Singapore Insured Lives

Mortality Investigation 2004 - 2008

Singapore Actuarial Society Mortality Workgroup
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DISCLAIMER

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EXECUTIVE SUMMARY

This report sets out the results of the investigations into the mortality and morbidity of insured lives in Singapore. The investigation is based on the returns made by Singapore Life Insurance Companies to the Monetary Authority of Singapore (MAS) for the period 2003 to 2008. Complete data was only available for years 2004 to 2008 and this is what was used to produce the graduated tables.

The aim of the investigation is to produce an updated mortality table for Singapore lives S0408, which can be used by life insurers in Singapore. Previous mortality graduated tables have been produced as S8388, S8893 and S9702.

As a result of the more detailed data received this time, separate graduated tables have been produced for Investment Linked (IL) and non Investment Linked (NL) business.

In Singapore the vast majority of mortality business has a Lump Sum Total and Permanent Disability (TPD) accelerator attached. TPD claims are on average 17% of Death and TPD claims for duration 2+ (of NL Whole Life/Endowment (WL&E)). In order to obtain a true Death table, adjustments have been made to allow for TPD claimants with higher mortality whose death cover has been terminated by the acceleration rider. A combined Death and TPD table has also been produced.

In addition, unadjusted results have been shown for Term Insurance, Critical Illness (CI) covers as well as for Lump Sum TPD covers. This is the first time that CI and TPD tables have been included in the investigation reports.

The outcomes of the current study:
1. graduated table S0408
2. graduated table S0408-IL
3. graduated table S0408DTPD
4. graduated table S0408DTPD-IL
5. crude rates for Term insurance
6. crude rates for Total and Permanent disability (TPD)
7. crude rates for CI

The graduated tables reflected adjustments made for TPD claims (via estimated death claims or additive TPD rates), while the crude rates are without adjustments.

There were considerable problems in ensuring that the correct data was recorded. In order to maintain confidentiality and also to ease the burden of data manipulation, information was received from companies in a summary format. Initially, data was requested without any allowance for policies where the CI benefit accelerates the death benefit. Based on this data the mortality incidence would have been understated.

Other inaccuracies in submitted data were identified from anomalies in the results. After a number of attempts, correct data was received and it was possible to produce the tables.

Overall the death (with TPD adjustment) table for NL business (duration 2+, ages 15 and above) was at a level of 71% of S9702. For IL business the result was 83% of S9702, both weighted by exposure.

CONTENT

1. Data used in Investigation

1.1 Outline of Data Received

Data was collected from each company in a summarised format by the MAS. This data consisted of policy counts in force at year end and exits for specific causes during the year. Data was received for year ends, 2003, 2004, 2005, 2006, 2007 and 2008. Exits were also received for the same years but the analysis was only made for the years 2004, 2005, 2006, 2007 and 2008. Year 2003 did not have an opening exposed to allow for the average exposure during the year and so was not used in the investigation

The following types of policies were excluded from the data collected:
- substandard policies i.e. policies issued on the basis of a rated up age, a contingent debt or an extra premium
- joint life policies
- reinsurance received from other companies, and
- group policies.

The tables that have been produced are based on age last. This is because the data was given as age last. This is different from S97-02 which is based on age nearest. In comparisons where S 97-02 has been used it has been adjusted to age last from age nearest.

1.2 Granularity of the Data

The data was provided in tables. There was one set of tables for each calendar year for the study period. Each table was split by age (0 to 99 last birthday) and then by the duration 0, 1, 2, 3, 4 and 5+. So each table consisted of 600 data items.

Separate tables were provided for each combination of data sources and were labelled with a six digit label as follows:
- First Digit
  - E : Exit
  - I : In Force
- Second Digit
  - M: Male
  - F: Female
- Third Digit
  - N: Non Investment Linked (NL)
  - I: Investment Linked (IL)
- Fourth Digit
  - T: Term Insurance
  - W: Whole Life/Endowment (WL&E)
- Fifth Digit
  - N: Death

- P: TPD
- M: Critical Illness with less than 100% acceleration of Death Benefit
- C: Critical Illness with 100% acceleration of Death Benefit
- Sixth Digit
  - N: Non medically examined
  - M: Medically examined

All together there were 768 tables of 600 data items each.

Policies with more than one benefit were included as in force for each benefit. So for a female, NL, WL&E policy, non medically underwritten and covering death, TPD and CI accelerating death 100%, a count of 1 was included in IFNWNN, IFNWPN and IFNWCN. However if a claim occurred under that policy it was only included under the cause of the claim. So if there was a TPD claim under that policy then it would be included under EFNWPN.

1.3   Impact of CI acceleration on Death Claims

Including policies with 100% acceleration of CI in the data would mean that death claims would be underestimated in the final answer. The reason for this is that for cases where a CI claim accelerated the death claim by 100%, the policy would be included in the death exposure but death claims would be reduced by the impact of the 100% CI acceleration.

In formula terms for the standard Accelerating CI formula of: $q_x + i_x - k_x q_x$ the result would reflect $q_x - k_x q_x$ rather than q_x.

To overcome this problem a new set of data was asked for which showed only the deaths from policies excluding those with 100% acceleration of the death benefit. The exposure was adjusted by subtracting cases with E***C* from those with E***N*.

This new set of data was held under with a fifth digit of D (****D*).

1.4   Impact of TPD on Death Claims

In the vast majority of cases, a TPD benefit accelerates the death benefit for policies sold in Singapore. Separate TPD data has been collected in the past for individual policies in Singapore but the numbers involved have been quite small. The impact of this acceleration on the results of the past investigation has been immaterial.

In this investigation, the TPD total number of claims (for all durations) is 2,547 with an exposure of 20,901,588 years. This is a crude rate of 0.12‰ which is too high to be ignored.

In order to obtain suitable tables to reflect the actual business two approaches have been taken:

- Base a table on reported deaths alone and add back into the investigation the deaths that are expected to have occurred if the death cover had not been accelerated by the TPD benefit.

- Produce a combined death and accelerating TPD table. This is the first time that such a table has been produced.

1.5 Lives Covered

The investigation was made on life insurance policies sold by insurance companies registered under the Insurance Act (Cap 142). The investigation focussed on Singapore Insurance Fund standard lives. The extent to which the data may include foreign lives is not known. This is dependent on the practice of each individual company.

The investigation is based on policy count. No adjustments were made for lives with multiple policies.

1.6 Exposures and Claims

Table 1.1 – Exposure In Years and Number of Claims

DEATH COVER Exposure in Years and Number of Claims

	Non Medical		Medical		Total	
	Exposure	Claims	Exposure	Claims	Exposure	Claims
Females						
Non Investment Linked						
WL&E	8,869,219	4,455	741,061	848	9,610,280	5,303
Term	407,779	140	89,704	35	497,483	175
	9,276,998	**4,595**	**830,764**	**883**	**10,107,762**	**5,478**
Investment Linked						
WL&E	2,767,630	1,198	60,905	43	2,828,535	1,241
Term	322	-	23	-	345	-
	2,767,952	**1,198**	**60,927**	**43**	**2,828,879**	**1,241**
Males						
Non Investment Linked						
WL&E	7,671,919	6,003	829,486	1,437	8,501,405	7,440
Term	524,021	312	171,761	109	695,782	421
	8,195,940	**6,315**	**1,001,246**	**1,546**	**9,197,186**	**7,861**
Investment Linked						
WL&E	3,048,479	2,660	89,920	104	3,138,399	2,764
Term	267	-	31	-	298	-
	3,048,746	**2,660**	**89,951**	**104**	**3,138,697**	**2,764**
TOTAL	**23,289,636**	**14,768**	**1,982,888**	**2,576**	**25,272,524**	**17,344**

DEATH COVER EXCLUDING 100% CI acceleration Exposure in Years and Number of Claims

	Non Medical		Medical		Total	
	Exposure	Claims	Exposure	Claims	Exposure	Claims
Females						
Non Investment Linked						
WL&E	6,446,906	3,772	502,846	764	6,949,752	4,536
Term	350,917	135	80,668	34	431,584	169
	6,797,823	**3,907**	**583,513**	**798**	**7,381,336**	**4,705**
Investment Linked						
WL&E	2,350,652	1,173	45,809	39	2,396,460	1,212
Term	322	-	23	-	345	-
	2,350,974	**1,173**	**45,831**	**39**	**2,396,805**	**1,212**
Males						
Non Investment Linked						
WL&E	5,770,221	5,087	624,189	1,311	6,394,410	6,398
Term	448,605	311	153,785	108	602,389	419
	6,218,826	**5,398**	**777,974**	**1,419**	**6,996,799**	**6,817**
Investment Linked						
WL&E	2,681,880	2,664	71,474	73	2,753,353	2,737
Term	267	-	31	-	298	-
	2,682,146	**2,664**	**71,505**	**73**	**2,753,651**	**2,737**
TOTAL	**18,049,768**	**13,142**	**1,478,822**	**2,329**	**19,528,590**	**15,471**

TPD COVER Exposure in Years and Number of Claims

	Non Medical		Medical		Total	
	Exposure	Claims	Exposure	Claims	Exposure	Claims
Females						
Non Investment Linked						
WL&E	8,364,391	636	706,027	265	9,070,418	901
Term	347,014	20	82,055	13	429,069	33
	8,711,405	**656**	**788,082**	**278**	**9,499,487**	**934**
Investment Linked						
WL&E	1,255,473	72	38,906	1	1,294,379	73
Term	-	-	-	-	-	-
	1,255,473	**72**	**38,906**	**1**	**1,294,379**	**73**
Males						
Non Investment Linked						
WL&E	7,301,699	942	793,676	369	8,095,375	1,311
Term	447,016	48	155,010	35	602,026	83
	7,748,715	**990**	**948,686**	**404**	**8,697,401**	**1,394**
Investment Linked						
WL&E	1,359,826	143	50,496	3	1,410,322	146
Term	-	-	-	-	-	-
	1,359,826	**143**	**50,496**	**3**	**1,410,322**	**146**
TOTAL	**19,075,419**	**1,861**	**1,826,169**	**686**	**20,901,588**	**2,547**

CRITICAL ILLNESS 100% acceleration Exposure in Years and Number of Claims

		Non Medical		Medical		Total	
		Exposure	Claims	Exposure	Claims	Exposure	Claims
Females							
Non Investment Linked							
	WL&E	2,422,313	3,899	238,215	838	2,660,528	4,737
	Term	56,863	34	9,036	12	65,899	46
		2,479,176	**3,933**	**247,251**	**850**	**2,726,427**	**4,783**
Investment Linked							
	WL&E	416,979	100	15,096	10	432,075	110
	Term	-	-	-	-	-	-
		416,979	**100**	**15,096**	**10**	**432,075**	**110**
Males							
Non Investment Linked							
	WL&E	1,901,698	2,275	205,297	666	2,106,995	2,941
	Term	75,417	36	17,976	33	93,393	69
		1,977,115	**2,311**	**223,273**	**699**	**2,200,387**	**3,010**
Investment Linked							
	WL&E	366,600	72	18,447	12	385,046	84
	Term	-	-	-	-	-	-
		366,600	**72**	**18,447**	**12**	**385,046**	**84**
TOTAL		**5,239,868**	**6,416**	**504,066**	**1,571**	**5,743,934**	**7,987**

CRITICAL ILLNESS < 100% acceleration Exposure in Years and Number of Claims

		Non Medical		Medical		Total	
		Exposure	Claims	Exposure	Claims	Exposure	Claims
Females							
Non Investment Linked							
	WL&E	560,444	332	63,631	75	624,075	407
	Term	2,274	6	1,390	4	3,664	10
		562,718	**338**	**65,021**	**79**	**627,738**	**417**
Investment Linked							
	WL&E	102,632	35	16,855	9	119,487	44
	Term	-	-	-	-	-	-
		102,632	**35**	**16,855**	**9**	**119,487**	**44**
Males							
Non Investment Linked							
	WL&E	490,064	288	65,461	80	555,525	368
	Term	2,669	5	2,482	2	5,151	7
		492,732	**293**	**67,943**	**82**	**560,675**	**375**
Investment Linked							
	WL&E	105,**592**	30	19,556	6	125,148	36
	Term	-	-	-	-	-	-
		105,592	**30**	**19,556**	**6**	**125,148**	**36**
TOTAL		**1,263,674**	**696**	**169,374**	**176**	**1,433,047**	**872**

<u>TOTAL CRITICAL ILLNESS Exposure in Years and Number of Claims</u>

	Non Medical		**Medical**		**Total**	
	<u>Exposure</u>	<u>Claims</u>	<u>Exposure</u>	<u>Claims</u>	<u>Exposure</u>	<u>Claims</u>
Females						
Non Investment Linked						
WL&E	2,982,757	4,231	301,846	913	3,284,603	5,144
Term	59,136	40	10,426	16	69,562	56
	3,041,893	**4,271**	**312,272**	**929**	**3,354,165**	**5,200**
Investment Linked						
WL&E	519,611	135	31,951	19	551,561	154
Term	-	-	-	-	-	-
	519,611	**135**	**31,951**	**19**	**551,561**	**154**
Males						
Non Investment Linked						
WL&E	2,391,762	2,563	270,758	746	2,662,519	3,309
Term	78,085	41	20,458	35	98,543	76
	2,469,847	**2,604**	**291,216**	**781**	**2,761,062**	**3,385**
Investment Linked						
WL&E	472,192	102	38,002	18	510,194	120
Term	-	-	-	-	-	-
	472,192	**102**	**38,002**	**18**	**510,194**	**120**
TOTAL	**6,503,542**	**7,112**	**673,440**	**1,747**	**7,176,981**	**8,859**

2. Mortality Results

2.1 Result of Investigation

The result of the investigation is 4 graduated tables which are set out in full in Appendix 1 :

- S0408 : NL WL&E Death with TPD adjustments
- S0408-IL : IL WL&E Death with TPD adjustments
- S0408DTPD : NL WL&E Death plus TPD
- S0408DTPD-IL : IL WL&E Death plus TPD.

The S0408 table shows a mortality rate which is on average 29% (weighted by exposure) lower than S9702. This table is derived after an adjustment for TPD has been made.

A separate graduated table S0408-IL, in respect of WL&E IL business was also produced. This shows a higher mortality than the S0408 table.

Term insurance results were not used to produce the final tables. The results for this business are shown separately.

