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Question: Does Joe Need Life Insurance?

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QUESTION: Given his age and the dire medical warnings, should Joe consider buying some life insurance?
Joe is very comfortable financially, and already has a $1,000,000 life insurance policy for which he is currently paying $15,000 per year in insurance premiums. The policy has no cash-value.
More Information About Joe

• Joe is very comfortable financially, and already has a $1,000,000 life insurance policy for which he is currently paying $15,000 per year in insurance premiums. The policy has no cash-value.

• Joe sold his plumbing manufacturing business to Canadian Tire before he retired and now has a net worth of approximately $25 million dollars, which is invested in a diversified portfolio of stocks, bonds and real-estate.

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**Question:** Does Joe really need (more) life insurance?
Question: Does Joanne Need Life Insurance?

- Joanne is 32 years old, with three lovely children ages 2, 5 and 8. She is working as a professor of Viking literature at a large Canadian university. Her common-law partner Frank is 28 and stays home to raise the kids. In his spare time he is working on (writing) a great novel and does some freelance magazine editing to pay-off student loans.

- Joanne earns $59,000 per year as a non-tenured faculty member, and the University offers a life insurance policy to all its employees which pays three (3) times annual salary to the beneficiary (Frank and the 3 kids) in the event of death.

- Joanne and Frank are in excellent health, and come from a lineage of long-lived Scandinavians. They exercise regularly, run marathons, do yoga (together) and are probably vegetarian (and vote NDP.)

Question #1: Do they need (more) Life Insurance?

Question #2: Do they need any other type of insurance?
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Life Insurance is not a consolation prize for the survivors.
So, Who Needs Life Insurance and How Much?

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- Forget about age, wage and health. Think liabilities, dependents and vulnerabilities.
- Life insurance is sold, not bought.
Important Concepts and Industry Background

- During the year 2009, Canadians purchased over $310 billion face value (death benefit) of life insurance, of which over $100 billion was part of a group purchase and over $200 billion was by individuals.

Canadians purchased 760,000 individual policies with an average face value (death benefit) of $270,000 during the year 2009.

By early 2010, almost 21 million Canadians owned a total of $3,475 billion (i.e. $3.4 trillion) face value of life insurance.

In 2009, Canadians paid LI premiums of $15 billion to insurance companies; policyholders and beneficiaries received $7.6 billion in LI benefits.

In early 2010 there were 96 active life insurance companies in Canada, holding almost $500 billion in assets, and employing 132,000 Canadians.

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Life insurance policies that have a savings/investment component, as opposed to pure insurance, enjoy tax-free accumulation, a.k.a. **inside buildup**. Think of this as an (expensive) TFSA.

Life insurance enjoys a very special (beneficial) tax treatment compared to other investment vehicles and the industry lobbies very aggressively to maintain this favorable treatment.
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What Does Basic Life Insurance Cost?

- The single most important factor is your age/gender.

<table>
<thead>
<tr>
<th>Monthly Premiums for $100K of Term LI (Excellent Health)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term of</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>5 years</td>
</tr>
<tr>
<td>10 years</td>
</tr>
<tr>
<td>20 years</td>
</tr>
<tr>
<td>30 years</td>
</tr>
<tr>
<td>Term-to-100*</td>
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<table>
<thead>
<tr>
<th>Term of</th>
<th>Age 30</th>
<th>Age 50</th>
<th>Age 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 years</td>
<td>12.71</td>
<td>11.53</td>
<td>19.65</td>
</tr>
<tr>
<td>10 years</td>
<td>8.21</td>
<td>7.68</td>
<td>17.95</td>
</tr>
<tr>
<td>20 years</td>
<td>11.01</td>
<td>9.68</td>
<td>27.56</td>
</tr>
<tr>
<td>30 years</td>
<td>15.47</td>
<td>12.88</td>
<td>46.23</td>
</tr>
<tr>
<td>Term-to-100*</td>
<td>33.51</td>
<td>27.27</td>
<td>103.60</td>
</tr>
</tbody>
</table>

- Review the relationship with each-other carefully. Do they make sense?
# Impact of Health Status on LI Cost

## Monthly Premiums for $100,000 of Term Life Insurance

50 year-old with varying Health Status (Scale of 1 to 5)

<table>
<thead>
<tr>
<th>Term</th>
<th>Average (2/5)</th>
<th>Excellent (4/5)</th>
<th>Exceptional (5/5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27.61</td>
<td>20.68</td>
<td>19.65</td>
</tr>
<tr>
<td></td>
<td>23.54</td>
<td>18.38</td>
<td>17.95</td>
</tr>
<tr>
<td></td>
<td>38.69</td>
<td>28.65</td>
<td>27.56</td>
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LSM Insurance was featured in February issue of The Insurance Journal. Enjoy the article!

Universal life:
Low interest rates drive up prices

Low interest rates have diminished the profitability of level cost universal life insurance for years. Although fierce competition may have overruled common sense for some time, manufacturers no longer have a choice. Long-term interest rates have finally forced changes.

