Continuous Mortality Investigation

Critical Illness Committee

WORKING PAPER 52

**Cause-specific CMI critical illness diagnosis
rates for accelerated business, 2003-2006**

The views expressed in this working paper are those of the members of the CMI Critical Illness Committee and do not necessarily represent the views of the CMI, the Actuarial Profession or the employers of Committee members. This paper is a discussion document and the Committee fully acknowledges that there may be other valid approaches to analysing the CMI's critical illness data. This paper does not provide any form of guidance and should not be relied on as such. The CMI and the Committee members accept no liability whatsoever for any direct or consequential loss arising from any use of this working paper or its contents.

June 2011

EXECUTIVE SUMMARY

This paper presents cause-specific claim diagnosis rates for accelerated critical illness insurance, on a 'lives' basis, based on data for nearly 16,000 claims settled in 2003 to 2006. Separate sets of rates are included in the paper for males and females and for non-smokers and smokers for ages 30 to 60. In each case, rates have been derived for those causes of claim with at least 200 settled claims during the period; i.e.:

Male Non-Smoker	Cancer, Heart attack, Death, Stroke, CABG and TPD
Male Smoker	Cancer, Heart attack and Death
Female Non-Smoker	Cancer, Death, Stroke and MS
Female Smoker	Cancer and Death.

These rates are intended to be illustrative and, in particular, do not form part of the formal AC04 Series of diagnosis rates published in Working Paper 50.

As in previous Working Papers, we again derive these rates by adjusting an initial set of rates (the cause-specific CIBT02 rates) first by age only, and then by duration only, to broadly fit the expected settled claims to the actual settled claims. This was done in a pragmatic manner – for each gender/smoker dataset and for each cause independently – to reach a reasonable fit, having regard to the data volumes.

The selection patterns inferred from the all-causes rates were used in this work, however the results in the paper illustrate the different degree of selection between different causes.

The rates show a high degree of consistency with the 1999-2004 rates (derived for male non-smokers only in Working Paper 43) and the sum of the cause-specific rates corroborates well with the all-causes rates for each dataset. The low absolute numbers of claims for some causes create considerable uncertainty in the cause-specific rates for certain causes.

Overall, the relationships between the various sets of cause-specific rates conform to prior expectations; for example, cancer rates are higher for females than males and the differentials between smokers and non-smokers are relatively narrow. A comparison of the four sets of death rates also produces a similar ranking to that visible in "normal" mortality experience. However the Committee considers that these rates add insights in a number of areas, including the following:

- The rates indicate that the adjustments required to the relevant CIBT02 rates vary considerably between the main causes, in particular the cancer rates are a significantly higher percentage of CIBT02 than the other main causes.
- Relative to CIBT02, the rates can also vary significantly by age, for example multiple sclerosis experience for female non-smokers appears to reduce with increasing age.
- The selection patterns by cause are also interesting, with relatively little positive selection on cancer, across all four gender/smoker datasets, and with apparent adverse selection at duration 0 for heart attack.

A large number of assumptions again underlie these diagnosis rates and a considerable degree of uncertainty surrounds the rates; consequently, the Committee is again making available to member offices spreadsheets containing summarised data that will allow practitioners to experiment with alternative approaches.

The other areas of further work indicated in Working Paper 50 are expected to be published in a Working Paper – provisionally entitled "Supplementary Analyses to CMI critical illness diagnosis rates for accelerated business, 2003-2006" – in Summer 2011.

Continuous Mortality Investigation

Critical Illness Committee

WORKING PAPER 52

Cause-specific CMI critical illness diagnosis rates for accelerated business, 2003-2006

CONTENTS

Continuous Mortality Investigation

Critical Illness Committee

WORKING PAPER 52

Cause-specific CMI critical illness diagnosis rates for accelerated business, 2003-2006

1. INTRODUCTION

1.1. This paper presents cause-specific claim diagnosis rates for accelerated critical illness insurance, on a 'lives' basis, using data for claims settled in 2003 to 2006. The derivation of these diagnosis rates replicates that set out in Working Paper 43 in which diagnosis rates were derived using data for claims settled in 1999 to 2004 for male non-smokers only. Draft rates for claims settled in 2003 to 2006 were included in a paper released only to firms that financially support the CMI in August 2010.

1.2. This paper complements the all-causes rates (the "AC04 Series") that were published in Working Paper 50 in January 2011.

1.3. Rates have been derived for the main causes of claim using a subset of the data used to derive all-causes rates in Working Paper 50. The dataset has been restricted to exclude offices that were unable to submit data with a cause of claim for most or all of their claims. This leaves a dataset of nearly 16,000 settled claims. Whilst this is a substantial dataset, and represents a large proportion of the entire market, there are few claims outside of the age range 30 to 60. The rates in this paper are therefore limited to this age range.

1.4. In this paper we again derive diagnosis rates by adjusting an initial set of rates (the relevant CIBT02 cause-specific rates) first by age only, and then by duration only, to broadly fit the expected settled claims to the actual settled claims. This is done in a pragmatic manner – for each gender/smoker dataset independently – to reach a reasonable fit, having regard to the data volumes.

1.5. The derivation of the rates is described in section 2 of this paper; the rates for each of the four gender/smoker datasets are then considered in sections 3 to 6 of this paper and some comparisons between the rates are contained in section 7.

1.6. These rates do not form part of the AC04 Series of rates contained in Working Paper 50 but the Committee views them as an aid to understanding the all-causes rates. It is also hoped that these rates will provide a useful comparison for future experience. The other areas of further work indicated in Working Paper 50 are expected to be published in a Working Paper – provisionally entitled "Supplementary Analyses to CMI critical illness diagnosis rates for accelerated business, 2003-2006" – in Summer 2011.

1.7. This paper complies with the material requirements of the principles in the Board for Actuarial Standard's generic TASs. In particular, TAS D and TAS M have been met insofar as their principles are applicable.

1.8. All feedback on this paper will be warmly welcomed by the CMI Critical Illness Committee.

2. THE DERIVATION OF DIAGNOSIS RATES BY CAUSE

2.1. In this section we describe the derivation of diagnosis rates for the main causes of claim. The Committee was keen to investigate cause-specific claim rates, not only for their intrinsic interest but also to aid understanding of the all-causes rates.

2.2. In Working Paper 43, the analysis by main cause of claim was limited to male non-smokers only; the reasons for this were explained in section 5 of Working Paper 43 but we have now undertaken similar analysis for each gender/smoker dataset. As with the all-causes rates published in Working Paper 50, these four datasets have been considered independently.

2.3. Table 2.1, below, shows the number of claims available in the 2003-2006 dataset for the main causes of claim.

Table 2.1: CMI accelerated critical illness claims, 2003-2006, for the main causes of claim.

	Male		Female	
	Non-smoker	**Smoker**	**Non-smoker**	**Smoker**
Death	1,896	901	727	383
Heart Attack	964	795	100	120
Breast Cancer*	2,770	816	1,522	297
Other cancers*			2,984	665
Stroke	390	178	237	118
Coronary Artery Bypass Graft	249	78	20	8
Multiple Sclerosis	177	88	412	129
Total and Permanent Disability	199	77	175	37
Sum of above	6,645	2,933	6,177	1,757
Total claims	**7,676**	**3,333**	**6,947**	**1,996**
% covered by above	87%	88%	89%	88%

*Please refer to paragraph 2.5 for a definition of these terms

2.4. Note that Table 2.1 shows the total number of claims for each cause; in order to develop a cause-specific claim development distribution we also need both date of diagnosis and date of settlement, limiting the number of causes for which we have credible volumes of data.

2.5. There is an important issue to note regarding analysis by any sub-division of cancer. We request that cancer claims are split by site but for around 44% of the total cancer claims the site is not specified. The figures for "Other cancers" above include all cancers, other than those specified to be breast cancer. As a result any rates derived for "female breast cancer" would understate the true rates if a significant number of female breast cancer claims were included under site not specified. The Committee believes this is likely to be the case and has therefore combined all the cancer claims and treated this as a single cause for the work in this paper.

2.6. The Committee decided to analyse those causes with 200 or more claims, with the exception that TPD was again investigated for male non-smokers only.

2.7. Although the total number of claims has increased compared to the 1999-2004 dataset, the numbers have reduced for most causes of claim. This is due to an increased

6

proportion of claims that are reported to the CMI as "unknown cause" in the 2003-2006 dataset, as noted in section 4 of Working Paper 50. Working Paper 43 noted the issue that arises with claims of unknown cause, which will include claims for the main causes. This was of little significance in the 1999-2004 dataset, where the claims of unknown cause only accounted for 0.7% of the total claims. This issue is greater in the 2003-2006 dataset, where the claims of unknown cause account for 6.6% of the total claims.

2.8. Without some adjustment, the cause-specific rates would be significantly understated to the extent that claims for each of the main causes are coded as 'unknown'. The Committee decided to remove the data for those offices that were unable to supply cause of claim for most or all of their claims from the datasets used to derive the cause-specific rates. Note that those offices that were unable to supply cause of claim for the critical illnesses did identify death claims, however all claims for these offices have been removed from the data, including the death claims.

2.9. This reduces the size of the dataset and also the proportion of claims recorded as unknown cause to 0.8% of the total claims in the (smaller) dataset, which is summarised in Table 2.2 below.

Table 2.2: CMI accelerated critical illness claims, 2003-2006, for the main causes of claim, adjusted.

	Male		Female	
	Non-smoker	**Smoker**	**Non-smoker**	**Smoker**
Death	1,745	823	667	346
Heart Attack	964	795	-	-
Cancer	2,770	816	4,506	962
Stroke	390	-	237	-
Coronary Artery Bypass Graft	249	-	-	-
Multiple Sclerosis	-	-	412	-
Total and Permanent Disability	199	-	-	-
Total claims	**6,317**	**2,434**	**5,822**	**1,308**

2.10. This could have resulted in a need to re-calculate all-causes rates from this smaller dataset, if the experience of the excluded offices differed from the remaining group. The tables in Appendix A illustrate the fit of the all-causes rates derived in section 6 of Working Paper 50 to the smaller dataset for each gender/smoker subset. Although different rates would have been derived for the offices where we have cause of claims, the Committee decided that the differences were small and did not, therefore, re-calculate all-causes rates from the smaller dataset.

2.11. The cause-specific claim development distributions used in this analysis are illustrated in Figure 2.1. These have been derived in a similar manner to those for the 1999-2004 dataset, in particular these distributions have been derived from all four gender/smoker datasets combined apart from the distribution for cancer, where separate distributions have been derived from male claims and female claims (note that each uses both smoker and non-smoker data).

Figure 2.1: Cumulative claim development distributions, by cause
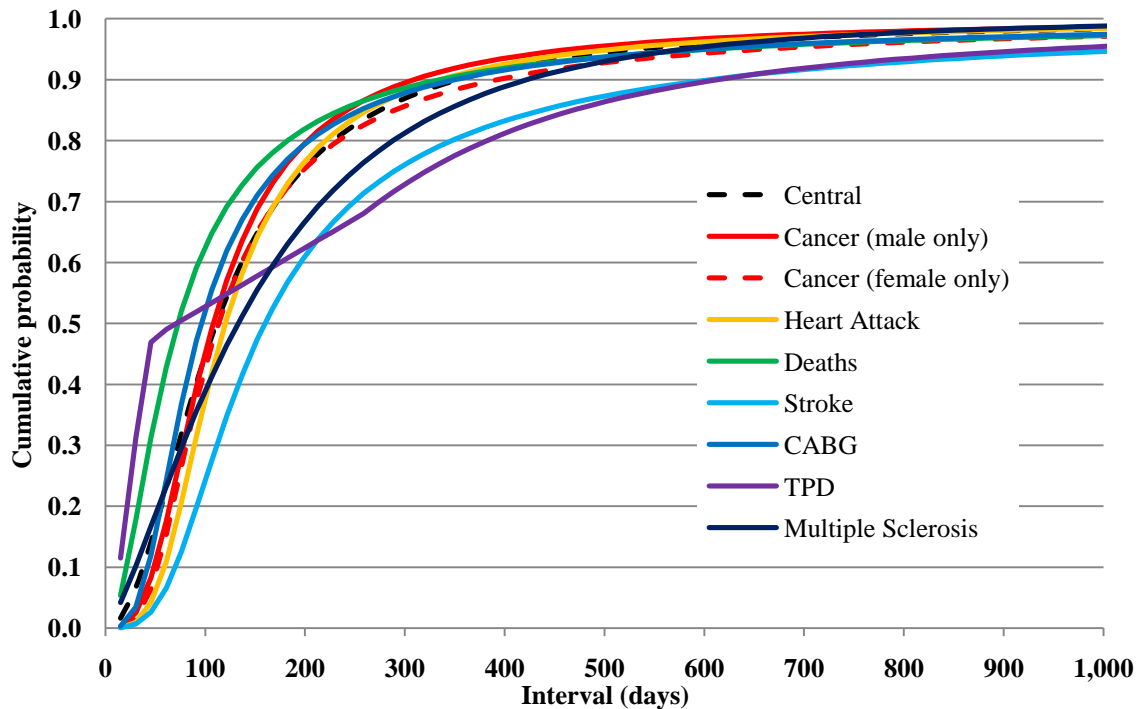
2.12. Note that the Committee has again not sought an alternative distribution to the Burr for TPD; instead the claim development distribution for TPD has been derived to reflect the "difference" between the claim development distributions for all-causes and for all-causes excluding TPD, with manual adjustments to ensure the cumulative distribution function was monotonically increasing. The unusual nature of the claim development distribution for TPD is apparent from Figure 2.1.

2.13. The distribution for death lies to the left of the central distribution in Figure 2.1, whilst those for stroke, TPD and multiple sclerosis (generally) lie to the right. The remaining cause-specific distributions are difficult to distinguish from each other and from the central distribution that has been used in the all-causes work. This demonstrates the relative lack of variation between these causes. Comparing Figure 2.1 to the corresponding chart for the 1999-2004 dataset (Figure 5.1 of Working Paper 43) shows that the new CDDs for death and TPD are closer to the central distribution than previously, whereas the distribution for stroke appears to have lengthened. Note that in Working Paper 43, CDDs were not shown for multiple sclerosis and female cancer.

The derivation of cause-specific rates
2.14. The methodology used to derive cause-specific rates is identical to that used for the all-causes rates in Working Paper 50, with the following exceptions:
   - The Expected Diagnosed Claims are calculated using the cause-specific rates from the CIBT02 table, rather than the all-causes rates;
   - The Expected Settled Claims are calculated from the Expected Diagnosed Claims using a cause-specific claim development distribution (CDD); and
   - The Actual Settled Claims are those for the particular cause of claim only.

2.15. For each cause of claim, the following tables are contained in Appendix B, for male non-smokers:
- The Actual Settled Claims;
- Adjustments to the cause-specific rates from the CIBT02 table for quinquennial ages; and
- The Actual Settled Claims / Expected Settled Claims values using the adjusted rates.

Note that the cause-specific rates from the CIBT02 Core Cover tables were used to calculate Expected Diagnosed Claims. Where the CIBT02 Core rates differ from the Extended rates, the adjustments will differ (and apply to the Core rate) but the cause-specific rates themselves should not be materially affected.

2.16. Corresponding tables are contained in Appendices C, D and E for male smokers, female non-smokers and female smokers, respectively. Appendix B also contains high-level accompanying notes illustrating the derivation of the cause-specific rates.

2.17. The tables of Actual Settled Claims cover the same age range (20 to 70) as the corresponding all-causes tables in section 6 of Working Paper 50; however because of the low numbers of claims at either end of this age range, the tables of adjustments and the fit of the cause-specific rates to the data cover ages 30 to 60 only.

2.18. In order to allow easier comparison of the cause-specific rates with the all-causes rates, the Committee opted to assume the same durational pattern as for the corresponding all-causes rates. For example, for male non-smokers we combined durations 1 to 4 for each cause.

2.19. The Committee recognises that the true underlying selection pattern could be hidden by the approach used and that different durational patterns may have been derived for the cause-specific rates, however the Committee considered that the numbers of claims were insufficient to justify this. Nevertheless, differences are then apparent from the tables of Actual / Expected in Appendices B to E.

2.20. The female non-smoker multiple sclerosis rates provide an example where the Committee would not have chosen the same grouping (of durations 1 to 4), as for the corresponding all-causes rates, if it had been deriving rates by duration specifically for that cause. Instead, the rates could have been different for each duration, with rates increasing from duration 0 to duration 1 to duration 2 etc, or perhaps by grouping durations 1 and 2 and durations 3 and 4.

2.21. The rates themselves are contained in Appendix F to this paper. Note that the Committee did not undertake the same level of smoothing as for the all-causes rates (see paragraph 8.2 of Working Paper 50). In particular, our approach of using "relatively smooth" adjustments to CIBT02 (see paragraph 6.12 of Working Paper 50) does not necessarily produce smooth rates where the CIBT02 rates are very low and changing rapidly, as can occur at a cause-specific level.

2.22. Appendix F also contains residual rates; these have been derived as the difference between the sum of the cause-specific rates and the all-causes rates, not as a separate "other causes" category. Note that the all-causes rates used to calculate the residuals are the fitted rates derived in section 6 of Working Paper 50; i.e. before the additional smoothing (referred to in paragraph 8.2 of Working Paper 50) was applied.

3. CAUSE-SPECIFIC RATES: MALE NON-SMOKERS

3.1. For male non-smokers, cause-specific rates have been derived for the following causes: cancer, heart attack, death, stroke, CABG and TPD. In total, these causes account for 89% of the claims within the dataset after excluding those offices that were unable to supply cause of claim (see paragraph 2.8).

3.2. Table 3.1 shows the overall percentages of the relevant cause-specific rates from CIBT02 that are required to equate the Actual Settled Claims with the Expected Settled Claims for male non-smokers for all ages and durations combined. This shows that a lower percentage adjustment to the cause-specific CIBT02 table than the corresponding all-causes adjustment of 35% is required for most of the causes considered to arrive at insured experience; this is especially so for heart attack and TPD. The exception is cancer, where the insured experience is a much higher percentage of the population experience.

Table 3.1: Percentage of the relevant cause-specific rates from CIBT02 to equate ASC and ESC

Cause	% of CIBT02
Cancer	57%
Heart Attack	21%
Death	31%
Stroke	29%
CABG	32%
TPD	11%

3.3. The Committee was pleased to note the overall similarity between these values and the corresponding figures from Table 5.2 of Working Paper 43, using the 1999-2004 dataset. (A more detailed comparison of these rates with those derived in Working Paper 43 is contained in Appendix H.)

3.4. Considerable variation in the adjustments to the cause-specific CIBT02 rates exists by age; this is shown in Figure 3.1, for ultimate durations only.

