Actuarial Underpinnings of Older Age Mortality

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Jeff Marks, FSA
Northwestern Mutual
Kevin Somerville, DM FRCP
Swiss Re, UK

When does Old Age Start?

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1. **Age 60-64**
2. **Age 65-69**
3. **Age 70-74**
4. **Age 75-79**
5. **Age 80 or over**
6. **5 years older than I am**
7. **10 years older than I am**

Age at which Older Age Market Begins

3

Older Age Begins	% of Respondents
45	8%
50	15%
55	4%
64½	4%
65	8%
70	31%
71	15%
75	12%
>75	4%
Total # of Respondents	**26**

Society of Actuaries Older Age Underwriting Practices Survey Subcommittee Report July 2007

Mail Online Science & Tech

Old age begins at 27: Scientists reveal new research into ageing

By MAIL ON SUNDAY REPORTER
UPDATED: 01:14 GMT, 15 March 2009

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Old age is often blamed for causing us to misplace car keys, forget a word or lose our train of thought.

But new research shows that many well-known effects of ageing may start decades before our twilight years.

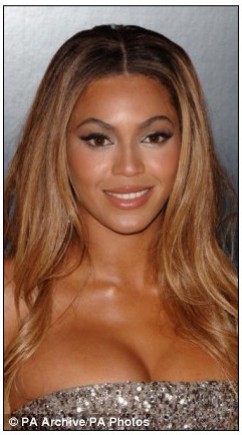
According to scientists, our mental abilities begin to decline from the age of 27 after reaching a peak at 22.

The researchers studied 2,000 men and women aged 18 to 60 over seven years. The people involved – who were mostly in good health and well-educated – had to solve visual puzzles, recall words and story details and spot patterns in letters and symbols.

Similar tests are often used to diagnose mental disabilities and declines, including dementia.

The research at the University of Virginia, reported in the academic journal Neurobiology Of Aging, found that in nine out of 12 tests the average age at which the top performance was achieved was 22.

The first age at which performance was significantly lower than the peak scores was 27 – for three tests of reasoning, speed of thought and spatial



Getting old already? 27-year-old singer Beyonce Knowles is already past her mental peak according to new research

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Mortality and Age

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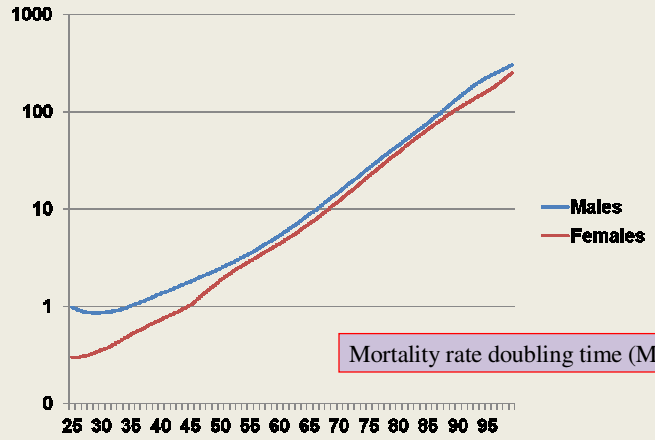

Mortality rate doubling time (MRDT): 7-8 years

Ultimate mortality, VBT 2008, Non-smokers, ALB

Mortality and Age

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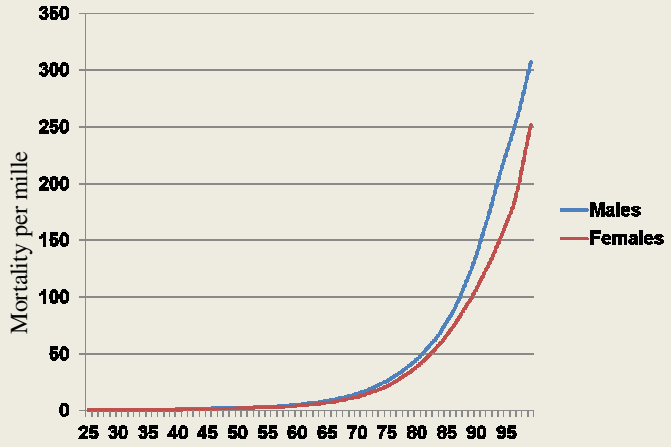

Ultimate mortality, VBT 2008, Non-smokers, ALB

Cause of death: USA, Males 2007

7

Age Group		Age Group		Age Group		Age Group	
35-44	%	65-74	%	75-84	%	85+	%
Injury	24	Cancer	35	Heart Disease	27	Heart Disease	33
Heart Disease	17	Heart Disease	25	Cancer	27	Cancer	16
Cancer	11	Chr Respiratory	7	Chr Respiratory	7	Cerebrovascular	6
Suicide	10	Cerebrovascular	4	Cerebrovascular	6	Chr Respiratory	5
HIV	5	Diabetes Mellitus	4	Diabetes Mellitus	3.	Alzheimer's	5
Homicide	5	Injury	3	Alzheimer's	3	Flu & Pneumonia	4
Liver Disease	3	Nephritis	2	Nephritis	2	Nephritis	3
Diabetes Mellitus	3	Septicemia	2	Flu & Pneumonia	2	Injury	3
Cerebrovascular	2	Liver Disease	2	Injury	2	Diabetes Mellitus	2
Septicemia	1	Flu & Pneumonia	1	Parkinson's	2	Parkinson's	2
Flu & Pneumonia	1	Suicide	1	Septicemia	2	Pneumonitis	2
Total	**82**		**85**		**83**		**80**