Table 2.1 – Crude Rate Analysis, comparison with S9702
(death unadjusted)

Age Last	Male Crude Rates ‰			Female Crude Rates ‰		
	NL WL&E	IL	q_x-S9702	NL WL&E	IL	q_x-S9702
0 – 4	0.127	0.165	0	0.182	0.122	0
5 – 9	0.094	0.118	0	0.120	0.000	0
10 – 14	0.115	0.241	0	0.124	0.109	0
15 – 19	0.244	0.068	0.222	0.147	0.234	0.131
20 – 24	0.337	0.553	0.434	0.230	0.224	0.178
25 – 29	0.330	0.405	0.468	0.162	0.159	0.206
30 – 34	0.308	0.370	0.375	0.181	0.204	0.328
35 – 39	0.463	0.550	0.661	0.269	0.260	0.444
40 – 44	0.662	0.928	0.963	0.537	0.671	0.601
45 – 49	1.023	1.498	1.362	0.726	0.907	1.093
50 – 54	2.017	2.490	2.513	1.217	1.231	1.594
55 – 59	2.683	3.304	4.101	1.850	2.014	2.764
60 – 64	4.415	3.395	6.757	2.570	2.391	3.799
65 – 69	9.087	10.066	14.115	3.975	2.854	6.337
70 – 74	17.915	7.273	26.463	8.864	8.314	14.929
75 – 79	25.733	41.353	34.682	21.465	8.415	24.679
80 – 84	37.677	0.000	54.830	42.531	85.714	27.460
85 – 89	71.097	0.000	79.096	66.508	222.222	95.238
90 – 94	44.944	285.714	115.385	35.714	–	285.714
95 – 99	0.000	–	–	29.412	–	327.788

Chart 2.1 – Crude Rate Analysis, comparison with S9702
(death unadjusted, per 1,000)

Male Crude Rate (no TPD adjustment)

Legend: Non IL WL&E — IL W&E — S9702

Female Crude Rate (no TPD adjustment)

Legend: Non IL WL&E — IL WL&E — S9702
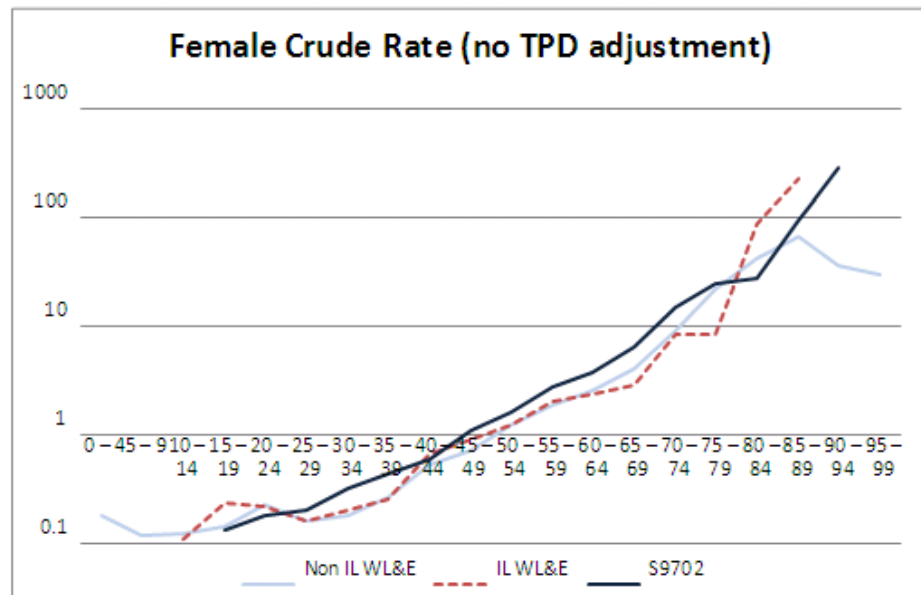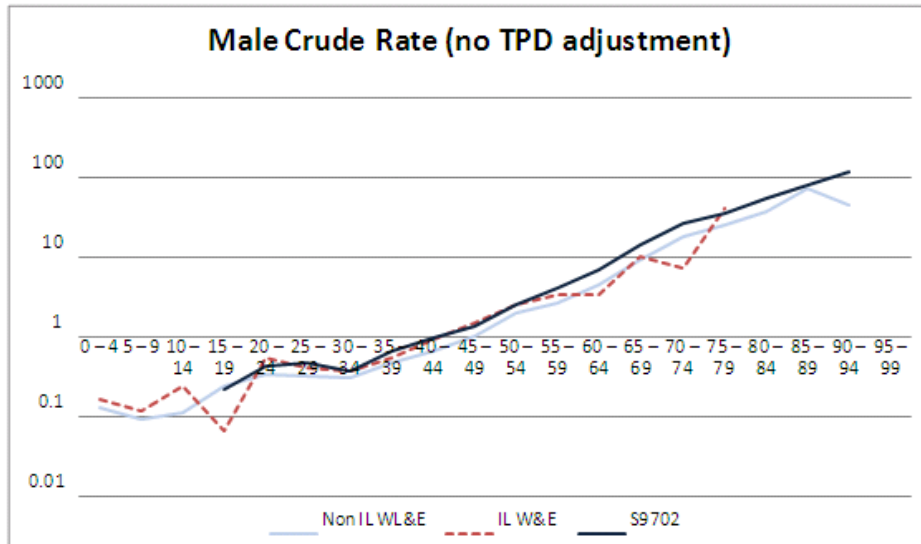
2.2 Select Period

The data is available for durations for 0, 1, 2, 3, 4 and 5+. A selection effect was very pronounced at Duration 0, and less pronounced up to Durations 5+.

Table 2.2 – Selection Analysis, NL WL&E comparison with S9702 (age 15 - 99)

Actual vs Expected Mortality as a Percentage of A/E at 5+, Med and Non-med, NL WL&E								
		Dur 0	Dur 1	Dur 2	Dur 3	Dur 4	Dur 5+	Dur 2+
Males	2004 - 08	56%	79%	96%	92%	88%	100%	98%
	1997 - 02	67%	88%	102%	91%	94%	100%	99%
Females	2004 - 08	34%	66%	71%	75%	68%	100%	91%
	1997 - 02	37%	73%	77%	83%	89%	100%	95%

The results are weighted by exposure and are without the TPD adjustment.
The results for Males duration 5+ are close to those for duration 2+. The impact of choosing 2+ as the ultimate period does not look unreasonable. However for Females the position is very different. The figures do not give any indication that there is a smooth progression in the select period.

Table 2.3 – Selection Analysis, IL WL&E comparison with S9702 (age 15 - 99)

Actual vs Expected Mortality as a Percentage of A/E at 5+, Med and Non-med, IL WL&E								
		Dur 0	Dur 1	Dur 2	Dur 3	Dur 4	Dur 5+	Dur 2+
Males	2004 - 08	89%	103%	93%	106%	106%	100%	101%
	1997 - 02	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Females	2004 - 08	39%	77%	72%	90%	83%	100%	91%
	1997 - 02	n/a	n/a	n/a	n/a	n/a	n/a	n/a

The results are weighted by exposure and are without the TPD adjustment.
For Male IL business there only appears to be a slight selection effect at duration 0. For Female IL business there is a longer selection effect.

It was decided to keep a 2-year select period in order to be consistent with previous investigations, although users of the table should verify that this approach is appropriate for their purposes.

The workgroup has not been able to reach a clear conclusion on the select period issues. Details of an attempt to analyse the impact of the 2004 issues are attached in Appendix 4.

2.3 Medical Case

In many investigations the experience of medically underwritten policies has been better than non medically underwritten policies. This is attributed to the better underwriting decision that can be made as a result of performing a medical as well as the fact that medically underwritten policies usually are for larger sums insured. The data from this investigation shows a different picture with the experience of medical business being worse than non medical. The working party is not aware of any reason for this.

The two sources of data were combined for all of the investigations in this report. Overall, weighted by exposure and before the TPD adjustment, the result of the medical/non medical business is as follows:

Table 2.4 – Medical Analysis (Death only, duration 2+)

Mortality impact of Medical Cases - Crude rate ‰		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 – 14	0.101	0.280	0.049	0.000	0.155	0.597
	15 – 64	0.935	1.486	0.861	0.682	1.074	1.073
	65 – 99	11.658	14.223	13.158	18.388	10.957	8.954
	Overall	0.902	2.122	0.828	0.778	1.074	1.191
Females	0 - 14	0.122	0.300	0.054	0.000	0.063	0.000
	15 – 64	0.623	0.996	0.465	0.468	0.587	0.987
	65 – 99	4.907	8.871	2.703	3.396	4.613	3.355
	Overall	0.609	1.510	0.441	0.486	0.588	1.053

Mortality impact of Medical Cases – Age Standardised Crude rate ‰		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 – 14	0.101	0.278	0.038	0.000	0.165	0.803
	15 – 64	0.941	1.069	1.011	0.596	1.192	0.920
	65 – 99	12.382	12.891	26.281	18.831	11.158	8.921
	Overall	0.967	1.103	1.158	0.712	1.185	0.985
Females	0 – 14	0.123	0.361	0.041	0.000	0.071	0.000
	15 – 64	0.608	0.764	0.648	0.432	0.681	0.882
	65 – 99	5.462	7.520	2.324	4.046	4.785	3.152
	Overall	0.623	0.810	0.612	0.436	0.675	0.828

Mortality impact of Medical Cases - Number of Claims		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 – 14	71	8	1	0	11	1
	15 – 64	4,205	786	289	81	1,857	54
	65 – 99	447	457	5	13	72	8
	Overall	4,723	1,251	295	94	1,940	63
Females	0 - 14	78	7	1	0	4	0
	15 - 64	3,069	403	120	29	869	30
	65 - 99	272	285	1	2	41	5
	overall	3,419	695	122	31	914	35

2.4 Mortality Results

2.4.1 Mortality Exposure and Claims

Table 2.5– Mortality Exposure (duration 2+, exclude Term and 100% CI acceleration)

Age Last	Male				Female			
	Life years exposed		Claims		Life years exposed		Claims	
	NL WL&E	IL WL&E	NL WL&E	IL WL&E	NL WL&E	IL WL&E	NL WL&E	IL WL&E
0 – 4	78,893	18,139	10	3	71,320	16,394	13	2
5 – 9	275,521	33,803	26	4	250,127	29,878	30	0
10 – 14	374,713	20,737	43	5	339,116	18,315	42	2
15 – 19	344,272	14,753	84	1	291,774	12,807	43	3
20 – 24	276,332	25,335	93	14	222,218	26,761	51	6
25 – 29	385,430	150,450	127	61	408,064	169,610	66	27
30 – 34	545,309	302,903	168	112	666,737	293,478	121	60
35 – 39	689,725	361,494	319	199	824,246	300,405	222	78
40 – 44	831,198	355,552	550	330	893,365	265,434	480	178
45 – 49	820,304	291,724	839	437	840,288	215,026	610	195
50 – 54	657,261	196,777	1,326	490	656,724	146,197	799	180
55 – 59	355,509	65,073	954	215	377,892	62,562	699	126
60 – 64	120,266	15,317	531	52	148,256	19,239	381	46
65 – 69	49,633	5,762	451	58	66,156	8,058	263	23
70 – 74	14,458	1,375	259	10	15,569	1,925	138	16
75 – 79	4,625	266	119	11	4,566	357	98	3
80 – 84	1,274	51	48	0	964	35	41	3
85 – 89	324	8	23	0	211	5	14	1
90 – 94	89	4	4	1	56	0	2	0
95 – 99	73	0	0	0	34	0	1	0
TOTAL	5,825,209	1,859,523	5,974	2,003	6,077,683	1,586,486	4,114	949

2.4.2 Crude Mortality Results Compared with S9702

The tables 2.6 to 2.8 compare the results with S9702. For male adults, crude rates of Death (with TPD adjustment) and Death+TPD are significantly lower than S9702. NL WL&E results are consistently lower than IL WL&E results. The picture is somewhat different for females. At ages beyond 25, crude rates of both NL and IL were lower than q_x of S9702. However at younger ages, both rates were higher than q_x of S9702 and proportionally significantly higher.

Compared with S9702, mortality rates at ages over 65 showed significant improvement for both males and females. NL WL&E results for ages 90+ have not been included in the analysis due to lack of exposure, making it difficult to have any firm conclusions for those ages.

Table 2.6 – Mortality Results per 1,000 No TPD Adjustments vs S9702 – Adults (15-89)

Age Last	Male Crude Rates ‰			Female Crude Rates ‰		
	NL WL&E	IL WL&E	q_x-S9702	NL WL&E	IL WL&E	q_x-S9702
15 – 19	0.244	0.068	0.286	0.147	0.234	0.171
20 – 24	0.337	0.553	0.508	0.230	0.224	0.190
25 – 29	0.330	0.405	0.433	0.162	0.159	0.227
30 – 34	0.308	0.370	0.424	0.181	0.204	0.322
35 – 39	0.463	0.550	0.644	0.269	0.260	0.456
40 – 44	0.662	0.928	1.017	0.537	0.671	0.690
45 – 49	1.023	1.498	1.542	0.726	0.907	1.105
50 – 54	2.017	2.490	2.591	1.217	1.231	1.783
55 – 59	2.683	3.304	4.582	1.850	2.014	2.806
60 – 64	4.415	3.395	8.084	2.570	2.391	4.264
65 – 69	9.087	10.066	15.066	3.975	2.854	7.461
70 – 74	17.915	7.273	24.276	8.864	8.314	15.524
75 – 79	25.733	41.353	37.693	21.465	8.415	27.479
80 – 84	37.677	0.000	62.625	42.531	85.714	49.386
85 – 89	71.097	0.000	103.015	66.508	222.222	87.845

Age Last	Male Crude Rates as % of S9702		Female Crude Rates as % of S9702	
	NL WL&E	IL WL&E	NL WL&E	IL WL&E
15 – 19	85.3%	23.8%	86.0%	136.8%
20 – 24	66.3%	108.9%	121.1%	117.9%
25 – 29	76.2%	93.5%	71.4%	70.0%
30 – 34	72.6%	87.3%	56.2%	63.4%
35 – 39	71.9%	85.4%	59.0%	57.0%
40 – 44	65.1%	91.2%	77.8%	97.2%
45 – 49	66.3%	97.1%	65.7%	82.1%
50 – 54	77.8%	96.1%	68.3%	69.0%
55 – 59	58.6%	72.1%	65.9%	71.8%
60 – 64	54.6%	42.0%	60.3%	56.1%
65 – 69	60.3%	66.8%	53.3%	38.3%
70 – 74	73.8%	30.0%	57.1%	53.6%
75 – 79	68.3%	109.7%	78.1%	30.6%
80 – 84	60.2%	0.0%	86.1%	173.6%
85 – 89	69.0%	0.0%	75.7%	253.0%