Figure 3.1: Cause-specific diagnosis rates relative to CIBT02 by age, male non-smokers, durations 5+
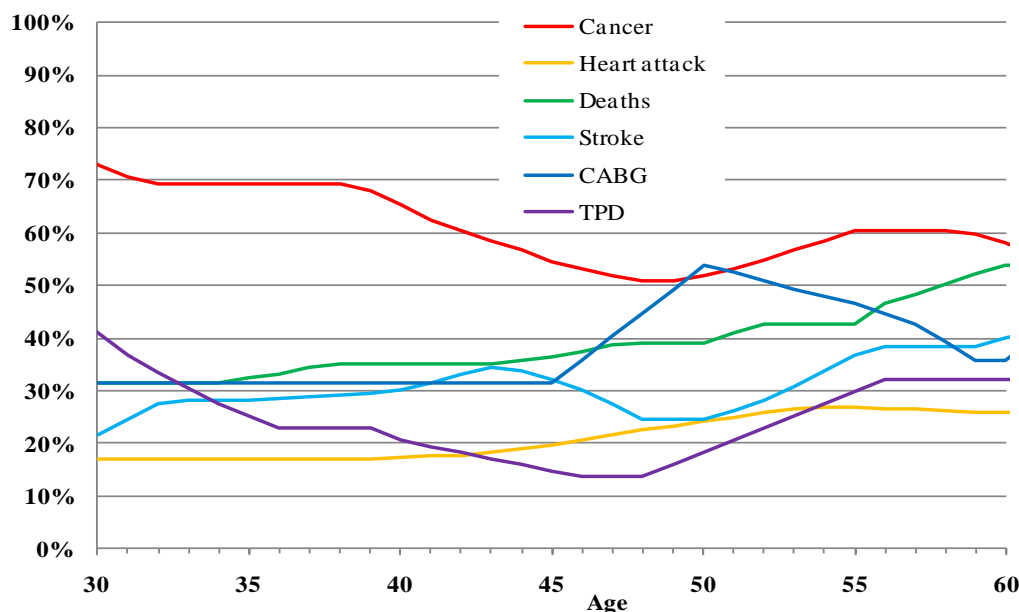
Comparison of cause-specific rates with all-causes rates

3.5. Figures 3.2 and 3.3 illustrate the cumulative cause-specific rates, in absolute terms and as a percentage of the all-causes rates. Both figures also show the residual rates.

3.6. Across the age range 30 to 60, the sum of the rates by cause varies between 84% and 100% of the all-causes rates derived earlier. The average residual, across these ages, is 10%, which is consistent with the percentage of the total claims that these "other" causes represent. These findings are very similar to those in Working Paper 43.

Figure 3.2: Cumulative cause-specific diagnosis rates by age, male non-smokers, durations 5+

Figure 3.3: Cumulative cause-specific diagnosis rates as a percentage of the all-causes rates, by age, male non-smokers, durations 5+
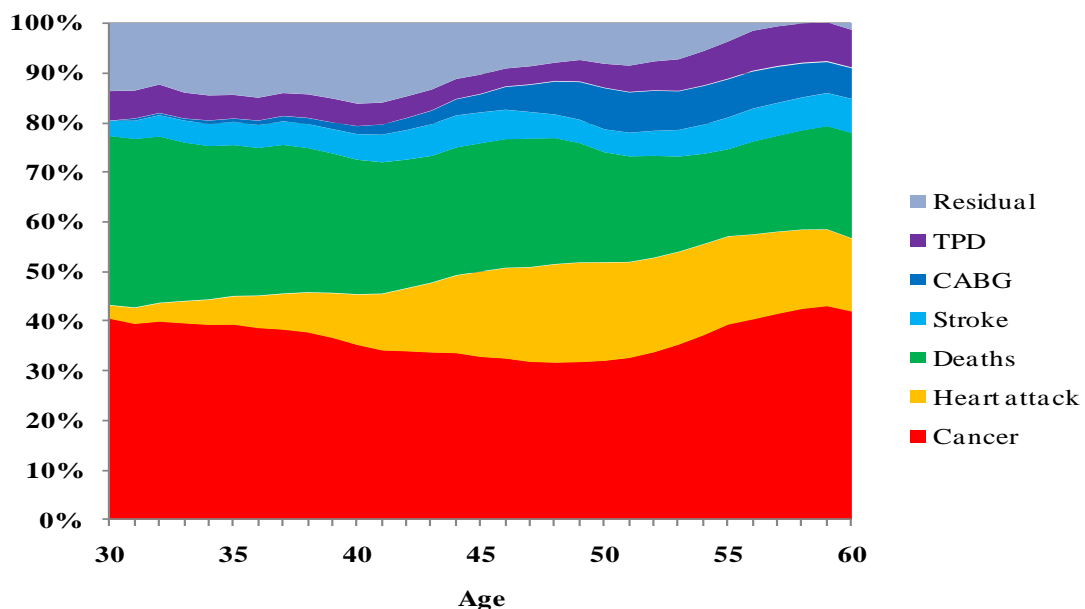
Selection

3.7. As noted in section 2, the cause-specific rates have been derived assuming that the same durational pattern applies to each set of cause-specific rates as for the all-causes rates in Working Paper 50, i.e. durations 0, 1-4 and 5+ for male non-smokers. Figure 3.4 shows the ratio of the rates at durations 0 and 1-4 to the ultimate duration 5+ rates for each

cause. In these rates, these ratios do not depend on age (other than from the rounding of rates).

Figure 3.4: Diagnosis rates at durations 0 and 1-4 as a percentage of the durations 5+ rates, male non-smokers
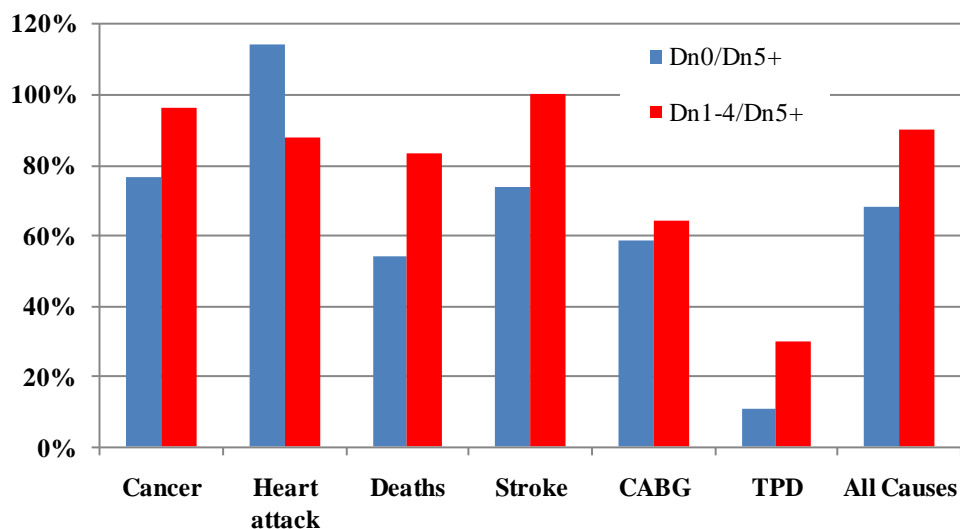
3.8. The extent of initial selection varies by cause, with less selection apparent for cancer, stroke and − in particular − heart attack, where the duration 0 rates exceed those at durations 1-4 and durations 5+ (this is discussed further in section 7).

4.   CAUSE-SPECIFIC RATES: MALE SMOKERS

4.1.   For male smokers, cause-specific rates have been derived for cancer, heart attack and death. In total, these causes account for 81% of the claims within the dataset after excluding those offices that were unable to supply cause of claim (see paragraph 2.8).

4.2.   Table 4.1 shows the overall percentages of the relevant cause-specific rates from CIBT02 that are required to equate the Actual Settled Claims with the Expected Settled Claims for all ages and durations combined. This shows that both cancer and heart attack require a higher percentage adjustment to the cause-specific CIBT02 table than the corresponding all-causes adjustment of 63%.

Table 4.1: Percentage of the relevant cause-specific rates from CIBT02 to equate ASC and ESC

Cause	% of CIBT02
Cancer	74%
Heart Attack	78%
Death	61%

4.3.   Considerable variation in the adjustments to the cause-specific CIBT02 rates exists by age; this is shown in Figure 4.1, for ultimate durations only.

Figure 4.1: Cause-specific diagnosis rates relative to CIBT02 by age, male smokers, durations 3+
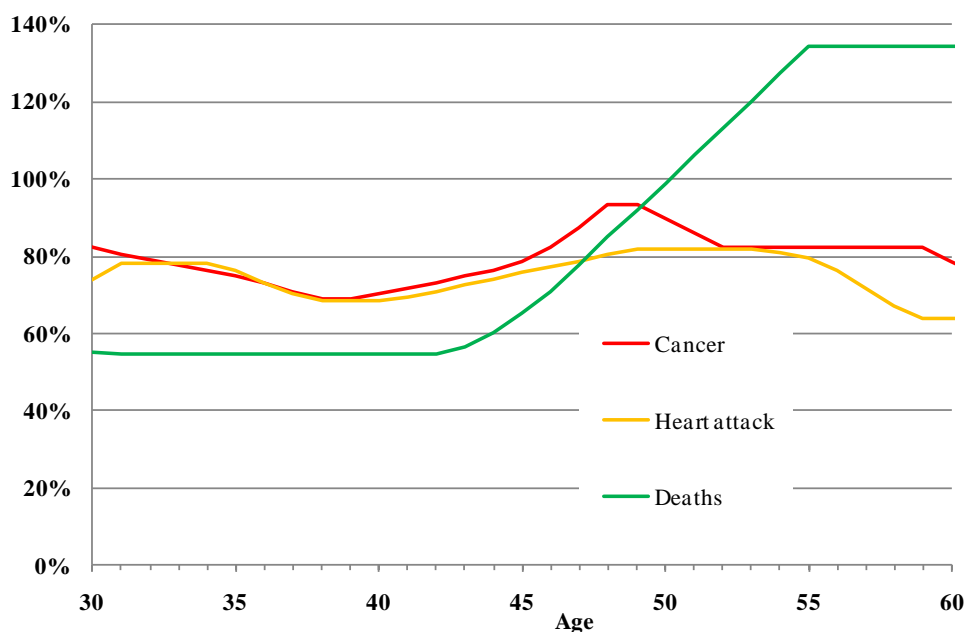
Comparison of cause-specific rates with all-causes rates

4.4.   Figures 4.2 and 4.3 illustrate the cumulative cause-specific rates for durations 3+, in absolute terms and as a percentage of the all-causes rates. Both figures also show the residual rates.

4.5.   Across the age range 30 to 60, the sum of the rates by cause varies between 77% and 94% of the all-causes rates derived earlier. The average residual, across these ages, is 18%.

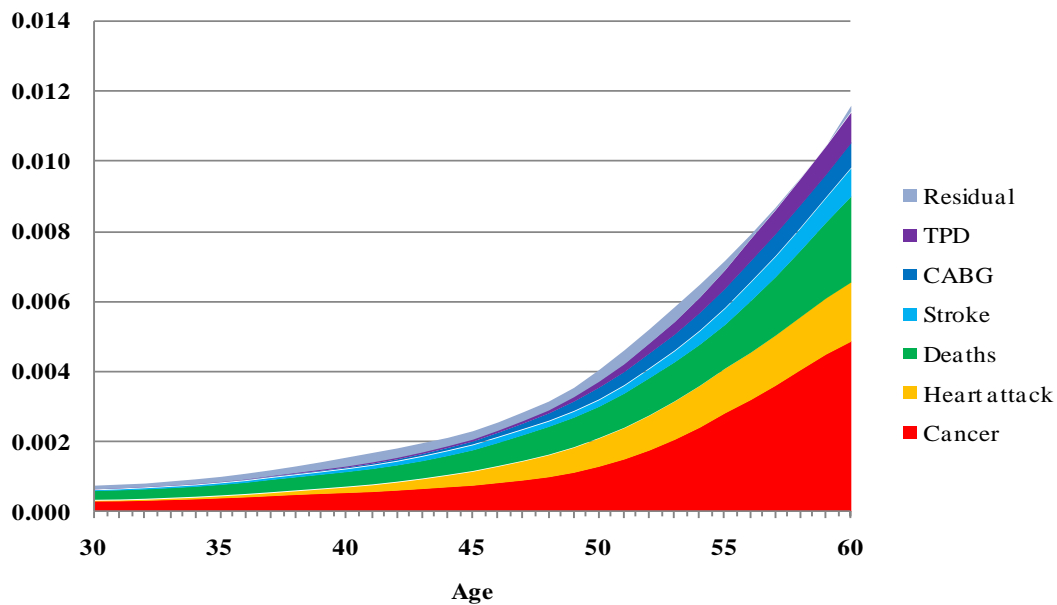Figure 4.2: Cumulative cause-specific diagnosis rates by age, male smokers, durations 3+
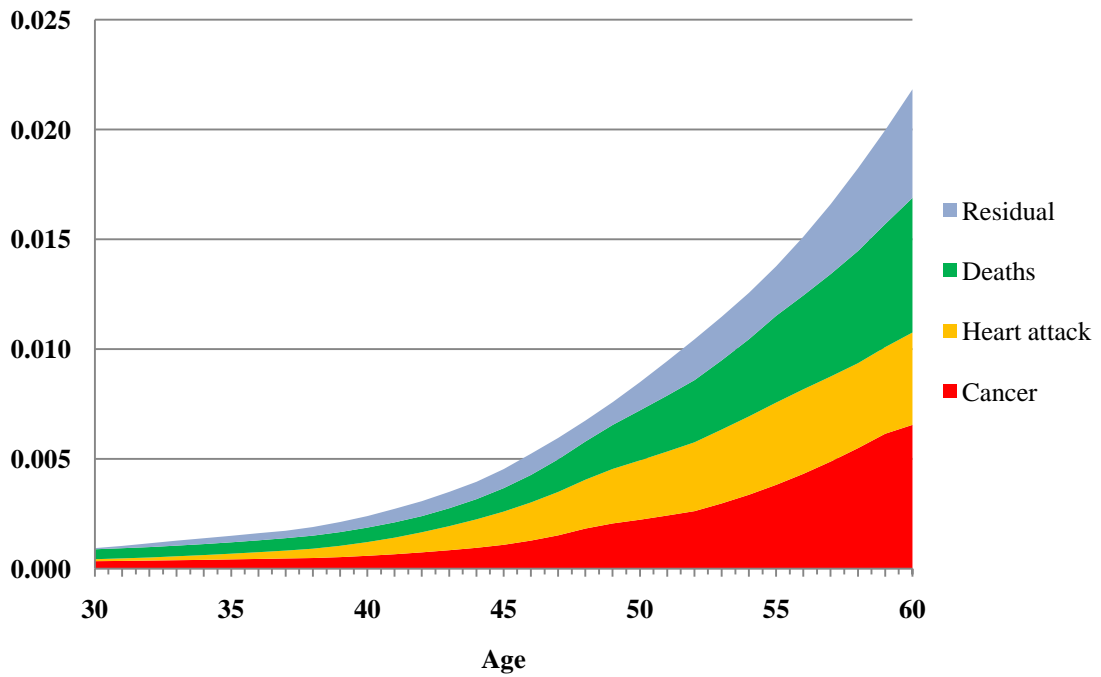
Figure 4.3: Cumulative cause-specific diagnosis rates as a percentage of the all-causes rates, by age, male smokers, durations 3+
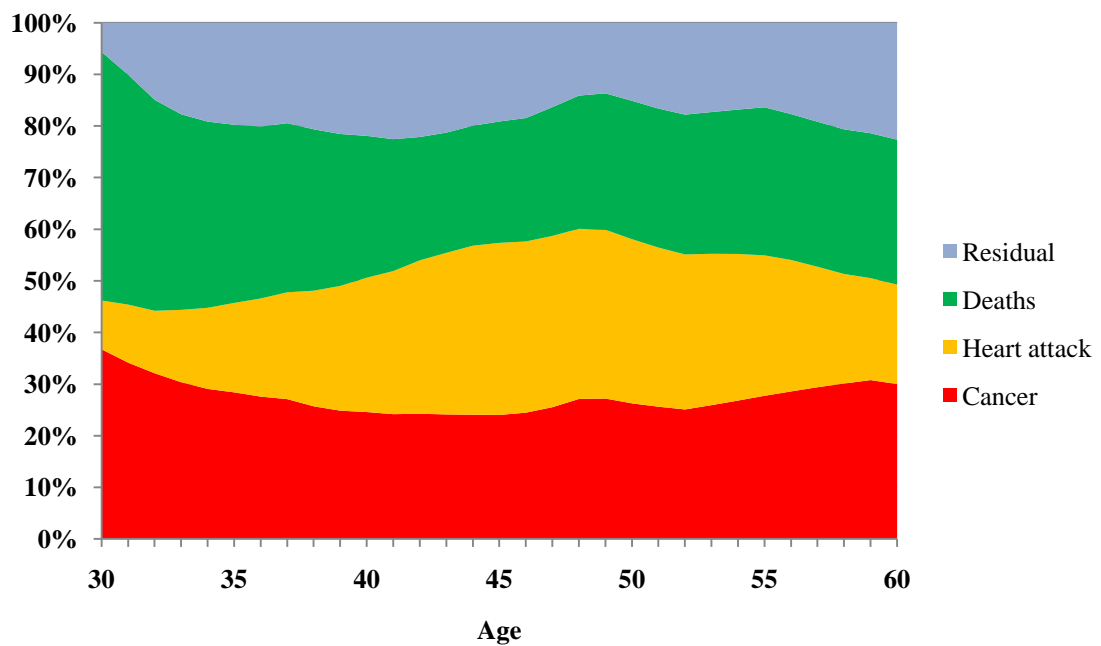
Selection

4.6. As noted in section 2, the cause-specific rates have been derived assuming that the same durational pattern applies to each set of cause-specific rates as for the all-causes rates in Working Paper 50, i.e. durations 0, 1-2 and 3+ for male smokers. Figure 4.4 shows the ratio of the rates at durations 0 and 1-2 to the ultimate duration 3+ rates for each cause. In these rates, these ratios do not depend on age (other than from the rounding of rates).