http://www.cdc.gov/men/lcod/2007/AllMen2007.pdf

Cause of death: USA, Females 2007

8

Age Group		Age Group		Age Group		Age Group	
35-44	%	65-74	%	75-84	%	85+	%
Cancer	25	Cancer	37	Heart Disease	25	Heart Disease	33
Injury	17	Heart Disease	20	Cancer	23	Cancer	10
Heart Disease	12	Chr Respiratory	8	Chr Respiratory	7	Cerebrovascular	9
Suicide	5	Cerebrovascular	5	Cerebrovascular	7	Alzheimer's	8
HIV	4	Diabetes Mellitus	4	Alzheimer's	4	Chr Respiratory	4
Cerebrovascular	3	Nephritis	2	Diabetes Mellitus	3	Flu & Pneumonia	3
Liver Disease	3	Injury	2	Flu & Pneumonia	2	Diabetes Mellitus	2
Homicide	3	Septicemia	2	Nephritis	2	Injury	2
Diabetes Mellitus	3	Flu & Pneumonia	2	Injury	2	Nephritis	2
Septicemia	2	Alzheimer's	1	Septicemia	2	Hypertension	2
Chr Respiratory	1	Liver Disease	1	Hypertension	1	Septicemia	1
Total	**77**		**84**		**80**		**76**

http://www.cdc.gov/women/lcod/07_all_females.pdf

How Reliable are the Cause of Death Statistics?

9

Cause of Death Determined From Postmortem Examination of 200 Persons 85 Years of Age and Older

Cause of Death	% of Cases
Atherosclerosis	24.0
Infarct, heart or bowel	15.0
Lesions of CNS	4.0
Congestive heart failure	3.5
Ruptured aortic aneurysm	1.5
Infections	17.0
Pneumonia	9.0
Other	8.0
Malignant neoplasm	11.5
Trauma	9.0
With severe complications	5.5
Without severe complications	3.5
Pulmonary embolism	6.5
Other causes	6.0
No acceptable cause	26.0

"When aged persons with many debilities die, and the physician is unsure about the cause of death, he or she is likely to list some variety of atherosclerosis, or if some infection appears to be present, to list pneumonia.

The tenuous nature of such diagnoses in the aged can be appreciated by noting a change in the Vital Statistics between 1967 and 1968, when the listing of "arteriosclerotic heart disease" was changed to "ischemic heart disease."

Age specific death rates for IHD for white males age 85 (per 100,000):
1967: 7892
1968: 9251

Kohn R, JAMA, 1982

Implications

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- No pre-set age at which "elderly" begins
- Causes of death
  - overlap with middle aged
  - some differences
  - some uncertainty about the accuracy
- High event rate should mean lots of meaningful data but limited published studies of older insured lives

What are the Financial Concerns of Older People which Relate to Mortality Risk ?

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- Life insurance:
  - Wealth Preservation, Estate Taxes, Income for beneficiaries,...
- Annuities
  - reduces the financial risk of outliving one's finances
    - voluntary
    - involuntary (UK) eg compulsory purchase annuities
    - can be risk assessed (enhanced or impaired life annuities)
- Viatical insurance
  - converts a mortality benefit into a living benefit
- STOLI (STranger Owned Life Insurance)

Life Insurance: Why Are We Concerned about Older Ages?

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Sales for Issue Ages 70+ Represent What % of Total Life Premium

1. 1%
2. 7%
3. 10%
4. 18%
5. 23%

Because There is a Lot of Money Involved

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2010 Sales - Ages 70+, Universal Life Only

- **Represents only 1% of all life insurance policies sold in US**
- **Represents 10% of all premium sold**
- **Very large policies: Av prem = $25,000 & Av Face = $675,000**

Notes

- **Source: LIMRA survey**
- **There are also a lot of very small whole life policies sold at these ages (12,000 av face)**

….and there's a Higher Claim Rate

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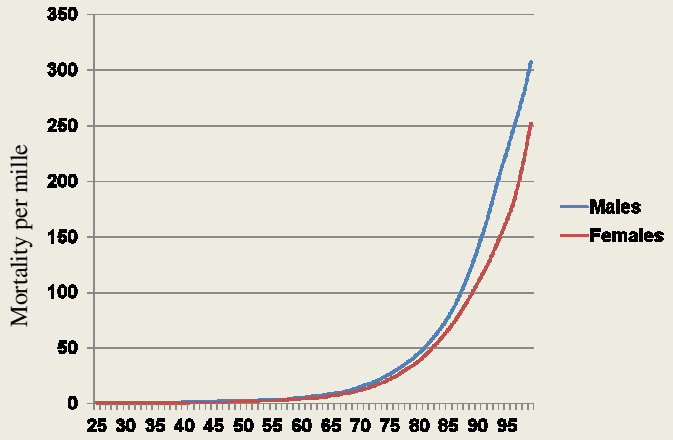

Ultimate mortality, VBT 2008, Non-smokers, ALB

Getting it Wrong……

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Misallocation standard as best class:

Age 40:

2% more claims over first 20 years

Age 70:

16% more claims over first 20 years

Mortality at Older Ages (70+)

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You have a female NT age 70 who you expect to live to age 85.

How would you rate her?

1. **Best Class**
2. **Standard**
3. **Mild Rating**
4. **Severe Rating**
5. **Decline**

Life Expectancy
NT, Issue Age 70

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	Expected to Live to Age	
	Female	Male
Best Class	94	91
Standard	92	88
Mild Rating	90	87
Severe Rating	88	84
Decline*	86	82
Gen Pop (US NT)	87	84

But Life Actuaries Never Use Life Expectancy

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You have a female NT age 70 who has a 91% chance of living to age 80

How would you rate her?

1. **Best Class**
2. **Standard**
3. **Mild Rating**
4. **Severe Rating**
5. **Decline**

But Actuaries Never Use Life Expectancy
It does not give the Appropriate Picture

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Female Issue Age 70 NT

	Probability of Living to Age		
	80	90	100
Best Class	95%	72%	22%
Standard	94%	60%	12%
Mild Rating	91%	50%	5%
Severe Rating	86%	31%	1%
Decline*	84%	24%	0% (a fraction)
Gen Pop (US NT)	77%	36%	5%

But MDs Might with Caution: Life Expectancy, Years Remaining

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Age	Std	+25	+50	+100	+200	+300
60	29	27	26	24	21	19
65	24	23	22	20	17	16
70	20	19	18	16	14	12
75	17	15	14	13	11	10
80	13	12	11	10	8	7
85	9	8	8	7	5	5

Female non smokers: VBT 2008 select & ultimate

Extreme caution !! Problem for mortality; disaster for longevity!