Table 2.7 – Mortality Results per 1,000 with TPD Adjustments vs S9702 – Adults (15-64)

Age Last	Male Crude Rates ‰			Female Crude Rates ‰		
	NL WL&E	ILWL&E	q_x-S9702	NL WL&E	ILWL&E	q_x-S9702
15 – 19	0.251	0.068	0.286	0.152	0.234	0.171
20 – 24	0.341	0.553	0.508	0.234	0.227	0.190
25 – 29	0.334	0.406	0.433	0.166	0.160	0.227
30 – 34	0.312	0.371	0.424	0.184	0.205	0.322
35 – 39	0.469	0.553	0.644	0.277	0.262	0.456
40 – 44	0.675	0.931	1.017	0.551	0.675	0.690
45 – 49	1.062	1.515	1.542	0.759	0.923	1.105
50 – 54	2.130	2.549	2.591	1.295	1.266	1.783
55 – 59	2.928	3.390	4.582	2.010	2.073	2.806
60 – 64	4.756	3.479	8.084	2.819	2.398	4.264

Age Last	Male Rates as % of S9702		Female Rates as % of S9702	
	NL WL&E	ILWL&E	NL WL&E	ILWL&E
15 – 19	87.8%	23.8%	88.9%	136.8%
20 – 24	67.1%	108.9%	123.2%	119.5%
25 – 29	77.1%	93.8%	73.1%	70.5%
30 – 34	73.6%	87.5%	57.1%	63.7%
35 – 39	72.8%	85.9%	60.7%	57.5%
40 – 44	66.4%	91.5%	79.9%	97.8%
45 – 49	68.9%	98.2%	68.7%	83.5%
50 – 54	82.2%	98.4%	72.6%	71.0%
55 – 59	63.9%	74.0%	71.6%	73.9%
60 – 64	58.8%	43.0%	66.1%	56.2%

Table 2.8 – Mortality Results Death+TPD per 1,000 vs S9702 – Adults (15-64)

Age Last	Male Crude Rates ‰			Female Crude Rates ‰		
	NL WL&E	IL WL&E	q_x-S9702	NL WL&E	IL WL&E	q_x-S9702
15 – 19	0.312	0.068	0.286	0.188	0.234	0.171
20 – 24	0.385	0.553	0.508	0.285	0.271	0.190
25 – 29	0.390	0.430	0.433	0.193	0.169	0.227
30 – 34	0.349	0.414	0.424	0.206	0.223	0.322
35 – 39	0.531	0.604	0.644	0.340	0.308	0.456
40 – 44	0.767	0.990	1.017	0.612	0.748	0.690
45 – 49	1.239	1.751	1.542	0.861	1.076	1.105
50 – 54	2.453	3.024	2.591	1.443	1.444	1.783
55 – 59	3.334	3.695	4.582	2.183	2.246	2.806
60 – 64	5.075	3.664	8.084	2.987	2.391	4.264

Age Last	Male Rates as % of S9702		Female Rates as % of S9702	
	NL WL&E	IL WL&E	NL WL&E	IL WL&E
15 – 19	109.1%	23.8%	109.9%	136.8%
20 – 24	75.8%	108.9%	150.0%	142.6%
25 – 29	90.1%	99.3%	85.0%	74.4%
30 – 34	82.3%	97.6%	64.0%	69.3%
35 – 39	82.5%	93.8%	74.6%	67.5%
40 – 44	75.4%	97.3%	88.7%	108.4%
45 – 49	80.4%	113.6%	77.9%	97.4%
50 – 54	94.7%	116.7%	80.9%	81.0%
55 – 59	72.8%	80.6%	77.8%	80.0%
60 – 64	62.8%	45.3%	70.1%	56.1%

**Chart 2.2 – Mortality Results Death and TPD vs S9702 – Males (15-64)
per 1,000**
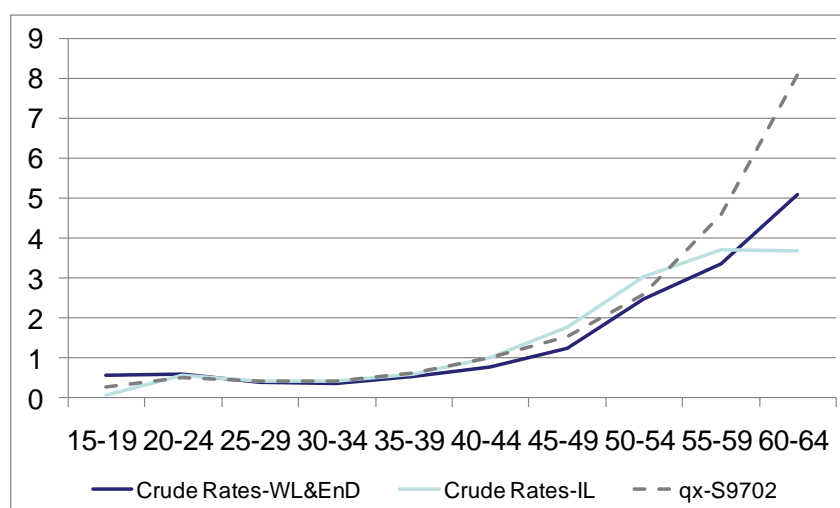
Chart 2.3 – Mortality Results Death and TPD vs S9702 – Females (15-64) per 1,000
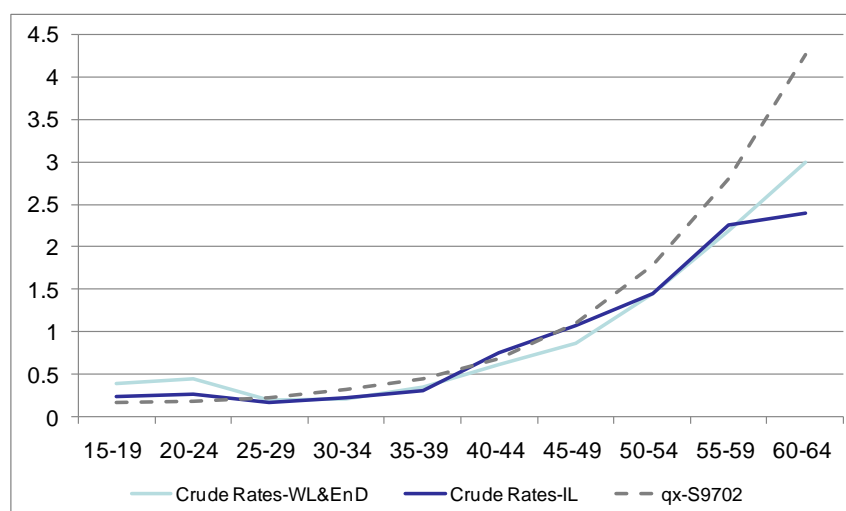
2.4.3 Crude Mortality Results compared with Population Mortality 2006

In previous investigations lives under age 15 were not included. A comparison of the crude rates with 2006 population rates shows that the insured experience is much closer to the population experience than at older ages.

The number of claims for IL business for lives under age 15 is too small to be credible and so has not been included in the comparison below.

Table 2.9– Mortality Results with No TPD Adjustments vs Population 2006 – Juveniles (0-14)

Age Last	Male Crude Rates ‰		Female Crude Rates ‰	
	NL WL&E	q_x pop 2006	NL WL&E	q_x pop 2006
0 – 4	0.127	0.100	0.182	0.100
5 – 9	0.094	0.100	0.120	0.100
10 – 14	0.115	0.200	0.124	0.100

Age Last	Male Rates as % of q_x pop 2006	Female Rates as % of q_x pop 2006
	NL WL&E	NL WL&E
0 – 4	127.0%	182.0%
5 – 9	94.0%	120.0%
10 – 14	57.5%	124.0%

Table 2.10 – Mortality Results with TPD Adjustments vs Population 2006 – Juveniles (0-14)

Age Last	Male Crude Rates ‰		Female Crude Rates ‰	
	NL WL&E	q_x pop 2006	NL WL&E	q_x pop 2006
0 – 4	0.128	0.100	0.184	0.100
5 – 9	0.098	0.100	0.124	0.100
10 – 14	0.120	0.200	0.127	0.100

	Male Rates as % of q_x pop 2006	Female Rates as % of q_x pop 2006
Age Last	NL WL&E	NL WL&E
0 – 4	128.0%	184.0%
5 – 9	98.0%	124.0%
10 – 14	60.0%	127.0%

Table 2.11– Mortality Results Death+TPD vs Population 2006 – Juveniles (0-14)

	Male Crude Rates ‰		Female Crude Rates ‰	
Age Last	NL WL&E	q_x pop 2006	NL WL&E	q_x pop 2006
0 – 4	0.144	0.100	0.201	0.100
5 – 9	0.132	0.100	0.158	0.100
10 – 14	0.163	0.200	0.158	0.100

	Male Rates as % of q_x pop 2006	Female Rates as % of q_x pop 2006
Age Last	NL WL&E	NL WL&E
0 – 4	144.0%	201.0%
5 – 9	132.0%	158.0%
10 – 14	81.5%	158.0%

2.5 Age 52 issues for Males

During the investigation, an abnormality became apparent at age 52 where the mortality rate for males significantly exceeded the crude rates of all neighbouring ages. Underlying data recording error is suspected to have caused it. The spike at age 52 was smoothed out at the graduation stage.

Table 2.12 – Crude Rate at age 52 and neighbouring ages

Age 52 issue for Males – Deaths

Age Last	Exposure		Claims		Crude q_x ‰	
	Males	Females	Males	Females	Males	Females
50	149,884	151,738	228	169	1.521	1.114
51	141,869	142,712	240	160	1.692	1.121
52	132,852	132,632	334	170	2.514	1.282
53	122,866	121,195	283	160	2.303	1.320
54	109,791	108,447	241	140	2.195	1.291

2.6 Term Insurance Business

Crude results have been produced for NL Term Insurance business. IL Term Insurance business is too small to be considered. These results have not been included with the NL WL&E business and IL WL&E business so as to maintain continuity with past investigations. There is not enough data to produce a graduated table for Term Insurance so only crude results have been produced. No adjustment has been made for TPD because of the number of TPD benefits attaching to Term Insurance policies is much lower than for WL&E policies.

It can be seen from the tables below that the experience is variable. On average NL Term business is 96% of Males NL WL&E and 84% of Females NL WL&E death rates, with TPD adjustment.

Table 2.13 – NL Term (no TPD adjustment)

Age Last	Male NL Term			Female NL Term		
	Exposure	Deaths	Crude rate ‰	Exposure	Deaths	Crude rate ‰
0 – 4	1,286	0	–	1,104	0	–
5 – 9	6,603	0	–	5,774	0	–
10 – 14	13,939	1	0.072	12,939	1	0.077
15 – 19	15,207	5	0.329	13,047	1	0.077
20 – 24	12,161	3	0.247	10,247	2	0.195
25 – 29	23,633	8	0.339	25,588	3	0.117
30 – 34	58,141	22	0.378	54,216	10	0.184
35 – 39	85,502	34	0.398	66,831	11	0.165
40 – 44	96,795	70	0.723	63,257	19	0.300
45 – 49	83,349	94	1.128	47,987	43	0.896
50 – 54	53,002	74	1.396	26,390	38	1.440
55 – 59	21,751	44	2.023	9,968	16	1.605
60 – 64	4,746	16	3.371	2,281	6	2.631
65 – 69	880	11	12.507	701	3	4.283
70 – 99	208	7	33.735	259	0	–
TOTAL	477,203	389		340,589	153	

Age Last	Male NL Term comparison with NL WL&E, both with TPD adjustment			Female NL Term comparison with NL WL&E, both with TPD adjustment		
	NL Term Crude Rate‰	NL WL&E Crude Rate‰	NL Term/NL WL&E	NL Term Crude Rate‰	NL WL&E Crude Rate‰	NL Term/NL WL&E
10 – 14	0.072	0.120	59.8%	0.072	0.127	56.5%
15 – 19	0.334	0.251	133.1%	0.077	0.152	50.4%
20 – 24	0.247	0.341	72.3%	0.195	0.234	83.4%
25 – 29	0.342	0.334	102.5%	0.117	0.166	70.6%
30 – 34	0.382	0.312	122.5%	0.184	0.184	100.2%
35 – 39	0.409	0.469	87.1%	0.169	0.277	60.9%
40 – 44	0.736	0.675	109.0%	0.314	0.551	56.9%
45 – 49	1.153	1.062	108.6%	0.918	0.759	120.9%
50 – 54	1.494	2.130	70.1%	1.532	1.295	118.3%
55 – 59	2.190	2.928	74.8%	1.782	2.010	88.7%
60 – 64	3.620	4.756	76.1%	2.631	2.819	93.3%

2.7 Dependents Protection Scheme (DPS)

This is a scheme that was previously operated by the Central Provident Fund (CPF). The scheme offers a death benefit and is operated on straightforward lines with minimal underwriting. The scheme was transferred to some Singaporean Life Companies in 2005. On looking at the data it was clear that this scheme, which is quite large, had a significant impact on the results for term only business. The working group felt that this particular scheme should be excluded from the results because of it special nature, which could be distorting to the final results.

In this investigation the Term results were not used to produce a graduated table, however in future investigations the DPS should be kept separate.

3. TPD Results

3.1 TPD Benefit

The payment of a benefit on the Total and Permanent Disability (TPD) of the insured is a common addition to a death benefit in Singapore. The benefit accelerates the death benefit. The definition of TPD is usually an 'any occupation' definition. TPD benefit for Payor waiver plans were excluded from the investigation.

In previous investigations the incidence of TPD claims reported was very low and as a consequence they were ignored in the analysis. In this investigation more detailed information was requested and seemingly as a result the incidence of TPD claims is much higher.

A separate TPD graduated table was not produced but allowance was made in the Death Only tables for the impact of TPD claims. In addition a separate Death and TPD table was produced.

The exposure for TPD Term IL business was small so this was excluded from the analysis below.

3.2 TPD Results of Non Investment Linked

The tables below show the crude TPD rates as well as the TPD rates as a percentage of the crude death rates for NL WL&E.