Figure 4.4: Diagnosis rates at durations 0 and 1-2 as a percentage of the durations 3+ rates, by cause, male smokers
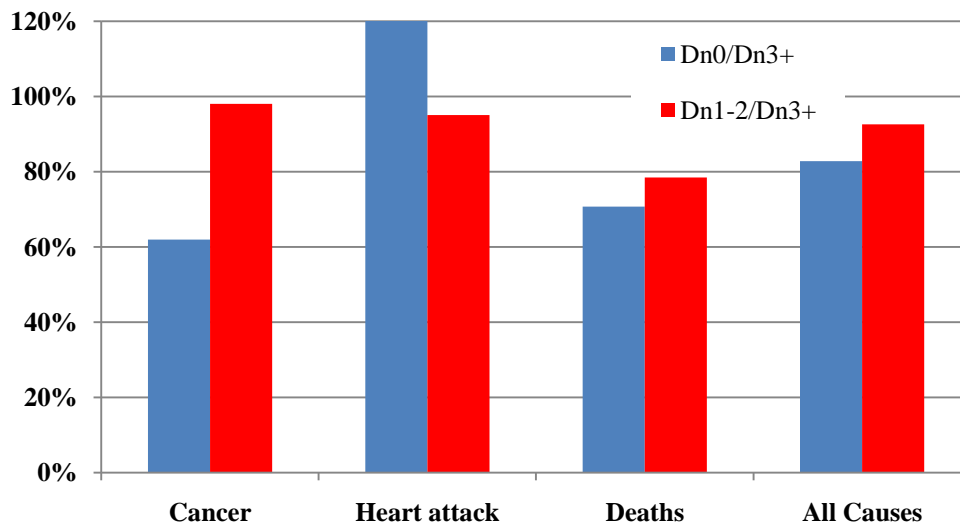
4.7. Cancer and deaths both exhibit greater initial selection than the all-causes rates however, as for male non-smokers, the duration 0 heart attack rates exceed those at later durations (this is discussed further in section 7).

5. CAUSE-SPECIFIC RATES: FEMALE NON-SMOKERS

5.1. For female non-smokers, cause-specific rates have been derived for cancer, death, stroke and multiple sclerosis (MS). In total, these causes account for 91% of the claims within the dataset after excluding those offices that were unable to supply cause of claim (see paragraph 2.8).

5.2. Table 5.1 shows the overall percentages of the relevant cause-specific rates from CIBT02 that are required to equate the Actual Settled Claims with the Expected Settled Claims for all ages and durations combined. The overall all-causes adjustment for female non-smokers was 42% so, as for males, the most notable feature of Table 5.1 is that the insured experience is a much higher percentage of the population experience for cancer.

Table 5.1: Percentage of the relevant cause-specific rates from CIBT02 to equate ASC and ESC

Cause	% of CIBT02
Cancer	66%
Death	39%
Stroke	27%
MS	46%

5.3. Considerable variation in the adjustments to the cause-specific CIBT02 rates exists by age; this is shown in Figure 5.1, for ultimate durations only.

Figure 5.1: Cause-specific diagnosis rates relative to CIBT02 by age, female non-smokers, durations 5+
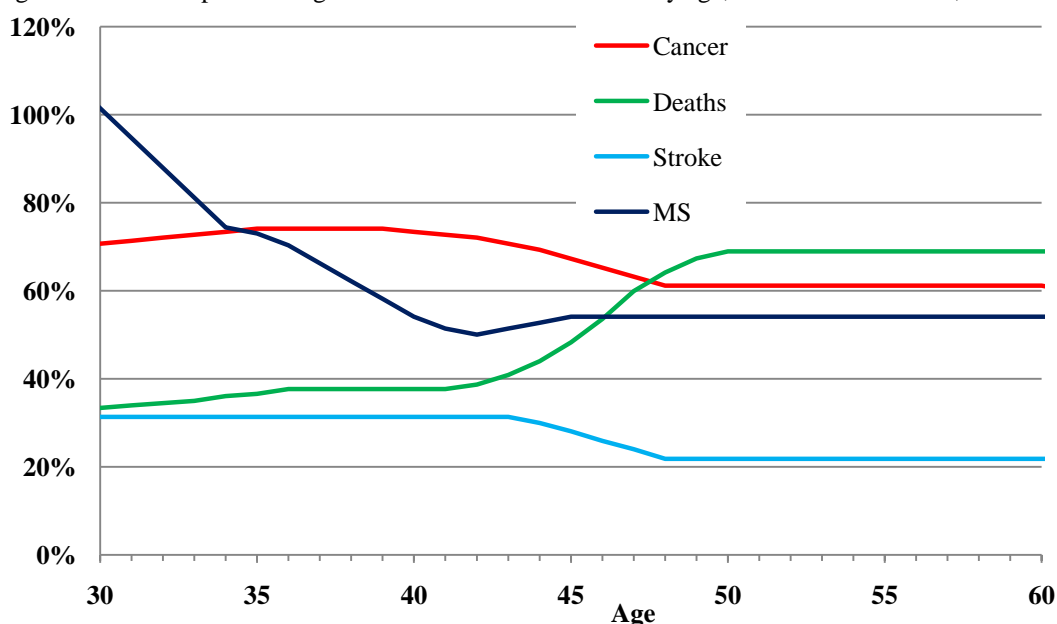
Comparison of cause-specific rates with all-causes rates

5.4. Figures 5.2 and 5.3 illustrate the cumulative cause-specific rates for durations 5+, in absolute terms and as a percentage of the all-causes rates. Both figures also show the residual rates.

5.5. Across the age range 30 to 60, the sum of the rates by cause varies between 81% and 95% of the all-causes rates derived earlier. The average residual, across these ages, is 10%.

Figure 5.2: Cumulative cause-specific diagnosis rates by age, female non-smokers, durations 5+
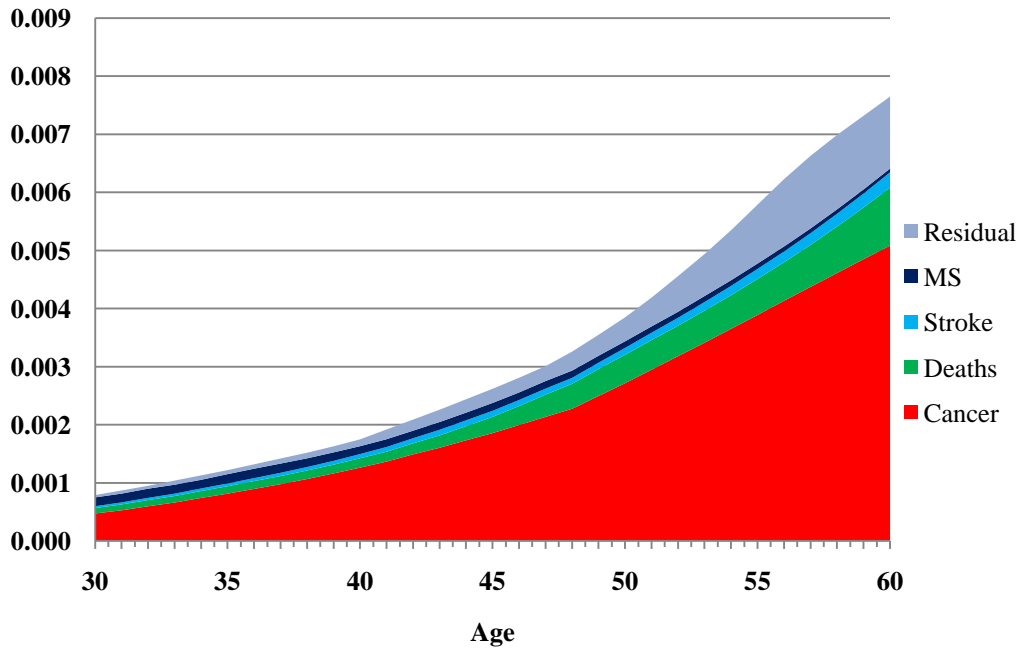
Figure 5.3: Cumulative cause-specific diagnosis rates as a percentage of the all-causes rates, by age, female non-smokers, durations 5+
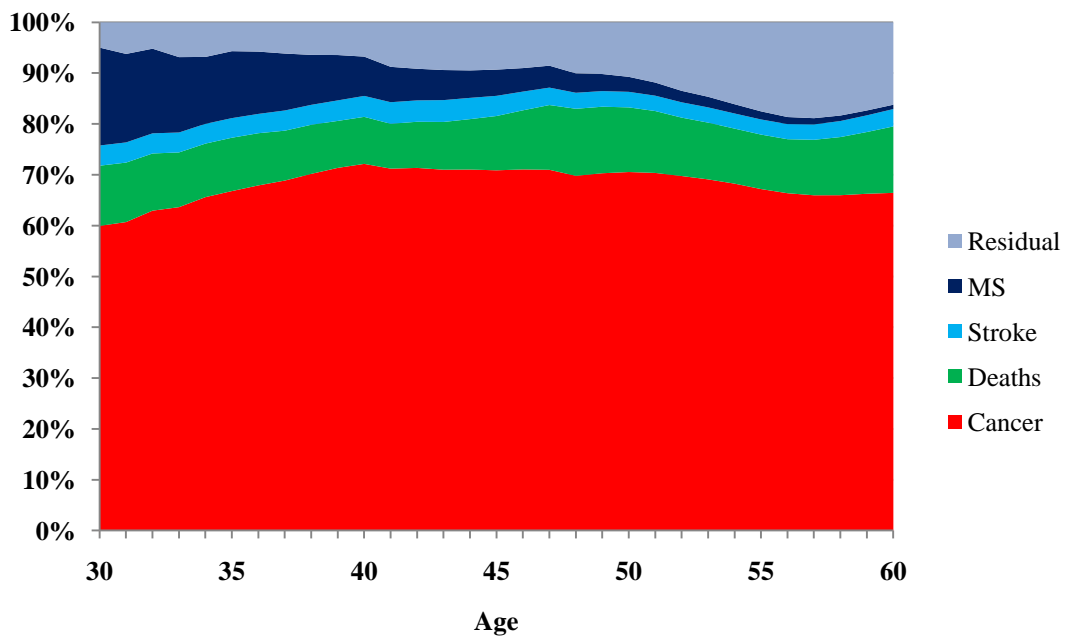
Selection

5.6. As noted in section 2, the cause-specific rates have been derived assuming that the same durational pattern applies to each set of cause-specific rates as for the all-causes rates in Working Paper 50, i.e. durations 0, 1-4 and 5+ for female non-smokers. Figure 5.4 shows the ratio of the rates at durations 0 and 1-4 to the ultimate duration 5+ rates for each cause. In these rates, these ratios do not depend on age (other than from the rounding of rates).

17

Figure 5.4: Diagnosis rates at durations 0 and 1-4 as a percentage of the durations 5+ rates, by cause, female non-smokers
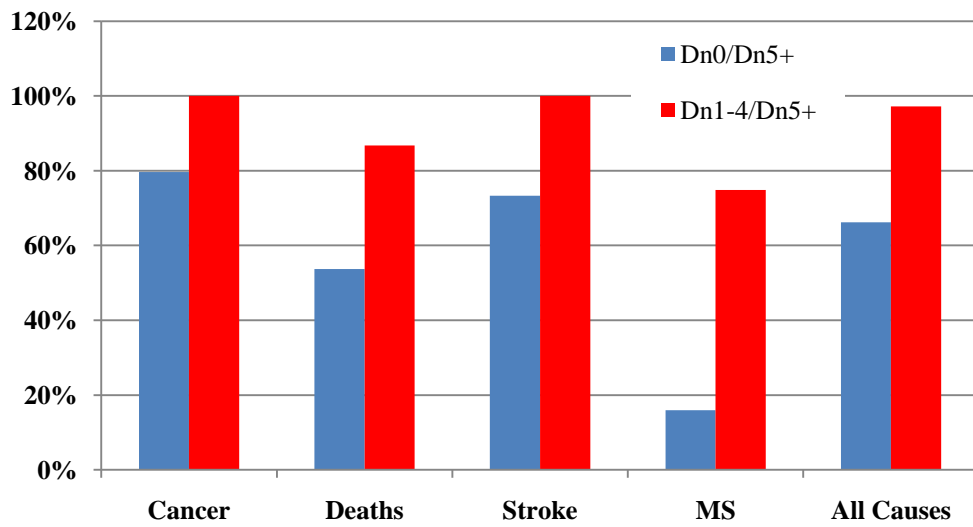
5.7. There is a high level of initial selection for MS and, to a lesser extent, death whilst cancer and stroke exhibit lower initial selection than the all-causes rates, with the durations 1-4 rates equal to the duration 5+ rates in each case.

6. CAUSE-SPECIFIC RATES: FEMALE SMOKERS

6.1. For female smokers, the numbers of claims only support the derivation of cause-specific rates for cancer and death. These causes account for 54% and 19% respectively of the claims within the dataset after excluding those offices that were unable to supply cause of claim (see paragraph 2.8).

6.2. Table 6.1 shows the overall percentages of the relevant cause-specific rates from CIBT02 that are required to equate the Actual Settled Claims with the Expected Settled Claims for all ages and durations combined. The overall all-causes adjustment for female smokers was 59%, much lower than the percentages for these two causes. Whilst the insured experience is a much lower percentage of the population experience for the other causes for which rates have not been derived, this also highlights that this first adjustment, applied at an all-ages and all-durations level, is quite a blunt tool. In particular the numbers of actual settled death claims at ages over 45 are significantly higher than the expected settled claims using the CIBT02 table.

Table 6.1: Percentage of the relevant cause-specific rates from CIBT02 to equate ASC and ESC

Cause	% of CIBT02
Cancer	71%
Death	105%

6.3. Considerable variation in the adjustments to the cause-specific CIBT02 rates exists by age; this is shown in Figure 6.1, for ultimate durations only.

Figure 6.1: Cause-specific diagnosis rates relative to CIBT02 by age, female smokers, durations 2+
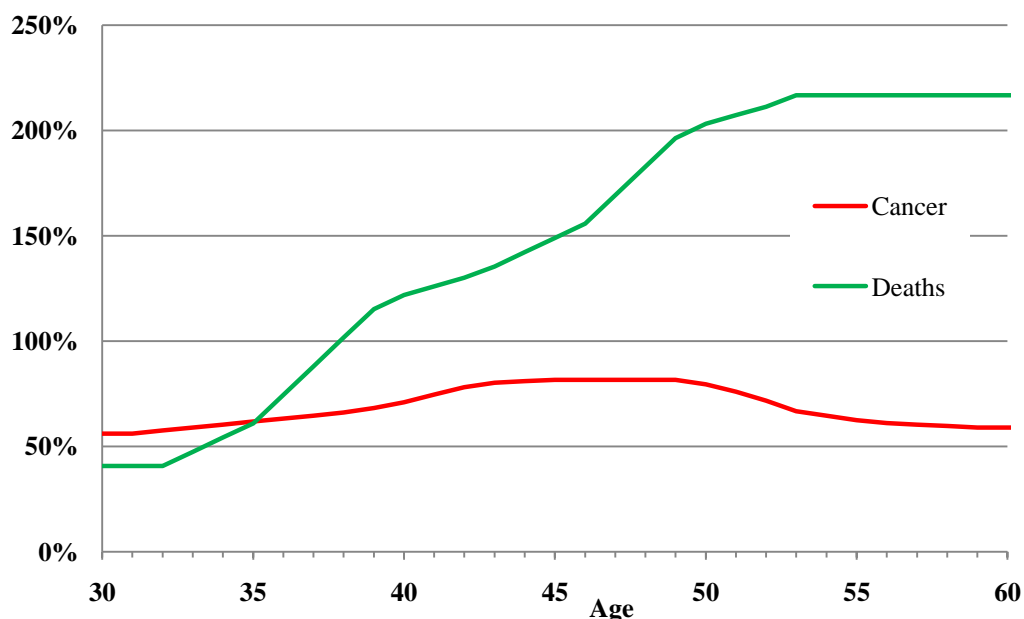
6.4. The very high adjustments to CIBT02 for deaths were investigated further. This is the smallest of the four gender/smoker datasets and the absolute numbers of claims at these older ages is relatively low (see Table E4 in Appendix E). In addition, it will be apparent from Table E6 that these rates do not fit closely to the data at ages 41-60. Nevertheless, to the extent that the volumes of data allow, the Committee consider that these rates provide a reasonable representation of the data.

Comparison of cause-specific rates with all-causes rates

6.5. Figures 6.2 and 6.3 illustrate the cumulative cause-specific rates for durations 2+, in absolute terms and as a percentage of the all-causes rates. Both figures also show the residual rates.

6.6. Across the age range 30 to 60, the sum of the rates by cause varies between 61% and 81% of the all-causes rates derived earlier. The average residual, across these ages, is 28%. Note that the residual element is higher for this dataset than for the other three gender/smoker datasets.

Figure 6.2: Cumulative cause-specific diagnosis rates by age, female smokers, durations 2+
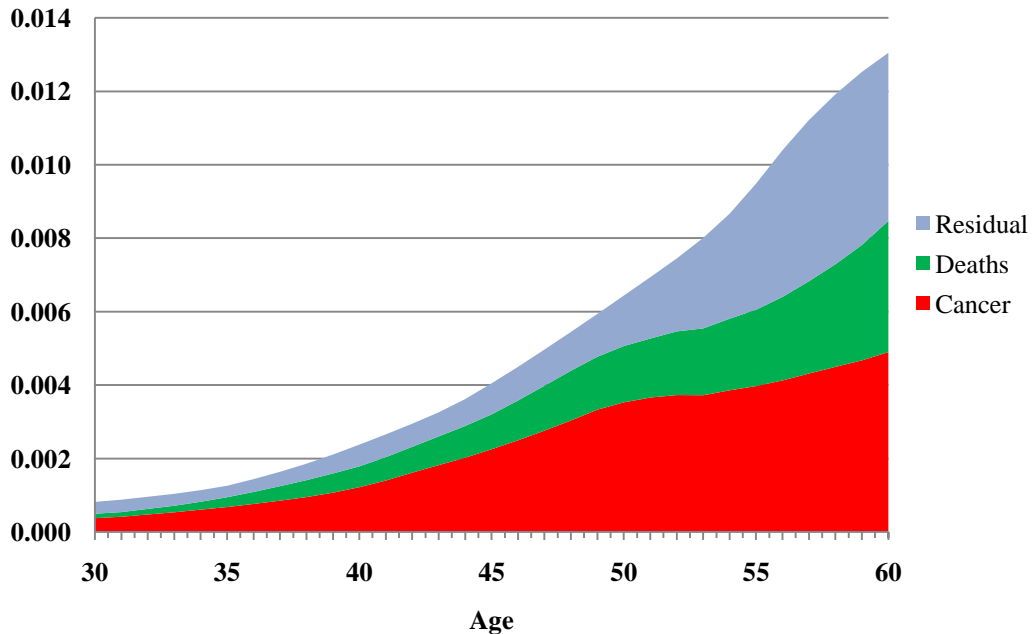
Figure 6.3: Cumulative cause-specific diagnosis rates as a percentage of the all-causes rates, by age, female smokers, durations 2+

20
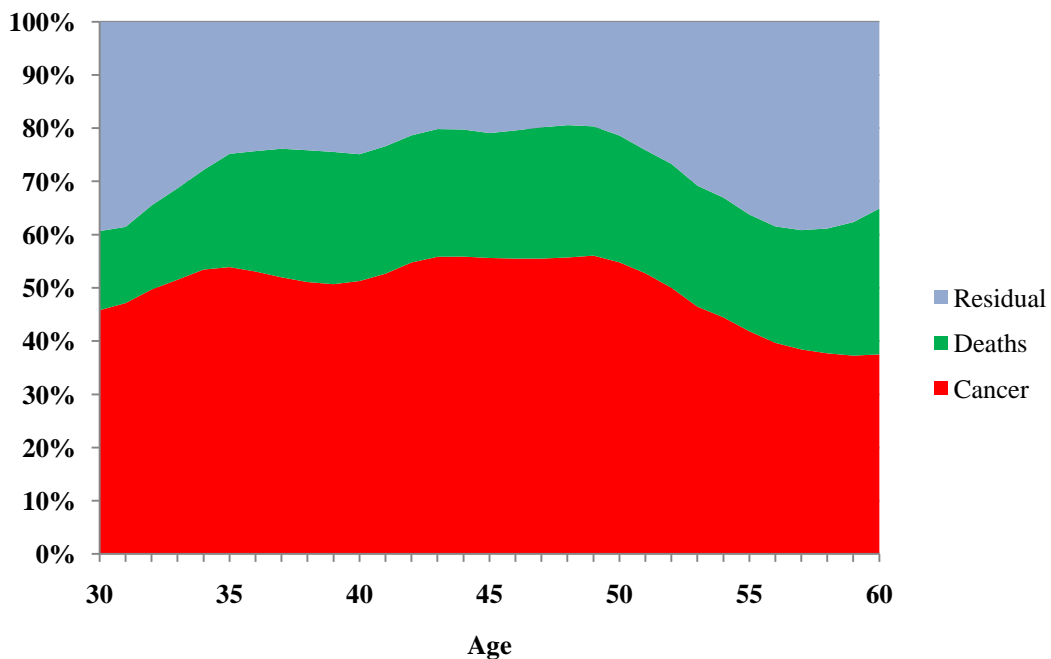
Selection

6.7. As noted in section 2, the cause-specific rates have been derived assuming that the same durational pattern applies to each set of cause-specific rates as for the all-causes rates in Working Paper 50, i.e. durations 0, 1 and 2+ for female smokers. Figure 6.4 shows the ratio of the rates at durations 0 and 1 to the ultimate duration 2+ rates for each cause. In these rates, these ratios do not depend on age (other than from the rounding of rates).