Life Expectancy, Years Remaining: Different Table

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Age	Std	+25	+50	+100	+[illegible]	[illegible]
60	31	30	28	[illegible]	[illegible]	21
65	27	25	[illegible]	[illegible]	20	18
70	23	[illegible]	[illegible]	18	16	14
75	19	[illegible]	16	15	13	11
80	[illegible]	14	13	11	9	8
[illegible]	11	10	9	8	6	5

So Jeff, what table should I use to work out life expectancy?

Female non smokers: 70% VBT 2008 select & ultimate

Extreme caution !! Problem for mortality; disaster for longevity!

What Table Works for Older People?

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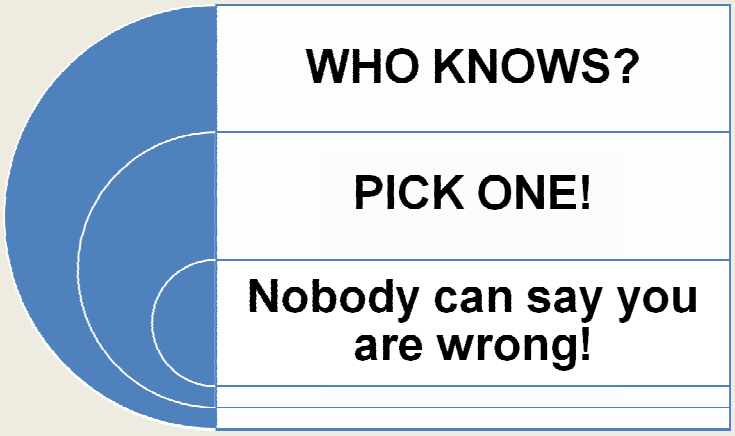

What is Select and Ultimate Mortality?

23

- There are two different impacts of underwriting
  - One that wears off after 20-30 years (US). This is Select Mortality
  - One that never wears off. This is Ultimate Mortality

Select and Ultimate

Mort Rates per 1,000 (assuming 25 yr Select period)

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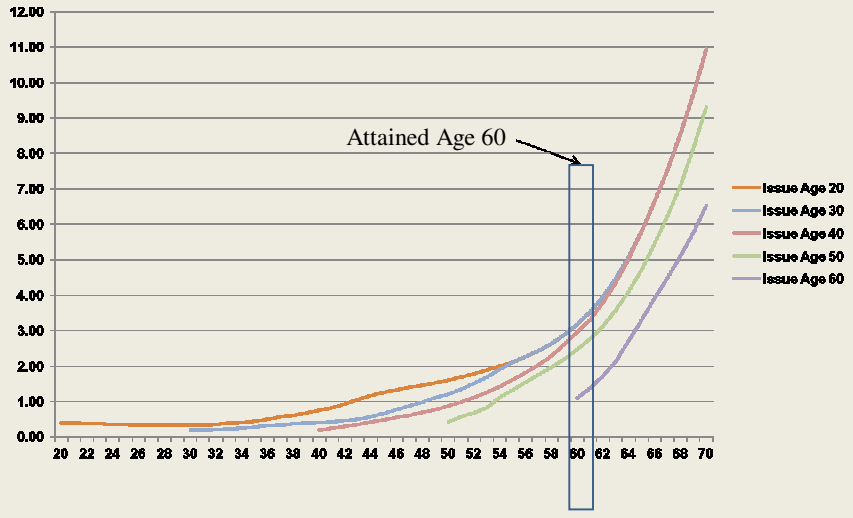

Select & Ultimate Mortality
For Male Age 60
Mort Rates per 1,000 (using 25 yr Select Period)

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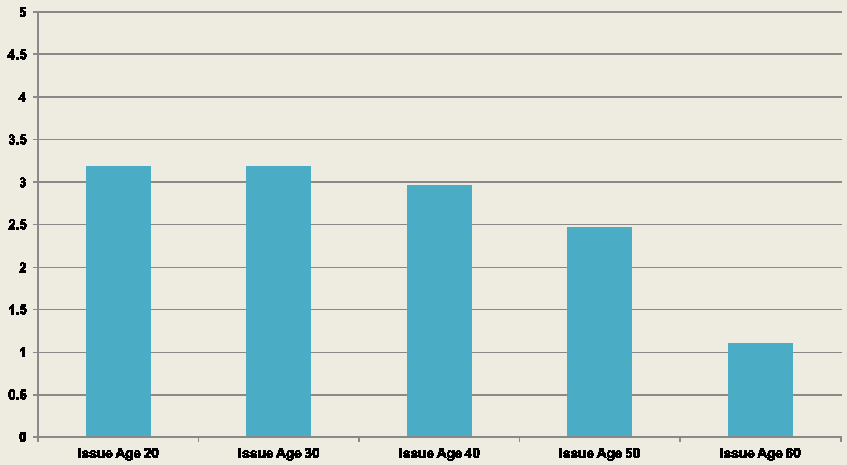

Mortality ratio select period 1 compared with period 2

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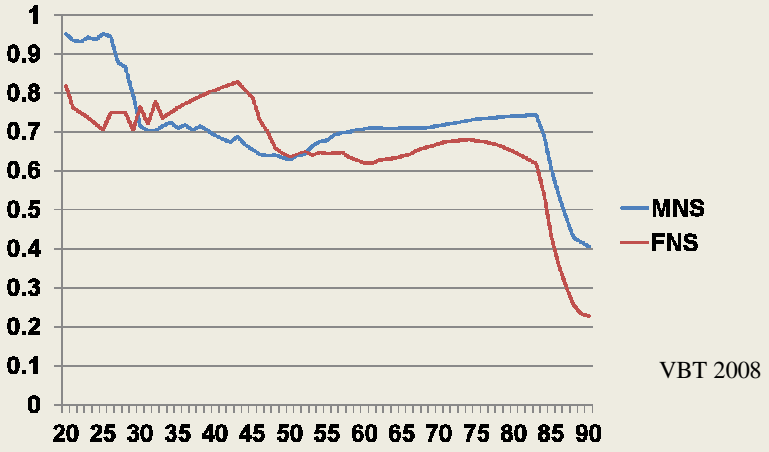

VBT 2008

Is There a Different Select Period for Older Ages?