Table 3.1 – TPD Results – NL WL&E (duration 2+)

Age Last	Male NL WL&E			Female NL WL&E		
	Exposure	TPD	Crude rate ‰	Exposure	TPD	Crude rate ‰
0 – 4	114,962	2	0.017	105,281	2	0.019
5 – 9	374,262	14	0.037	341,887	13	0.038
10 – 14	477,971	23	0.048	433,780	15	0.035
15 – 19	427,643	29	0.068	366,948	15	0.041
20 – 24	368,009	18	0.049	308,396	17	0.055
25 – 29	525,350	32	0.061	578,868	18	0.031
30 – 34	731,032	30	0.041	928,599	23	0.025
35 – 39	894,343	61	0.068	1,110,178	78	0.070
40 – 44	1,039,738	110	0.106	1,169,441	87	0.074
45 – 49	986,505	213	0.216	1,080,724	146	0.135
50 – 54	769,191	335	0.436	836,131	189	0.226
55 – 59	418,424	272	0.650	485,464	162	0.334
60 – 64	130,434	86	0.659	174,892	73	0.417
65 – 69	50,947	19	0.373	73,959	21	0.284
70 – 99	19,202	34	1.771	20,557	9	0.438
TOTAL	7,328,013	1,278		8,015,105	868	

Table 3.2 – Ratio between TPD and Mortality (with TPD adjustment) Results

Age Last	Male NL WL&E			Female NL WL&E		
	Death Crude Rate‰	TPD Crude Rate‰	TPD/Death	Death Crude Rate‰	TPD Crude Rate‰	TPD/Death
0 – 4	0.128	0.017	13.3%	0.184	0.019	10.3%
5 – 9	0.098	0.037	37.9%	0.124	0.038	30.6%
10 – 14	0.120	0.048	40.1%	0.127	0.035	27.5%
15 – 19	0.251	0.068	27.1%	0.152	0.041	27.0%
20 – 24	0.341	0.049	14.4%	0.234	0.055	23.5%
25 – 29	0.334	0.061	18.2%	0.166	0.031	18.7%
30 – 34	0.312	0.041	13.2%	0.184	0.025	13.6%
35 – 39	0.469	0.068	14.5%	0.277	0.070	25.3%
40 – 44	0.675	0.106	15.7%	0.551	0.074	13.4%
45 – 49	1.062	0.216	20.3%	0.759	0.135	17.8%
50 – 54	2.130	0.436	20.5%	1.295	0.226	17.4%
55 – 59	2.928	0.650	22.2%	2.010	0.334	16.6%
60 – 64	4.756	0.659	13.9%	2.819	0.417	14.8%
65 – 69	9.294	0.373	4.0%	4.134	0.284	6.9%
70 – 99	22.564	1.771	7.8%	14.014	0.438	3.1%

3.3 TPD Results of Investment-Linked

The tables below show the crude TPD rates as well as the TPD rates as a percentage of the crude death rates for IL WL&E.

Table 3.3 – TPD Results – IL WL&E (duration 2+)

Age Last	Male IL			Female IL		
	Exposure	TPD	Crude rate ‰	Exposure	TPD	Crude rate ‰
0 – 4	23,264	0	–	21,204	0	–
5 – 9	40,624	0	–	35,910	0	–
10 – 14	21,169	1	0.047	18,696	0	–
15 – 19	15,244	0	–	13,210	0	–
20 – 24	21,239	0	–	21,319	1	0.047
25 – 29	80,583	2	0.025	97,963	1	0.010
30 – 34	159,869	7	0.044	161,104	3	0.019
35 – 39	187,709	10	0.053	164,189	8	0.049
40 – 44	177,340	11	0.062	141,244	11	0.078
45 – 49	142,357	36	0.253	112,635	19	0.169
50 – 54	93,638	50	0.534	75,081	16	0.213
55 – 59	33,284	13	0.391	34,419	8	0.232
60 – 64	7,445	2	0.269	8,559	0	–
65 – 69	2,715	0	–	3,238	0	–
70 – 99	868	0	–	942	0	–
TOTAL	1,007,346	132		909,708	67	

Table 3.4 – Ratio between TPD and Mortality (with TPD adjustment) Results

Age Last	Male IL WL&E			Female IL WL&E		
	TPD Crude Rate‰	Death Crude Rate‰	TPD/Death	TPD Crude Rate‰	Death Crude Rate‰	TPD/Death
20 – 24	0	0.508	0.0%	0.047	0.227	20.7%
25 – 29	0.025	0.433	5.8%	0.010	0.160	6.3%
30 – 34	0.044	0.424	10.4%	0.019	0.205	9.3%
35 – 39	0.053	0.644	8.2%	0.049	0.262	18.7%
40 – 44	0.062	1.017	6.1%	0.078	0.675	11.6%
45 – 49	0.253	1.542	16.4%	0.169	0.923	18.3%
50 – 54	0.534	2.591	20.6%	0.213	1.266	16.8%
55 – 59	0.391	4.582	8.5%	0.232	2.073	11.2%
60 – 64	0.269	8.084	3.3%	0	2.398	0.0%

3.4 Select Period

The data is available for duration for 0, 1, 2, 3, 4 and 5+. A selection effect was very pronounced at Duration 0, but less pronounced at other durations

Table 3.5 – Selection Analysis of TPD (age 15 – 99)

Actual TPD claims as % of expected death claims vs A/E at 5+, Med and Non-med		Dur 0	Dur 1	Dur 2	Dur 3	Dur 4	Dur 5+	Dur 2+
Males	2004 - 08	18%	40%	85%	80%	116%	100%	99%
Females	2004 - 08	15%	37%	51%	79%	137%	100%	97%

3.5 Medical Case

Table 3.6 – Impact of Medical Cases (duration 2+)

TPD impact of Medical Cases - Crude rate ‰		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 - 14	0.036	0.141	0.000	0.000	0.012	0.000
	15 - 64	0.156	0.463	0.145	0.280	0.145	0.089
	65 - 99	0.058	1.419	0.000	1.634	0.000	0.000
	overall	0.138	0.494	0.136	0.284	0.133	0.083
Females	0 - 14	0.028	0.206	0.000	0.000	0.000	0.000
	15 - 64	0.090	0.398	0.069	0.177	0.082	0.039
	65 - 99	0.056	0.662	0.000	1.880	0.000	0.000
	overall	0.082	0.406	0.064	0.188	0.075	0.036

TPD impact of Medical Cases – Age standardised Crude Rate ‰		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 - 14	0.036	0.162	–	–	0.023	–
	15 - 64	0.160	0.327	0.154	0.216	0.160	0.127
	65 - 99	0.082	1.283	–	1.526	–	–
	overall	0.144	0.315	0.134	0.201	0.142	0.110
Females	0 - 14	0.028	0.201	–	–	–	–
	15 - 64	0.090	0.310	0.083	0.160	0.093	0.035
	65 - 99	0.051	0.656	–	2.443	–	–
	overall	0.083	0.302	0.073	0.168	0.082	0.031

TPD impact of Medical Cases - Number of claims		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 - 14	34	5	0	0	1	0
	15 - 64	875	311	47	33	128	3
	65 - 99	2	51	0	1	0	0
	overall	911	367	47	34	129	3
Females	0 - 14	24	6	0	0	0	0
	15 - 64	579	229	17	11	66	1
	65 - 99	3	27	0	1	0	0
	overall	606	262	17	12	66	1

4. Critical Illness Results

4.1 Critical Illness Benefit

Critical Illness policies sold in Singapore are mainly standardised, with the same conditions covered and the same definitions used. However there are some variations in the benefits covered. Information was collected on CI business and the results presented but there has been no attempt to analyse the results in depth.

Data was collected separately for exposure 100% Acceleration of death benefit (5,743,934 years of exposure) and exposure < 100% Acceleration of death benefit (1,433,047 years of exposure). In the analysis below this data has been combined.

4.2 Critical Illness Results of Non Investment Linked

Table 4.1 – Total CI Results – NL WL&E (duration 2+)

Age Last	Male Total CI			Female Total CI		
	Exposure	CI incidence	Crude rate ‰	Exposure	CI incidence	Crude rate ‰
0 – 4	52,020	21	0.404	48,436	8	0.165
5 – 9	133,699	34	0.254	123,732	39	0.315
10 – 14	131,091	52	0.397	119,986	41	0.342
15 – 19	106,723	61	0.572	96,308	38	0.395
20 – 24	120,063	50	0.416	116,232	43	0.370
25 – 29	216,936	53	0.244	274,701	77	0.280
30 – 34	315,269	90	0.285	430,925	216	0.501
35 – 39	342,516	197	0.575	451,429	444	0.984
40 – 44	340,544	441	1.295	419,188	705	1.682
45 – 49	274,283	597	2.177	356,155	1114	3.128
50 – 54	181,169	694	3.831	256,407	1015	3.959
55 – 59	92,360	571	6.182	146,761	763	5.199
60 – 64	29,448	249	8.456	50,850	335	6.588
65 – 69	8,740	124	14.188	16,854	156	9.256
70 – 99	993	22	22.155	2,057	23	11.181
TOTAL	2,345,851	3,256		2,910,017	5,017	

4.3 Critical Illness Results of Investment Linked

Table 4.2 – Total CI Results – IL WL&E (duration 2+)

Age Last	Male Total CI			Female Total CI		
	Exposure	CI incidence	Crude rate ‰	Exposure	CI incidence	Crude rate ‰
0 – 4	16,747	6	0.358	15,762	4	0.254
5 – 9	29,236	5	0.171	26,633	9	0.338
10 – 14	14,658	0	–	13,327	3	0.225
15 – 19	9,264	4	0.432	8,158	1	0.123
20 – 24	11,672	0	–	13,835	1	0.072
25 – 29	39,896	2	0.050	49,081	5	0.102
30 – 34	61,813	9	0.146	58,660	13	0.222
35 – 39	48,870	8	0.164	46,594	19	0.408
40 – 44	36,790	11	0.299	39,285	18	0.458
45 – 49	26,279	18	0.685	33,241	22	0.662
50 – 54	16,377	9	0.550	25,437	19	0.747
55 – 59	6,445	9	1.396	12,895	11	0.853
60 – 64	1,058	3	2.837	2,688	3	1.116
65 – 69	115	0	–	226	1	4.435
70 – 99	3	0	–	5	0	–
TOTAL	319,219	84		345,821	129	

4.4 Select Period

The data is available for duration for 0, 1, 2, 3, 4 and 5+. The selection effect was very pronounced at Duration 0, and continues for some time after that.

IL and NL results are combined for this analysis. The analysis is based on the Total Critical Illness result.

Table 4.3 – Selection Analysis of CI (age 15 – 99)

Actual CI claims as %of expected death claims vs A/E at 5+, Med and Non-med								
		Dur 0	Dur 1	Dur 2	Dur 3	Dur 4	Dur 5+	Dur 2+
Males	2004 - 08	20%	42%	67%	62%	62%	100%	94%
Females	2004 - 08	21%	43%	60%	73%	65%	100%	95%

4.5 Medical Case

The results for Critical Illness again show that the experience for those who undergo a medical case is higher than those who do not.

Table 4.4 – Impact of Medical Cases (duration 2+)

Total CI impact of Medical Cases - Crude rate ‰		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 - 14	0.328	0.600	0.000	0.000	0.188	0.000
	15 - 64	1.340	2.729	0.776	2.441	0.254	0.541
	65 - 99	12.629	16.598	0.000	0.000	0.000	0.000
	overall	1.212	2.964	0.768	2.435	0.241	0.497
Females	0 - 14	0.294	0.501	0.000	0.000	0.278	0.545
	15 - 64	1.712	2.992	1.136	2.294	0.358	0.732
	65 - 99	7.845	10.379	0.000	0.000	0.000	8.929
	overall	1.575	3.234	1.124	2.283	0.345	0.756

Total CI impact of Medical Cases – Crude Rate Age Standardised ‰		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 - 14	0.327	0.640	0.000	0.000	0.144	0.000
	15 - 64	1.384	1.837	1.393	4.284	0.350	0.588
	65 - 99	13.623	16.501	0.000	0.000	0.000	0.000
	overall	1.280	1.722	1.191	3.662	0.320	0.502
Females	0 - 14	0.292	0.394	0.000	0.000	0.272	0.520
	15 - 64	1.756	2.137	1.438	1.925	0.392	0.718
	65 - 99	7.798	10.320	0.000	0.000	0.000	8.224
	overall	1.635	1.998	1.276	1.708	0.377	0.741

Total CI impact of Medical Cases - Number of claims		NL WL&E		NL Term		IL WL&E	
	Age	Non Med	Med	Non Med	Med	Non Med	Med
Males	0 - 14	100	7	0	0	11	0
	15 - 64	2,349	605	28	21	59	14
	65 - 99	49	97	0	0	0	0
	overall	2,498	709	28	21	70	14
Females	0 - 14	83	5	0	0	15	1
	15 - 64	3,973	736	32	9	96	16
	65 - 99	53	126	0	0	0	1
	overall	4,109	867	32	9	111	18

5. Adjustment for TPD

The workgroup considered it important to address the question of how to adjust pure death only experience for TPD claimants whose claim terminates the policy, causing them to leave the investigation as impaired lives. To the extent this group of people is material in size and has significantly impaired mortality, it could make a significant impact on the death only rates.

The workgroup struggled to find a suitable basis for determining impaired mortality of TPD claimants. For the purpose of this report, the workgroup has adopted the impaired mortality rates of long term care claimants who are unable to perform 3 of 6 activities of daily living, as reported in Dullaway and Elliott [1] as a starting point (although the relevant column headings in Appendix 11 appear to have been switched with the 2 of 6 column). These mortality rates are replicated in Appendix 2.

TPD claimants are then exposed to these higher mortality rates for half the duration of the investigation, and the resulting deaths and exposure are added to the crude mortality rates before being graduated.

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[1] Dullaway D & Elliott S, 1998, *Long-Term Care Insurance: A Guide to Product Design and Pricing*, Staple Inn Actuarial Society, London

6. Graduation Approach

The Whittaker-Henderson method of graduation was selected as a relatively straightforward method to apply, offering a good balance between smoothness and fit. The method is documented in detail elsewhere (see, for example, IAAust Mortality Committee[2]) but a short summary is presented below.

The method aims to calculate q_i, the graduated mortality rates which minimise the following statistic:

$$Q = \sum_{i=0}^{\omega} w_i (q_i - q_i')^2 \; + \; \sum_{i=0}^{\omega-3} k_i \left(\Delta^3 q_i \right)^2$$

where ω is the maximum age, the q_i' are the ungraduated mortality rates, w_i are weighting factors, k_i are positive constants and Δ^3 represents the 3rd difference operator.