Figure 6.4: Diagnosis rates at durations 0 and 1 as a percentage of the durations 2+ rates, by cause, female smokers
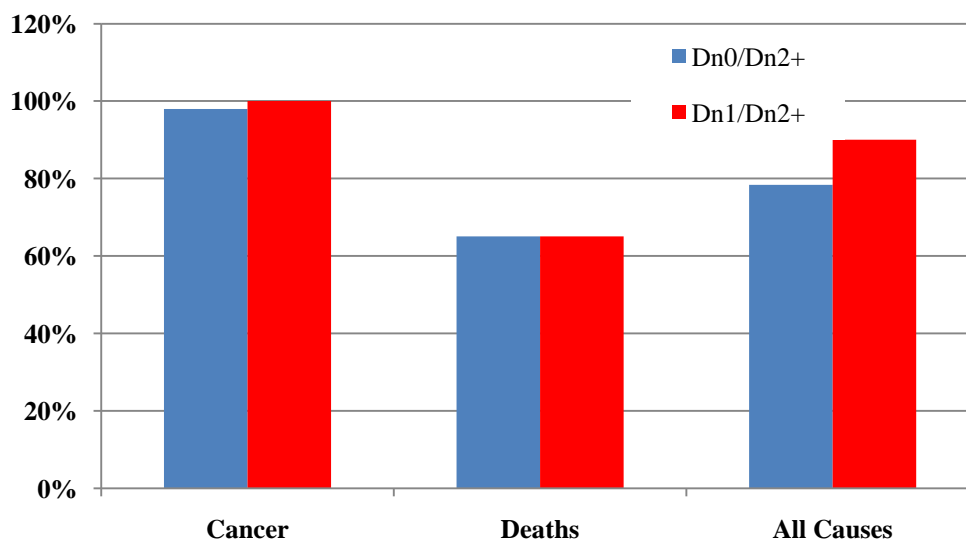
6.8. Cancer shows particularly low initial selection, with the duration 0 and 1 rates almost equal to the durations 2+ rates.

7. COMPARISONS OF CAUSE-SPECIFIC RATES

7.1. In this section we compare the various sets of cause-specific rates. Note that rates have only been derived for all four gender/smoker datasets for cancer and death; however we have also derived heart attack rates for both male datasets and rates for stroke for male and female non-smokers.

7.2. Note also that the ultimate rates referred to below differ between the datasets (2+ for female smokers, 3+ for male smokers and 5+ for male and female non-smokers). They may therefore not be directly comparable.

Cancer

7.3. The four sets of ultimate cancer rates are shown in Figure 7.1. Female rates exceed male rates at most ages, although at age 60 the rates for both female datasets are similar to that for male non-smokers. It is evident from the chart that the smoker/non-smoker differentials are reasonably consistent by gender up to age 50 when the numbers of claims start to tail off.

7.4. Note that at some ages the female non-smoker rates are higher than the corresponding smoker rates. This feature has not been removed in the cause-specific rates in Appendix F.

Figure 7.1: Ultimate cancer rates, by age, for all four gender/smoker datasets
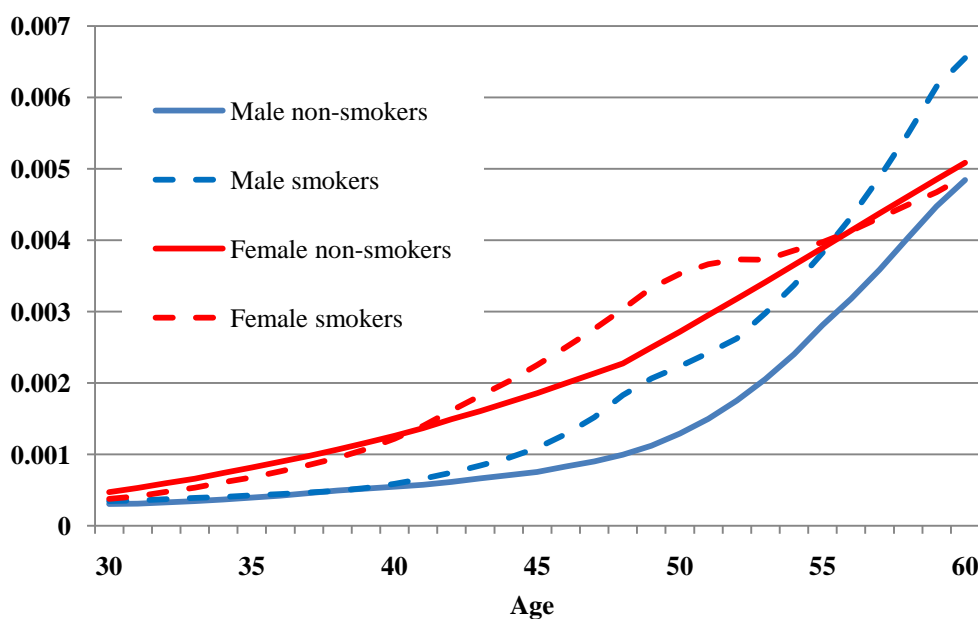
7.5. Figure 7.2 shows the ratio of the cancer rates at durations 0,1,2,3 and 4 to the ultimate duration 5+ rates. In these rates, these ratios do not depend on age (other than from the rounding of rates).

7.6. In all four datasets there is little selection after duration 0. The extent of selection apparent at duration 0 is around 20% for the two largest datasets (male and female non-smokers), with greater selection apparent for male smokers and less for female smokers.

Figure 7.2: Cancer diagnosis rates at durations 0,1,2,3 and 4 as a percentage of the durations 5+ rates, for all four gender/smoker datasets
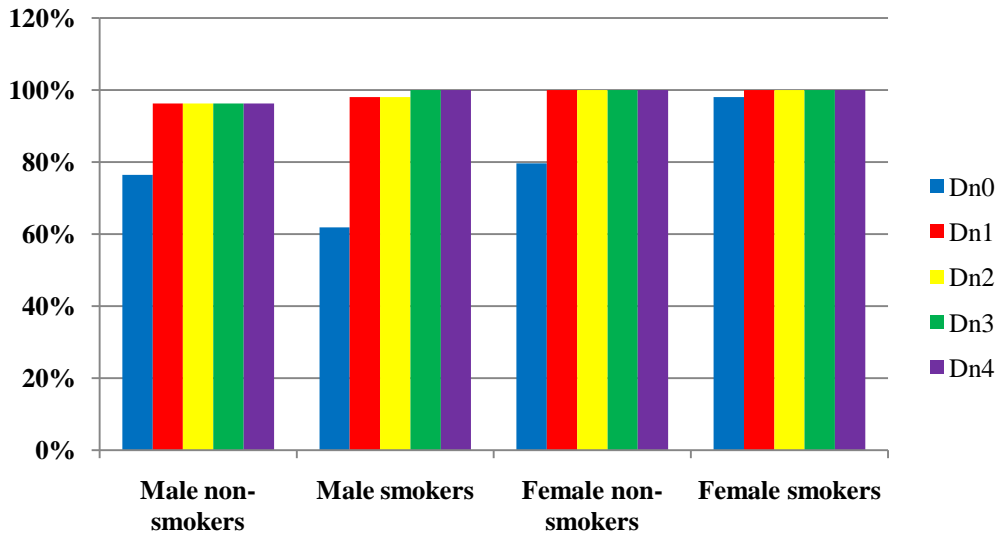
Death

7.7. The four sets of ultimate rates for death are shown in Figure 7.3. This highlights a clear differential between smokers and non-smokers for both males and females. As might be expected, female death rates are lower than the corresponding male rates (although this is not a given, since we are concerned with residual deaths after the lives with prior critical illness have left the exposure).

Figure 7.3: Ultimate death rates, by age, for all four gender/smoker datasets
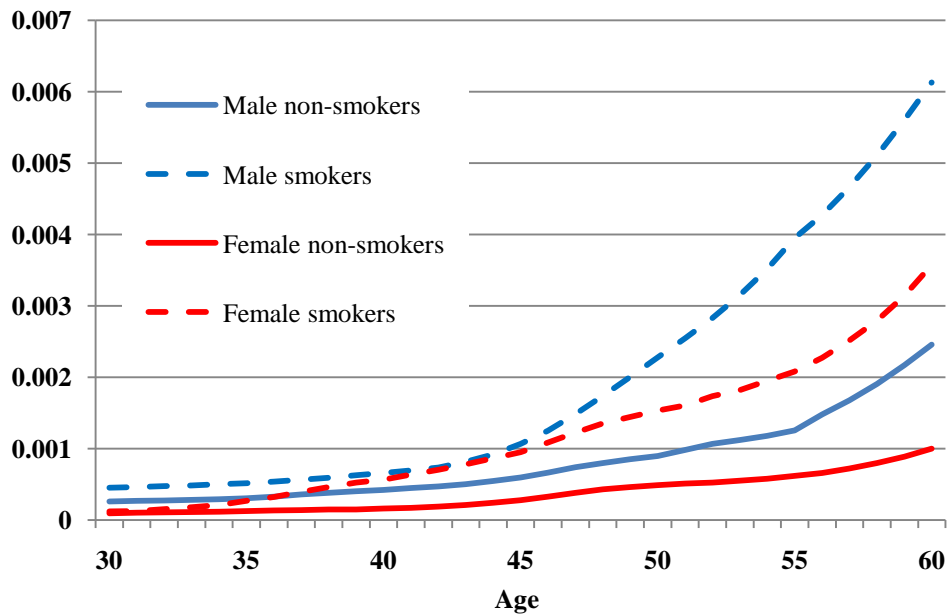
7.8. Figure 7.4 shows the ratio of the death rates at durations 0, 1, 2, 3 and 4 to the ultimate duration 5+ rates. Again, these ratios do not depend on age (other than from the rounding of rates).

7.9. In all four datasets there is significant selection at all durations (other than those combined with 5+ for ultimate rates).

Figure 7.4: Death rates at durations 0, 1, 2, 3 and 4 as a percentage of the durations 5+ rates, for all four gender/smoker datasets
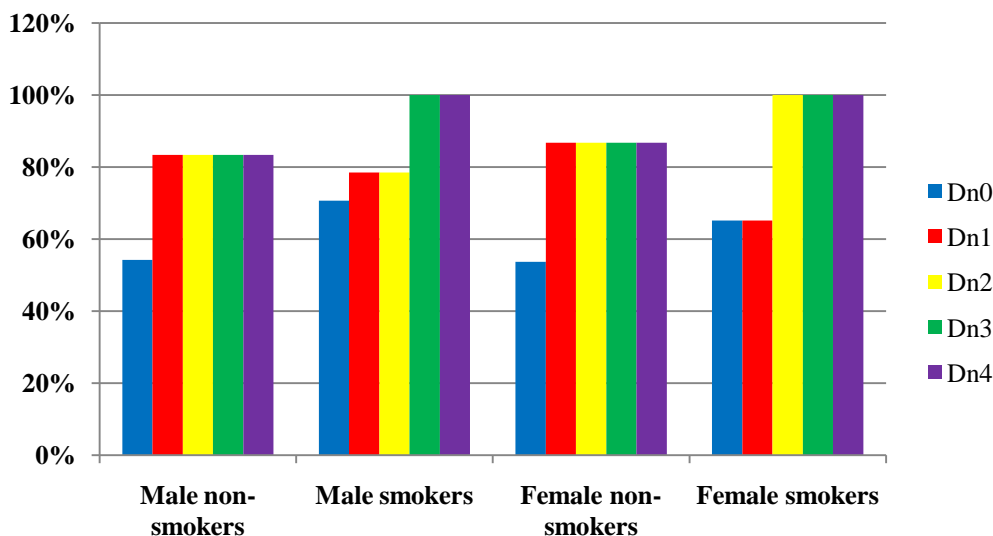
Heart attack

7.10. The ultimate rates for heart attack for the two male datasets are shown in Figure 7.5.

Figure 7.5: Ultimate heart attack rates, by age, for the two male datasets
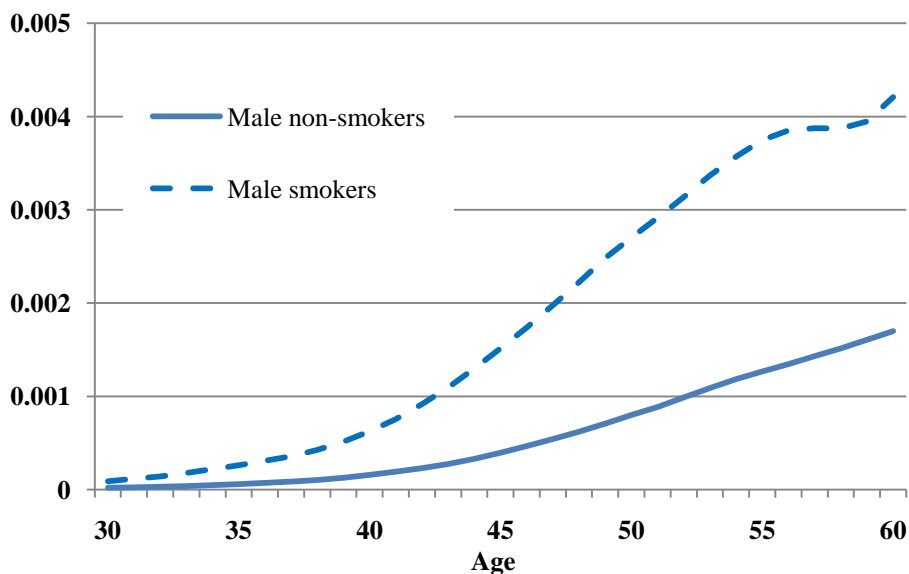
7.11. Figure 7.6 shows the ratio of the heart attack rates at durations 0, 1, 2, 3 and 4 to the ultimate duration 5+ rates. Again, these ratios do not depend on age (other than from the rounding of rates).

7.12. Both the male datasets show adverse selection at duration 0, with relatively weak positive selection thereafter for male smokers but higher selection at durations 1 to 4 for male non-smokers.

7.13. This apparent anti-selection for heart attack was not visible in the rates for 1999-2004 data, derived in Working Paper 43. Whilst is does appear to be a genuine feature of these rates, for both male datasets, the Committee highlights:

- The relatively low number of claims underlying these rates (163 claims settled at duration 0 across the two datasets); and
- That the methodology uses a single CDD, derived from all heart attack claims whereas the true underlying distribution for claims diagnosed at very short durations could be very different.

Figure 7.6: Heart attack rates at durations 0,1,2,3 and 4 as a percentage of the durations 5+ rates, for the two male datasets
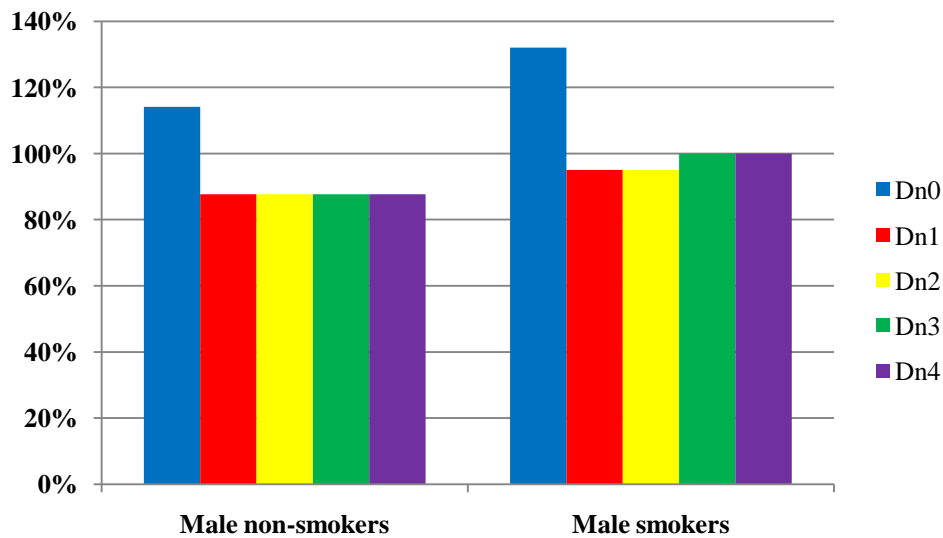
Stroke

7.14. The ultimate rates for stroke for male and female non-smokers are shown in Figure 7.7. The female rates are noticeably higher than the male rates at many ages; this is in contrast with population experience, as represented by CIBT02.