27

- Normal Select Period is 25 or 30 yrs (US)
- Mortality of someone age 80
  - Is better if they were underwritten when they were 65?
  - Than if they were underwritten when 55?
- What about someone age 100?
  - Is the mortality better if they were underwritten at age 85?
  - Than if they were underwritten at age 75?
- VBT 2008 select period stops at age 90, from age 110 fixed mortality rate of 450 per 1,000!
- Don't Know

Insured Life Select Mortality as Proportion Population: US Males

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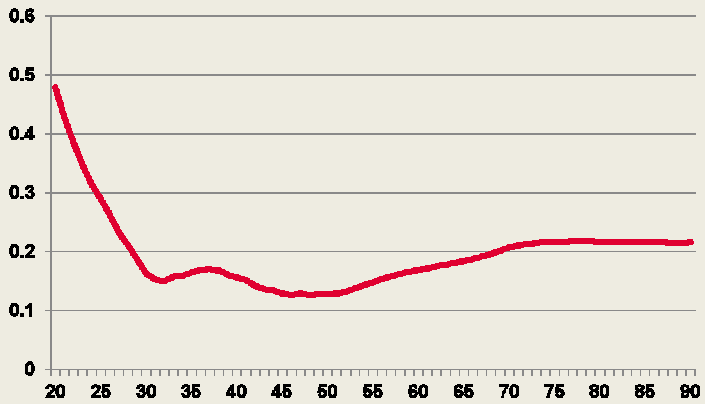

Population mortality: 2007, US Life tables,
Insured mortality: VBT 2008, Male SUN ALB

Insured Life Select and Population Mortality: UK Males

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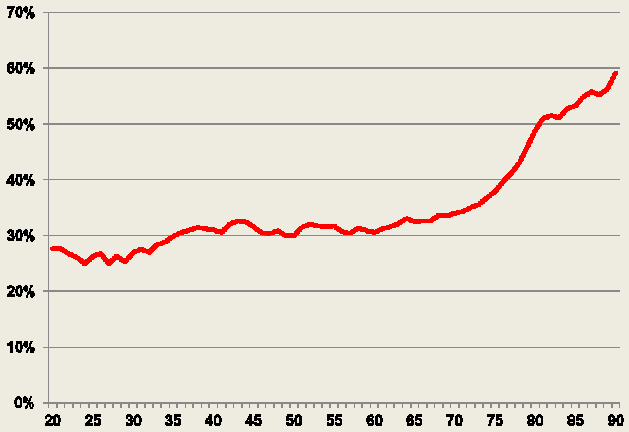
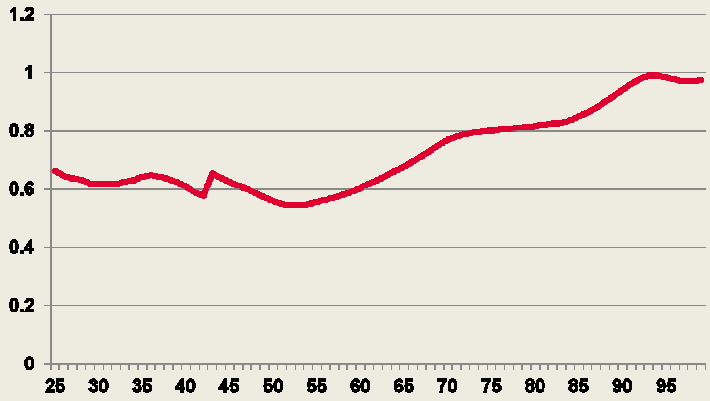


Population mortality: 1999-2001, GAD update
Insured mortality: AM00 SEL

Insured Life Ultimate Mortality as Proportion Population: US Males

30



Population mortality: 2007, US Life tables,
Insured mortality: VBT 2008, Male SUN ALB

Insured Life Ultimate and Population Mortality: UK Males

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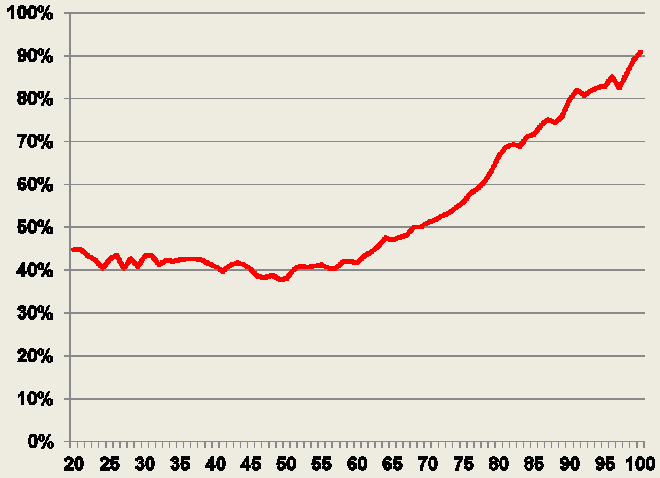

Population mortality: 1999-2001, GAD update

Insured mortality: AM00 SEL

Risk Selection Categories: One Direct Company

Includes reinsurer's evaluation

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	Age range (years)				
Rating	25-34	35-44	45-54	55-64	65+
Preferred	90%	84%	76%	63%	43%
Standard	6%	10%	13%	19%	21%
Borderline substandard	1%	1%	2%	4%	6%
Substandard	1%	1%	1%	2%	4%
Decline	3%	4%	7%	11%	21%