In this exercise the w_i have been set equal to the proportional exposure of the data in question and k_i have been fixed at 5 across the age range. This approach was adopted through visual inspection of a range of different parameter combinations, and was felt to give an adequate balance between fit and smoothness. More sophisticated approaches are possible but were not pursued in the interest of time.

The actual calculations were carried using software known as GIST, which was released in 2001 by the German reinsurer, Gerling Global Re. The software is now owned by the French reinsurer Scor, which has kindly permitted the workgroup to use it for this purpose.

The Heligmann-Pollard formula was also considered, but not adopted due to the challenges of achieving a good fit.

Graduations were conducted for the following crude data sets:

Table 6.1

Class	Cause of claim	Sex	Codes
Traditional (Non-linked) Whole Life and Endowment	Death and TPD	Male	S0408DTPD(M)
		Female	S0408DTPD(F)
	Adjusted Death only	Male	S0408(M)
		Female	S0408(F)
Linked Whole Life and Endowment	Adjusted Death only	Male	S0408-IL(M)
		Female	S0408-IL(F)

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[2] IAAust Mortality Committee, 2001, *Mortality Investigation IA 95-97 M and F: Graduated Mortality Tables,* Institute of Actuaries of Australia

All graduations were performed using a 2 year select period. The number of deaths for the non-linked tables was felt sufficient to have some degree of confidence in the level and shape of the curve, although conclusions are difficult to draw in the tails.

At the very old ages the data are very sparse, and the level of the Singapore population mortality table at age 99 was felt to be a useful reference point for use in determining the level of the tails of the various graduations. Table 6.2 below summarises the means by which the population table has been incorporated into the graduation. For these purposes, the 2006 population tables (S2006) have been adopted (see Singapore Department of Statistics (2010)[3]), representing the year corresponding to the midpoint of the insured lives' investigation.

Table 6.2

Code	Method to incorporate S2006
S0408DTPD(M)	Equal geometric increase from graduated rate at age 83 to reach S2006M at age 99.
S0408DTPD(F)	Equal geometric increase from graduated rate at age 84 to reach S2006F at age 99.
S0408(M)	Equal geometric increase from graduated rate at age 77 to reach S2006M at age 99.
S0408(F)	Equal geometric increase from graduated rate at age 84 to reach S2006F at age 99.

It should be noted that while the S2006 tables are death only tables, TPD claims at the very old ages are very rare, so it was felt to be appropriate for use with both the Death only and Death and TPD tables.

The graduated tables are based on durations 2+. As a result there are no rates for ages 0 and 1. For completeness, rates at ages 0 and 1 were included in the graduated table. These rates were determined by extrapolation from ages 2 through to 10.

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[3] Singapore Department of Statistics, 2010, *Complete Life Tables 2006 - 2009 for Singapore Resident Population*, Singapore Department of Statistics

7. Graduation Results

7.1 NL, Death+TPD, Males (S0408DTPD(M))

Chart 7.1 – Graduation vs Crude and Population rates - Males
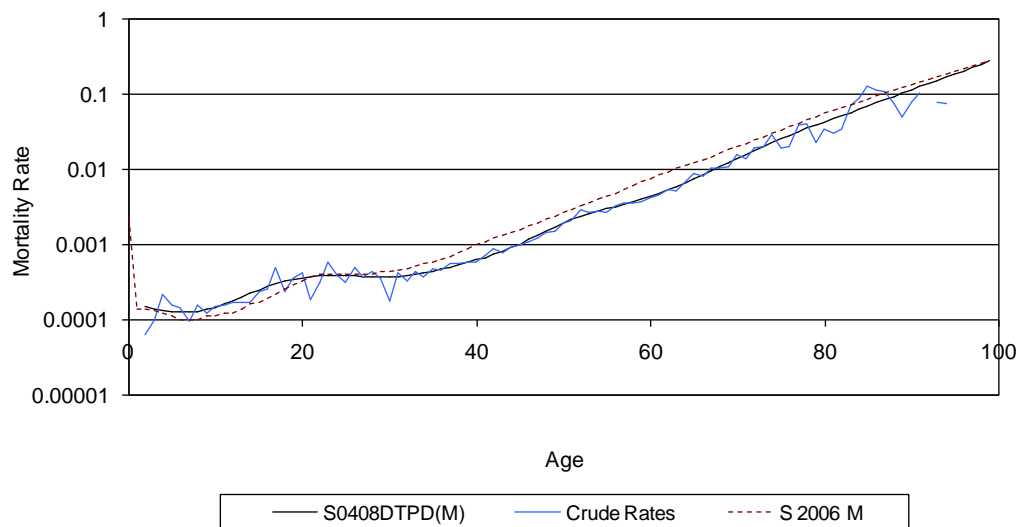
Comparison of the graduation with the crude rates reveals a reasonable looking fit with the following exceptions:

- Higher volatility in the tails – not unusual given fewer claims and exposure in those ranges.
- Upward spike in observed deaths at age 52, which is quite unusual

The spike at age 52 is proving difficult to explain. It may not appear to be a large deviation, but represents a large number of excess claims – 89 more than the 312 predicted by the graduation. Furthermore, the effect seems to persist across most companies, most durations and most years within the investigation period. There is even a (somewhat smaller) peak that appears in the crude rates in the previous investigation.

The workgroup was unable to find any satisfactory explanation and therefore highlights this as an open issue, but has not made any adjustment to the graduation in this regard.

Chart 7.2 – Male Graduation vs Previous Investigation
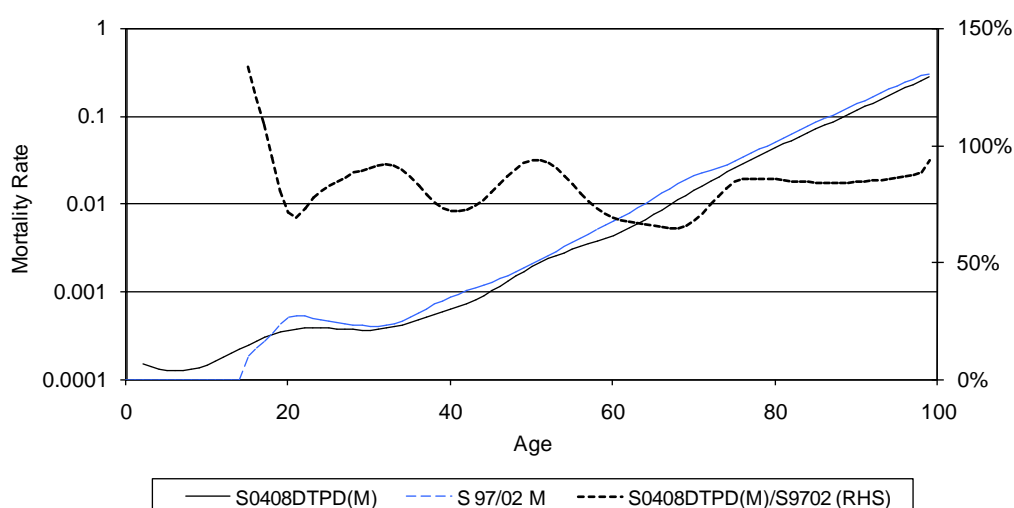
Comparison with the graduation produced in the previous investigation, known as S9702, reveals a reasonably consistent shape over most of the range.

It should also be noted that the previous investigation did not include TPD claims, so direct comparison with this table may have limited use. There is, however, some debate as to whether some contributors to that investigation recorded TPD claims as death claims, potentially resulting in a hybrid table, of sorts.

On the other hand, no adjustment was made to the S97/02 mortality rates for lives leaving the exposure due to TPD. The vast majority of life policies in Singapore include TPD acceleration of the death benefit, leading to termination of the policy. Such claims should be included in some manner in order to determine true mortality rates, since their exclusion may result in an understatement (as disabled lives are likely to die earlier than standard lives). Nevertheless, this set of tables is utilised as a benchmark in the absence of any relevant alternatives.

7.2 NL, Death+TPD, Females (S0408DTPD(F))

Chart 7.3 – Graduation vs Crude and Population rates – Females

Comparison of the graduation with the crude rates reveals a reasonable looking fit with the following exceptions:

- High volatility from age 2 to late 30s, which isn't unusual
- An apparent 'dip' from about age 55 to 75, which seems somewhat unusual
- Increasing volatility from around age 70, also not unusual.

Chart 7.4 – Female Graduation vs Previous Investigation
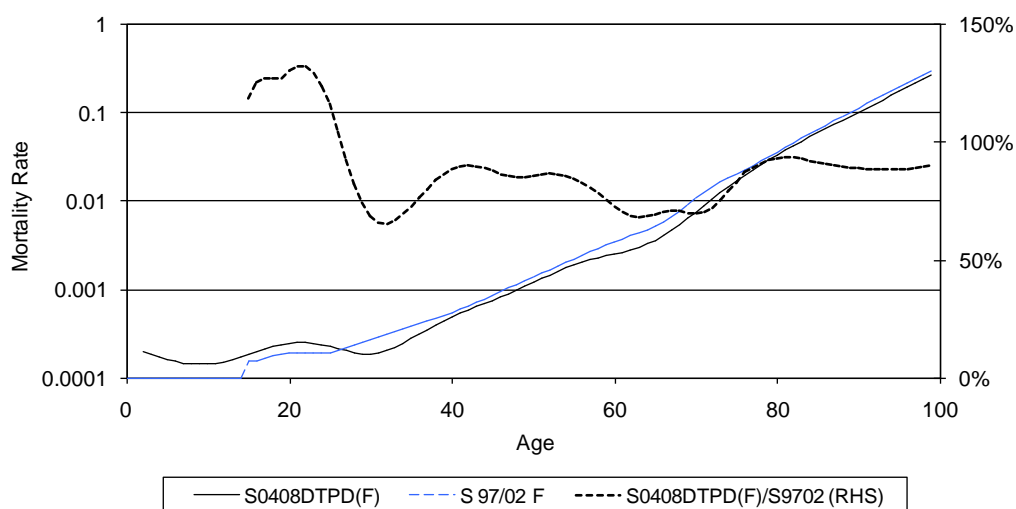
Comparison with the graduation produced in the previous investigation reveals a reason ably consistent shape over most of the range.

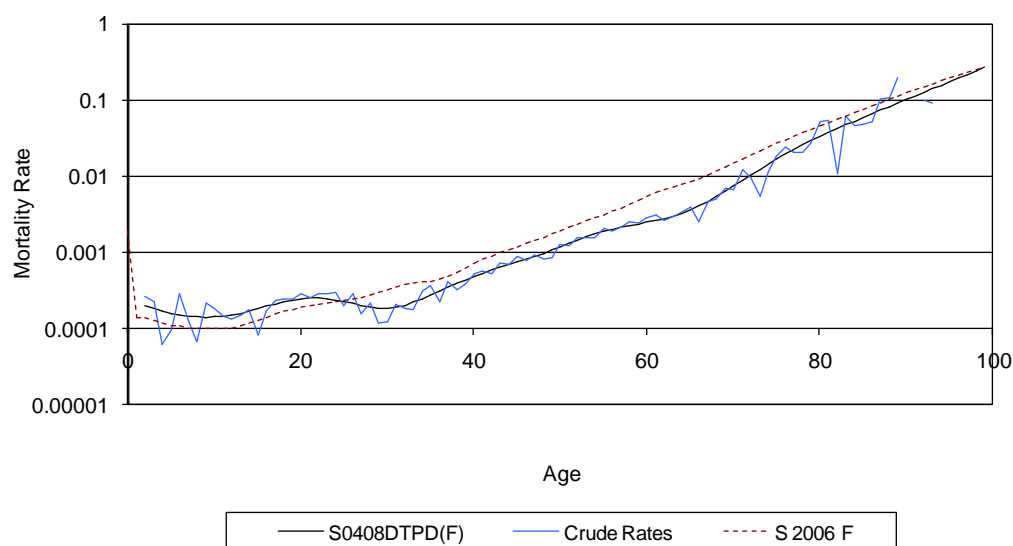## 7.3 NL, Death only, Males with TPD Adjustments (S0408(M))

Chart 7.5 – Loading to crude pure death rates for estimated male TPD deaths
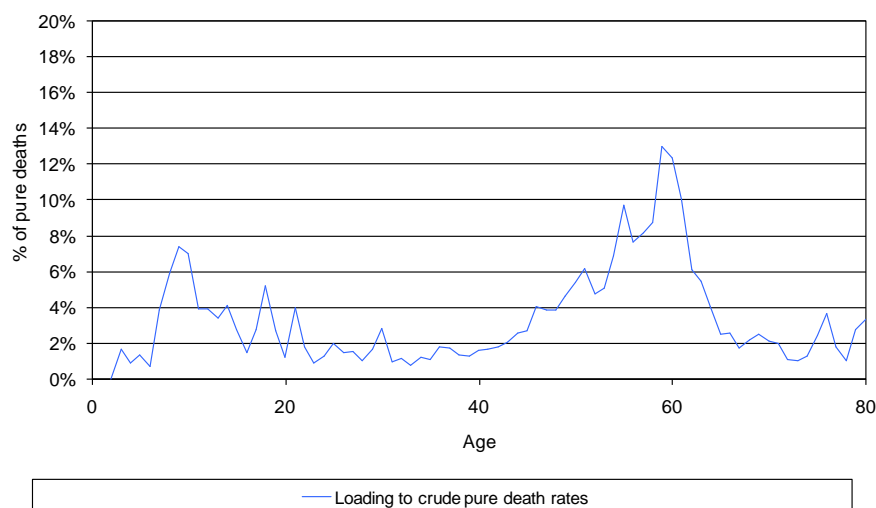
The above figure shows the additional loading implied by the method described in section 5 above to the crude pure death only rates. A relatively small addition is observed over most of the younger ages, but this increases significantly between the ages of 40 and 60, due to the larger absolute number of TPD claimants, combined with the relatively high impaired mortality at those ages. The sharp change in gradient seen in the high 70's is a result of the blending into the population rates which commences at that point.

Chart 7.6 – Male Graduation vs Previous Investigation

Chart 7.6 compares the death only graduation with the previous investigation, while Table 7.1 below shows the annual improvement reflected by the graduation, together with historic average improvements from the 2 investigations prior to the previous one.