Figure 7.7: Ultimate stroke rates, by age, for the two non-smoker datasets
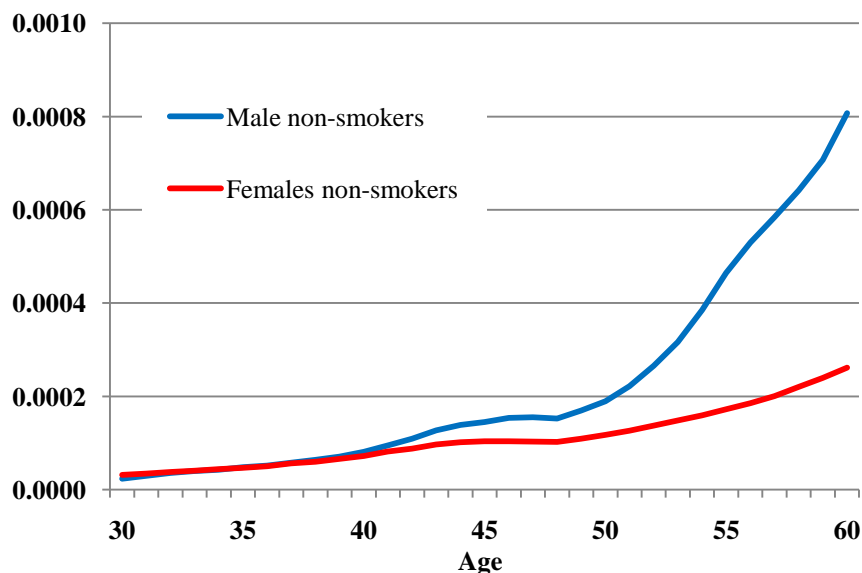
7.15. Figure 7.8 shows the ratio of the stroke rates at durations 0, 1 ,2, 3 and 4 to the ultimate duration 5+ rates. Again, these ratios do not depend on age (other than from the rounding of rates).

7.16. In both datasets, selection of around 30% is apparent at duration 0, with no positive selection at durations 1 to 4.

Figure 7.8: Stroke rates at durations 0, 1, 2, 3 and 4 as a percentage of the durations 5+ rates, for the two non-smoker datasets
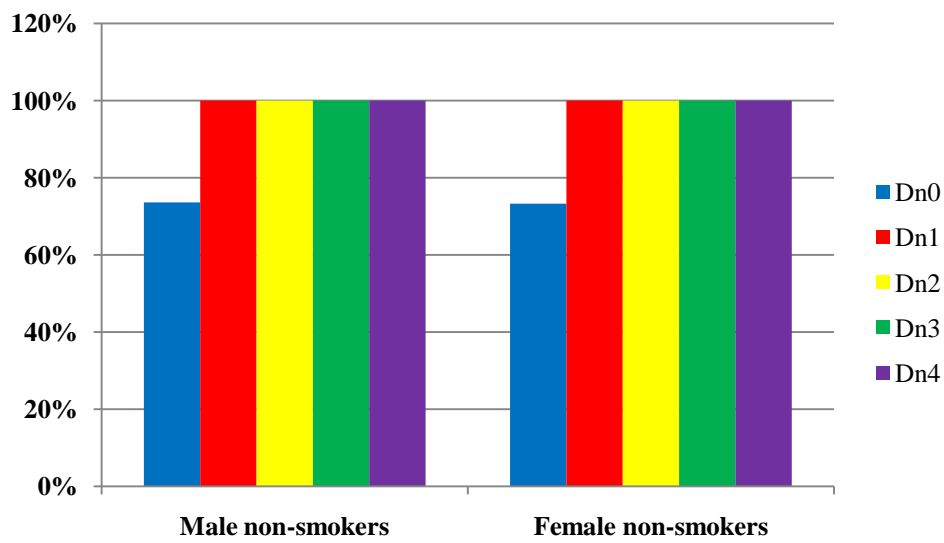
8. SUMMARY

8.1. This paper presents cause-specific claim diagnosis rates for accelerated critical illness insurance, on a 'lives' basis, using data for claims settled in 2003 to 2006. Separate sets of rates are included in the paper for males and females and for non-smokers and smokers for ages 30 to 60. In each case, rates have been derived for those causes of claim with at least 200 settled claims during the period; i.e.:

Male Non-Smoker	Cancer, Heart attack, Death, Stroke, CABG and TPD
Male Smoker	Cancer, Heart attack and Death
Female Non-Smoker	Cancer, Death, Stroke and MS
Female Smoker	Cancer and Death.

8.2. These rates are intended to be illustrative and, in particular, do not form part of the formal AC04 Series of diagnosis rates published in Working Paper 50.

8.3. The overall 2003-2006 dataset is described in more detail in Working Paper 50 and this is not repeated here. In particular, the immaturity of the 2003-2006 dataset and the possible consequent distortion of the shape of the rates by both age and duration was noted. The data underlying this work is a subset of that used to derive all-causes rates; but nevertheless contains nearly 16,000 settled claims.

8.4. Section 2 of this paper considers the data available to us; in particular it shows the fitted claim development distributions (CDDs) for the 2003-2006 dataset using a Burr model. We have used a single CDD for each cause in this work, derived from data for both genders and both smoker statuses, with the exception of cancer where separate CDDs were used for males and females. For many causes, the resulting CDD is reasonably close to the central CDD fitted to the all-causes data and used in Working Paper 50.

8.5. The derivation of the cause-specific diagnosis rates is also described in section 2. The method used to derive these rates is consistent with that used to derive the all-causes rates in Working Paper 50; i.e. we adjusted an initial set of rates (in this case the relevant cause-specific CIBT02 rates) first by age only, and then by duration only, to broadly fit the expected settled claims to the actual settled claims. This was done in a pragmatic manner – for each gender/smoker dataset and for each cause independently – to reach a reasonable fit, having regard to the data volumes. The selection patterns inferred from the all-causes rates were also used in this work, however the results in the paper illustrate the different degree of selection between different causes.

8.6. The rates for each of the four gender/smoker datasets are then considered in sections 3 to 6 of this paper and some comparisons between the rates are contained in section 7.

8.7. Note that the Committee did not undertake the same level of smoothing as the all-causes rates; in particular, our approach of using "relatively smooth" adjustments to CIBT02 does not necessarily produce smooth rates where the CIBT02 rates are very low and changing rapidly, as can occur at a cause-specific level.

8.8. The low absolute numbers of claims for some causes again create considerable uncertainty in the cause-specific rates for certain causes, particularly CABG and TPD for male non-smokers and stroke for female non-smokers. However the sum of the cause-specific rates corroborates well with the all-causes rates for each dataset and the

latest rates show a high degree of consistency with the 1999-2004 rates (derived for male non-smokers only).

8.9. In many cases, the relationships between the various sets of cause-specific rates conform to what one might reasonably have expected; for example, cancer rates are higher for females than males and the differentials between smokers and non-smokers are relatively narrow. A comparison of the four sets of death rates also produces a similar ranking to that visible in "normal" mortality experience. However the Committee considers that these rates add insights in a number of areas, including the following:

- The rates indicate that the adjustments required to the relevant CIBT02 rates vary considerably between the main causes, in particular the cancer rates are a significantly higher percentage of CIBT02 than the other main causes.
- Relative to CIBT02, the rates can also vary significantly by age, for example multiple sclerosis experience for female non-smokers appears to reduce with increasing age.
- The selection patterns by cause are also interesting, with relatively little positive selection on cancer, across all four gender/smoker datasets, and with apparent adverse selection at duration 0 for heart attack.

8.10. A substantial number of assumptions again underlie these rates. It is important to recognise that there is some uncertainty associated with each of these, and hence a considerable degree of uncertainty surrounds the rates. Most of these assumptions are unchanged from those used to produce adjusted results in Working Paper 33. Indeed, no additional assumptions were required to produce the diagnosis rates in this paper (or the AC04 rates). These assumptions were discussed in Working Paper 43 and, although not repeated here, also apply to these rates.

8.11. Although the Committee considers these rates to be a reasonable estimate of the true underlying rates, it is by no means the only set of rates that could have been derived and other approaches may be equally valid. Consequently, and as for the earlier sets of rates, the Committee is making available to member offices spreadsheets containing summarised data that will allow practitioners to experiment with alternative approaches to deriving the rates (subject to the limitation that a single claim development distribution underpins the data in each spreadsheet and cannot be varied). Member offices wishing to receive these spreadsheets should use the e-mail address at the end of this section. Feedback on our rates from those who undertake their own analyses will be particularly welcome.

8.12. These rates do not form part of the AC04 Series of rates contained in Working Paper 50 but the Committee views them as an aid to understanding the all-causes rates. It is also hoped that these rates will provide a useful comparison for future experience. The other areas of further work indicated in Working Paper 50 are expected to be published in a Working Paper – provisionally entitled "Supplementary Analyses to CMI critical illness diagnosis rates for accelerated business, 2003-2006" – in Summer 2011.

8.13. All feedback on this paper will be warmly welcomed by the CMI Critical Illness Committee. Please e-mail feedback to ci@cmib.org.uk.

REFERENCES

CMI Working Paper 33 : A new methodology for analysing CMI critical illness experience (July 2009)

CMI Working Paper 43 : CMI critical illness diagnosis rates for accelerated business, 1999-2004 (February 2010)

CMI Working Paper 50 : CMI critical illness diagnosis rates for accelerated business, 2003-2006 (January 2011)

(All of the above are available from http://www.actuaries.org.uk/research-and-resources/pages/continuous-mortality-investigation-working-papers)

Draft CMI critical illness diagnosis rates for accelerated business, 2003-2006 (August 2010). This paper was released only to firms that financially support the CMI.

Board for Actuarial Standards: Technical Actuarial Standard D: Data (November 2009)

Board for Actuarial Standards: Technical Actuarial Standard M: Modelling (April 2010)

(These documents can be found at: http://www.frc.org.uk/bas/standards/tas.cfm)

The CIBT02 tables are developed in:

Critical Illness Trends Research Group : "Exploring the Critical Path" presented to the Staple Inn Actuarial Society on 6 December 2006. Available from:

http://www.sias.org.uk/siaspapers/search/view_paper?id=CITrends

The CIIT00 tables are developed in:

Gen Re : "A Critical Table" (2007). Available from:
http://www.genre.com/sharedfile/pdf/LifeHealthUKCriticalTable-en.pdf

Appendix A: Fit of all-causes rates to the datasets used for the cause-specific analysis

A1.   The tables in this appendix illustrate the fit of the all-causes rates derived in section 6 of Working Paper 50 to the smaller dataset for each gender/smoker subset. These tables correspond to Table 6.6 of Working Paper 50 for male non-smokers and to Tables 6.9, 6.12 and 6.15 for male smokers, female non-smokers and female smokers, respectively.

A2.   Note that deviations from values of 100 usually relate to areas where the derived rates do not closely fit the data (and hence also appear in the corresponding table of Working Paper 50); for example the all-durations values of 135 at ages 20-25 and 79 at ages 66-70 for male smokers in Table A2 below are comparable to the values of 141 and 77 for those age bands in Table 6.9 of Working Paper 50.

Table A1: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 6.7 of Working Paper 50 applied to the set of offices where we have cause of claim for male non-smokers

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
20-25	85	94	123	94	90	210	**102**	103
26-30	100	103	99	80	99	142	**102**	96
31-35	116	94	85	122	104	97	**100**	100
36-40	93	111	99	107	89	94	**99**	102
41-45	95	91	101	100	98	101	**98**	97
46-50	93	93	90	90	97	109	**99**	92
51-55	105	92	84	113	105	105	**101**	98
56-60	122	111	96	104	106	96	**100**	103
61-65	85	121	115	116	107	95	**102**	114
66-70	0	66	145	165	97	92	**101**	126
ALL	**100**	**99**	**95**	**104**	**99**	**101**	**100**	**99**

Table A2: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 6.10 of Working Paper 50 applied to the set of offices where we have cause of claim for male smokers

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
20-25	63	208	83	203	144	0	**135**	166
26-30	119	106	118	83	41	114	**103**	98
31-35	84	109	92	113	119	97	**102**	107
36-40	105	93	96	113	98	96	**99**	100
41-45	110	90	106	89	88	100	**97**	94
46-50	107	83	99	112	108	91	**98**	100
51-55	89	99	91	98	120	96	**99**	101
56-60	91	84	122	104	93	100	**100**	102
61-65	72	20	166	58	70	105	**96**	82
66-70	0	0	0	168	0	92	**79**	56
ALL	**100**	**97**	**102**	**103**	**100**	**97**	**99**	**100**

Table A3: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 6.13 of Working Paper 50 applied to the set of offices where we have cause of claim for female non-smokers

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
20-25	117	97	101	88	150	0	**101**	101
26-30	86	99	98	101	109	119	**101**	100
31-35	93	99	94	104	103	99	**99**	99
36-40	93	101	98	102	87	103	**99**	98
41-45	113	102	99	100	103	96	**100**	101
46-50	105	94	104	87	99	107	**101**	96
51-55	110	119	105	99	94	87	**97**	104
56-60	106	123	84	84	82	105	**98**	91
61-65	218	57	86	82	72	98	**92**	76
66-70	0	0	92	129	120	104	**104**	105
ALL	**100**	**101**	**98**	**98**	**97**	**100**	**99**	**99**

Table A4: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table 6.16 of Working Paper 50 applied to the set of offices where we have cause of claim for female smokers

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
20-25	80	96	215	51	60	0	**110**	124
26-30	64	124	101	127	127	65	**104**	118
31-35	110	95	89	88	94	87	**93**	91
36-40	70	105	95	95	111	108	**100**	101
41-45	134	99	98	83	110	94	**99**	96
46-50	107	90	105	103	97	105	**102**	99
51-55	86	90	96	117	83	94	**96**	98
56-60	110	124	103	112	115	92	**102**	113
61-65	0	0	37	156	52	100	**90**	77
66-70	0	0	0	307	0	143	**129**	101
ALL	**96**	**100**	**100**	**100**	**102**	**97**	**99**	**100**

Appendix B: Derivation of cause-specific rates for male non-smokers

B1.   This appendix contains tables and notes illustrating the derivation of cause-specific diagnosis rates for male non-smokers, as discussed in section 3 of this paper.

B2.   These notes are also relevant to the derivation of cause-specific diagnosis rates for male smokers, female non-smokers and female smokers in Appendices C, D and E, respectively.

B3.   Paragraphs B4 to B7 describe the structure of the remainder of this appendix for each cause of claim.

B4.   The first table (e.g. Table B1 for cancer) shows the Actual Settled Claims for that cause. This table corresponds to Table 6.1 of Working Paper 50 for all-causes combined. Note that this table covers the same age range (20 to 70) as the earlier paper; however because of the low numbers of claims at either end of this age range, the other tables (described in paragraphs B6 and B7, respectively) cover ages 30 to 60 only. Note also that the total claims may differ slightly to that shown in Table 2.2, due to the small number of claims settled outside of the age range 20 to 70.

B5.   For each cause we have then included brief notes that may aid understanding of the derivation. In each case, the notes relate to the three stages of adjustment (corresponding to those used for the all-causes rates, set out in paragraph 6.4 of Working Paper 50), i.e.:
   i.   An all-ages, all-durations adjustment is used to achieve an overall 100 A/E of 100. Note that here the relevant cause-specific CIBT02 table is used to calculate the expected settled claims.
   ii. A brief description of the shape of the age adjustments that are then applied to achieve all-durations 100 A/Es of close to 100 for each age band.
   iii. The re-shaping by duration that is then applied to achieve all-ages 100 A/Es of close to 100 for each duration. As noted in section 2, the Committee used the same durational pattern as for the corresponding all-causes rates, irrespective of whether this particular approach appeared to be implied by the data for that cause, i.e.:

Male Non-smoker:	0, 1-4, 5+
Male Smoker:	0, 1-2, 3+
Female Non-smoker:	0, 1-4, 5+
Female Smoker:	0, 1, 2+

B6.   The second table (e.g. Table B2 for cancer) shows the adjustments to the cause-specific rates from the relevant CIBT02 table by age and duration after steps i to iii. This table corresponds to Table 6.7 of Working Paper 50 for all-causes combined. Note that this table only shows the adjustments to the nearest integer for quinquennial ages.

B7.   The third table (e.g. Table B3 for cancer) shows the values of 100 x Actual Settled Claims / Expected Settled Claims using the adjusted rates and hence illustrates the fit of the cause-specific rates to the data. This table corresponds to Table 6.6 of Working Paper 50 for the all-causes rates. Note that in this table "ALL" means ages 30-60 only.

Cancer

Table B1: Actual Settled Claims in 2003-2006, male non-smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	1	2	3	4	5+	ALL
20-25	9	19	18	3	0	1	**50**
26-30	30	58	46	24	13	26	**197**
31-35	45	72	51	64	35	76	**343**
36-40	40	92	92	82	44	111	**461**
41-45	30	55	88	65	50	155	**443**
46-50	16	46	56	51	46	160	**375**
51-55	21	36	54	72	50	159	**392**
56-60	14	46	42	47	40	172	**361**
61-65	0	7	12	13	16	70	**118**
66-70	0	1	3	4	2	17	**27**
ALL	**205**	**432**	**462**	**425**	**296**	**947**	**2,767**

Steps in deriving rates:

i. The overall 100 A/E was 57% of CIBT02 (cancer).
ii. The shaping by age increased the adjustments at ages up to 41 and reduced the adjustments at ages 43 and over.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 21% and increased the adjustments at durations 5+ by 4%.

Table B2: Adjustments to CIBT02 (cancer only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	1	2	3	4	5+
30	56%	70%	70%	70%	70%	73%
35	53%	67%	67%	67%	67%	69%
40	50%	63%	63%	63%	63%	65%
45	42%	52%	52%	52%	52%	54%
50	40%	50%	50%	50%	50%	52%
55	46%	58%	58%	58%	58%	60%
60	44%	56%	56%	56%	56%	58%

Table B3: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table B2

Age last at settlement	Curtate duration at settlement							
	0	1	2	3	4	5+	ALL	1-4
31-35	123	102	73	117	94	102	**100**	96
36-40	99	113	107	116	88	87	**101**	107
41-45	92	79	112	95	100	109	**100**	97
46-50	68	87	91	91	110	116	**100**	94
51-55	109	78	93	127	110	96	**100**	103
56-60	112	141	93	99	97	94	**100**	105
ALL	**100**	**98**	**96**	**108**	**100**	**100**	**100**	**100**

Heart Attack

Table B4: Actual Settled Claims in 2003-2006, male non-smokers, by age band and duration

Age last at settlement	0	1	2	3	4	5+	ALL
			Curtate duration at settlement				
20-25	0	1	0	0	0	2	**3**
26-30	1	0	3	0	2	0	**6**
31-35	9	9	8	11	3	5	**45**
36-40	11	21	13	14	13	25	**97**
41-45	19	22	28	26	22	60	**177**
46-50	16	35	29	24	30	88	**222**
51-55	14	28	29	28	21	89	**209**
56-60	9	15	21	10	18	67	**140**
61-65	1	6	2	9	8	29	**55**
66-70	0	0	0	2	1	4	**7**
ALL	80	137	133	124	118	369	961

Steps in deriving rates:

i. The overall 100 A/E was 21% of CIBT02 (heart attack).

ii. The shaping by age reduced the adjustments up to age 47 and increased the adjustments at ages 48 and over.

iii. The re-shaping by duration *increased* the adjustments at duration 0 by 30% (i.e. there appears to be a degree of anti-selection) and increased the adjustments at durations 5+ by 14%.