Risk Rating: Options

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- Percentage extra mortality
  - "Table" ratings
- Flat extras:
  - Permanent
  - Temporary
- Other eg lien, add years to age

Percentage Extra Mortality

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You consider rating a 70 year old non-smoker male at 4 tables (+100)

1. The rating should apply throughout the policy term
2. Such a rating should only apply for the first 5 years
3. There's no point in applying a rating as the actuaries have got it hopelessly wrong anyway
4. Ratings that are this high will make the insurance unaffordable
5. All of the above
6. None of the above

Impact of Percentage Extra Mortality

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- Commonly used at younger ages
- The force of mortality increases rapidly at older ages
- The relative impact of disease/risk marker is lower at older ages and attenuates
- A fixed percentage extra is a conservative estimate of the mortality risk
- A fixed percentage extra mortality applied to an impaired annuity will underestimate survival probability

Impact of Flat Extras

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Flat Extra is a common approach for someone who had cancer but is symptom free

Allows us to issue a policy sooner while recognizing the increased mortality for over a limited period of time

Impact of Flat Extra at Age 40
Assume $10 flat for 5 yrs

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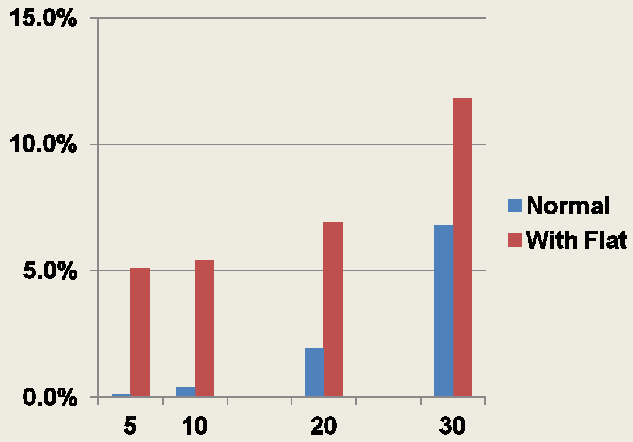

$10 Flat for 5 yrs = Total mort through 28 yrs

Impact of Flat Extra at Age 70
Assume $10 flat for 5 yrs

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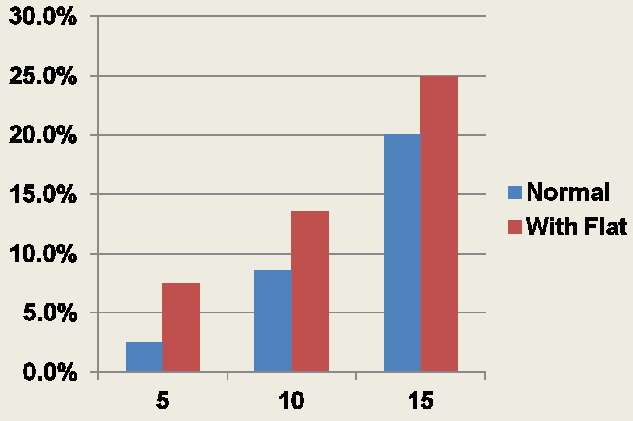

$10 Flat for 5 yrs = Total mort through 7 yrs

Males: Differential Survival Curves, Age 75

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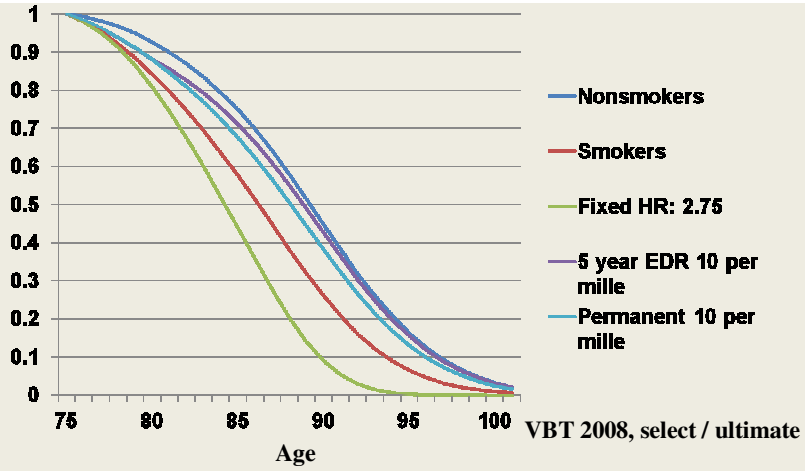

VBT 2008, select / ultimate

What about Longevity? Annuities……

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"But if you observe, people always live for ever when there is an annuity to be paid them…….. An annuity is a very serious business; it comes over and over every year, and there is no getting rid of it……

I have known a great deal of the trouble of annuities."

Jane Austen: Sense and Sensibility, 1864

Annuities: Increasing Mortality

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- Standard
- Location (postcode) differentiation
- Lifestyle & Smoker/Non-smoker differentiation
- Enhanced
- Impaired
- Immediate Care

Longevity Products: Survival Curves from Age 65, Females, NS, VBT 2008

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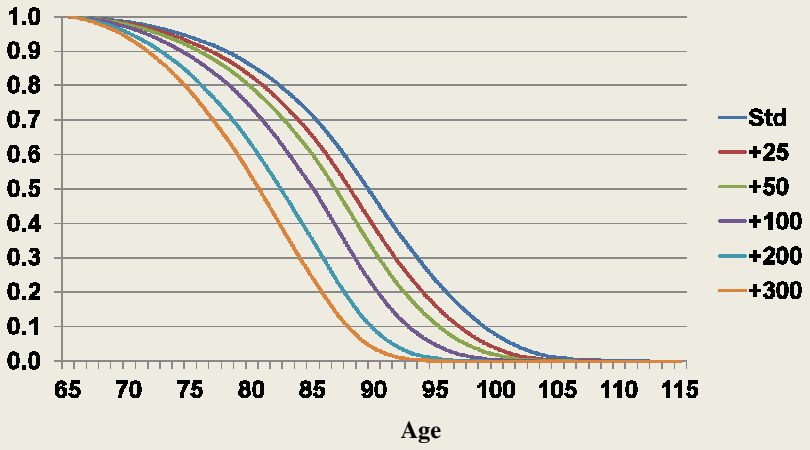