Table 7.1

Annual improvement from/to 97/02

Age Last	S0408(M)	S8893	S8388
20	5.5%	3.9%	2.7%
30	4.3%	1.4%	3.1%
40	5.5%	2.0%	3.5%
50	4.7%	3.7%	5.2%
60	6.7%	3.3%	3.9%
70	4.1%	2.8%	3.7%
80	3.3%	1.4%	2.8%
90	2.4%	-1.1%	1.1%

Caution should be exercised when interpreting the rather strong implied improvement rates for the most recent period. Using population improvements derived from Singapore Department of Statistics (2010a)[4], the insured life improvements are compared with population over two of the same periods as shown in Table 7.2 below.

Table 7.2 – Population vs Insured Improvements

Age Last	S9702 to S0408 Males			S8893 to S9702 Males		
	Insured	Pop	Difference	Insured	Pop	Difference
20	5.5%	2.8%	2.7%	3.9%	1.9%	2.0%
30	4.3%	3.0%	1.3%	1.4%	3.0%	-1.6%
40	5.5%	1.8%	3.7%	2.0%	1.8%	0.2%
50	4.7%	2.6%	2.1%	3.7%	2.6%	1.1%
60	6.7%	3.8%	2.9%	3.3%	3.8%	-0.5%
70	4.1%	2.4%	1.7%	2.8%	2.4%	0.4%
80	3.3%	0.9%	2.4%	1.4%	0.9%	0.5%
Average			**2.4%**			**0.3%**

Male insured lives' mortality appeared to improve on average more than 2% points more than population over the most recent period. By contrast, during the period between the prior two studies, the average improvement rate was almost the same for both population and insured lives.

7.4   NL, Death only, Females with TPD Adjustments (S0408(F))

The same approach to making allowance for deaths of TPD claimants within the period of investigation was made for females as for males, and the resulting loads are shown in Chart 7.7 below.

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[4] Singapore Department of Statistics, 2010a, *Population Trends 2010*, Singapore Department of Statistics

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Chart 7.7 – Loadings to pure death rates for estimated female TPD deaths
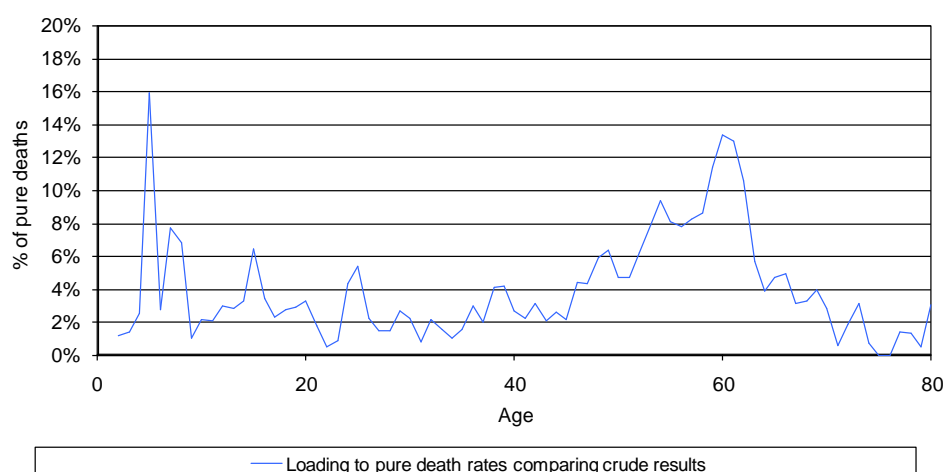
A similar shape and level emerged for females as for males.

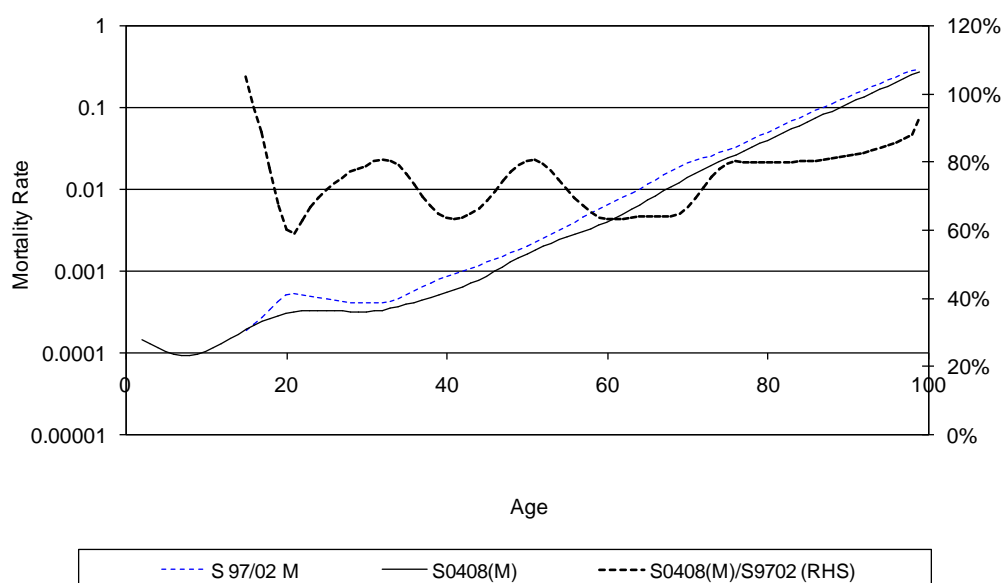**Chart 7.8 – Female Graduation vs Previous Investigation**
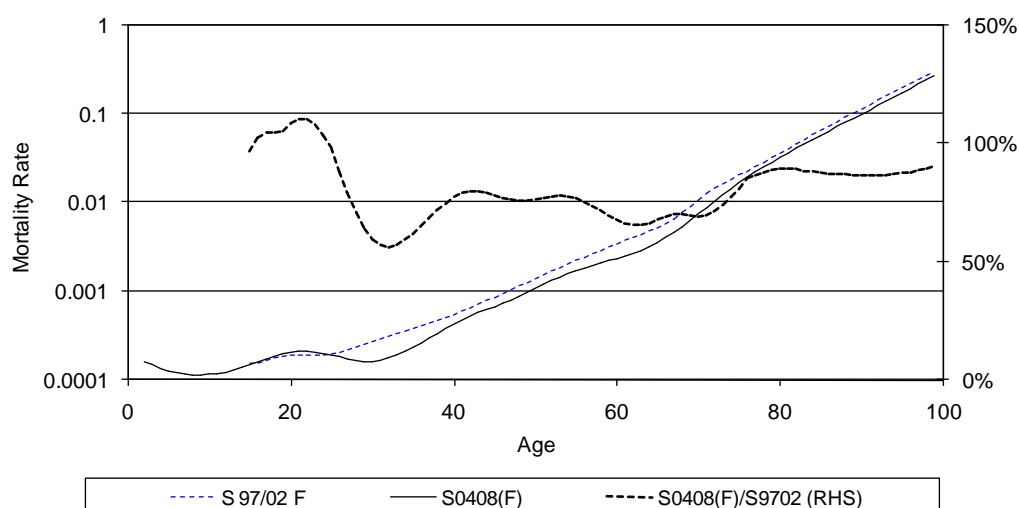
while Table 7.3 below shows the annual improvement reflected by the graduation, together with historic average improvements from the 2 investigations prior to the previous one.

Table 7.3

Annual improvement from/to 97/02

Age Last	S0408(F)	S8893	S8388
20	0.9%	4.6%	2.3%
30	6.8%	0.5%	3.3%
40	3.8%	2.3%	2.0%
50	4.2%	0.6%	4.2%
60	5.8%	6.6%	5.6%
70	3.5%	3.2%	3.2%
80	1.9%	-0.5%	1.0%
90	2.0%	-3.6%	-1.8%

Caution should also be exercised when interpreting the strong implied improvement rates for females the most recent period. Using population

improvements derived from Singapore Department of Statistics (2010a)[5], the insured life improvements are compared with population over two of the same periods as shown in Table 7.4 below.

Table 7.4 – Population vs Insured Improvements

| Age Last	S9702 to S0408 Females			S8893 to S9702 Females		
	Insured	Pop	Difference	Insured	Pop	Difference
20	0.9%	2.3%	-1.4%	4.6%	2.8%	1.8%
30	6.8%	3.6%	3.2%	0.5%	3.6%	-3.1%
40	3.8%	1.6%	2.2%	2.3%	1.6%	0.7%
50	4.2%	2.7%	1.5%	0.6%	2.7%	-2.1%
60	5.8%	4.1%	1.7%	6.6%	4.1%	2.5%
70	3.5%	3.0%	0.5%	3.2%	3.0%	0.2%
80	1.9%	1.6%	0.3%	-0.5%	1.6%	-2.1%
Average			**1.1%**			**-0.3%**

Female insured lives' mortality appeared to improve on average by 1.4% points more than population over the most recent period. By contrast, during the period between the prior two studies, the average improvement rate was slightly lower for insured lives than population.

7.5 IL, Death only, Males with TPD Adjustments (S0408-IL(M))

Inspection of the experience from IL policies suggests that TPD claims form a smaller proportion of total claims than for traditional policies. Comparison will therefore be made between the death claim experience, adjusted for projected deaths of the TPD claimants.

Chart 7.9
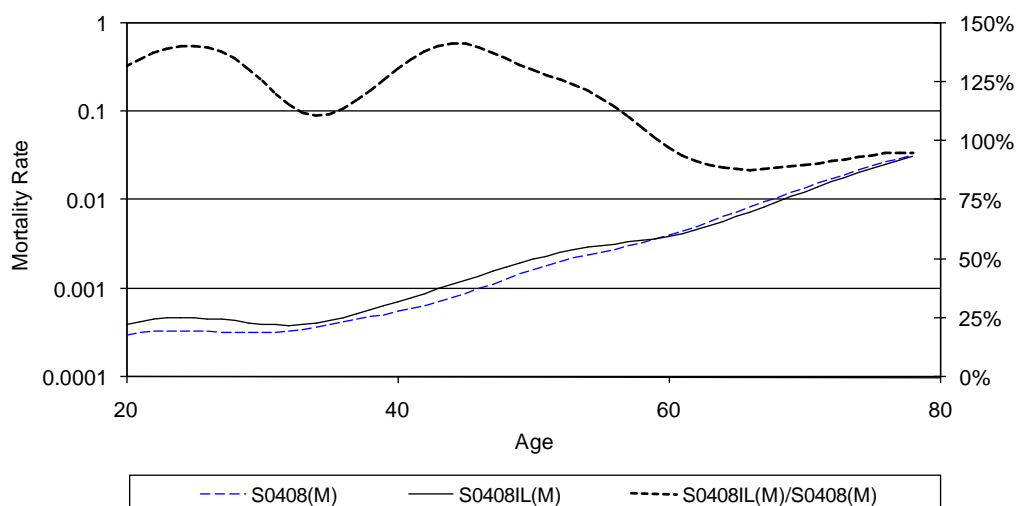
The shape of the curve as shown above is similar to the non-linked business, although at a higher level below age 60.

Higher mortality experience is not unexpected for this product class – the policy sizes tend to be smaller, and there's a greater risk of anti-selection. However older age experience appears relatively good – perhaps those who maintain their

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[5] ibid.

policy into their retirement years tend to be from a higher socioeconomic group, experiencing better long-term mortality due to improved access to medical treatment, education etc. On the other hand, the low number of claims at 60 and above (132) could render this result spurious.

7.6 IL, Death only, Females with TPD Adjustments (S0408-IL(F))

Chart 7.10
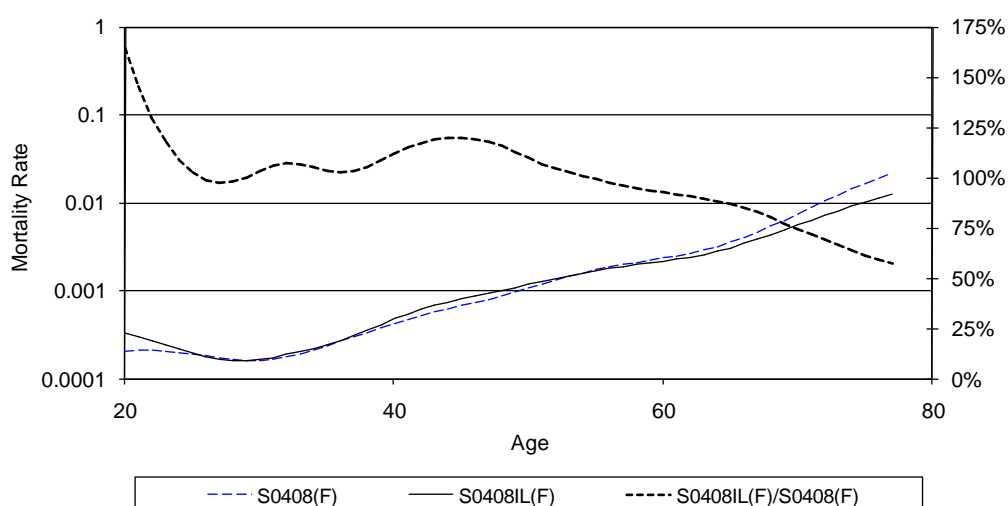
The comparison of the linked female graduation with the non-linked graduation reveals a similar set of features to males.

Similar rationalization for the females' experience could be applied as for males, although with less data the results are less robust.

7.7 Population Mortality Improvement

Comparing S0408 table with S9702 shows an average annual mortality improvement of 5.3% for male and over 4.8% for female. This is higher than the annual mortality improvement observed on general Singapore population.

Table 7.5 – Comparison with Singapore Population Improvement

Singapore Insured Mortality Improvement : annual geometric average

	S9702 to S0408		S8893 to S0408	
Age Last	**Male**	**Female**	**Male**	**Female**
15 – 19	-2.79%	0.22%	-4.92%	-0.69%
20 – 24	-7.29%	1.27%	-5.63%	-3.12%
25 – 29	-4.67%	-4.35%	-3.61%	-3.02%
30 – 34	-3.67%	-9.26%	-2.34%	-3.80%
35 – 39	-5.83%	-6.63%	-3.18%	-2.85%
40 – 44	-7.06%	-4.55%	-3.90%	-2.62%
45 – 49	-4.74%	-5.14%	-3.24%	-3.36%
50 – 54	-3.96%	-4.94%	-3.41%	-2.21%
55 – 59	-6.43%	-5.77%	-5.09%	-2.30%
60 – 64	-7.26%	-7.30%	-5.23%	-6.22%
65 – 69	-7.10%	-7.11%	-4.28%	-6.19%
Weighted Avg	**-5.32%**	**-4.84%**	**-3.94%**	**-3.04%**

Singapore Population Mortality Improvement : annual geometric average

Age Last	1997-02 to 2004-08		1989-93 to 2004-08	
	Male	**Female**	**Male**	**Female**
15 – 19	-5.15%	-5.87%	-4.52%	-2.90%
20 – 24	-3.02%	0.61%	-2.02%	-2.50%
25 – 29	-2.59%	-3.37%	-0.95%	-3.66%
30 – 34	-3.54%	-4.22%	-2.89%	-3.27%
35 – 39	-2.48%	-4.56%	-1.86%	-3.66%
40 – 44	-1.85%	-0.76%	-2.13%	-3.03%
45 – 49	-1.67%	-3.01%	-2.85%	-3.00%
50 – 54	-1.88%	-2.86%	-3.22%	-3.36%
55 – 59	-3.20%	-2.81%	-3.66%	-3.57%
60 – 64	-3.93%	-4.17%	-3.75%	-3.65%
65 – 69	-3.52%	-4.98%	-2.92%	-3.65%
Weighted Avg	**-2.85%**	**-3.19%**	**-2.74%**	**-3.27%**

Note: Negative means an improvement.

