A 5-minute tour of mortality rates

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What an actuary does

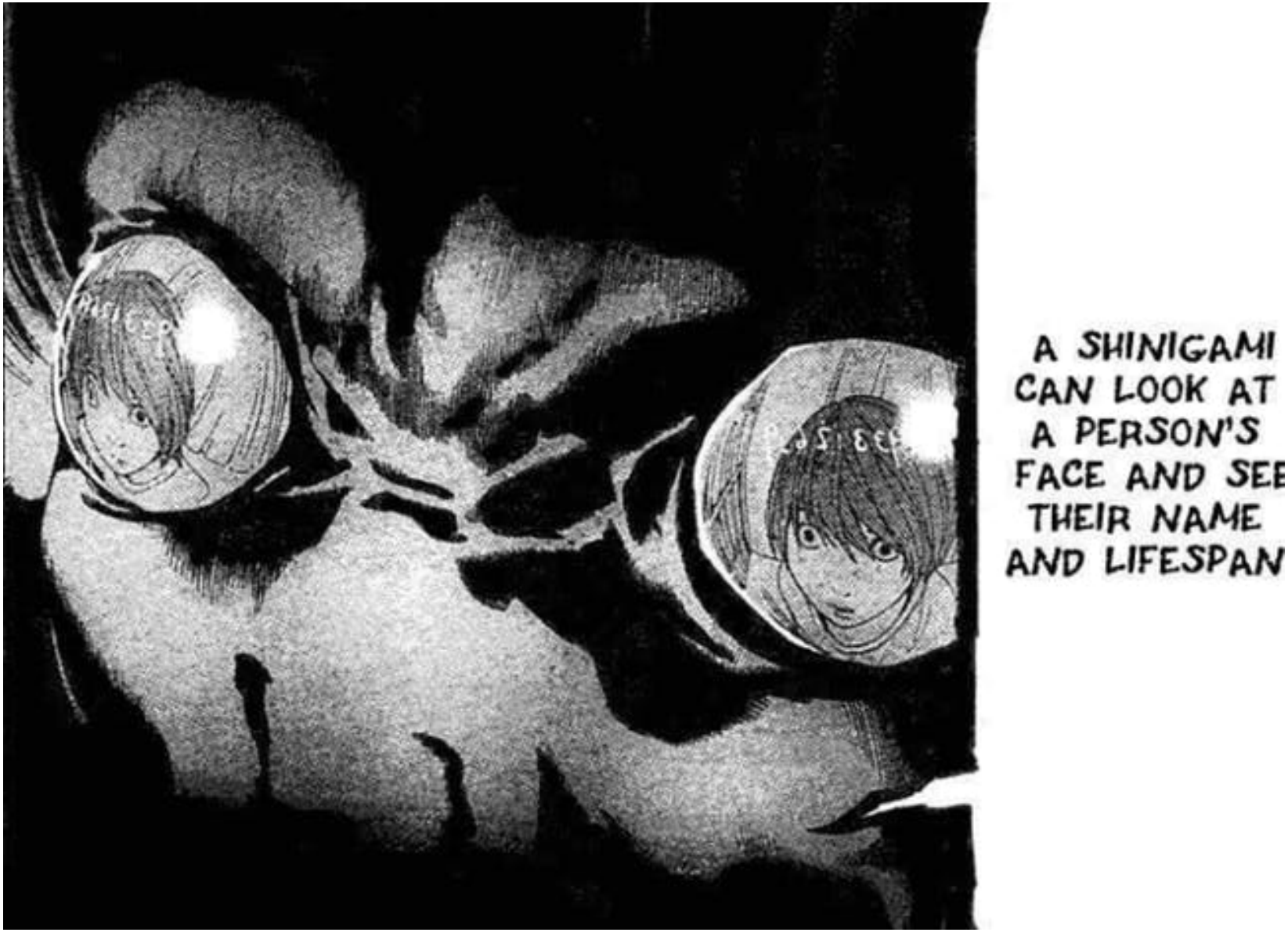
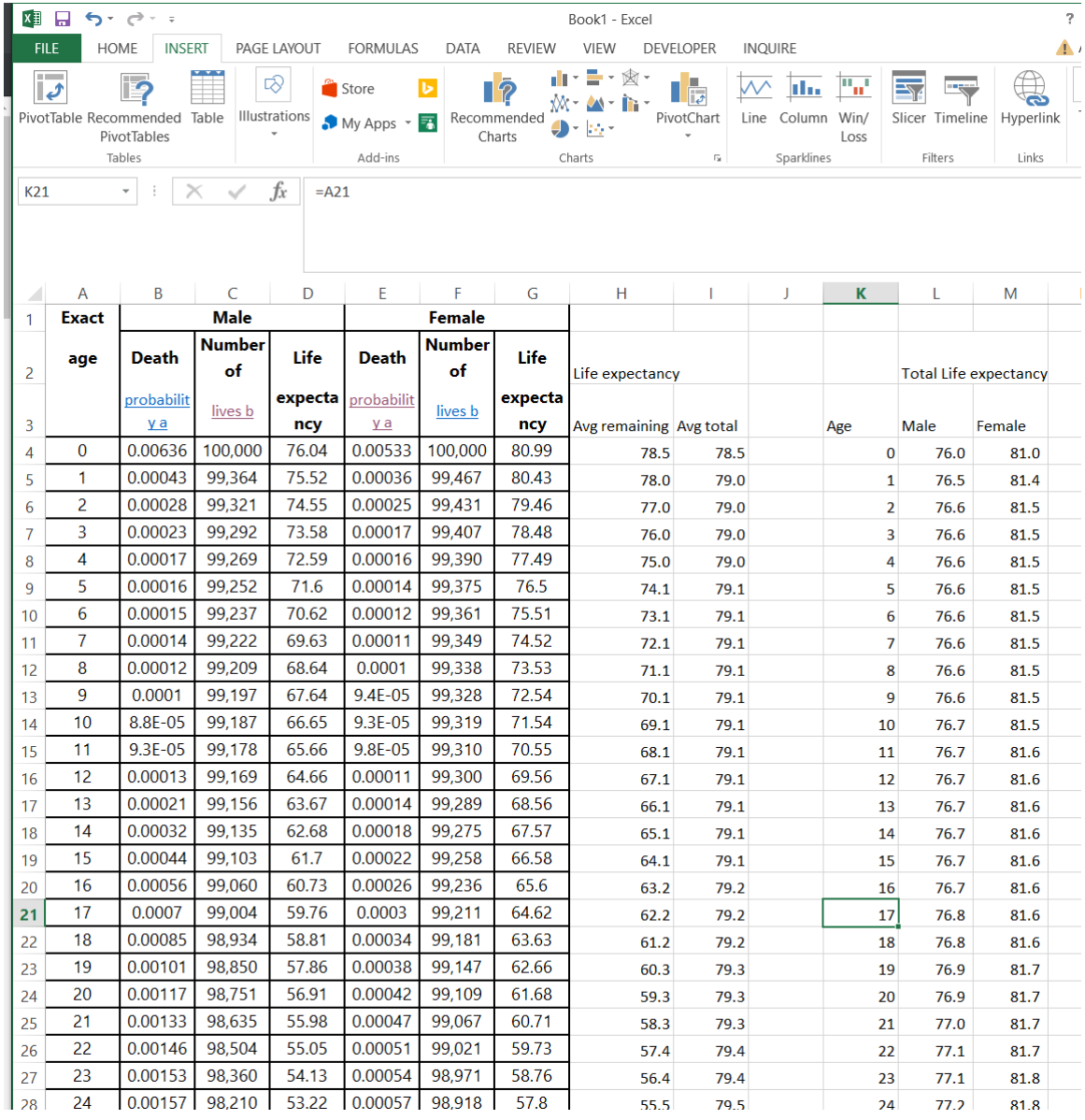


