WE ARE THRILLED TO PRESENT TODAY ON LIFE EXPECTANCY!

AND WE HOPE TO CLARIFY QUESTIONS ABOUT THE MEASURE AS WE BUILD IT FROM THE GROUND UP, THAT IS,

WHAT DOES IT MEAN, HOW DO WE CALCULATE IT AS WELL AS PRESENT ON SOME COMPARISONS AND TRENDS.
TO GIVE YOU AN OVERVIEW OF OUR TALK

WE WILL FIRST DEFINE IN BROAD TERMS WHAT IS IT  WE MEAN BY LIFE-EXPECTANCY

AS WELL AS CONSIDER WHY THE INTEREST IN IT AND WHO USES IT

THEN THE DISCUSSION WILL TURN TO LIFE-TABLES WHICH ARE CENTRAL TO THE CALCULATION OF LE

FOLLOWED BY AN EXAMPLE SHOWCASING AN EXTRACT OF A NYC LIFE-TABLE FOR 2007

AFTER WE’VE SEEN HOW THE MEASURE IS COMPUTED WE WILL LOOK AT CROSS COUNTRY COMPARISONS

THEN WE PRESENT A 50 PLUS YEAR TRENDS OF LIFE-EXPECTANCY FOR THE US

THIS WILL SET THE STAGE FOR COMPARISONS BETWEEN THE NATIONAL AND NYC LE
AND FINALLY WE’LL TAKE A LOOK AT NYC TRENDS, OVERALL AND BY SEX
## Life-Expectancy 2008 for Selected Ages (Expected Remaining Years of Life)

<table>
<thead>
<tr>
<th>Exact age in years</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>76.3</td>
<td>82.0</td>
</tr>
<tr>
<td>5</td>
<td>71.8</td>
<td>77.4</td>
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<tr>
<td>25</td>
<td>52.3</td>
<td>57.6</td>
</tr>
<tr>
<td>35</td>
<td>42.8</td>
<td>47.9</td>
</tr>
<tr>
<td>45</td>
<td>33.5</td>
<td>38.3</td>
</tr>
<tr>
<td>55</td>
<td>25.1</td>
<td>29.4</td>
</tr>
<tr>
<td>65</td>
<td>18.0</td>
<td>21.3</td>
</tr>
<tr>
<td>75</td>
<td>11.4</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Source: NYC BVS Summary 2009 Table 2.25


**THE CURRENT SLIDE SHOULD GIVE YOU A TASTE OF OUR LIFE-EXPECTANCY TABLE FOR NYC IN 2008 BY SEX FOR SELECTED AGES.**

**IT SHOWS FOR EXAMPLE THAT A 45 YEAR OLD MALE IN 2008 COULD EXPECT TO LIVE 33.5 ADDITIONAL YEARS ON AVERAGE, WHEREAS A WOMAN OF THE SAME AGE IS EXPECTED TO LIVE ON AVERAGE 38.3 ADDITIONAL YEARS**

**THE FULL LIFE-TABLES FOR NYC CAN BE FOUND IN OUR ANNUAL SUMMARY OF VITAL STATISTICS**

**... AND YES THIS IS A SHAMELESS PLUG!**

**BUT I DO ENCOURAGE YOU TO TAKE A CLOSER LOOK BY VISITING THE LINK HERE PROVIDED.**
NOW, FOR OBVIOUS REASONS WE ARE ALL INTERESTED IN HAVING SOME SENSE OF EXPECTED LONGEVITY, NOT ONLY THAT OF OUR OWN BUT OF THOSE WE CARE ABOUT AND OF SOCIETY IN GENERAL.

BUT HOW DO WE MEANINGFULLY MEASURE IT? IMMEDIATELY BUT INCORRECTLY TWO CANDIDATES COME TO MIND

~TAKE THE AVERAGE OR THE MEDIAN AGE AT DEATH OF ALL D E C E D E N T S AND PRESTO!

UNFORTUNATELY, ALTHOUGH SIMPLE AND APPEALING, THE AVERAGE AND MEDIAN AGE AT DEATH ARE NOT ADEQUATE MEASURES OF LIFE-EXPECTANCY,

BECAUSE UNLIKE THESE MEASURES, LIFE EXPECTANCY SHOULD BE FORWARD LOOKING.