8. Regional Comparisons

Comparison was made with output from several insured lives' experience studies (Australia, Hong Kong, Malaysia) and standard industry tables (Korea and UK), and the results are presented in Tables 8.1 and 8.2 below. Most studies utilised a 2 year select period (3 for Korea), and applied to traditional whole of life and endowment policies. Adjustments were made to for differences in age bases where necessary.

Table 8.1 – Percentage of S0408(M)

Age Last	Australia IA95-97	Hong Kong 2002-06	Korea ~2006	Malaysia 2004-08	UK ~2000
5 – 9	436%	78%	228%		
10 – 14	315%	85%	149%	245%	
15 – 19	239%	78%	199%	271%	
20 – 24	258%	104%	222%	290%	146%
25 – 29	241%	113%	241%	288%	154%
30 – 34	205%	135%	245%	294%	166%
35 – 39	165%	132%	250%	309%	154%
40 – 44	146%	152%	266%	274%	146%
45 – 49	123%	142%	245%	240%	128%
50 – 54	117%	132%	214%	215%	121%
55 – 59	136%	147%	205%	217%	141%
60 – 64	148%	154%	190%	208%	151%
65 – 69	147%	121%	161%	204%	143%
70 – 74	146%	120%	137%	196%	138%
75 – 79	152%	120%	135%		141%
80 – 84	159%	103%	144%		143%
85 – 89	156%	130%	155%		140%
90 – 94	137%		167%		133%
95 – 99	105%		173%		121%

There exists a wide range of variation across the data analysed. However the Singapore graduation appears to be consistently below all other tables, including the most recent ones based on similar populations and economic development, namely Hong Kong and Korea. .

Table 8.2 – Percentage of S0408(F)

Age Last	Australia IA95-97	Hong Kong 2002-06	Korea ~2006	Malaysia 2004-08	UK ~2000
5 – 9	160%	40%	135%		
10 – 14	152%	77%	108%	149%	
15 – 19	129%	58%	131%	185%	
20 – 24	130%	85%	159%	143%	101%
25 – 29	148%	128%	201%	182%	146%
30 – 34	185%	176%	219%	271%	187%
35 – 39	164%	140%	182%	245%	158%
40 – 44	151%	129%	149%	212%	139%
45 – 49	150%	134%	140%	209%	144%
50 – 54	135%	126%	114%	218%	146%
55 – 59	142%	118%	112%	208%	166%
60 – 64	179%	143%	126%	273%	206%
65 – 69	173%	130%	119%	281%	200%
70 – 74	128%	110%	98%	240%	157%
75 – 79	111%	81%	90%		129%
80 – 84	116%	88%	94%		120%
85 – 89	122%	114%	102%		118%
90 – 94	117%		111%		114%
95 – 99	102%		118%		108%

The picture for females appears less.

9. Recommendation for Future Investigations

The workgroup recommends that the graduated tables:

- S0408 : NL WL&E Death with TPD adjustment
- S0408-IL : IL WL&E Death with TPD adjustment
- S0408DTPD : NL WL&E Death plus TPD
- S0408DTPD-IL : IL WL&E Death plus TPD

be endorsed by the SAS as recognised life tables.

The workgroup also recommends that the data should continue to be collected with one change and future investigations be made. The change recommended is that the data be collected for duration 0 to 9 inclusive and 10+, rather than 0 to 5 inclusive and 5+. This will allow for better understanding of the select effect.

Care should be taken to provide death < 100% CI acceleration and death 100% CI acceleration separately for both exposure and claims.

In future it would be useful to consider producing a joint table for death plus 100% CI acceleration. We should also consider asking for data on deaths with 100% TPD acceleration and deaths with < 100% TPD acceleration separately?

The information collected is fairly complex and it was necessary to go back to contributors a number of times in order to clarify issues or correct the data. As the data is confidential to the clients, only the MAS is able to liaise with the contributors. This is a major disadvantage.

It is recommended that future investigations be carried out by impartial third parties who can have access to the individual company data and directly query any of the contributors on data issues. The Singapore Actuarial Society (SAS) would still be responsible for reviewing the results.

10. Additional Appendices

The following Appendices are held in a separate document:

- Appendix 1 : – Full Graduated S0408 Mortality Tables
    – (qx per 1,000)

- Appendix 2 : – Full Graduated S0408 compared against S9702
    – (qx per 1,000)

- Appendix 3 : – Singapore Population Mortality

- Appendix 4 : – Analysis on Select Effect

- Appendix A : – Crude mortality rates NL WL&E - Death no TPD adjustment, Death with TPD adjustment, Death+TPD
    – Crude mortality rates IL WL&E ‑ Death no TPD adjustment, Death with TPD adjustment, Death+TPD
    – Crude mortality rates NL Term ‑ Death no TPD adjustment, Death with TPD adjustment, Death+TPD.

- Appendix B : – Crude TPD rates ‑ NL WL&E, IL WL&E, NL Term.

- Appendix C : – Crude Critical Illness rates 100% acceleration of Death ‑ NL WL&E, IL WL&E, NL Term
    – Crude Critical Illness rates < 100% acceleration of Death ‑ NL WL&E, IL WL&E, NL Term
    – Crude Critical Illness rates Total 100% acceleration of Death ‑ NL WL&E, IL WL&E, NL Term.

Appendix 1 : Full Graduated S0408 Mortality Tables (q$_x$ per 1,000)

Age Last	S0408		S0408-IL		S0408DTPD		S0408DTPD-IL	
	Male	Female	Male	Female	Male	Female	Male	Female
0	0.184	0.194			0.185	0.240		
1	0.163	0.176			0.164	0.219		
2	0.144	0.160			0.148	0.200		
3	0.128	0.147			0.139	0.184		
4	0.115	0.136			0.132	0.171		
5	0.104	0.127			0.127	0.160		
6	0.097	0.121			0.125	0.152		
7	0.093	0.117			0.125	0.147		
8	0.092	0.115			0.128	0.143		
9	0.095	0.114			0.135	0.142		
10	0.103	0.116			0.145	0.143		
11	0.114	0.118			0.159	0.146		
12	0.130	0.123			0.177	0.152		
13	0.149	0.130			0.198	0.160		
14	0.171	0.138			0.222	0.170		
15	0.194	0.149			0.247	0.183		
16	0.219	0.161			0.273	0.197		
17	0.243	0.174			0.298	0.212		
18	0.266	0.186			0.321	0.225		
19	0.286	0.196			0.342	0.237		
20	0.303	0.204	0.400	0.335	0.358	0.246	0.424	0.345
21	0.317	0.208	0.427	0.303	0.371	0.250	0.447	0.328
22	0.327	0.209	0.448	0.271	0.380	0.250	0.464	0.311
23	0.332	0.206	0.463	0.242	0.385	0.246	0.475	0.278
24	0.334	0.199	0.469	0.217	0.386	0.238	0.481	0.248
25	0.333	0.191	0.468	0.195	0.383	0.226	0.480	0.221
26	0.329	0.181	0.461	0.179	0.378	0.214	0.475	0.199
27	0.325	0.172	0.448	0.167	0.372	0.201	0.467	0.183
28	0.320	0.164	0.432	0.161	0.366	0.191	0.457	0.175
29	0.317	0.160	0.415	0.160	0.363	0.185	0.446	0.173
30	0.318	0.160	0.400	0.165	0.363	0.184	0.437	0.179
31	0.324	0.164	0.389	0.174	0.368	0.190	0.432	0.191
32	0.334	0.175	0.385	0.187	0.379	0.203	0.433	0.208
33	0.349	0.190	0.391	0.202	0.395	0.222	0.442	0.228
34	0.368	0.210	0.408	0.220	0.417	0.247	0.460	0.252
35	0.391	0.235	0.437	0.243	0.442	0.277	0.487	0.279
36	0.418	0.264	0.476	0.271	0.471	0.311	0.523	0.312
37	0.447	0.298	0.525	0.308	0.503	0.350	0.566	0.351
38	0.478	0.336	0.581	0.354	0.538	0.392	0.618	0.400
39	0.512	0.378	0.646	0.411	0.576	0.438	0.679	0.458
40	0.550	0.424	0.718	0.475	0.620	0.487	0.752	0.525
41	0.593	0.472	0.799	0.543	0.671	0.537	0.840	0.597
42	0.644	0.521	0.890	0.611	0.733	0.589	0.945	0.672
43	0.706	0.570	0.993	0.678	0.809	0.642	1.070	0.749
44	0.783	0.620	1.110	0.742	0.902	0.696	1.219	0.827
45	0.879	0.672	1.243	0.805	1.017	0.754	1.393	0.906
46	0.995	0.728	1.394	0.869	1.155	0.818	1.590	0.990
47	1.133	0.794	1.561	0.935	1.317	0.892	1.810	1.077
48	1.291	0.870	1.745	1.006	1.502	0.978	2.046	1.168
49	1.466	0.961	1.943	1.084	1.706	1.079	2.295	1.263

Age Last	S0408		S0408-IL		S0408DTPD		S0408DTPD-IL	
	Male	Female	Male	Female	Male	Female	Male	Female
50	1.653	1.066	2.152	1.170	1.921	1.194	2.546	1.363
51	1.844	1.183	2.363	1.264	2.141	1.323	2.793	1.469
52	2.036	1.310	2.569	1.367	2.359	1.461	3.022	1.579
53	2.223	1.442	2.761	1.476	2.572	1.605	3.224	1.690
54	2.409	1.577	2.932	1.587	2.781	1.749	3.394	1.797
55	2.600	1.711	3.083	1.695	2.989	1.891	3.531	1.898
56	2.805	1.842	3.219	1.798	3.206	2.027	3.644	1.987
57	3.036	1.967	3.353	1.893	3.440	2.155	3.747	2.064
58	3.305	2.089	3.501	1.982	3.704	2.276	3.858	2.131
59	3.627	2.211	3.682	2.070	4.011	2.393	3.998	2.195
60	4.015	2.339	3.917	2.165	4.374	2.512	4.189	2.264
61	4.483	2.484	4.223	2.276	4.809	2.644	4.451	2.349
62	5.043	2.659	4.620	2.412	5.327	2.803	4.803	2.461
63	5.705	2.882	5.123	2.585	5.944	3.007	5.262	2.611
64	6.478	3.170	5.744	2.805	6.670	3.276	5.841	2.810
65	7.371	3.544	6.494	3.080	7.519	3.632	6.551	3.080
66	8.390	4.027	7.383	3.420	8.503	4.100	7.404	3.420
67	9.543	4.641	8.419	3.833	9.636	4.702	8.419	3.833
68	10.837	5.406	9.610	4.324	10.930	5.463	9.610	4.324
69	12.278	6.344	10.963	4.897	12.401	6.406	10.963	4.897
70	13.873	7.472	12.488	5.556	14.061	7.551	12.488	5.556
71	15.626	8.810	14.191	6.302	15.924	8.919	14.191	6.302
72	17.543	10.373	16.079	7.136	18.004	10.530	16.079	7.136
73	19.628	12.177	18.156	8.060	20.312	12.400	18.156	8.060
74	21.885	14.236	20.426	9.072	22.862	14.547	20.426	9.072
75	24.319	16.560	22.891	10.173	25.665	16.984	22.891	10.173
76	26.933	19.161	25.552	11.363	28.731	19.722	25.552	11.363
77	29.818	22.046	28.408	12.642	31.948	22.772	28.408	12.642
78	33.012	25.222	31.461		35.485	26.142	31.461	
79	36.548	28.696			39.291	29.840		
80	40.463	32.471			43.370	33.870		
81	44.798	36.552			47.725	38.237		
82	49.596	40.943			52.359	42.945		
83	54.909	45.644			57.782	47.997		
84	60.791	51.027			63.768	53.396		
85	67.302	57.049			70.374	59.454		
86	74.511	63.780			77.665	66.274		
87	82.493	71.306			85.710	73.876		
88	91.329	79.720			94.589	82.350		
89	101.112	89.127			104.388	91.796		
90	111.943	99.644			115.202	102.325		
91	123.934	111.402			127.136	114.063		
92	137.210	124.548			140.306	127.146		
93	151.907	139.244			154.841	141.731		
94	168.179	155.675			170.881	157.988		
95	186.194	174.044			188.583	176.110		
96	206.138	194.581			208.119	196.311		
97	228.219	217.542			229.679	218.829		
98	252.665	243.211			253.472	243.930		
99	279.730	271.910			279.730	271.910		

Appendix 2 : Full Graduated S0408 Compared Against S9702 (q$_x$ per 1,000)