Figure 1: Expectation

What an actuary does



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Exact	Male			Female								
2	age	Death	Number of	Life	Death	Number of	Life	Life expectancy				Total Life expectancy	
3		probability a	lives b	expectancy	probability a	lives b	expectancy	Avg remaining	Avg total		Age	Male	Female
4	0	0.00636	100,000	76.04	0.00533	100,000	80.99	78.5	78.5		0	76.0	81.0
5	1	0.00043	99,364	75.52	0.00036	99,467	80.43	78.0	79.0		1	76.5	81.4
6	2	0.00028	99,321	74.55	0.00025	99,431	79.46	77.0	79.0		2	76.6	81.5
7	3	0.00023	99,292	73.58	0.00017	99,407	78.48	76.0	79.0		3	76.6	81.5
8	4	0.00017	99,269	72.59	0.00016	99,390	77.49	75.0	79.0		4	76.6	81.5
9	5	0.00016	99,252	71.6	0.00014	99,375	76.5	74.1	79.1		5	76.6	81.5
10	6	0.00015	99,237	70.62	0.00012	99,361	75.51	73.1	79.1		6	76.6	81.5
11	7	0.00014	99,222	69.63	0.00011	99,349	74.52	72.1	79.1		7	76.6	81.5
12	8	0.00012	99,209	68.64	0.0001	99,338	73.53	71.1	79.1		8	76.6	81.5
13	9	0.0001	99,197	67.64	9.4E-05	99,328	72.54	70.1	79.1		9	76.6	81.5
14	10	8.8E-05	99,187	66.65	9.3E-05	99,319	71.54	69.1	79.1		10	76.7	81.5
15	11	9.3E-05	99,178	65.66	9.8E-05	99,310	70.55	68.1	79.1		11	76.7	81.6
16	12	0.00013	99,169	64.66	0.00011	99,300	69.56	67.1	79.1		12	76.7	81.6
17	13	0.00021	99,156	63.67	0.00014	99,289	68.56	66.1	79.1		13	76.7	81.6
18	14	0.00032	99,135	62.68	0.00018	99,275	67.57	65.1	79.1		14	76.7	81.6
19	15	0.00044	99,103	61.7	0.00022	99,258	66.58	64.1	79.1		15	76.7	81.6
20	16	0.00056	99,060	60.73	0.00026	99,236	65.6	63.2	79.2		16	76.7	81.6
21	17	0.0007	99,004	59.76	0.0003	99,211	64.62	62.2	79.2		17	76.8	81.6
22	18	0.00085	98,934	58.81	0.00034	99,181	63.63	61.2	79.2		18	76.8	81.6
23	19	0.00101	98,850	57.86	0.00038	99,147	62.66	60.3	79.3		19	76.9	81.7
24	20	0.00117	98,751	56.91	0.00042	99,109	61.68	59.3	79.3		20	76.9	81.7
25	21	0.00133	98,635	55.98	0.00047	99,067	60.71	58.3	79.3		21	77.0	81.7
26	22	0.00146	98,504	55.05	0.00051	99,021	59.73	57.4	79.4		22	77.1	81.7
27	23	0.00153	98,360	54.13	0.00054	98,971	58.76	56.4	79.4		23	77.1	81.8
28	24	0.00157	98,210	53.22	0.00057	98,918	57.8	55.5	79.5		24	77.2	81.8