The rating is applied throughout

Survival Curves: Females, NS, VBT 2008, Attenuating Risks from Age 80

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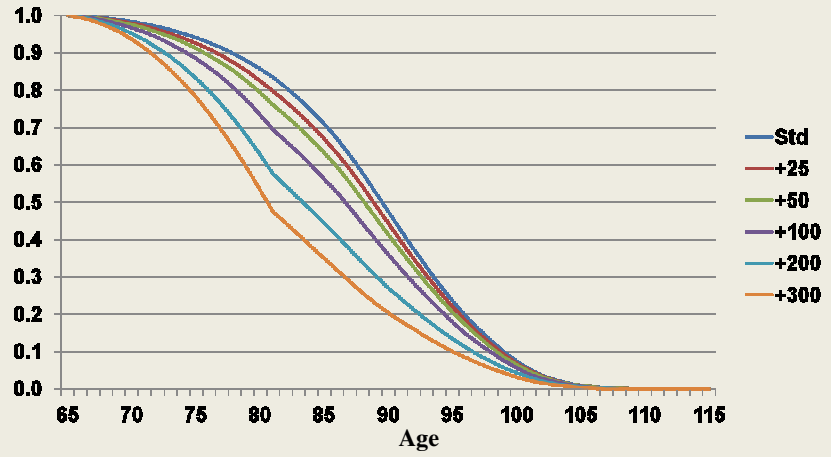

Survival Curves: Females, NS, VBT 2008, Attenuating Risks from Age 65

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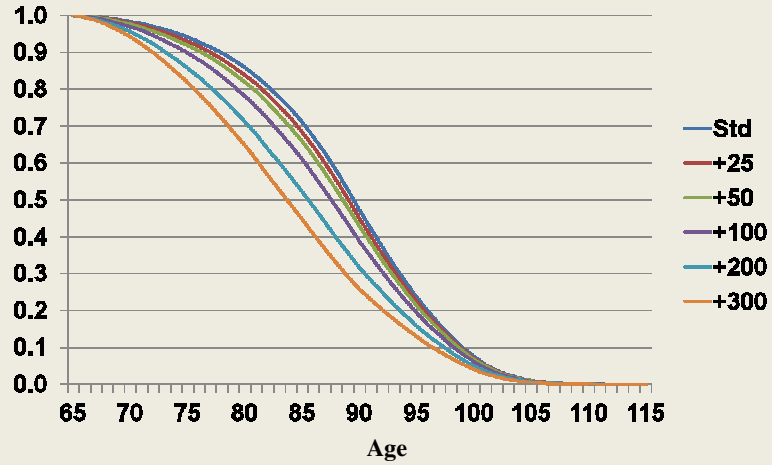

Differing Life Expectancies

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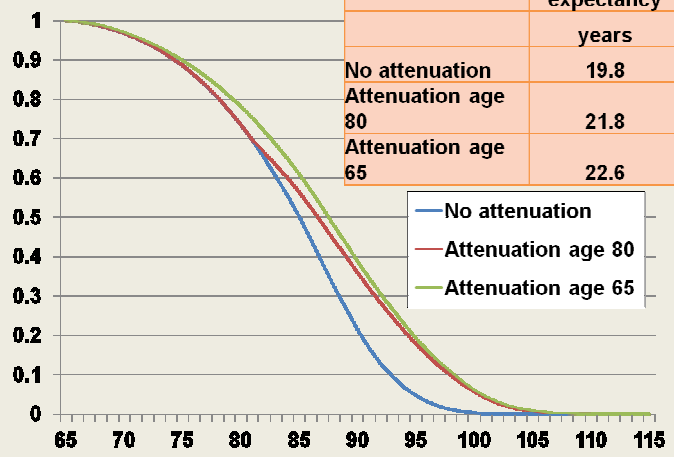

	Life expectancy	Probability alive	
	years	Age 95	Age 100
No attenuation	19.8	5%	3%
Attenuation age 80	21.8	18%	6%
Attenuation age 65	22.6	19%	6%

Rating +100,
VBT 2008
Female NS, ALB

Survival Proportion of Baseline (from Age 65 years): Area under the Survival Curve

46

		Rating attenuating from:	
Rating	Pan-policy rating	Age 80	Age 65
+25	94%	98%	98%
+50	88%	95%	96%
+100	81%	91%	92%
+200	71%	83%	85%
+300	64%	76%	79%

from age 65, Females, NS, VBT 2008

Survival Proportion of Baseline (from Age 65 years): Mortality Enhancements

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	Rating attenuating from:		
Rating	Pan-policy rating	Age 80	Age 65
+25	6%	2%	2%
+50	14%	5%	4%
+100	23%	10%	9%
+200	41%	20%	18%
+300	56%	32%	27%

Excludes discount rates, mortality improvements, other factors such as education, size of pension pot, income, postcode

from age 65, Females, NS, VBT 2008

2010 Ultimate Mortality 70+ By Cause of Death

Cause of Death	Insured lives	Population 65+*
Heart disease	29%	27%
Cancer	23%	22%
Alzheimer's	9%	4%
Chronic Respiratory	7%	7%
Cerebrovascular	6%	6%
Pneumonia/Influenza	6%	3%
Injury	3%	2%
Parkinson's disease	3%	1%
Acute/Chronic Kidney	2%	2%
Diabetes Mellitus	1%	3%
Septicaemia	1%	2%
Hypertensive	1%	1%
All other causes	11%	20%