Table B5: Adjustments to CIBT02 (heart attack only) by age and duration

Age exact at diagnosis	0	1	2	3	4	5+
			Curtate duration at diagnosis			
30	19%	15%	15%	15%	15%	17%
35	19%	15%	15%	15%	15%	17%
40	20%	15%	15%	15%	15%	17%
45	23%	17%	17%	17%	17%	20%
50	28%	21%	21%	21%	21%	24%
55	31%	24%	24%	24%	24%	27%
60	29%	23%	23%	23%	23%	26%

Table B6: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table B5

Age last at settlement	0	1	2	3	4	5+	ALL	1-4
			Curtate duration at settlement					
31-35	160	109	114	203	82	62	**118**	127
36-40	91	112	78	103	135	94	**100**	104
41-45	101	73	97	104	122	106	**100**	96
46-50	79	102	85	79	132	108	**100**	97
51-55	96	105	101	100	94	101	**100**	100
56-60	128	107	126	58	121	93	**99**	102
ALL	**100**	**98**	**97**	**95**	**117**	**100**	**100**	**101**

Deaths

Table B7: Actual Settled Claims in 2003-2006, male non-smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	13	15	11	7	5	4	**55**
26-30	19	36	25	17	13	21	**131**
31-35	25	40	54	49	25	50	**243**
36-40	24	60	52	52	31	96	**315**
41-45	20	54	43	48	34	103	**302**
46-50	12	33	43	38	26	105	**257**
51-55	8	22	17	26	21	107	**201**
56-60	6	10	15	22	12	90	**155**
61-65	3	3	13	7	4	39	**69**
66-70	0	0	0	3	1	8	**12**
ALL	**130**	**273**	**273**	**269**	**172**	**623**	**1,740**

Steps in deriving rates:

i. The overall 100 A/E was 31% of CIBT02 (deaths).
ii. The shaping by age reduced the adjustments at ages up to 45 and increased the adjustments at ages 46 and over.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 35% and increased the adjustments at durations 5+ by 20%.

Table B8: Adjustments to CIBT02 (death only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	17%	26%	26%	26%	26%	32%
35	18%	27%	27%	27%	27%	32%
40	19%	29%	29%	29%	29%	35%
45	20%	30%	30%	30%	30%	36%
50	21%	33%	33%	33%	33%	39%
55	23%	36%	36%	36%	36%	43%
60	29%	45%	45%	45%	45%	54%

Table B9: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table B8

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	107	84	112	129	97	84	**100**	105
36-40	99	115	93	111	93	98	**101**	104
41-45	102	121	84	107	104	95	**100**	103
46-50	83	96	105	102	93	99	**98**	100
51-55	96	102	61	95	95	116	**101**	87
56-60	132	78	83	115	72	105	**98**	88
ALL	**100**	**103**	**92**	**110**	**94**	**100**	**100**	**100**

Stroke

Table B10: Actual Settled Claims in 2003-2006, male non-smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	1	0	0	0	0	0	**1**
26-30	5	2	2	0	0	1	**10**
31-35	4	9	8	6	6	3	**36**
36-40	1	7	14	10	9	16	**57**
41-45	3	10	16	12	7	29	**77**
46-50	6	7	10	10	3	21	**57**
51-55	3	6	6	15	11	21	**62**
56-60	1	5	8	13	11	21	**59**
61-65	0	0	2	2	1	15	**20**
66-70	0	0	0	0	2	7	**9**
ALL	**24**	**46**	**66**	**68**	**50**	**134**	**388**

Steps in deriving rates:

i. The overall 100 A/E was 29% of CIBT02 (stroke).
ii. The shaping by age reduced the adjustments at ages up to 40 and 46 to 52 and increased the adjustments for ages 41 to 45 and 54 and over.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 26% with the adjustments at durations 5+ equal to those at durations 1-4.

Table B11: Adjustments to CIBT02 (stroke only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	16%	22%	22%	22%	22%	22%
35	21%	28%	28%	28%	28%	28%
40	22%	30%	30%	30%	30%	30%
45	24%	32%	32%	32%	32%	32%
50	18%	25%	25%	25%	25%	25%
55	27%	37%	37%	37%	37%	37%
60	29%	40%	40%	40%	40%	40%

Table B12: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table B11

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	136	130	106	100	146	37	**101**	118
36-40	26	72	127	107	135	95	**99**	109
41-45	68	87	115	97	77	113	**100**	96
46-50	206	87	98	106	42	90	**93**	86
51-55	136	94	69	171	154	82	**105**	123
56-60	66	103	110	167	160	70	**101**	138
ALL	**100**	**93**	**106**	**123**	**114**	**86**	**100**	**109**

CABG

Table B13: Actual Settled Claims in 2003-2006, male non-smokers, by age band and duration

Age last at settlement	0	1	2	3	4	5+	ALL
20-25	0	0	0	0	0	0	**0**
26-30	0	0	0	0	0	0	**0**
31-35	0	1	1	1	0	0	**3**
36-40	3	6	2	4	1	3	**19**
41-45	2	3	5	3	1	12	**26**
46-50	4	5	7	5	4	31	**56**
51-55	2	11	2	11	9	38	**73**
56-60	1	1	3	3	11	27	**46**
61-65	0	3	2	2	4	11	**22**
66-70	0	0	0	0	0	4	**4**
ALL	**12**	**30**	**22**	**29**	**30**	**126**	**249**

Steps in deriving rates:
  i. The overall 100 A/E was 32% of CIBT02 (CABG).
  ii. The shaping by age reduced the adjustments at ages up to 47 and for ages 57 to 61 and increased the adjustments for ages 49 to 55 and over 63.
  iii. The re-shaping by duration reduced the adjustments at duration 0 by 9% and increased the adjustments at durations 5+ by 56%.

Table B14: Adjustments to CIBT02 (CABG only) by age and duration

Age exact at diagnosis	0	1	2	3	4	5+
30	18%	20%	20%	20%	20%	31%
35	18%	20%	20%	20%	20%	31%
40	18%	20%	20%	20%	20%	31%
45	18%	20%	20%	20%	20%	31%
50	31%	35%	35%	35%	35%	54%
55	27%	30%	30%	30%	30%	47%
60	21%	23%	23%	23%	23%	36%

Table B15: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table B14

Age last at settlement	0	1	2	3	4	5+	ALL	1-4
31-35	0	181	189	242	0	0	**102**	169
36-40	306	348	115	279	98	79	**178**	220
41-45	99	80	124	85	39	112	**98**	86
46-50	111	71	89	70	75	120	**99**	77
51-55	59	152	23	127	130	104	**102**	105
56-60	60	26	58	56	235	89	**90**	94
ALL	**100**	**112**	**71**	**102**	**125**	**103**	**101**	**100**

TPD

Table B16: Actual Settled Claims in 2003-2006, male non-smokers, by age band and duration

Age last at	Curtate duration at settlement						
settlement	0	1	2	3	4	5+	ALL
20-25	0	0	0	0	0	0	**0**
26-30	0	2	3	1	0	5	**11**
31-35	0	3	1	2	5	13	**24**
36-40	1	3	3	5	1	11	**24**
41-45	1	1	2	6	2	14	**26**
46-50	0	0	0	2	0	19	**21**
51-55	0	1	2	3	1	32	**39**
56-60	1	0	1	6	4	25	**37**
61-65	0	0	0	2	0	15	**17**
66-70	0	0	0	0	0	0	**0**
ALL	**3**	**10**	**12**	**27**	**13**	**134**	**199**

Steps in deriving rates:
  i. The overall 100 A/E was 11% of CIBT02 (TPD).
 ii. The shaping by age reduced the adjustments at ages 36 to 51.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 63% and increased the adjustments at durations 5+ by 335%.

Table B17: Adjustments to CIBT02 (TPD only) by age and duration

Age exact at	Curtate duration at diagnosis					
diagnosis	0	1	2	3	4	5+
30	5%	12%	12%	12%	12%	41%
35	3%	8%	8%	8%	8%	25%
40	2%	6%	6%	6%	6%	21%
45	2%	4%	4%	4%	4%	15%
50	2%	5%	5%	5%	5%	18%
55	3%	9%	9%	9%	9%	30%
60	4%	10%	10%	10%	10%	32%

Table B18: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table B17

Age last at	Curtate duration at settlement							
settlement	0	1	2	3	4	5+	ALL	1-4
31-35	0	134	37	90	326	149	**133**	127
36-40	149	124	99	189	52	77	**96**	120
41-45	185	48	72	233	105	86	**100**	118
46-50	0	0	0	98	0	122	**90**	27
51-55	0	51	69	101	42	120	**105**	69
56-60	319	0	41	222	168	78	**89**	122
ALL	**99**	**68**	**56**	**158**	**111**	**100**	**100**	**99**

Appendix C: Derivation of cause-specific rates for male smokers

Cancer

Table C1: Actual Settled Claims in 2003-2006, male smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	1	2	3	4	5+	ALL
20-25	1	4	4	0	0	0	9
26-30	15	23	18	3	2	3	64
31-35	8	33	21	16	15	19	112
36-40	12	27	24	23	14	23	123
41-45	8	16	28	17	16	39	124
46-50	11	18	25	29	13	45	141
51-55	1	12	15	27	17	46	118
56-60	3	8	15	18	13	38	95
61-65	1	0	4	3	4	16	28
66-70	0	0	0	0	0	1	1
ALL	60	141	154	136	94	230	815

Steps in deriving rates:

i. The overall 100 A/E was 74% of CIBT02 (cancer).
ii. The shaping by age increased the adjustments at ages up to 35 and at ages 43 and over and reduced the adjustments at ages 36 to 42.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 37% and increased the adjustments at durations 3+ by 2%.

Table C2: Adjustments to CIBT02 (cancer only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	1	2	3	4	5+
30	51%	81%	81%	82%	82%	82%
35	46%	73%	73%	75%	75%	75%
40	43%	69%	69%	70%	70%	70%
45	49%	77%	77%	78%	78%	78%
50	56%	88%	88%	90%	90%	90%
55	51%	81%	81%	82%	82%	82%
60	49%	77%	77%	78%	78%	78%

Table C3: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C2

Age last at settlement	Curtate duration at settlement						
	0	1	2	3	4	5+	ALL
31-35	75	135	85	87	128	95	102
36-40	123	114	93	110	98	76	99
41-45	100	77	115	81	106	106	98
46-50	153	91	103	130	77	98	103
51-55	21	84	77	139	111	95	97
56-60	122	94	118	132	111	84	101
ALL	100	102	98	113	103	93	100

Heart Attack

Table C4: Actual Settled Claims in 2003-2006, male smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	0	3	0	0	0	0	**3**
26-30	3	3	1	0	1	0	**8**
31-35	9	12	11	14	5	6	**57**
36-40	15	24	21	23	13	21	**117**
41-45	22	30	34	28	14	48	**176**
46-50	17	23	34	27	34	54	**189**
51-55	14	22	20	22	22	49	**149**
56-60	3	11	14	8	7	32	**75**
61-65	0	0	3	3	2	12	**20**
66-70	0	0	0	0	0	1	**1**
ALL	**83**	**128**	**138**	**125**	**98**	**223**	**795**

Steps in deriving rates:

i. The overall 100 A/E was 78% of CIBT02 (heart attack).

ii. The shaping by age reduced the adjustments up to age 46 and at ages 56 and over and increased the adjustments at ages 47 to 55.

iii. The re-shaping by duration ***increased*** the adjustments at duration 0 by 39% (i.e. there appears to be a degree of anti-selection, as for male non-smokers) and increased the adjustments at durations 3+ by 5%.

Table C5: Adjustments to CIBT02 (heart attack only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	98%	70%	70%	74%	74%	74%
35	101%	73%	73%	76%	76%	76%
40	91%	65%	65%	69%	69%	69%
45	100%	72%	72%	76%	76%	76%
50	108%	78%	78%	82%	82%	82%
55	105%	76%	76%	80%	80%	80%
60	84%	61%	61%	64%	64%	64%

Table C6: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C5

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
31-35	93	87	102	173	96	66	**101**
36-40	91	96	99	133	110	83	**100**
41-45	107	91	113	107	74	104	**101**
46-50	92	72	112	96	158	93	**100**
51-55	129	108	91	100	125	89	**101**
56-60	75	130	140	75	75	90	**96**
ALL	**100**	**92**	**108**	**109**	**113**	**92**	**100**

Deaths

Table C7: Actual Settled Claims in 2003-2006, male smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	3	14	2	7	1	0	**27**
26-30	12	13	10	8	1	4	**48**
31-35	18	30	24	22	19	21	**134**
36-40	16	20	26	27	14	36	**139**
41-45	12	17	21	19	16	34	**119**
46-50	9	12	20	17	15	49	**122**
51-55	2	13	20	13	21	52	**121**
56-60	2	3	12	16	11	38	**82**
61-65	0	0	4	0	1	21	**26**
66-70	0	0	0	1	0	2	**3**
ALL	**74**	**122**	**139**	**130**	**99**	**257**	**821**

Steps in deriving rates:
  i. The overall 100 A/E was 61% of CIBT02 (deaths).
 ii. The shaping by age reduced the adjustments at ages up to 45 and increased the adjustments at ages 47 and over.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 10% and increased the adjustments at durations 3+ by 27%.

Table C8: Adjustments to CIBT02 (death only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	39%	43%	43%	55%	55%	55%
35	39%	43%	43%	54%	54%	54%
40	39%	43%	43%	54%	54%	54%
45	46%	51%	51%	65%	65%	65%
50	70%	78%	78%	99%	99%	99%
55	95%	105%	105%	134%	134%	134%
60	95%	105%	105%	134%	134%	134%

Table C9: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table C8

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
31-35	107	112	98	104	132	84	**104**
36-40	110	81	107	118	85	101	**100**
41-45	120	94	109	98	108	93	**101**
46-50	103	71	107	84	93	110	**97**
51-55	33	99	124	69	133	103	**100**
56-60	69	42	125	133	100	89	**96**
ALL	**100**	**89**	**110**	**99**	**108**	**98**	**100**

Appendix D: Derivation of cause-specific rates for female non-smokers

Cancer

Table D1: Actual Settled Claims in 2003-2006, female non-smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	17	22	17	6	3	0	**65**
26-30	28	73	64	42	27	41	**275**
31-35	59	139	137	109	78	151	**673**
36-40	76	172	185	161	91	259	**944**
41-45	68	155	170	159	115	279	**946**
46-50	48	96	122	99	82	273	**720**
51-55	29	76	86	84	54	198	**527**
56-60	13	36	29	32	32	150	**292**
61-65	1	2	6	5	3	36	**53**
66-70	0	0	0	2	1	7	**10**
ALL	**339**	**771**	**816**	**699**	**486**	**1,394**	**4,505**

Steps in deriving rates:

  i. The overall 100 A/E was 66% of CIBT02 (cancer).
 ii. The shaping by age increased the adjustments at ages up to 44 and reduced the adjustments at ages 45 and over.
iii. The re-shaping by duration reduced the adjustments at duration 0 by 20%; the adjustments at durations 5+ were set equal to those at durations 1 to 4.

Table D2: Adjustments to CIBT02 (cancer only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	56%	71%	71%	71%	71%	71%
35	59%	74%	74%	74%	74%	74%
40	58%	73%	73%	73%	73%	73%
45	54%	67%	67%	67%	67%	67%
50	49%	61%	61%	61%	61%	61%
55	49%	61%	61%	61%	61%	61%
60	49%	61%	61%	61%	61%	61%

Table D3: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table D2

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	89	105	100	100	105	99	**100**	102
36-40	96	104	104	109	86	96	**100**	102
41-45	102	107	103	109	108	91	**101**	106
46-50	108	96	104	92	100	102	**100**	98
51-55	113	122	109	108	87	88	**99**	107
56-60	137	140	80	83	94	103	**101**	96
ALL	**100**	**107**	**102**	**103**	**97**	**96**	**100**	**103**

Deaths

Table D4: Actual Settled Claims in 2003-2006, female non-smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	5	6	4	2	2	0	**19**
26-30	11	9	15	9	3	5	**52**
31-35	13	22	20	14	11	21	**101**
36-40	7	19	24	15	8	42	**115**
41-45	8	21	18	14	11	39	**111**
46-50	4	14	21	13	12	50	**114**
51-55	3	10	11	10	9	24	**67**
56-60	0	7	5	10	5	34	**61**
61-65	1	1	1	3	4	12	**22**
66-70	0	0	1	0	0	3	**4**
ALL	**52**	**109**	**120**	**90**	**65**	**230**	**666**

Steps in deriving rates:

   i. The overall 100 A/E was 39% of CIBT02 (deaths).

  ii. The shaping by age reduced the adjustments at ages up to 44 and increased the adjustments at ages 45 and over.

 iii. The re-shaping by duration reduced the adjustments at duration 0 by 38% and increased the adjustments at durations 5+ by 15%.

Table D5: Adjustments to CIBT02 (death only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	18%	29%	29%	29%	29%	33%
35	20%	32%	32%	32%	32%	37%
40	20%	33%	33%	33%	33%	38%
45	26%	42%	42%	42%	42%	48%
50	37%	60%	60%	60%	60%	69%
55	37%	60%	60%	60%	60%	69%
60	37%	60%	60%	60%	60%	69%

Table D6: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table D5

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	145	113	99	87	100	82	**100**	100
36-40	82	98	113	84	63	114	**99**	93
41-45	116	129	95	84	90	97	**100**	100
46-50	65	93	118	79	96	108	**100**	97
51-55	91	115	98	91	101	66	**84**	100
56-60	0	191	95	179	102	141	**136**	139
ALL	**100**	**113**	**105**	**91**	**90**	**100**	**100**	**100**

43

Stroke

Table D7: Actual Settled Claims in 2003-2006, female non-smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	3	2	2	0	0	0	**7**
26-30	5	6	1	2	1	0	**15**
31-35	5	8	10	7	2	10	**42**
36-40	3	13	9	5	5	16	**51**
41-45	2	6	13	11	4	21	**57**
46-50	2	4	5	3	1	13	**28**
51-55	0	7	3	5	4	5	**24**
56-60	0	1	2	1	0	6	**10**
61-65	0	0	0	1	1	1	**3**
66-70	0	0	0	0	0	0	**0**
ALL	**20**	**47**	**45**	**35**	**18**	**72**	**237**

Steps in deriving rates:

    i. The overall 100 A/E was 27% of CIBT02 (stroke).

    ii. The shaping by age increased the adjustments at ages up to 45 and reduced the adjustments at ages 46 and over.

    iii. The re-shaping by duration reduced the adjustments at duration 0 by 27% with the adjustments at durations 5+ equal to those at durations 1-4.