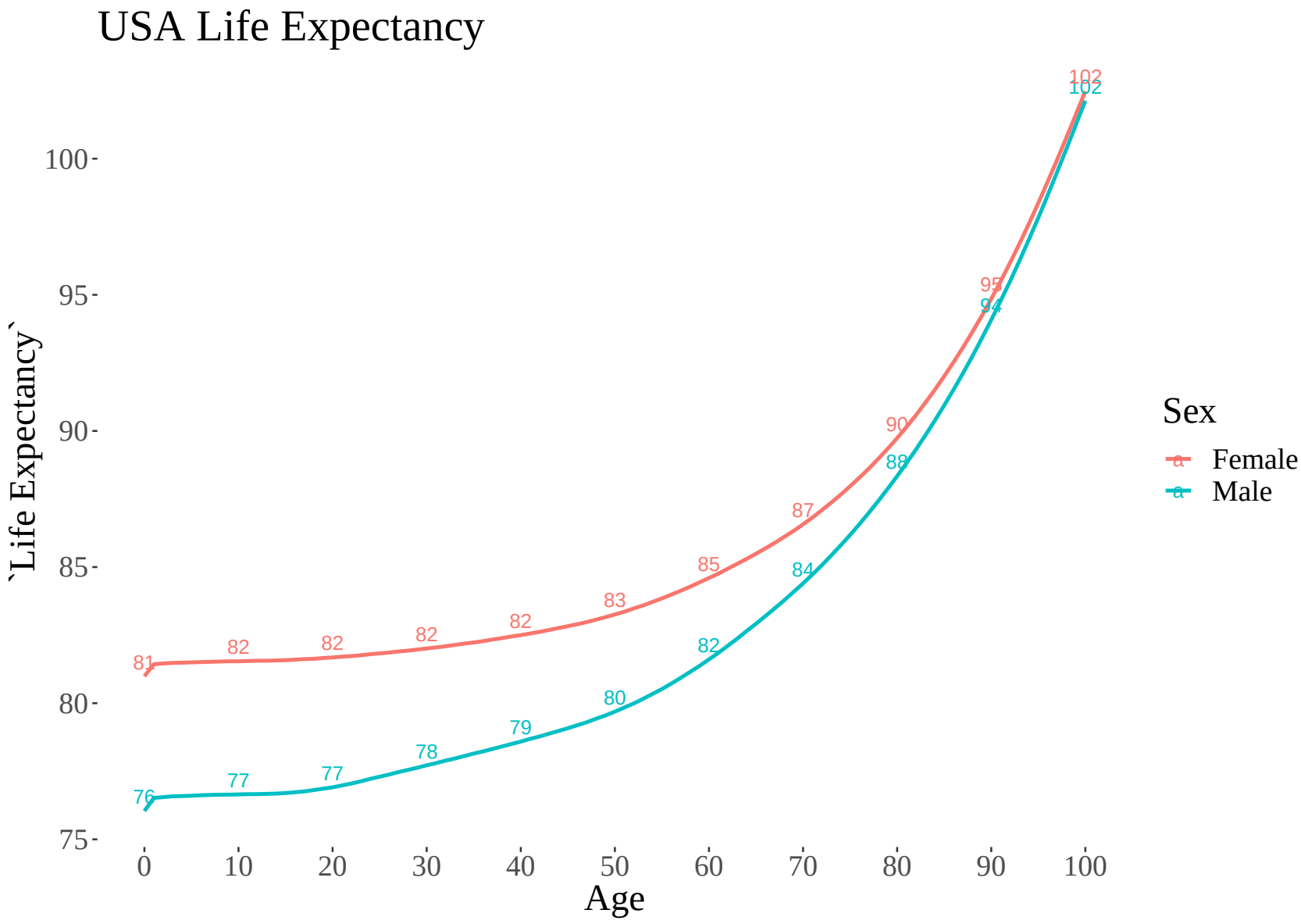
Figure 2: Reality

How long will I live?

- US Life expectancy **at birth** is 78.6
  - Male 76 years vs Female 81 years
  - Compare to 80 and 87 for Japanese newborns
- Life expectancy for a 30-year-old:
  - Male 48 years (to age 78)
  - Female 52 years (to age 82)
- Life expectancy for an 80-year-old:
  - Male 8 years (to age 88)
  - Female 10 years (to age 90)

Source: Social Security 2015 Actuarial Life Table

Life expectancy increases with attained age



What are the most important risk factors for mortality?