Age Last	S0408		S9702[6]		S0408 / S9702	
	Male	Female	Male	Female	Male	Female
0	0.184	0.194				
1	0.163	0.176				
2	0.144	0.160				
3	0.128	0.147				
4	0.115	0.136				
5	0.104	0.127				
6	0.097	0.121				
7	0.093	0.117				
8	0.092	0.115				
9	0.095	0.114				
10	0.103	0.116				
11	0.114	0.118				
12	0.130	0.123				
13	0.149	0.130				
14	0.171	0.138				
15	0.194	0.149				
16	0.219	0.161	0.227	0.161	96.4%	99.8%
17	0.243	0.174	0.274	0.171	88.7%	101.4%
18	0.266	0.186	0.339	0.181	78.4%	102.3%
19	0.286	0.196	0.425	0.187	67.3%	104.9%
20	0.303	0.204	0.505	0.188	60.0%	108.4%
21	0.317	0.208	0.537	0.189	58.9%	110.2%
22	0.327	0.209	0.520	0.190	62.8%	109.9%
23	0.332	0.206	0.497	0.191	66.8%	107.6%
24	0.334	0.199	0.481	0.193	69.6%	103.4%
25	0.333	0.191	0.464	0.199	71.8%	95.8%
26	0.329	0.181	0.448	0.211	73.6%	85.9%
27	0.325	0.172	0.431	0.224	75.3%	76.6%
28	0.320	0.164	0.415	0.240	77.2%	68.4%
29	0.317	0.160	0.407	0.258	78.1%	61.9%
30	0.318	0.160	0.404	0.279	78.8%	57.3%
31	0.324	0.164	0.404	0.300	80.2%	54.9%
32	0.334	0.175	0.413	0.321	80.8%	54.4%
33	0.349	0.190	0.433	0.343	80.6%	55.3%
34	0.368	0.210	0.465	0.367	79.2%	57.3%
35	0.391	0.235	0.511	0.392	76.6%	59.8%
36	0.418	0.264	0.570	0.420	73.3%	62.8%
37	0.447	0.298	0.638	0.452	70.0%	65.9%
38	0.478	0.336	0.712	0.487	67.1%	68.9%
39	0.512	0.378	0.789	0.527	64.9%	71.8%
40	0.550	0.424	0.864	0.573	63.6%	74.1%
41	0.593	0.472	0.937	0.624	63.2%	75.6%
42	0.644	0.521	1.012	0.682	63.6%	76.3%
43	0.706	0.570	1.092	0.748	64.7%	76.2%
44	0.783	0.620	1.179	0.821	66.4%	75.5%
45	0.879	0.672	1.278	0.903	68.8%	74.4%
46	0.995	0.728	1.391	0.993	71.5%	73.3%
47	1.133	0.794	1.521	1.094	74.5%	72.5%
48	1.291	0.870	1.673	1.206	77.2%	72.2%
49	1.466	0.961	1.850	1.328	79.3%	72.4%

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[6] Adjusted from age nearest

Age Last	S0408		S9702[6]		S0408/S9702	
	Male	Female	Male	Female	Male	Female
50	1.653	1.066	2.052	1.463	80.6%	72.9%
51	1.844	1.183	2.284	1.609	80.7%	73.5%
52	2.036	1.310	2.553	1.769	79.7%	74.0%
53	2.223	1.442	2.860	1.943	77.7%	74.2%
54	2.409	1.577	3.207	2.131	75.1%	74.0%
55	2.600	1.711	3.599	2.334	72.3%	73.3%
56	2.805	1.842	4.038	2.553	69.5%	72.1%
57	3.036	1.967	4.528	2.789	67.0%	70.5%
58	3.305	2.089	5.072	3.041	65.2%	68.7%
59	3.627	2.211	5.674	3.311	63.9%	66.8%
60	4.015	2.339	6.339	3.600	63.3%	65.0%
61	4.483	2.484	7.084	3.907	63.3%	63.6%
62	5.043	2.659	7.941	4.234	63.5%	62.8%
63	5.705	2.882	8.941	4.586	63.8%	62.8%
64	6.478	3.170	10.116	4.994	64.0%	63.5%
65	7.371	3.544	11.496	5.515	64.1%	64.3%
66	8.390	4.027	13.101	6.216	64.0%	64.8%
67	9.543	4.641	14.924	7.166	63.9%	64.8%
68	10.837	5.406	16.902	8.423	64.1%	64.2%
69	12.278	6.344	18.907	9.987	64.9%	63.5%
70	13.873	7.472	20.793	11.774	66.7%	63.5%
71	15.626	8.810	22.497	13.639	69.5%	64.6%
72	17.543	10.373	24.125	15.485	72.7%	67.0%
73	19.628	12.177	25.905	17.351	75.8%	70.2%
74	21.885	14.236	28.059	19.373	78.0%	73.5%
75	24.319	16.560	30.480	21.465	79.8%	77.1%
76	26.933	19.161	33.536	23.982	80.3%	79.9%
77	29.818	22.046	37.309	27.103	79.9%	81.3%
78	33.012	25.222	41.358	30.520	79.8%	82.6%
79	36.548	28.696	45.785	34.323	79.8%	83.6%
80	40.463	32.471	50.673	38.591	79.9%	84.1%
81	44.798	36.552	56.067	43.377	79.9%	84.3%
82	49.596	40.943	62.016	48.741	80.0%	84.0%
83	54.909	45.644	68.574	54.749	80.1%	83.4%
84	60.791	51.027	75.796	61.473	80.2%	83.0%
85	67.302	57.049	83.744	68.993	80.4%	82.7%
86	74.511	63.780	92.483	77.394	80.6%	82.4%
87	82.493	71.306	102.082	86.769	80.8%	82.2%
88	91.329	79.720	112.613	97.219	81.1%	82.0%
89	101.112	89.127	124.154	108.850	81.4%	81.9%
90	111.943	99.644	136.784	121.776	81.8%	81.8%
91	123.934	111.402	150.584	136.116	82.3%	81.8%
92	137.210	124.548	165.637	151.993	82.8%	81.9%
93	151.907	139.244	182.028	169.533	83.5%	82.1%
94	168.179	155.675	199.837	188.861	84.2%	82.4%
95	186.194	174.044	219.143	210.100	85.0%	82.8%
96	206.138	194.581	240.019	233.364	85.9%	83.4%
97	228.219	217.542	262.528	258.756	86.9%	84.1%
98	252.665	243.211	286.723	286.358	88.1%	84.9%
99	279.730	271.910	299.247	300.721	93.5%	90.4%

Appendix 3 : Singapore Population Mortality

Singapore Population Mortality – Male & Female Age – specific Death Rates (per thousand residents)
Year Book of Statistics Singapore (1998 - 2002, Table3.7, p.27; 2008, Table3.8, p.29; 2009, Table3.8, p.47 & 48)

Age Last	Avg 1984-1988		Avg 1989-1993		Avg 1992-1996		Avg 1997-2002		Avg 2004-2008	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
15-19	0.760	0.380	0.520	0.280	0.500	0.260	0.367	0.267	0.260	0.180
20-24	1.060	0.460	0.760	0.380	0.740	0.300	0.683	0.250	0.560	0.260
25-29	1.140	0.600	0.600	0.420	0.680	0.340	0.617	0.300	0.520	0.240
30-34	1.260	0.780	0.900	0.560	0.800	0.500	0.733	0.450	0.580	0.340
35-39	1.880	1.100	1.220	0.840	1.220	0.760	1.083	0.650	0.920	0.480
40-44	2.880	1.640	2.100	1.460	2.000	1.240	1.717	0.967	1.520	0.920
45-49	4.720	2.820	3.640	2.180	3.400	2.020	2.633	1.683	2.360	1.380
50-54	8.780	5.000	6.760	3.940	6.020	3.680	4.683	2.850	4.140	2.360
55-59	15.460	7.960	12.040	6.760	10.500	6.280	8.500	4.717	6.880	3.920
60-64	23.580	13.660	20.380	11.040	18.580	10.160	14.900	8.333	11.480	6.320
65-69	36.280	21.780	30.780	18.340	29.740	17.140	24.900	14.633	19.720	10.500
Weighted Avg	4.598	2.690	3.852	2.335	3.815	2.278	3.416	2.026	3.097	1.752

Appendix 4 : Analysis on Selection Effect

The Workgroup pursued various ways to tackle the dip in mortality at duration 4. But no definite conclusion was arrived at.

It would facilitate the selection analysis if future data collection would be for each duration up to duration 10+.

The following analyses were performed for the NL WL&E.

1) 2004 issues

From the distribution of inforce policies for the death exposure, there was a surge in 2004 for both Male and Female. For Male this surge in new business was never surpassed, and for Female it was surpassed only in 2008.

Male by issue year	# of pol for death exp (excl.100%CI), med+non-med						all dur
	0	1	2	3	4	5+	
2008	62,219	0	0	0	0	0	62,219
2007	48,544	41,194	0	0	0	0	89,738
2006	37,472	43,172	40,897	0	0	0	121,541
2005	50,332	49,677	46,131	44,724	0	0	190,864
2004	75,136	72,085	68,223	67,675	60,447	0	343,566
2003	66,858	62,652	59,544	58,929	53,301	965,958	1,267,242
2002	0	90,000	85,654	82,982	78,218	978,440	1,315,294
2001	0	0	133,016	128,640	121,535	977,542	1,360,733
2000	0	0	0	74,738	70,711	911,601	1,057,050
1999	0	0	0	0	80,361	898,609	978,970
1998 & prior	0	0	0	0	0	874,798	874,798
all years	340,561	358,780	433,465	457,688	464,573	5,606,948	7,662,015

Female by issue year	# of pol for death exp (excl.100%CI), med+non-med						all dur
	0	1	2	3	4	5+	
2008	114,338	0	0	0	0	0	114,338
2007	75,041	64,970	0	0	0	0	140,011
2006	53,046	69,525	67,274	0	0	0	189,845
2005	74,199	77,679	68,635	68,144	0	0	288,657
2004	113,738	111,314	106,269	104,656	91,190	0	527,167
2003	96,670	93,396	90,486	86,863	76,902	957,668	1,401,985
2002	0	132,295	128,257	125,479	117,503	956,042	1,459,576
2001	0	0	172,380	168,221	157,258	943,323	1,441,182
2000	0	0	0	97,849	92,605	858,052	1,048,506
1999	0	0	0	0	92,339	828,377	920,716
1998 & prior	0	0	0	0	0	790,654	790,654
all years	527,032	549,179	633,301	651,212	627,797	5,334,116	8,322,637

The analysis tries to find out the impact of 2004 issues on the ratio of actual to expected claims.

The 2004 issues were removed via the simplistic method of taking out the # of policies and death claims for the same duration. So for taking out # of policies of 2004_dur0, the claims of 2004_dur0 were also taken out. By doing so, there would

be some mismatch between exposures and claims. The mismatch can be avoided if claim data is available by issue year and duration.

From the tables below it can be seen that 2004 issues in general has a lower actual to expected ratio (bearing in mind that due to the method used, 2003 issues may also be one of the contributor). By removing the 2004 issues, the overall ratio is higher by 2% for Male and Female. This analysis does not shed any light on the dip in duration 4; rather, it may provide some insight on the overall lowering of the actual to expected ratio.

Male, age15-99						actual claim / expected claim		
duration	0	1	2	3	4	5+	2+	overall
yr 2004-2008	38%	55%	66%	63%	60%	69%	68%	66%
2004 issue	27%	53%	46%	54%	42%	N/A	48%	45%
net of 2004 issue	42%	55%	72%	66%	65%	69%	68%	67%

Female, age15-99						actual claim / expected claim		
duration	0	1	2	3	4	5+	2+	overall
yr 2004-2008	25%	48%	52%	55%	50%	74%	67%	62%
2004 issue	19%	53%	52%	54%	42%	N/A	50%	45%
net of 2004 issue	27%	47%	53%	56%	52%	74%	68%	64%

Male, age15-99			ratio of Actual / Expected claims as % of dur 5+				
duration	0	1	2	3	4	5+	2+
yr 2004-2008	56%	79%	96%	92%	88%	100%	98%
net of 2004 issue	62%	80%	104%	96%	95%	100%	100%

Female, age15-99			ratio of Actual / Expected claims as % of dur 5+				
duration	0	1	2	3	4	5+	2+
yr 2004-2008	34%	66%	71%	75%	68%	100%	91%
net of 2004 issue	37%	64%	71%	76%	71%	100%	93%

2) Reinstatements

The analysis tried to look at whether there exists impact due to reinstatement.

The data collected for a certain year is slotted back to its deduced issue year according to its then duration, for example, duration 3 of 2004 data would be slotted back as duration 3 from issue year 2001.

Reinstatement here is calculated as the difference between $IF_{t+1,n+1,x+1}$ and $IF_{t,n,x}$ whenever $IF_{t+1,n+1,x+1}$ is bigger than $IF_{t,n,x}$, with t denotes data year, n denotes duration, and x denoted attained age. By not factoring in decrements this would give the most conservative estimate of reinstatement, ie, assuming the data is correct.

In the tables below are the reinstatements for issue year 2002 to 2007.

Male	duration			
	1	2	3	4
iss yr 2007	67	N/A	N/A	N/A
iss yr 2006	6,692	69	N/A	N/A
iss yr 2005	915	7	58	N/A
iss yr 2004	3	20	423	0
iss yr 2003	2	1	647	7
iss yr 2002	N/A	0	2	85
total	7,679	97	1,130	92
04-08 exposure	293,183	346,509	397,957	394,169

Female	duration			
iss yr	1	2	3	4
iss yr 2007	91	N/A	N/A	N/A
iss yr 2006	17,068	43	N/A	N/A
iss yr 2005	4,215	0	258	N/A
iss yr 2004	8	86	358	0
iss yr 2003	22	0	919	5
iss yr 2002	N/A	0	0	243
total	21,404	129	1,535	248
04-08 exposure	450,547	513,474	568,216	536,033

Issue year 2003 & 2004 have much more reinstatements for duration 3. For Male, the reinstatements concentrate in the age group 40-59, and 60-99. For Female, the concentration is around age group 60-99.

age distribution of reinstatement for duration 3, issue year 2003 and 2004:

	total reinst	age 0-19	age 20-39	age 40-59	age 60-99
Male: iss yr 2004	423	14	4	101	304
Male: iss yr 2003	647	32	30	123	462
Female: iss yr 2004	358	12	36	41	269
Female: iss yr 2003	919	57	0	0	862

The ratios of actual to expected claims vs duration 5+ by age group and duration are shown in the two tables below. Female age 60-99 clearly exhibits reverse trend for duration 3 and 4.

Male   ratio of Actual /Expected claims as % of dur 5+:

	0	1	2	3	4	5+	2+
15-19	80%	38%	42%	119%	37%	100%	97%
20-39	65%	96%	96%	97%	103%	100%	100%
40-59	56%	77%	92%	98%	87%	100%	99%
60-99	52%	80%	106%	80%	86%	100%	98%
age15-99	56%	79%	96%	92%	88%	100%	98%

Female   ratio of Actual /Expected claims as % of dur 5+:

	0	1	2	3	4	5+	2+
15-19	57%	0%	0%	71%	0%	100%	93%
20-39	49%	93%	92%	90%	84%	100%	97%
40-59	36%	69%	67%	79%	74%	100%	92%
60-99	26%	56%	75%	65%	52%	100%	86%
age15-99	34%	66%	71%	75%	68%	100%	91%