Insured Lives; Source: Northwestern Mutual

*2009: http://www.cdc.gov/nchs/data/dvs/LCWK3_2009.pdf

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Mortality Improvement

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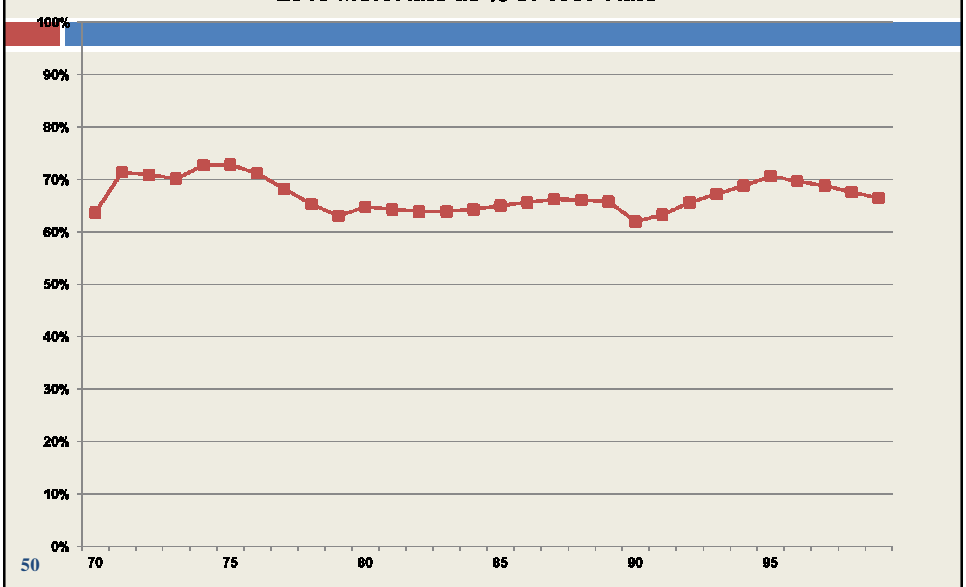
Best Class NT Male
1997 vs 2010
Issue Age 70

How much has mortality improved since 1997 for this person?

1. **Less than 10%**
2. **10%-20%**
3. **20%-30%**
4. **30%-40%**

Male Best Class NT Issue Age 70



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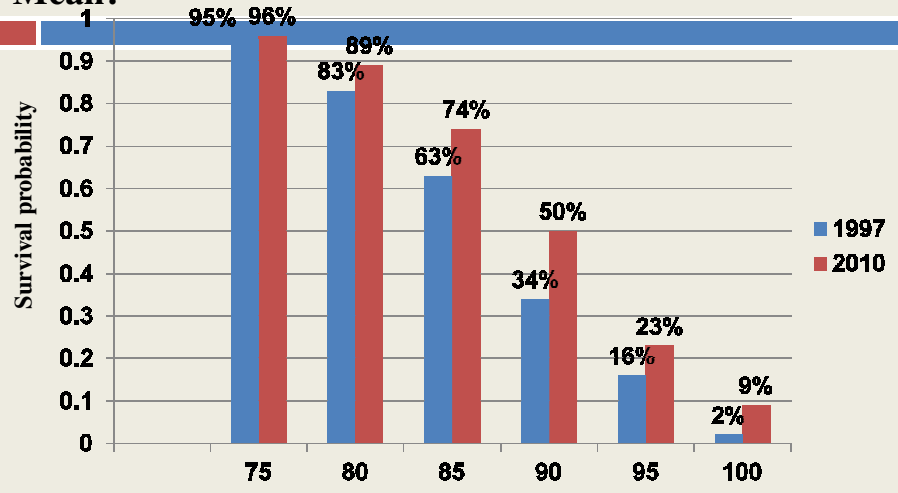
What Does That Mortality Improvement Really Mean?



Male, NT, Best Class, Issue Age 70

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Life Expectancy Trends C20-21: USA, Decennial Tables and 2008

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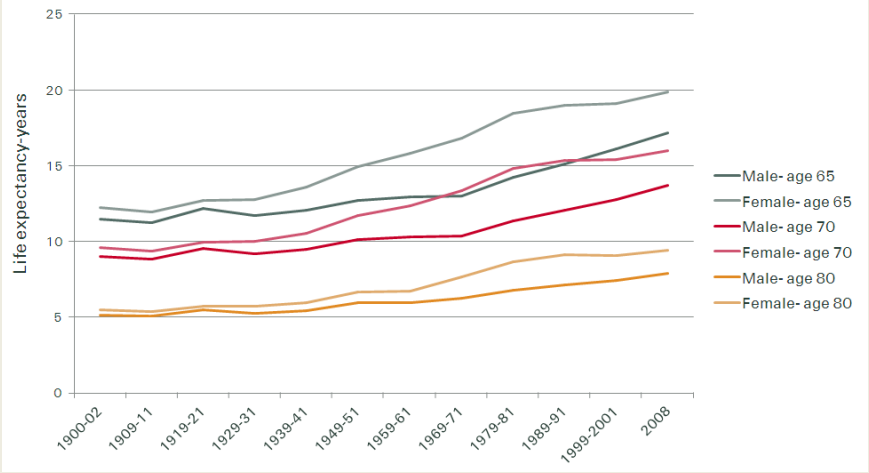