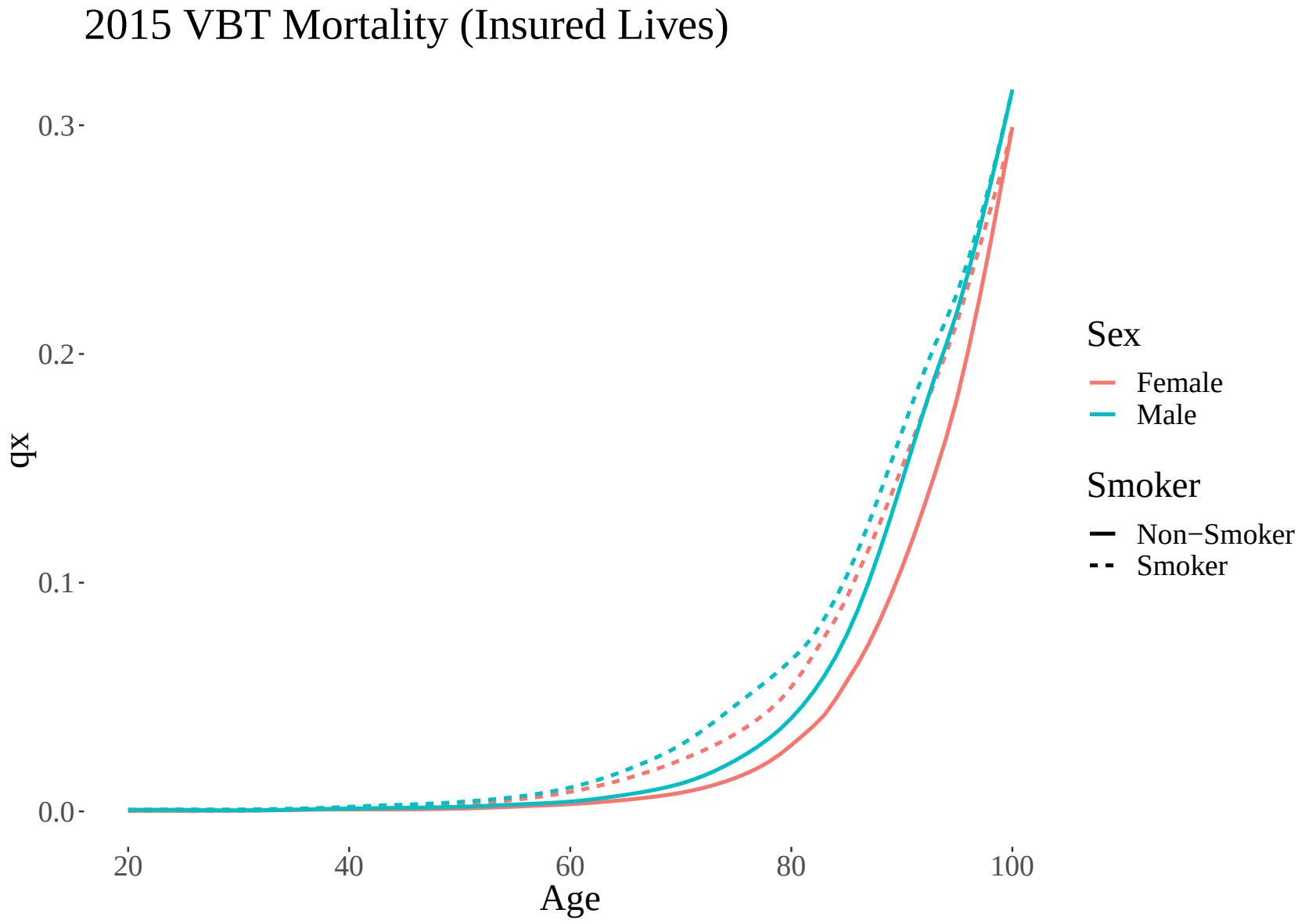
Annual mortality rate is the probability you'll die in the **next year**.