IN CONTRAST

THE AVERAGE OR MEDIAN AGE AT DEATH ARE STATIC REPRESENTATIONS OF THE MORTALITY PROFILE OF A POPULATION AT A POINT IN TIME (A SNAPSHOT), AS OPPOSED TO A PROJECTION OF EXPECTED LIFETIME REMAINING. IN ADDITION THEY DO NOT TAKE INTO ACCOUNT THE AGE DISTRIBUTION OF THE POPULATION.
Why Life-Expectancy?

- Public Health, Epidemiologists, & Medicine
  Surveillance & Informing Policy Decisions
- Insurance
  Setting insurance premiums (Actuaries)
- Demographers
  Understanding population trends
- Other Investigators
  e.g. Fiscal Policy, Solvency of Social Safety net programs like Social Security, Medicare and Disability Insurance

SO WHY LIFE EXPECTANCY?

THE USES OF LIFE EXPECTANCY ARE MANY AND APPLIED ACROSS SEVERAL DISCIPLINES AS IN PUBLIC HEALTH AND EPIDEMIOLOGY FOR SURVEILLANCE AND TO INFORM POLICY DECISIONS (e.g. INSURANCE, DEMOGRAPHY, PUBLIC POLICY IN GENERAL, MEDICINE)

OF INCREASING RELEVANCE IS ITS APPLICATION IN RELATION TO FISCAL CONSIDERATIONS REGARDING THE SOLVENCY OF OUR SOCIAL SAFETY-NET APPARATUS.

ALL VERY SERIOUS STUFF!

BUT ONE OF THE MOST IMPORTANT AND COMPELLING REASONS TO STUDY LIFE-EXPECTANCY

IS WHEN THE BOSS...
...IS KEENLY INTERESTED IN IT!

...YES MIKE IS A FAN

AND FOR VERY GOOD REASON SINCE IT’S A USEFUL AND INFORMATIVE METRIC; IN A SENSE A BAROMETOR OF A POPULATION’S HEALTH.

BUT HOW IS IT CALCULATED? HOW DO WE COMPUTE THIS – SEEMINGLY MYSTERIOUS MEASURE - THAT SEeks TO PEEK INTO THE FUTURE?
THE ANSWER IS THAT THEY ARE OBTAINED BY CONSTRUCTING WHAT ARE CALLED LIFE TABLES, WHOSE EARLIEST PRECURSOR DATES BACK TO THE 3\textsuperscript{RD} CENTURY AD.

THE MODERN LIFE TABLE, AS WE CURRENTLY USE, FINDS ITS UNDERPINNINGS IN THE WORK OF JOHN GRAUNT’S “BILL OF MORTALITY (1662)” AND ESPECIALLY HALLEY’S CELEBRATED TABLE FOR THE CITY OF BRESLAU,

BUT THE TABLE’S EVOLUTION CONTINUES TO THIS DAY.

AND IT IS FROM THE COLUMNS OF THE LIFE TABLE THAT WE OBTAIN THE MEASURE OF LIFE EXPECTANCY FOR ANY ARBITRARY AGE $X$ AS IN OUR 45 YEAR OLD EXAMPLE.
IN GENERAL THERE ARE TWO TYPES OF LIFE TABLES. 

IN THIS TALK WE FOCUS ON CURRENT OR PERIOD LIFE TABLES WHICH ARE BASED ON THE AGE-SPECIFIC MORTALITY RATES OF A POPULATION AT A GIVEN POINT IN TIME. 

AS WE WILL SEE THIS TYPE OF TABLE RELIES ON A BASELINE POPULATION AS A HYPOTHETICAL COHORT AND IT ALSO HAS THE PROPERTY OF BEING FORWARD LOOKING. 

THE OTHER TYPE, COHORT OR GENERATION TABLES, ARE USED TO STUDY GROUPS OF INDIVIDUALS WHERE WE FOLLOW THE INDIVIDUALS IN THE COHORT FROM BIRTH TO DEATH. THIS WOULD REQUIRE TRACKING EVERY INDIVIDUAL BORN, SAY IN 1920, UNTIL ALL THOSE BORN THAT YEAR HAVE DIED. THIS COULD BE DIFFICULT AND RESOURCE INTENSIVE TO DO, NOT TO MENTION THAT THESE TABLES ARE RETROSPECTIVE IN NATURE. 

SO FOR PRACTICAL REASONS AND FOR A FORWARD LOOKING MEASURE WE, AS WELL AS THE NCHS, FOCUS ON CURRENT LIFE TABLES.
ON SCREEN IS THE GENERAL FORMAT OF LIFE TABLES. IN ESSENCE THE LIFE TABLE HAS 8 COLUMNS FROM WHICH LIFE-EXPECTANCY IS CALCULATED FOR EACH AGE-GROUP IN THE TABLE.