Historic Mortality Rates by year of Death: England & Wales, Males

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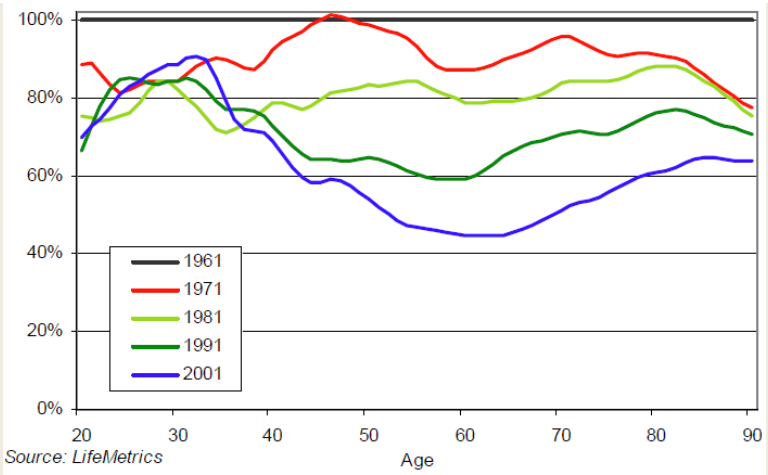

1961=100% Financial Reporting Council: Discussion paper March 2008

Changes in Ultimate Mortality 70+ From 1997 to 2010 Overall Mortality has improved 30%

54

Cause of Death	Change since 1997
Cerebrovascular disease	49% improvement
Heart	47% improvement
Cancer	33% improvement
Chronic Respiratory	24% improvement
All other causes	24% improvement
Pneumonia/Influenza	14% improvement
Injury	13% improvement
Diabetes Mellitus	8% improvement
Acute/Chronic Kidney Disease	0%
Septicaemia	8% worse
Parkinson's	27% worse
Hypertensive	47% worse
Alzheimer's	157% worse

Source: Northwestern Mutual

Life Expectancy Age 65 Years: 2009

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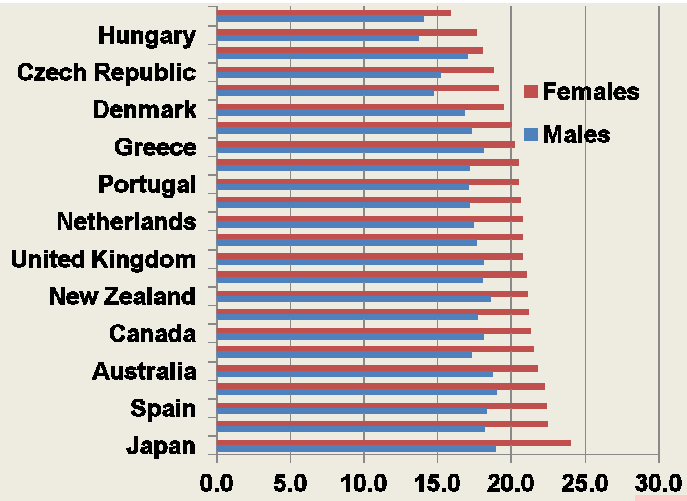

OECD Health Data 2011

Life Expectancy at Age 65: Years Gained 1990 to 2009

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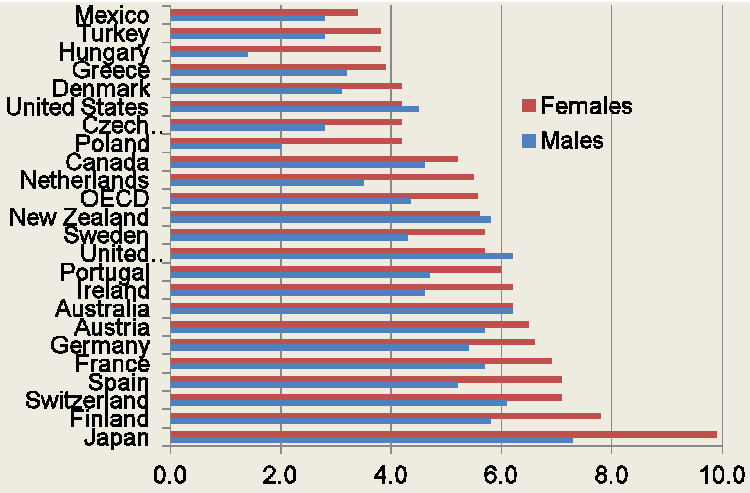
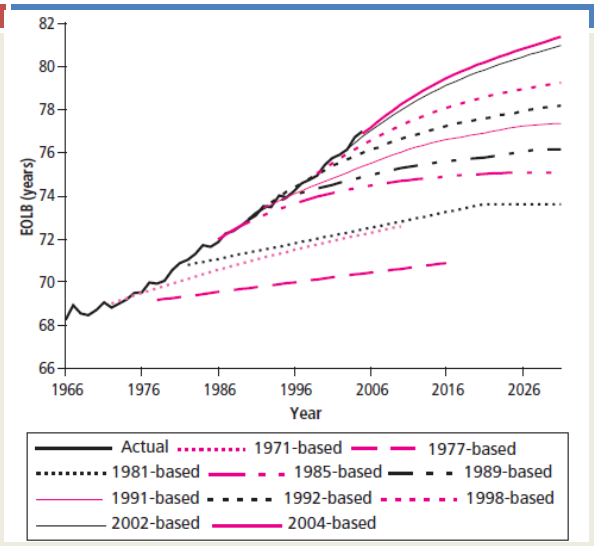


OECD Health Data 2011

Actual and Projected Life Expectancy at Birth: UK Males 1966-2031



Chris Shaw. Fifty years of United Kingdom national population projections: how accurate
have they been? population trends 128, 2007

Summary: Actuarial Underpinnings of Older Age Mortality

- Lots of clinical data on older ages
- Older age insurance involves a lot of premium
- Surprisingly little insurance data
- Will see mistakes sooner than at younger ages
- People living longer (helps with mistakes on life insurance; need to save more for a pension)
- Plenty of Opportunity for Medical Staff to show up the limited knowledge of our actuarial colleagues

How Would You Rate This Session?

1. Great
2. Best I have ever seen
3. Ranks in the top 15 presentations ever by Jeff and Kevin together
4. I want to buy them both drinks
5. I don't want to hurt their feelings