Table 1: Source: 2015 VBT for Insured Population

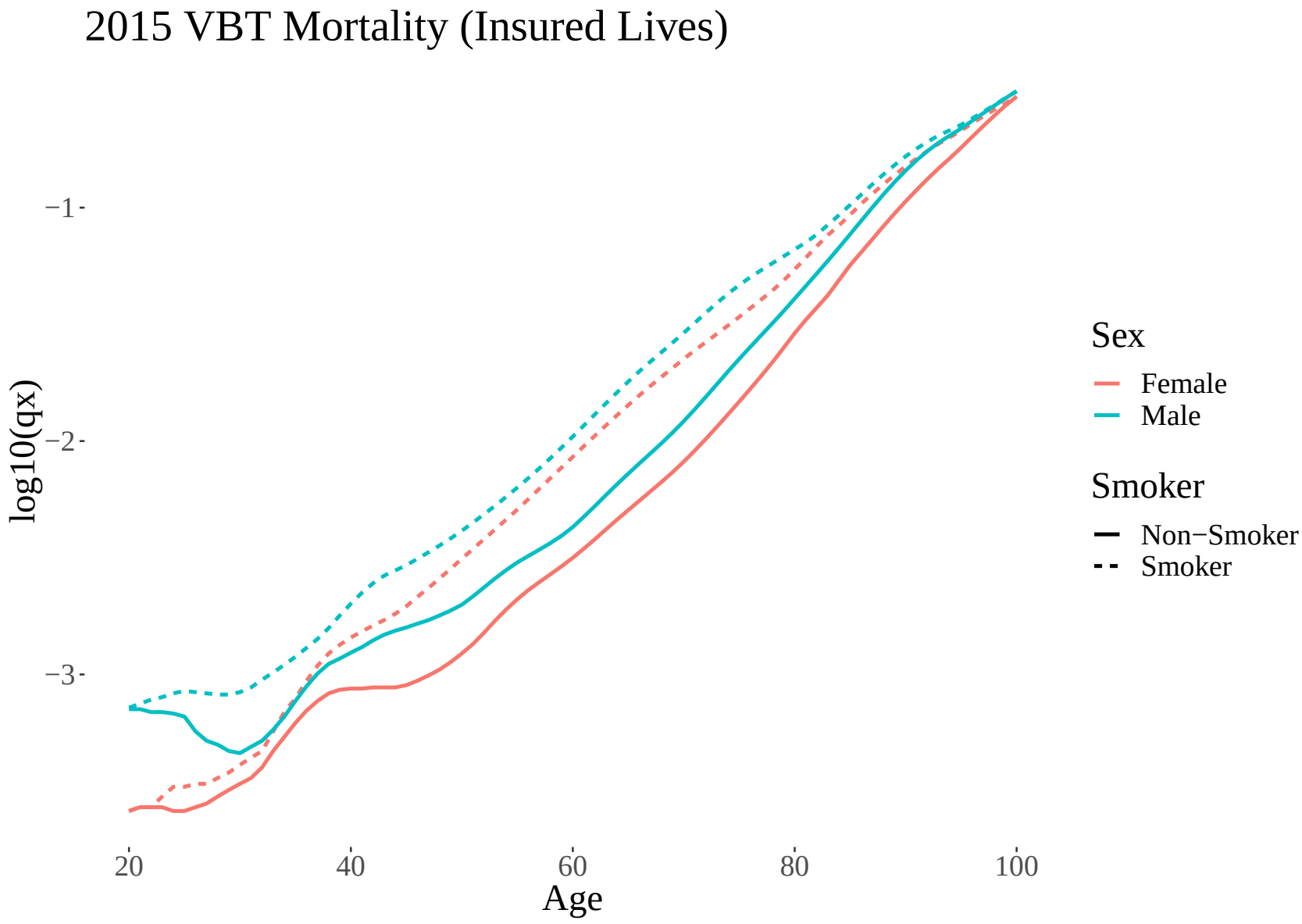
Age	F Non-Smoker	F Smoker	M Non-Smoker	M Smoker
20	0.00026	0.00026	0.00071	0.00072
30	0.00034	0.00041	0.00046	0.00084
40	0.00087	0.00144	0.00124	0.00201
50	0.00123	0.00313	0.00199	0.00413
60	0.00316	0.00856	0.00428	0.01045
70	0.00816	0.02249	0.01216	0.02908
80	0.02896	0.05443	0.04076	0.06627
90	0.10638	0.15026	0.14417	0.16584
100	0.29921	0.29921	0.31552	0.31552

A 26yo has 99% chance of living to 30, 87% to 60, 52% to 80, 1% to 100.

Annual mortality rate increases exponentially with age



Logarithm of the annual mortality rate



Food for thought...

- Say you are insuring 1000 30yo's for $100,000 each. Which statistical distribution(s) can you use to describe the possible outcomes?
  - Usual assumption is that life insurance claims are independent
  - Hello, Monte Carlo!
- Differences in mortality in General Population mortality vs. Insured Population?
  - Underwriting, demographic, censoring
- Survival analysis can be applied to anything with a "lifetime"
  - Time-to-X: Lifetime of a machine component, first heart attack, mortgage redemption, customer engagement, etc....

Data science innovations in life insurance

The world is quickly moving beyond traditional actuarial mathematics:

- John Hancock's new program offers life insurance discount if you send them your wearable fitness tracker data
- Philip Morris starts life insurance firm that offers discounts to smokers who quit or who switch to their vaping device
- "Advanced underwriting"
  - Fast and non-invasive
  - Instead of time- and labor-intensive paperwork, blood tests, blood pressure measurements, and urine samples,
  - An algorithm looks at your credit history, motor vehicle records, demographics, Rx, social media, and more!
  - Predictive accuracy, but at what cost?