120
Total (20+)	146	170	170	130	120

Table B4. Female smokers as a percentage of non-smokers by underwriting class

Age band	All (%)	Best (%)	Second-best (%)	Third-best (%)	Worst (%)
20–29	109	68	168	110	106
30–39	80	158	100	73	83
40–49	143	133	180	122	192
50–59	122	231	158	107	109
60–69	150	129	166	248	109
70+	143	234	220	146	17
Total (20+)	111	146	142	104	103

APPENDIX C
ANALYSIS BY PROVINCE

Table C1. Male mortality rates by province

Age band	Gaut	NProv	Mpum	NWest	KZN	ECape	WCape	NCape	FS
15–19	0,0014	–	0,0033	0,0062	0,0029	0,0024	0,0019	–	0,0026
20–24	0,0038	0,0035	0,0030	0,0026	0,0050	0,0050	0,0023	0,0034	0,0054
25–29	0,0036	0,0044	0,0043	0,0031	0,0059	0,0054	0,0026	0,0075	0,0063
30–34	0,0035	0,0043	0,0042	0,0037	0,0068	0,0059	0,0022	0,0051	0,0064
35–39	0,0031	0,0047	0,0042	0,0035	0,0063	0,0054	0,0021	0,0054	0,0068
40–44	0,0037	0,0068	0,0053	0,0051	0,0069	0,0060	0,0020	0,0068	0,0078
45–49	0,0041	0,0092	0,0066	0,0080	0,0086	0,0068	0,0031	0,0045	0,0078
50–54	0,0053	0,0077	0,0080	0,0060	0,0109	0,0101	0,0033	0,0107	0,0093
55–59	0,0070	0,0103	0,0088	0,0073	0,0155	0,0112	0,0043	0,0101	0,0144
60–64	0,0106	0,0134	0,0149	0,0062	0,0206	0,0148	0,0100	0,0149	0,0181
65–69	0,0142	0,0219	0,0135	0,0158	0,0255	0,0119	0,0168	0,0150	0,0144
70–74	0,0203	0,0157	0,0138	0,0303	0,0279	0,0317	0,0167	0,0164	0,0198
75–79	0,0261	0,0355	0,0211	0,0360	0,0370	0,0576	0,0286	0,0135	0,0305
80–84	0,0278	–	0,0968	0,0143	0,0468	0,0603	0,0523	0,0769	0,0413
85+	0,0737	0,0556	0,0625	0,0455	0,0546	0,0843	0,0276	–	0,1186
Total	0,0047	0,0058	0,0057	0,0050	0,0086	0,0074	0,0036	0,0071	0,0080

Table C2. Female mortality rates by province

Age band	Gaut	NProv	Mpum	NWest	KZN	ECape	WCape	NCape	FS
15–19	0,0012	0,0026	0,0051	–	0,0025	0,0007	0,0019	–	0,0009
20–24	0,0013	0,0003	0,0017	0,0004	0,0025	0,0014	0,0004	0,0047	0,0015
25–29	0,0010	0,0015	0,0008	0,0017	0,0038	0,0021	0,0005	0,0028	0,0033
30–34	0,0013	0,0015	0,0017	0,0017	0,0031	0,0021	0,0007	0,0022	0,0034
35–39	0,0016	0,0021	0,0024	0,0013	0,0032	0,0022	0,0006	0,0030	0,0037
40–44	0,0023	0,0024	0,0025	0,0018	0,0029	0,0038	0,0015	0,0007	0,0028
45–49	0,0024	0,0032	0,0017	0,0034	0,0042	0,0048	0,0019	0,0055	0,0058
50–54	0,0035	0,0055	0,0042	0,0049	0,0072	0,0056	0,0020	0,0063	0,0079
55–59	0,0064	0,0066	0,0060	0,0077	0,0123	0,0096	0,0041	0,0052	0,0067
60–64	0,0092	0,0104	0,0045	0,0052	0,0236	0,0153	0,0068	0,0054	0,0077
65–69	0,0180	0,0074	0,0301	0,0127	0,0302	0,0274	0,0094	–	0,0126
70–74	0,0214	0,0080	0,0329	0,0152	0,0249	0,0309	0,0152	0,0086	0,0091
75–79	0,0343	0,0299	0,0130	0,0192	0,0482	0,0457	0,0231	0,0154	0,0481
80–84	0,0567	–	0,0667	0,0385	0,0480	0,0476	0,0408	–	0,0533
85+	0,0811	–	–	–	0,0375	0,0882	0,0455	–	0,0698
Total	0,0025	0,0022	0,0026	0,0024	0,0053	0,0043	0,0015	0,0033	0,0043

APPENDIX D
ANALYSIS BY ACCELERATOR RIDER

Table D1. Male mortality rates for those with accelerator rider

Age band	All	Best	Second-best	Third-best	Worst
15–19	0,0023	0,0030	0,0000	0,0023	0,0043
20–24	0,0032	0,0023	0,0020	0,0028	0,0040
25–29	0,0034	0,0016	0,0018	0,0032	0,0041
30–34	0,0035	0,0016	0,0021	0,0034	0,0042
35–39	0,0036	0,0020	0,0024	0,0039	0,0034
40–44	0,0043	0,0025	0,0030	0,0044	0,0048
45–49	0,0055	0,0029	0,0029	0,0055	0,0068
50–54	0,0078	0,0041	0,0055	0,0063	0,0060
55–59	0,0135	0,0041	0,0061	0,0098	0,0082

Table D2. Male mortality rates for those without accelerator rider

Age band	All	Best	Second-best	Third-best	Worst
15–19	0,0014	0,0016	0,0004	0,0015	0,0044
20–24	0,0034	0,0040	0,0030	0,0035	0,0055
25–29	0,0036	0,0018	0,0024	0,0039	0,0052
30–34	0,0043	0,0018	0,0022	0,0041	0,0060
35–39	0,0042	0,0026	0,0023	0,0040	0,0053
40–44	0,0048	0,0029	0,0032	0,0051	0,0066
45–49	0,0059	0,0032	0,0038	0,0068	0,0084
50–54	0,0073	0,0048	0,0053	0,0078	0,0104
55–59	0,0097	0,0057	0,0072	0,0117	0,0157