Table D8: Adjustments to CIBT02 (stroke only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	23%	31%	31%	31%	31%	31%
35	23%	31%	31%	31%	31%	31%
40	23%	31%	31%	31%	31%	31%
45	21%	28%	28%	28%	28%	28%
50	16%	22%	22%	22%	22%	22%
55	16%	22%	22%	22%	22%	22%
60	16%	22%	22%	22%	22%	22%

Table D9: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table D8

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**1-4**
31-35	164	109	122	106	44	105	**107**	101
36-40	89	155	92	60	84	103	**100**	99
41-45	68	78	138	130	64	115	**108**	107
46-50	126	93	91	58	25	99	**83**	69
51-55	0	288	90	151	148	50	**107**	161
56-60	0	93	122	56	0	87	**75**	66
ALL	**99**	**125**	**111**	**95**	**64**	**97**	**100**	**101**

Multiple Sclerosis

Table D10: Actual Settled Claims in 2003-2006, female non-smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	1	2	3	4	5+	ALL
20-25	0	3	4	2	2	0	11
26-30	1	12	19	16	10	13	71
31-35	2	14	19	30	18	30	113
36-40	2	11	9	18	17	46	103
41-45	3	6	8	7	6	30	60
46-50	0	1	9	5	4	13	32
51-55	0	1	2	2	3	5	13
56-60	0	0	4	1	0	3	8
61-65	0	0	0	0	0	1	1
66-70	0	0	0	0	0	0	0
ALL	8	48	74	81	60	141	412

Steps in deriving rates:

i. The overall 100 A/E was 46% of CIBT02 (MS).

ii. The shaping by age increased the adjustments at ages up to 38 and reduced the adjustments for ages 39 and over3.

iii. The re-shaping by duration reduced the adjustments at duration 0 by 79% and increased the adjustments at durations 5+ by 34%.

Table D11: Adjustments to CIBT02 (MS only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	1	2	3	4	5+
30	16%	76%	76%	76%	76%	101%
35	12%	55%	55%	55%	55%	73%
40	9%	40%	40%	40%	40%	54%
45	9%	40%	40%	40%	40%	54%
50	9%	40%	40%	40%	40%	54%
55	9%	40%	40%	40%	40%	54%
60	9%	40%	40%	40%	40%	54%

Table D12: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table D11

Age last at settlement	Curtate duration at settlement							
	0	1	2	3	4	5+	ALL	1-4
31-35	66	80	78	151	132	86	100	107
36-40	90	81	46	107	142	118	100	89
41-45	277	86	75	72	85	115	97	79
46-50	0	32	181	106	111	87	100	115
51-55	0	90	106	105	197	71	95	125
56-60	0	0	793	180	0	113	178	276
ALL	100	77	82	117	125	102	100	99

Appendix E: Derivation of cause-specific rates for female smokers

Cancer

Table E1: Actual Settled Claims in 2003-2006, female smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	3	4	7	1	0	0	**15**
26-30	7	23	15	13	10	0	**68**
31-35	15	30	21	19	12	23	**120**
36-40	12	38	31	30	15	49	**175**
41-45	27	35	38	27	27	52	**206**
46-50	15	27	29	33	22	62	**188**
51-55	7	17	20	23	17	38	**122**
56-60	1	7	9	7	8	26	**58**
61-65	0	0	1	1	2	5	**9**
66-70	0	0	0	0	0	1	**1**
ALL	**87**	**181**	**171**	**154**	**113**	**256**	**962**

Steps in deriving rates:
  i. The overall 100 A/E was 71% of CIBT02 (cancer).
  ii. The shaping by age reduced the adjustments at ages up to 39 and at ages 53 and over and increased the adjustments at ages 41 to 52.
  iii. The re-shaping by duration reduced the adjustments at duration 0 by 2% with the adjustments at duration 1 equal to those at durations 2+.

Table E2: Adjustments to CIBT02 (cancer only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	55%	56%	56%	56%	56%	56%
35	61%	62%	62%	62%	62%	62%
40	70%	71%	71%	71%	71%	71%
45	80%	82%	82%	82%	82%	82%
50	78%	80%	80%	80%	80%	80%
55	61%	62%	62%	62%	62%	62%
60	58%	59%	59%	59%	59%	59%

Table E3: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table E2

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**2+**
31-35	98	113	85	103	100	101	**100**	97
36-40	63	110	92	112	83	119	**101**	104
41-45	142	96	101	84	118	91	**101**	96
46-50	103	93	91	114	102	100	**100**	101
51-55	102	109	106	123	112	78	**98**	96
56-60	48	134	125	92	118	96	**104**	103
ALL	**100**	**105**	**96**	**105**	**105**	**97**	**100**	**99**

Deaths

Table E4: Actual Settled Claims in 2003-2006, female smokers, by age band and duration

Age last at settlement	Curtate duration at settlement						
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**
20-25	1	3	2	1	0	0	**7**
26-30	3	5	3	3	1	3	**18**
31-35	5	3	8	5	2	5	**28**
36-40	5	10	12	9	7	14	**57**
41-45	5	7	11	10	7	21	**61**
46-50	4	9	12	11	7	27	**70**
51-55	1	3	6	7	4	20	**41**
56-60	3	4	6	8	8	21	**50**
61-65	0	0	0	4	0	8	**12**
66-70	0	0	0	1	0	1	**2**
ALL	**27**	**44**	**60**	**59**	**36**	**120**	**346**

Steps in deriving rates:
   i. The overall 100 A/E was 105% of CIBT02 (deaths).
  ii. The shaping by age reduced the adjustments at ages up to 42 and increased the adjustments at ages 44 and over.
 iii. The re-shaping by duration reduced the adjustments at durations 0 and 1 by 16% and increased the adjustments at durations 2+ by 29%.

Table E5: Adjustments to CIBT02 (death only) by age and duration

Age exact at diagnosis	Curtate duration at diagnosis					
	0	**1**	**2**	**3**	**4**	**5+**
30	26%	26%	41%	41%	41%	41%
35	40%	40%	61%	61%	61%	61%
40	79%	79%	122%	122%	122%	122%
45	97%	97%	149%	149%	149%	149%
50	132%	132%	203%	203%	203%	203%
55	141%	141%	217%	217%	217%	217%
60	141%	141%	217%	217%	217%	217%

Table E6: Values of 100A/E using percentages of CIBT02 by age and duration shown in Table E5

Age last at settlement	Curtate duration at settlement							
	0	**1**	**2**	**3**	**4**	**5+**	**ALL**	**2+**
31-35	147	59	127	96	58	76	**94**	93
36-40	86	111	101	87	99	87	**94**	92
41-45	88	74	83	81	79	94	**85**	86
46-50	91	119	107	99	83	111	**104**	104
51-55	43	67	81	87	61	94	**82**	85
56-60	359	219	175	201	224	147	**179**	170
ALL	**102**	**96**	**103**	**98**	**92**	**103**	**100**	**100**

Appendix F: Cause-specific diagnosis rates, 2003-2006

F1.   The cause-specific rates for ultimate durations are shown in this appendix, together with the residual rates, which have been derived as the difference between the sum of the cause-specific rates and the fitted all-causes rates derived in Working Paper 50 (see Paragraph 2.22).

F2.   For completeness the AC04 rates are also shown in the tables below where they differ from the fitted rates. This principally occurs at ages 55-60, where the fitted rates were blended to the older age rates, but also for male smokers (at ages 45-54) and female smokers (at ages 30-35) where additional smoothing was applied.

Table F1. Male Non-Smoker cause-specific rates (durations 5+)

Age Exact	Cancer	Heart attack	Deaths	Stroke	CABG	TPD	Residual	Fitted rates	ACMNL 04
30	0.00031	0.00002	0.00026	0.00002	0.00000	0.00005	0.00010	0.00076	
31	0.00031	0.00003	0.00027	0.00003	0.00000	0.00004	0.00011	0.00079	
32	0.00033	0.00003	0.00028	0.00004	0.00000	0.00005	0.00010	0.00082	
33	0.00035	0.00004	0.00028	0.00004	0.00000	0.00005	0.00012	0.00088	
34	0.00037	0.00005	0.00029	0.00004	0.00001	0.00005	0.00014	0.00094	
35	0.00040	0.00006	0.00031	0.00005	0.00001	0.00005	0.00015	0.00101	
36	0.00042	0.00007	0.00033	0.00005	0.00001	0.00005	0.00017	0.00110	
37	0.00046	0.00009	0.00036	0.00006	0.00001	0.00005	0.00017	0.00120	
38	0.00049	0.00010	0.00038	0.00006	0.00002	0.00006	0.00019	0.00131	
39	0.00052	0.00013	0.00040	0.00007	0.00002	0.00007	0.00022	0.00143	
40	0.00055	0.00016	0.00042	0.00008	0.00003	0.00007	0.00025	0.00156	
41	0.00058	0.00019	0.00045	0.00009	0.00003	0.00007	0.00027	0.00169	
42	0.00062	0.00023	0.00047	0.00011	0.00004	0.00008	0.00027	0.00182	
43	0.00066	0.00028	0.00050	0.00013	0.00005	0.00008	0.00027	0.00197	
44	0.00071	0.00033	0.00055	0.00014	0.00007	0.00008	0.00024	0.00212	
45	0.00076	0.00040	0.00060	0.00015	0.00008	0.00009	0.00024	0.00231	
46	0.00083	0.00047	0.00067	0.00015	0.00012	0.00009	0.00024	0.00256	
47	0.00090	0.00054	0.00074	0.00015	0.00016	0.00010	0.00025	0.00285	
48	0.00099	0.00062	0.00080	0.00015	0.00021	0.00012	0.00025	0.00315	
49	0.00112	0.00071	0.00085	0.00017	0.00027	0.00015	0.00027	0.00354	
50	0.00129	0.00080	0.00090	0.00019	0.00034	0.00019	0.00034	0.00405	
51	0.00150	0.00089	0.00098	0.00022	0.00038	0.00024	0.00040	0.00461	
52	0.00175	0.00099	0.00107	0.00027	0.00042	0.00030	0.00041	0.00521	
53	0.00206	0.00109	0.00112	0.00032	0.00046	0.00037	0.00043	0.00584	
54	0.00240	0.00119	0.00118	0.00039	0.00051	0.00045	0.00037	0.00648	
55	0.00281	0.00127	0.00126	0.00046	0.00055	0.00054	0.00027	0.00716	0.00714
56	0.00318	0.00135	0.00148	0.00053	0.00060	0.00063	0.00013	0.00789	0.00782
57	0.00359	0.00143	0.00168	0.00058	0.00063	0.00069	0.00006	0.00867	0.00856
58	0.00404	0.00152	0.00191	0.00064	0.00065	0.00075	0.00001	0.00952	0.00941
59	0.00447	0.00161	0.00217	0.00071	0.00066	0.00081	*	0.01042	0.01037
60	0.00484	0.00170	0.00246	0.00081	0.00072	0.00087	0.00017	0.01157	0.01144

* Note that the sum of the cause-specific rates at age 59 is slightly greater than the all-causes rate derived in Working Paper 50, resulting in a negative residual.

Table F2: Male Smoker cause-specific rates (durations 3+)

Age exact	Cancer	Heart attack	Deaths	Residual	Fitted rates	ACMSL04
30	0.00035	0.00009	0.00045	0.00005	0.00094	
31	0.00036	0.00012	0.00046	0.00010	0.00104	
32	0.00037	0.00014	0.00047	0.00017	0.00116	
33	0.00039	0.00018	0.00048	0.00023	0.00128	
34	0.00040	0.00022	0.00050	0.00027	0.00139	
35	0.00043	0.00026	0.00052	0.00030	0.00150	
36	0.00045	0.00031	0.00054	0.00033	0.00162	
37	0.00047	0.00036	0.00057	0.00034	0.00173	
38	0.00049	0.00043	0.00059	0.00039	0.00190	
39	0.00053	0.00051	0.00063	0.00046	0.00213	
40	0.00059	0.00062	0.00066	0.00053	0.00240	
41	0.00066	0.00076	0.00070	0.00062	0.00273	
42	0.00075	0.00092	0.00074	0.00068	0.00308	
43	0.00084	0.00110	0.00082	0.00074	0.00350	
44	0.00095	0.00130	0.00092	0.00079	0.00396	
45	0.00109	0.00151	0.00107	0.00087	0.00454	0.00460
46	0.00128	0.00174	0.00125	0.00097	0.00524	0.00543
47	0.00152	0.00198	0.00149	0.00097	0.00596	0.00630
48	0.00183	0.00223	0.00174	0.00095	0.00675	0.00718
49	0.00206	0.00248	0.00201	0.00104	0.00759	0.00807
50	0.00223	0.00270	0.00228	0.00129	0.00850	0.00897
51	0.00242	0.00292	0.00255	0.00157	0.00946	0.00988
52	0.00262	0.00314	0.00283	0.00186	0.01045	0.01080
53	0.00298	0.00337	0.00315	0.00199	0.01148	0.01173
54	0.00337	0.00357	0.00352	0.00211	0.01257	0.01267
55	0.00382	0.00375	0.00395	0.00226	0.01378	0.01373
56	0.00432	0.00385	0.00428	0.00268	0.01513	0.01495
57	0.00488	0.00388	0.00467	0.00319	0.01661	0.01622
58	0.00549	0.00387	0.00511	0.00377	0.01824	0.01761
59	0.00615	0.00395	0.00561	0.00428	0.01998	0.01907
60	0.00655	0.00421	0.00613	0.00495	0.02184	0.02071

Table F3: Female Non-Smoker cause-specific rates (durations 5+)

Age exact	Cancer	Deaths	Stroke	MS	Residual	Fitted rates	ACFNL04
30	0.00047	0.00009	0.00003	0.00015	0.00004	0.00079	
31	0.00053	0.00010	0.00003	0.00015	0.00005	0.00087	
32	0.00060	0.00011	0.00004	0.00016	0.00005	0.00095	
33	0.00066	0.00011	0.00004	0.00015	0.00007	0.00104	
34	0.00074	0.00012	0.00004	0.00015	0.00008	0.00113	
35	0.00082	0.00013	0.00005	0.00016	0.00007	0.00122	
36	0.00090	0.00014	0.00005	0.00016	0.00008	0.00132	
37	0.00098	0.00014	0.00006	0.00016	0.00009	0.00142	
38	0.00107	0.00015	0.00006	0.00015	0.00010	0.00152	
39	0.00116	0.00015	0.00007	0.00015	0.00010	0.00163	
40	0.00126	0.00016	0.00007	0.00014	0.00012	0.00175	
41	0.00137	0.00017	0.00008	0.00013	0.00017	0.00192	
42	0.00149	0.00019	0.00009	0.00013	0.00019	0.00209	
43	0.00160	0.00021	0.00010	0.00013	0.00021	0.00226	
44	0.00173	0.00024	0.00010	0.00013	0.00023	0.00244	
45	0.00186	0.00028	0.00010	0.00014	0.00024	0.00262	
46	0.00200	0.00033	0.00010	0.00013	0.00025	0.00281	
47	0.00214	0.00038	0.00010	0.00013	0.00026	0.00301	
48	0.00228	0.00043	0.00010	0.00012	0.00033	0.00326	
49	0.00250	0.00046	0.00011	0.00012	0.00036	0.00355	
50	0.00272	0.00049	0.00012	0.00011	0.00041	0.00385	
51	0.00295	0.00051	0.00013	0.00011	0.00050	0.00419	
52	0.00318	0.00052	0.00014	0.00010	0.00061	0.00456	
53	0.00341	0.00055	0.00015	0.00010	0.00072	0.00494	
54	0.00365	0.00058	0.00016	0.00010	0.00086	0.00535	
55	0.00389	0.00062	0.00017	0.00009	0.00101	0.00579	0.00577
56	0.00414	0.00066	0.00019	0.00009	0.00116	0.00623	0.00619
57	0.00437	0.00072	0.00020	0.00008	0.00125	0.00663	0.00663
58	0.00461	0.00080	0.00022	0.00008	0.00128	0.00699	0.00710
59	0.00485	0.00089	0.00024	0.00007	0.00127	0.00732	0.00765
60	0.00508	0.00100	0.00026	0.00006	0.00124	0.00765	0.00824

Table F4: Female Smoker cause-specific rates (durations 2+)

| Age exact	Cancer	Deaths	Residual	Fitted rates	ACFSL04
30	0.00038	0.00011	0.00033	0.00082	0.00086
31	0.00042	0.00012	0.00034	0.00088	0.00092
32	0.00048	0.00013	0.00036	0.00096	0.00100
33	0.00054	0.00015	0.00035	0.00104	0.00108
34	0.00061	0.00018	0.00035	0.00114	0.00118
35	0.00068	0.00021	0.00037	0.00126	0.00130
36	0.00076	0.00027	0.00041	0.00144	
37	0.00085	0.00033	0.00046	0.00164	
38	0.00095	0.00040	0.00051	0.00186	
39	0.00107	0.00046	0.00058	0.00211	
40	0.00122	0.00052	0.00063	0.00238	
41	0.00140	0.00057	0.00069	0.00266	
42	0.00162	0.00064	0.00070	0.00295	
43	0.00182	0.00070	0.00073	0.00326	
44	0.00202	0.00078	0.00081	0.00362	
45	0.00225	0.00086	0.00093	0.00405	
46	0.00250	0.00095	0.00105	0.00450	
47	0.00276	0.00108	0.00113	0.00497	
48	0.00304	0.00123	0.00119	0.00545	
49	0.00333	0.00136	0.00125	0.00594	
50	0.00353	0.00144	0.00147	0.00644	
51	0.00366	0.00153	0.00174	0.00694	
52	0.00373	0.00161	0.00212	0.00745	
53	0.00372	0.00173	0.00255	0.00801	
54	0.00386	0.00182	0.00299	0.00867	
55	0.00397	0.00195	0.00357	0.00949	0.00943
56	0.00413	0.00208	0.00419	0.01040	0.01031
57	0.00432	0.00228	0.00463	0.01122	0.01125
58	0.00450	0.00251	0.00491	0.01192	0.01210
59	0.00467	0.00280	0.00506	0.01253	0.01282
60	0.00490	0.00314	0.00501	0.01305	0.01357

Appendix G: Comparison of cause-specific rates for 2003-2006 with CIIT00

G1. A comparison of the all-causes WP43 rates with CIIT00 was included in Working Paper 43 (in section 6 and Appendix E). In Working Paper 43, the comparison was restricted to all-causes rates. In this section we compare the cause-specific rates for 2003-2006 derived in this paper (for simplicity referred to as the "WP52 rates") with CIIT00. Note we are seeking to compare the rates but not necessarily seeking to explain the differences, which can arise from features of CIIT00.