IT’S IMPORTANT TO KEEP IN MIND THAT THERE ARE DIFFERENT METHODOLOGIES AND APPROACHES TO THEIR CONSTRUCTION EACH WITH THEIR NUANCES, BUT FOR SIMPLICITY WE WILL FOCUS ON THE KEY ELEMENTS.

ALSO OF NOTE IS THAT CURRENT LIFE TABLES CAN BE BY SINGLE-YEAR OF AGE, WHAT ARE CALLED COMPLETE CURRENT LIFE TABLES, OR ALTERNATIVELY THEY CAN BE ABRIDGED LIFE-TABLES WHICH LOOK AT BROADER AGE GROUPS THAN SINGLE-YEAR e.g. IN 5 OR 10 YEAR AGE GROUPS.

TODAY WE FOCUS ON COMPLETE LIFE TABLES (SINGLE-YEAR AGE TYPE).

SO LET’S TAKE A CLOSER LOOK AT THE TABLE’S COMPOSITION, COLUMN BY COLUMN:

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
<th>Column 7</th>
<th>Column 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Interval ((x, x+n))</td>
<td>Proportion Dying in the Interval (q_x)</td>
<td>Number Living at Age (x) (l_x)</td>
<td>Number Dying in Interval (d_x)</td>
<td>Fraction of Last Year of Life (\sigma_x)</td>
<td>Number of Years Lived (l_x)</td>
<td>Total Number of Years Lived Beyond (x) (T_x)</td>
<td>Observed Expectation of Life at Age (x) (e_x)</td>
</tr>
</tbody>
</table>

\[
q_x = \frac{D_x}{N_x} \quad l_{x+1} = (1 - q_x) l_x \quad d_x = q_x l_x \quad From \ Vital \ Records \quad L_x = l_x - d_x \quad T_x = l_x + l_{x+1} + \cdots + l_{x+w} \quad e_x = \frac{T_x}{l_x}
\]

Where \(x\) = Exact Age considered
\(N_x\) = Number of people alive at age \(x\)
\(n\) = Age-interval length
\(w\) = Lower age of oldest age group
Here is an example of a complete life table which is constructed as mentioned for single-year of age for NYC males in 2007.

1) The first column gives us the age-interval where the first term in the bracket is the exact age being considered. Note that the first cell is for infants.

2) The second column is the proportion of the population that dies in the age interval. Note that at the bottom, the proportion dying at ages 100 and over equals 1, which means that all people 100 years of age and older die in that age range by construction.

3) The third column is a theoretical baseline population as it lives throughout time. Here we consider a theoretical starting population of 100,000 newborns; in this sense they are a theoretical cohort.

4) The fourth column is the number of those newborns that will die within the age-interval. This is obtained by the product of column 2 with column 3. So, for the first age-interval 556 of those 100,000 newborns will die in infancy.
5) **BECAUSE PEOPLE LIVE A FRACTION OF THE YEAR ON THEIR LAST YEAR OF LIFE, THE FIFTH COLUMN REPORTS ESTIMATES OF THIS FRACTION. FOR SIMPLICITY IT IS REASONABLE TO SET THIS FRACTION TO ½ BY ASSUMING THAT DEATHS OCCUR UNIFORMLY THROUGHOUT ANY SINGLE YEAR. THIS IS MOSTLY THE CASE EXCEPT FOR INFANTS WHERE A SIGNIFICANT NUMBER DIE SHORTLY AFTER BIRTH.**

6) **THIS FRACTION IS USED TO ESTIMATE THE TOTAL NUMBER OF PERSON-YEARS LIVED IN THE AGE-INTERVAL. THESE PERSON-YEARS LIVED ARE CALCULATED FOR EACH AGE-INTERVAL AND THEY ARE PRESENTED IN COLUMN SIX.**

7) **COLUMN 7 IS THE SUM OF ALL PERSON-YEARS LIVED BEYOND A GIVEN AGE, THAT IS, A SERIES OF PROGRESSIVE SUMS OF COLUMN 6 ITEMS.**

**SO FOR EXAMPLE, THE INFANTS IN THE FIRST AGE-INTERVAL WILL LIVE THE AGGREGATE OF 7,629,711 PERSON-YEARS.**
8) **FINALY COLUMN EIGHT GIVES US WHAT WE’RE AFTER, THE EXPECTED YEARS OF LIFE REMAINING FOR THOSE WHO HAVE REACHED A PARTICULAR EXACT AGE.**