Based on outdated actuarial assumptions, level cost universal life insurance needed a serious overhaul to return to profitability. After bottoming out in 2008, long-term interest rates once again fell below 3.5% just before year Alliance boosted its level cost on Jan.17. Sun Life Financial followed on Jan. 28 and Canada Life did the same on Feb. 7. Empire Life announced that it would make a similar Alliance, told The Insurance and Investment Journal. With this generalized increase, he thinks the industry has solved its interest rate problem for 2011.

Sun Life explains the increase to its advisers on its website: “Interest rates have continued to fall, with long-term Canadian bond yields falling to their lowest levels in recent history...This continued low interest rate environment puts pressure on margins for
### Canadian Population 2000/2002

<table>
<thead>
<tr>
<th>Age</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.340</td>
<td>0.820</td>
</tr>
<tr>
<td>30</td>
<td>0.390</td>
<td>0.880</td>
</tr>
<tr>
<td>40</td>
<td>0.920</td>
<td>1.520</td>
</tr>
<tr>
<td>50</td>
<td>2.290</td>
<td>3.600</td>
</tr>
<tr>
<td>60</td>
<td>5.870</td>
<td>9.820</td>
</tr>
<tr>
<td>70</td>
<td>14.930</td>
<td>25.550</td>
</tr>
<tr>
<td>80</td>
<td>42.400</td>
<td>68.460</td>
</tr>
<tr>
<td>90</td>
<td>130.880</td>
<td>182.640</td>
</tr>
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</table>

**Statistics Canada (84-537-XIE)**
A mortality table maps an age \( x \) into a probability of death \( q_x \), during the next year. By definition, \( 0 \leq q_x \leq 1 \) and \( q_N = 1 \), for some large enough \( N \approx 110 \).
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Mind your \( p \)'s and \( q \)'s! It can get confusing.
Computing the General Survival Probability

- If an individual is currently aged $x$, then the probability of surviving to age $n$ is denoted and defined by:

$$ (n p_x) = \prod_{i=0}^{n-1} (1 - q_{x+i}) $$

- The probability that two (independent) people of age $(x, y)$ survive for $n$ years is equal to:

$$ (n p_x) (n p_y) = \prod_{i=0}^{n-1} (1 - q_{x+i}) \prod_{i=0}^{n-1} (1 - q_{y+i}) $$

- The probability that at least one survives $n$ years:

$$ 1 - (n q_x) (n q_y) $$

Remember: Only Four (4) things can happen.
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$$\left( np_x \right) \left( np_y \right) = \left( \prod_{i=0}^{n-1} (1 - q_{x+i}) \right) \left( \prod_{i=0}^{n-1} (1 - q_{y+i}) \right)$$

- The probability that at least one survives $n$-years:

$$1 - \left( nq_x \right) (x q_y)$$
Computing the General Survival Probability

- If an individual is currently aged \( x \), then the probability of surviving to age \( n \) is denoted and defined by:

\[
(n p_x) = \prod_{i=0}^{n-1} (1 - q_{x+i})
\]

- The probability that two (independent) people of age \((x, y)\) survive for \( n \) years is equal to:

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(n p_x)(n p_y) = \left( \prod_{i=0}^{n-1} (1 - q_{x+i}) \right) \left( \prod_{i=0}^{n-1} (1 - q_{y+i}) \right)
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1 - (n q_x)(x q_y)
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- Remember: Only Four (4) things can happen.
Numerical Examples: Mortality

- **Question:** Using Canadian population mortality rates, what is the probability that a 20-year old (male/female) dies within the next five years, before the age of 25?

<table>
<thead>
<tr>
<th>Male</th>
<th>1 \times (1 - q_{20}) \times (1 - q_{21}) \times (1 - q_{22}) \times (1 - q_{23}) \times (1 - q_{24}) = 0.99574 = 0.4253%</th>
</tr>
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**Question:** What is the probability that at least one member of a 20-year old couple (male/female) dies before their 25th birthday?

**Answer:**

1 \times (0.998321) \times (0.995747) = 0.59245%
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\[ 1 - (1 - q_{20})(1 - q_{21})(1 - q_{22})(1 - q_{23})(1 - q_{24}), \]

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- **Are these probabilities independent, in practice?**
# Life Expectancy: The 50% Mark

## Life Expectancy at Birth in 2005

<table>
<thead>
<tr>
<th>Bottom 10 Countries</th>
<th>Top 10 Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swaziland (35.3)</td>
<td>Japan (82.4)</td>
</tr>
<tr>
<td>Lesotho (36.3)</td>
<td>Sweden (80.7)</td>
</tr>
<tr>
<td>Djibouti (37.6)</td>
<td>Hong Kong (80.6)</td>
</tr>
<tr>
<td>Botswana (38.2)</td>
<td>Macao (80.07)</td>
</tr>
<tr>
<td>Mozambique (38.4)</td>
<td>Israel (79.97)</td>
</tr>
<tr>
<td>Malawi (40.52)</td>
<td>Iceland (79.91)</td>
</tr>
<tr>
<td>Sierra Leone (42.37)</td>
<td>Norway (79.73)</td>
</tr>
<tr>
<td>South Africa (42.44)</td>
<td>France (79.69)</td>
</tr>
<tr>
<td>Burundi (42.66)</td>
<td>Australia (79.64)</td>
</tr>
<tr>
<td>Rwanda (43.33)</td>
<td>Belgium (79.59)</td>
</tr>
</tbody>
</table>