G2. CIIT00 was chosen as it is the most recently-developed published table and it may be considered the closest comparator, as the authors used CMI data (for 1999-2002) to adjust the population to insured experience.

G3. However, there are numerous differences in the construction of the two tables; summarised in Appendix E of Working Paper 43.

Male Non-smokers

G4. Figure G1 shows the WP52 rates as a percentage of the ultimate rates from CIIT00 for male non-smokers. Note that the definitions of "ultimate" are different in the two tables (the CIIT00 tables use durations 3+ for each gender/smoker category).

Figure G1: Ultimate WP52 rates as a percentage of CIIT00, male non-smokers
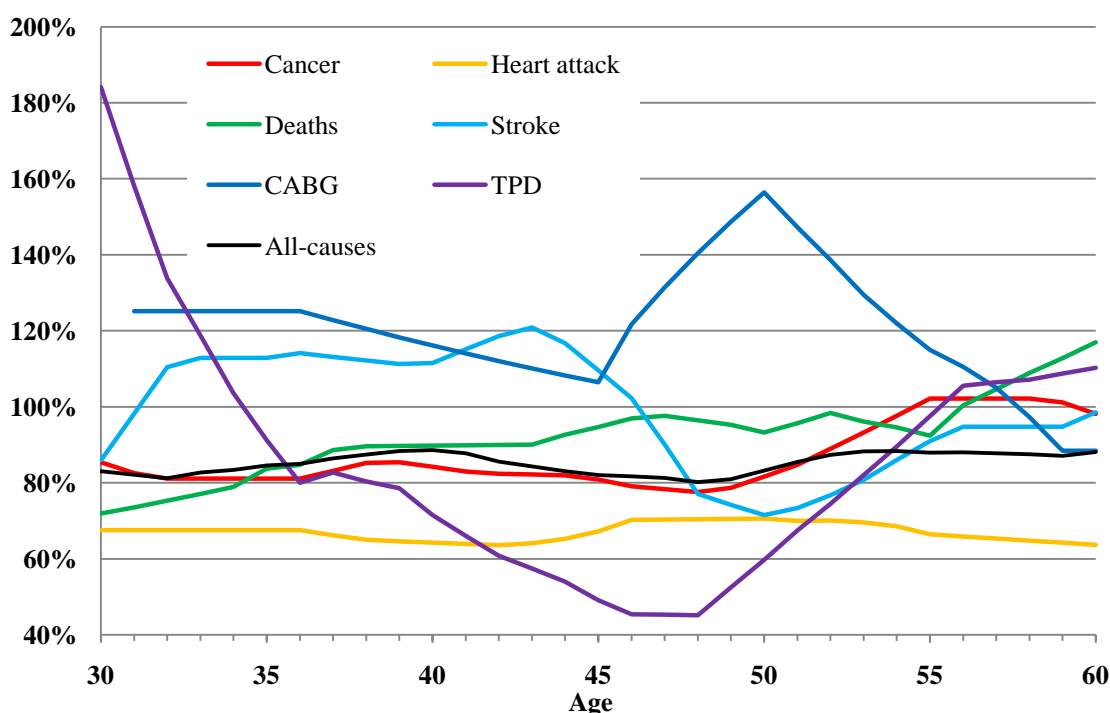

G5. Apart from TPD and CABG, the WP52 rates are between 60% and 100% of those in CIIT00 for the age range with the most credible volumes of data (ages 35-55). A difference of this order may simply be the result of the different time-periods – the Committee has used 2003-2006 data, whereas the 1999-2002 CMI data was used for CIIT00.

Male smokers

G6. Figure G2 shows the ultimate WP52 rates as a percentage of the ultimate rates from CIIT00 for male smokers.

Figure G2: Ultimate WP52 rates as a percentage of CIIT00, male smokers
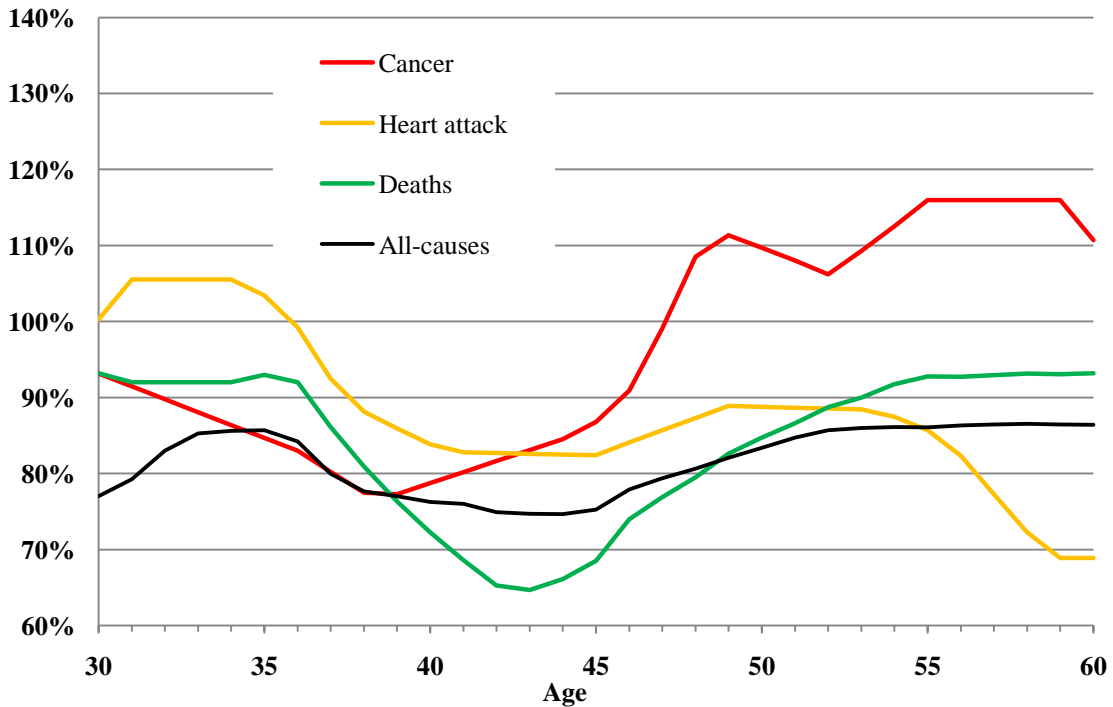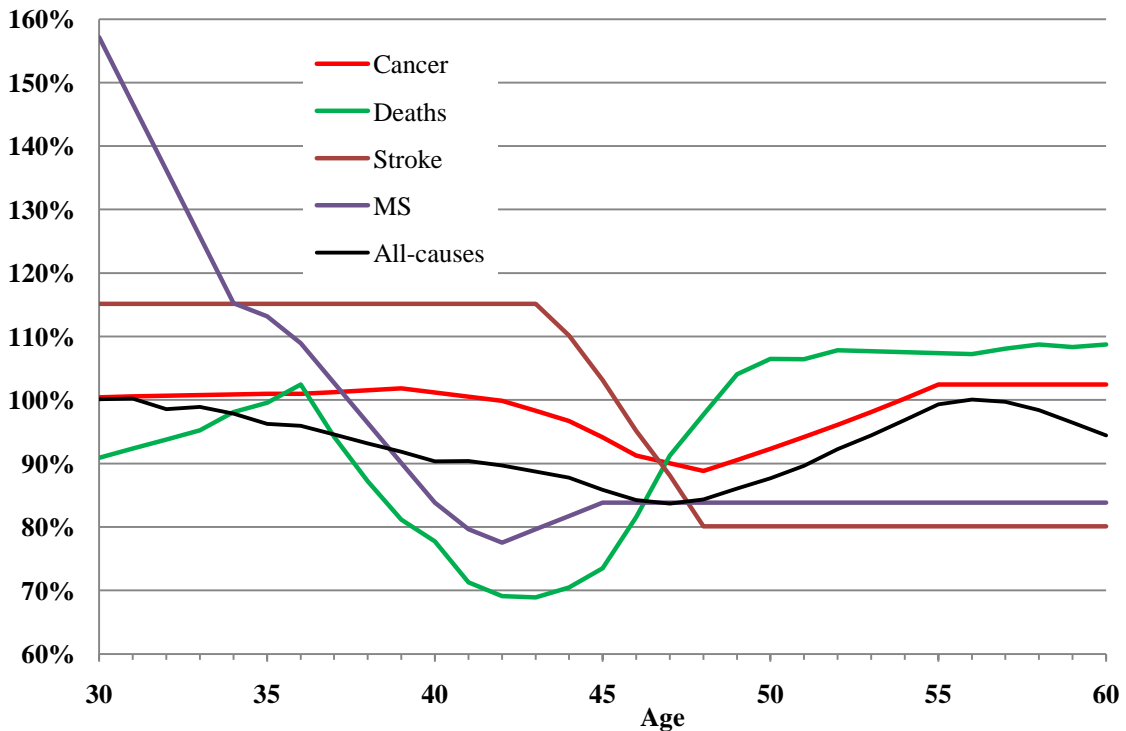

G7. Figure G2 shows the greater extent of variation with the smoker dataset compared to the non-smokers, in particular at younger ages and for cancer.

Female Non-smokers

G8. Figure G3 shows the ultimate WP52 rates as a percentage of the ultimate rates from CIIT00 for female non-smokers.

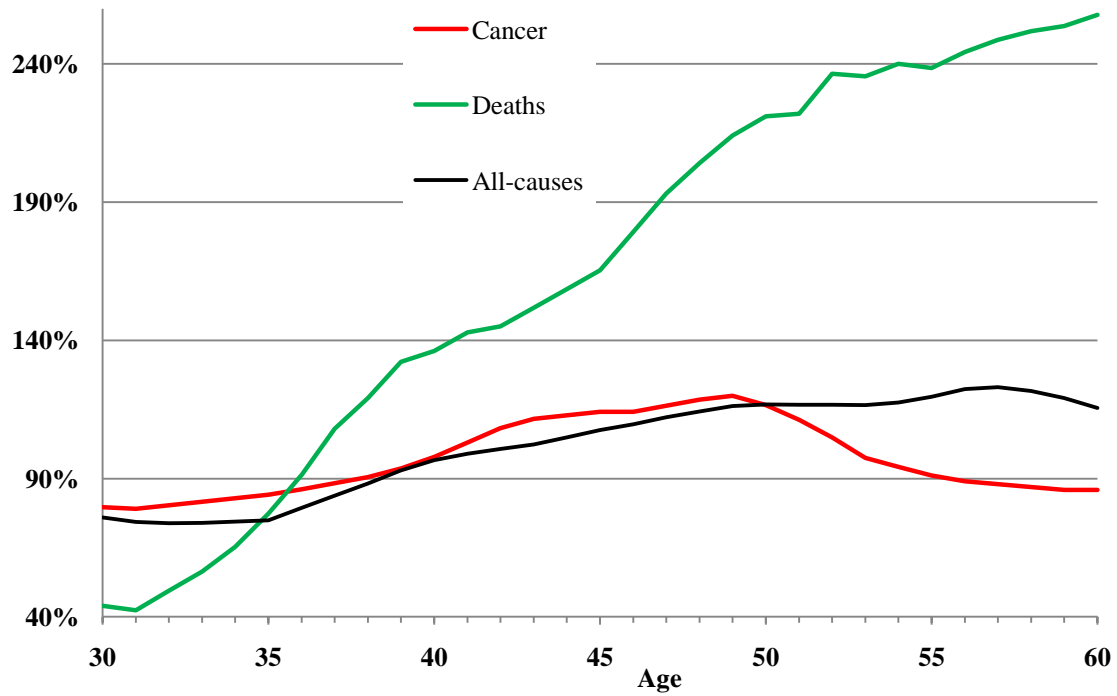Figure G3: Ultimate WP52 rates as a percentage of CIIT00, female non-smokers

G9. Cancer rates look relatively stable at around 100% apart from a dip at ages 43 to 53.

Female Smokers

G10. Figure G4 shows the ultimate WP52 rates as a percentage of the ultimate rates from CIIT00 for female smokers.

Figure G4: Ultimate WP52 rates as a percentage of CIIT00, female smokers

G11. The most prominent feature of Figure G4 is the rapid increase in the death rates derived in this paper compared with CIIT00. This was also reflected in the comparison of the WP52 rates with CIBT02 (see Figure 6.1 and paragraph 6.4).

**Appendix H: Comparison of cause-specific rates for 2003-2006 with 1999-2004 rates**

H1. In Working Paper 43, the Committee derived cause-specific rates for male non-smokers only. This appendix contains a comparison of the 2003-2006 rates with the earlier rates.

H2. Figures H1 and H2 show the 2003-2006 cause-specific rates for duration 5+ as a percentage of the corresponding 1999-2004 rates.

Figure H1: 2003-2006 Cause-specific diagnosis rates relative to 1999-2004 rates by age, male non-smokers, durations 5+ for cancer, heart attack and death
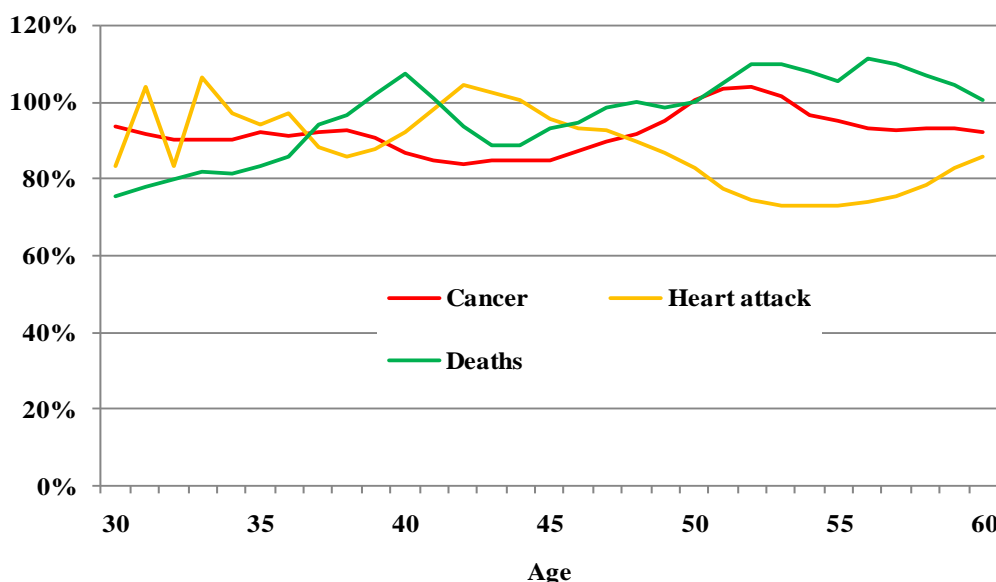
H3. Figure H1 shows only the three causes with a substantial number of claims – nearly 3,000 cancer claims in each of the 1999-2004 and 2003-2006 datasets, nearly 2,000 death claims and around 1,000 heart attack claims. For these three causes, the two sets of rates appear reasonably consistent with the corresponding WP43 cause-specific rates:
- Below ages 50, the 2003-2006 cancer rates are consistently lower than the WP43 rates varying between around 90% to just above 80%. From ages 45 to 52 there is a period of rapid increase where they then peak at around 105% before settling at just above 90% from ages 55 to 60.
- The heart attack rates are quite erratic compared to the WP43 rates at younger ages, but the rates are low in absolute terms and there are few claims. The subsequent shape of the comparison is a reversal of that for cancer with the new rates highest against the WP43 rates around age 42 then reducing to around 70%.
- The 2003-2006 death rates are generally similar to the corresponding WP43 rates from age 39, but lower at younger ages.

H4. Figure H2 shows the other three causes for which we have produced rates. These have considerably fewer claims – the largest number, around 400 claims in each of the 1999-2004 and 2003-2006 datasets, is for stroke. Unsurprisingly, therefore, the comparison of the two sets of rates exhibits greater volatility, reflecting the limited credibility of these rates.

Figure H2: 2003-2006 Cause-specific diagnosis rates relative to 1999-2004 rates by age, male non-smokers, durations 5+ for stroke, CABG and TPD
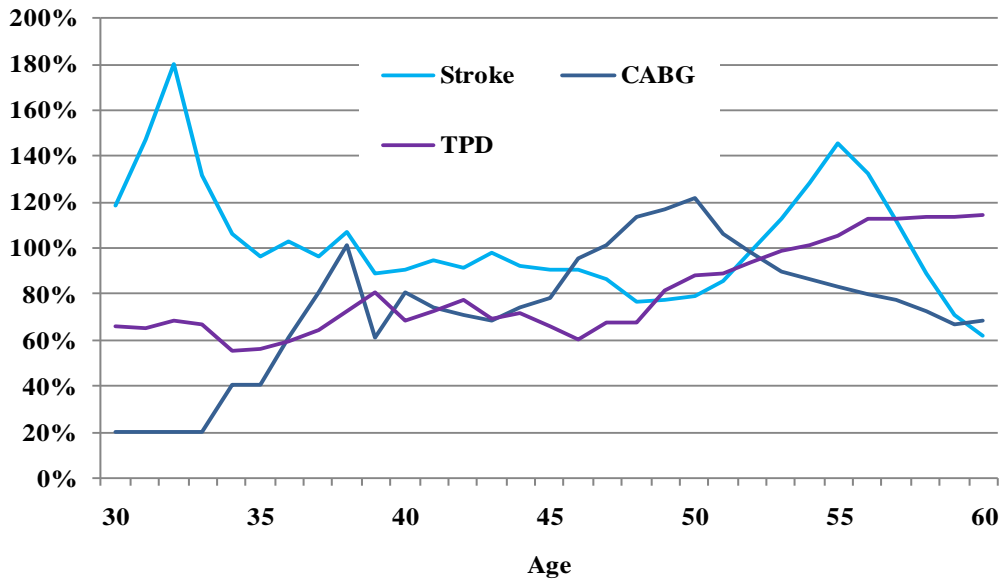
H5. It should be noted that our approach of using "relatively smooth" adjustments to CIBT02 (see paragraph 6.12 of Working Paper 50) does not necessarily produce smooth rates where the CIBT02 rates are very low and changing rapidly, as can occur at a cause-specific level; in particular, we have not applied further smoothing to the cause-specific rates (as we did for the all-causes rates). In addition, as noted in paragraph 2.13, the cause-specific CDDs for stroke and TPD were notably different from the corresponding distributions for the 1999-2004 dataset which may also result in the two sets of rates diverging.