**THIS IS OBTAINED BY DIVING THE AGGREGATE PERSON-YEARS LIVED IN COLUMN 7 BY THE NUMBER OF PERSONS ACTUALLY LIVING, AS PRESENTED IN COLUMN 3, FOR THE PARTICULAR AGE-INTERVAL CONSIDERED.**

**SO FOR OUR 100,000 NEWBORNS WE HAVE THEIR ESTIMATED AGGREGATE FUTURE PERSONS-YEARS OF 7,629,711 DIVIDED BY THOSE 100,000 NEWBORNS,**

**TO GET 76.3 YEARS OF EXPECTED (OR AVERAGE) FUTURE LIFE YEARS REMAINING.**

<table>
<thead>
<tr>
<th>(1) Age Interval ((x, x+1))</th>
<th>(2) Proportion Dying in the Interval</th>
<th>(3) Number Living at Age (x)</th>
<th>(4) Number Dying in Interval</th>
<th>(5) Fraction of Last Year of Life</th>
<th>(6) Number of Years Lived in Interval</th>
<th>(7) Total Number of Years Lived Beyond (x)</th>
<th>(8) Observed Expectation of Life at Age (x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>0.00556</td>
<td>100,000</td>
<td>556</td>
<td>0.48</td>
<td>99,722</td>
<td>7,629,711</td>
<td><strong>76.3</strong></td>
</tr>
<tr>
<td>1-2</td>
<td>0.00027</td>
<td>99,444</td>
<td>27</td>
<td>0.50</td>
<td>99,430</td>
<td>7,529,989</td>
<td>75.7</td>
</tr>
<tr>
<td>2-3</td>
<td>0.00033</td>
<td>99,417</td>
<td>33</td>
<td>0.50</td>
<td>99,400</td>
<td>7,430,559</td>
<td>74.7</td>
</tr>
<tr>
<td>.....</td>
<td>.....</td>
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<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
</tr>
<tr>
<td>60-61</td>
<td>0.01380</td>
<td>85,074</td>
<td>1,174</td>
<td>0.50</td>
<td>84,487</td>
<td>1,832,376</td>
<td>21.5</td>
</tr>
<tr>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
</tr>
<tr>
<td>99-100</td>
<td>0.29154</td>
<td>1,793</td>
<td>1,793</td>
<td>0.50</td>
<td>1,525</td>
<td>2,154</td>
<td>1.2</td>
</tr>
<tr>
<td>100 and over</td>
<td>1.00000</td>
<td>1,257</td>
<td>1,257</td>
<td>0.50</td>
<td>629</td>
<td>629</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Source: NYC DOHMH BVS
USUALLY WE ARE MOSTLY INTERESTED IN LIFE-EXPECTANCY AT BIRTH, WHICH IS THE FIRST AGE INTERVAL IN OUR LIFE-TABLE.

THE CURRENT SLIDE PRESENTS A GRAPHIC REPRESENTATION OF COUNTRY ESTIMATES OF LE AT BIRTH FOR 2008. PLEASE KEEP IN MIND THAT THIS SLIDE PRESENTS ESTIMATES AND ARE INTENDED AS A ROUGH PICTURE OF COMPARATIVE LE, SINCE THERE IS GREAT VARIANCE NOT ONLY IN HOW VITAL STATISTICS ARE COLLECTED ACROSS COUNTRIES BUT IN HOW THE MEASURE IS COMPUTED.

NOW IT’S IMPORTANT TO POINT OUT THE CRITICAL ROLE THAT INFANT MORTALITY AND PREMATURE DEATHS PLAY IN LIFE-EXPECTANCY AS FOR EXAMPLE THE DRAMATICALLY LOWER LE IN SUB-SAHARAN AFRICA.

COMPARED TO OTHER COUNTRIES THIS REGION HAS HIGHER INFANT MORTALITY RATES AND AIDS RELATED DEATHS RATES AFFECTING THE YOUNGER POPULATION WHICH IN TURN TRANSLATES INTO LOWER LE.

IN GENERAL PREMATURE DEATHS (THAT IS, PEOPLE WHO DIE RELATIVELY YOUNG) ADVERSELY AFFECT CHANGES IN LIFE EXPECTANCY AND THEREFORE OUR AGENCY’S EMPHASIS IN REDUCING PREVENTABLE DEATHS CAUSED BY FOR EXAMPLE: SMOKING, HOMICIDES AND OTHER RISK FACTORS.