Source: Watson Wyatt
Consider a one-year term life insurance policy for an $x$-year-old individual, paying $1$ (at the end of the year) if the insured dies at any time during the year. The mortality rate is $q_x$, which implies that if the insurance company sells $N$ of these polices it will have to pay death benefit claims on approximately $q_xN$ policies. The $q_xN$ will be paid at the end of the year, so its present value is: $q_xN/(1 + v)$, where $v$ denotes the valuation rate.
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The **Actuarial Premium** of a one-year life insurance policy is:

$$A_{x:1} := \frac{q_x}{1 + v},$$
The quantity $A_{x:1}$ is often referred to as the **actuarial** net single premium (NSP). The word actuarial is meant to remind you that the only thing the premium covers, is the pure death benefit. It does not account for profits or anything non actuarial.
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In practice, of course, you would have to pay more than the no-profit (actuarial) cost to the insurance company, and so with a slight play on words, the Insurance Cost is defined as:

$$\text{Insurance Cost} = (1 + \Lambda) \times \text{Actuarial Premium}$$

where the symbol $\Lambda > 0$ denotes the percentage profit plus commission plus fees (loading) above and beyond the pure actuarial cost of insurance.
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In this case the actuarial premium for a two-year policy, denoted by $A_{x:2}$, is computed by:

$$A_{x:2} = \frac{q_x}{1 + \nu} + \frac{(1-p_x)q_{x+1}}{(1 + \nu)^2}.$$
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What would this look like for 3 years of coverage?
The $n$-year term policy actuarial premium is:

$$ (A_{x:n}) = \sum_{j=0}^{n-1} \frac{(j p_x) q_{x+j}}{(1 + v)^{j+1}}. $$

Finally, when the awkward term $n$ is missing from the subscript $(A_{x:n})$, the symbol denotes a policy with a term of infinity, which is basically a permanent life policy that never expires. Regardless of when you die, the insurance company pays your heirs a $1$ death benefit. Note that rarely if ever do people pay the entire $A_{x:n}$ up-front and in one lump-sum. It is often amortized over the $n$-year period, which is actually more complicated than you think...
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Question: Using the Canadian population mortality rates, please compute the monthly actuarial cost/price of a 1-year term life insurance policy for a Canadian male/female that pays $100,000 if the individual dies during the year. Do this for age 30, 50 and then 70, assuming a $v = 5\%$ valuation rate.

Answer: Multiply the death probability ($q_x$) by the death benefit ($100,000$), divide by the TVM factor ($1.05$) and express monthly.

**Male:**
- $1_{12}A_{30} = $7,011.2
- $1_{12}A_{50} = $28,622.5
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How does this compare to the real-world prices I showed earlier? Why the discrepancy?
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- Think of any insurance policy as money going into a (big) lock-box with two compartments. Some of the money is dedicated to pure protection, and other to pure investment. Each year you can decide how to move money between the two compartments.
<table>
<thead>
<tr>
<th>Types of Life Insurance (in Canada)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Term</td>
</tr>
<tr>
<td>Features / Category</td>
</tr>
<tr>
<td>Tax-sheltered Savings:</td>
</tr>
<tr>
<td>Regular Dividends:</td>
</tr>
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<td>Investment Options:</td>
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</tr>
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<td>Flexible Premiums:</td>
</tr>
<tr>
<td>Popularity / Market:</td>
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## Summary Table: 3 Different Life Insurance Policies

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<th>Whole Life</th>
<th>Universal Life</th>
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<tbody>
<tr>
<td><strong>Features / Category</strong></td>
<td>(Temporary)</td>
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<td></td>
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<td>Popularity / Market:</td>
<td>30%</td>
<td>25%</td>
<td>45%</td>
</tr>
</tbody>
</table>
Tradeoff: Short Term vs. Long Term

Annual Premium ($)

Age at purchase

30 year-term

1 year-term
Which One is Best for Me and My Family?

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CHM (Cambridge 2012)
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- If you have used-up RRSP and TFSA room, you might want to consider using insurance for tax-reasons as opposed to risk-management reasons (only).
- Owners of a small-business with partners (or even a family cottage) might have buy/sell clauses in their agreements, or tax liabilities upon death that might create a need for insurance.
Life Insurance Death Benefit: How Much Do You Need?

Expense Approach

Income Approach

Lower Bound

Upper Bound

Taxes

I’m not here
The same exact principles would apply to disability insurance, health insurance as well as critical illness insurance. In this case the payout would go to the insured (as opposed to beneficiary). The actuarial modeling approach is exactly the same.
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Like any other type of insurance, don’t over-pay or waste premiums on unnecessary protection!