WHAT IS CLEAR IS THAT BOTH LE AT BIRTH AND AT AGE 65 HAVE BEEN INCREASING CONSISTENTLY FOR THE US FOR THE LAST 50 PLUS YEARS.

NOTE THAT A BABY BORN IN 2007 HAD A LE OF CLOSE TO 78 YEARS WHEREAS A 65 YEAR OLD IN 2007 COULD EXPECT TO LIVE CLOSE TO 84.

THIS AGAIN UNDERSCORES HOW PREMATURE DEATHS IN GENERAL AND INFANT MORTALITY IN PARTICULAR CAN DRAMATICALLY IMPACT LE.

FINALLY THIS SLIDE REPORTS THE TRENDS OF LIFE EXPECTANCY AT BIRTH FOR NYC FROM 2000 TO 2008 BY SEX AND OVERALL.

AS YOU CAN SEE IN NYC FOR A BABY BORN IN 2008 (THE MOST RECENT YEAR AVAILABLE) THEIR LIFE EXPECTATION IS ESTIMATED AT 79.4 YEARS WHICH REPRESENTS APPROX. A 12 AND A QUARTER MONTHS INCREASE FROM LE IN 2000. THERE ARE HOWEVER SHARP DIFFERENCES DUE TO SEX.

A MALE BORN IN 2008 IS EXPECTED TO LIVE 76.3 YEARS WHEREAS A BABY GIRL BORN IN THE SAME YEAR HAS AN 82 YEARS LIFE EXPECTANCY, AN ALMOST 6 YEARS DIFFERENCE.

NEVERTHELESS WE CAN SEE THAT FOR THE TIME PERIOD THE TRENDS FOR LE HAVE EXPERIENCED UPWARD MOVEMENTS FOR NYC.

NOW, THERE IS IN THE LITERATURE AN ONGOING DEBATE AS TO WHETHER LE IS REACHING AN UPPER THRESHOLD AGAINST THOSE WHO ARGUE THAT THE SKY IS THE LIMIT; THE JURY IS CLEARLY STILL OUT.

IT IS REASONABLE THEN TO ASSUME, BARRING SOME CATASTROPHIC PANDEMIC, THAT LE WILL CONTINUE ON ITS UPWARD MOVEMENT AS BREAKTHROUGHS IN MEDICINE, THE LIFE-SCIENCES AND HEALTH SUPPORTING LIFE-STYLES TAKE HOLD.

PERSONALLY I’M VERY BULLISH ON NYC LIFE EXPECTANCY!
Summary

- Life-Expectancy is a forward looking measure of longevity from some chosen age that finds many applications in public health, industry, research and government.
- They are derived from life tables for single-age or broader age groups.
- Cohort life tables follow individuals from birth to death making them impractical for many applications.
- Current life tables focus on the mortality of a population at a point in time and are what NYC and the NCHS report.
- Infant and premature mortality can dramatically affect LE at birth.
- Improvements in life-expectancy at birth continue unabated in the US, especially in NYC.

1) LIFE-EXPECTANCY IS A FORWARD LOOKING MEASURE OF LONGEVITY FROM SOME CHOSEN AGE THAT FIND MANY APPLICATIONS IN PUBLIC HEALTH, INDUSTRY, RESEARCH AND GOVERNMENT

2) THEY ARE DERIVED FROM LIFE TABLES FOR SINGLE-AGE OR BROADER AGE GROUPS

3) COHORT LIFE TABLES FOLLOW INDIVIDUALS FROM BIRTH TO DEATH MAKING THEM IMPRACTICAL FOR MANY APPLICATIONS

4) CURRENT LIFE TABLES FOCUS ON THE MORTALITY OF A POPULATION AT A POINT IN TIME AND ARE WHAT NYC AND THE NCHS REPORT ON

5) INFANT AND PREMATURE MORTALITY CAN DRAMATICALLY AFFECT LE AT BIRTH

6) IMPROVEMENTS IN LIFE-EXPECTANCY AT BIRTH CONTINUE UNABATED IN THE US, ESPECIALLY IN NYC
I’D LIKE TO THANK ALL THE FOLLOWING, FOR THEIR HELPFUL COMMENTS, OBSERVATIONS AND ASSISTANCE IN THE PREPARATION OF THIS PRESENTATION.

THANK YOU ALL FOR YOUR KIND ATTENTION.
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