

Guide for Sub-County Assessment of Life Expectancy (SCALE)





Table of Contents

I. Executive Summary

II. Introduction

III. SCALE Project Description

- a. SCALE project goal
- b. SCALE Phase I project process and methods
- c. SCALE Phase II project description

IV. Standard Approaches for Calculating Life Expectancy

- a. Definition of life expectancy
- b. Overview of approaches considered to develop the life expectancy tool
 - i. Life tables
 - ii. Abridged life table
 - iii. Adjusted Chiang II methods
- c. Addressing small-area methodologic issues
 - i. Small populations/minimum population size
 - ii. Standard errors and confidence intervals (to be added)
 - iii. Zero cells
 - iv. Age 85+ year category
 - v. Populations (to be added)
- I. Method chosen

V. Step-by-Step Guide for Using the SEPHO Excel Tool

- a. Data required for using this tool
- b. Preparing the data
- c. SEPHO tool download
- d. Selecting a software: available options
- e. Geocoding mortality data
 - I. Geocoding definition
 - II. Software for geocoding.
 - III. After batch geocoding
 - IV. Methods to assign unmatched addresses

VI. Small-Area Life Expectancy Estimates in Action

- a. Case studies of small-area life expectancy estimates at the local level (why, how, what was gained/accomplished?)
 - I. Public Health, Seattle & King County

- II. Los Angeles County
- III. Others

VII. Once the Estimates are In: Interpreting and Using the Findings (to be added)

- a. Interpreting the findings
 - i. Special considerations
 - 1. Unique tracts
 - 2. Large facilities (airports, universities, large prisons)
 - 3. Facilities that impact life expectancy (retirement homes, neonatal hospitals)
 - 4. Mobility issues
 - 5. Standard errors and confidence Intervals
 - ii. Limitations of the tool
- b. Using the life expectancy estimates

Appendix A: Summary of Peer-Reviewed Literature (to be added)

I. Executive Summary

This **Sub-County Assessment of Life Expectancy** (SCALE) Guide is intended as a resource for public health practitioners and their partners working to identify, measure, and understand growing and persistent community level health disparities and catalyze collective actions to address the underlying causes. The Guide was inspired by the success of Public Health, Seattle & King County, the Los Angeles County Department of Health, and others, in drawing public attention to communities experiencing the largest health burdens by examining neighborhood level estimates of Life Expectancy (LE) at birth in the context of known behavioral, social, and environmental risk and protective factors.

Scaling these efforts across the United States can inform future research and focus attention of policy makers, legislators, and the public on underlying conditions that are immediately actionable. To advance this initiative, the Council of State and Territorial Epidemiologists (CSTE), Centers for Disease Control and Prevention (CDC), six state (Florida, Massachusetts, Maine, New York, Washington, and Wisconsin) and two local (Los Angeles County and Public Health, Seattle & King County) health departments reviewed existing literature and methods, identified software tools, and developed this draft Guide.

Examining Disparities in Life Expectancy

Life expectancy at birth is defined as the estimated number of years a newborn can expect to live if current age-specific death rates in that population remained the same over time [1]. This measure is particularly useful for examining community-level disparities because it reflects the impact of major illnesses and injuries and their underlying causes, enables direct comparisons across geographies and time, and is simpler and more intuitive to the public and policy makers than are other measures of death (e.g., standardized mortality ratios, age-adjusted mortality rates, and years of potential life lost) [2 -7].

The ultimate goal for the SCALE project is that sub-county–level life expectancy estimates will be available from every state and large local health department which will enable the public health community and their partners to:

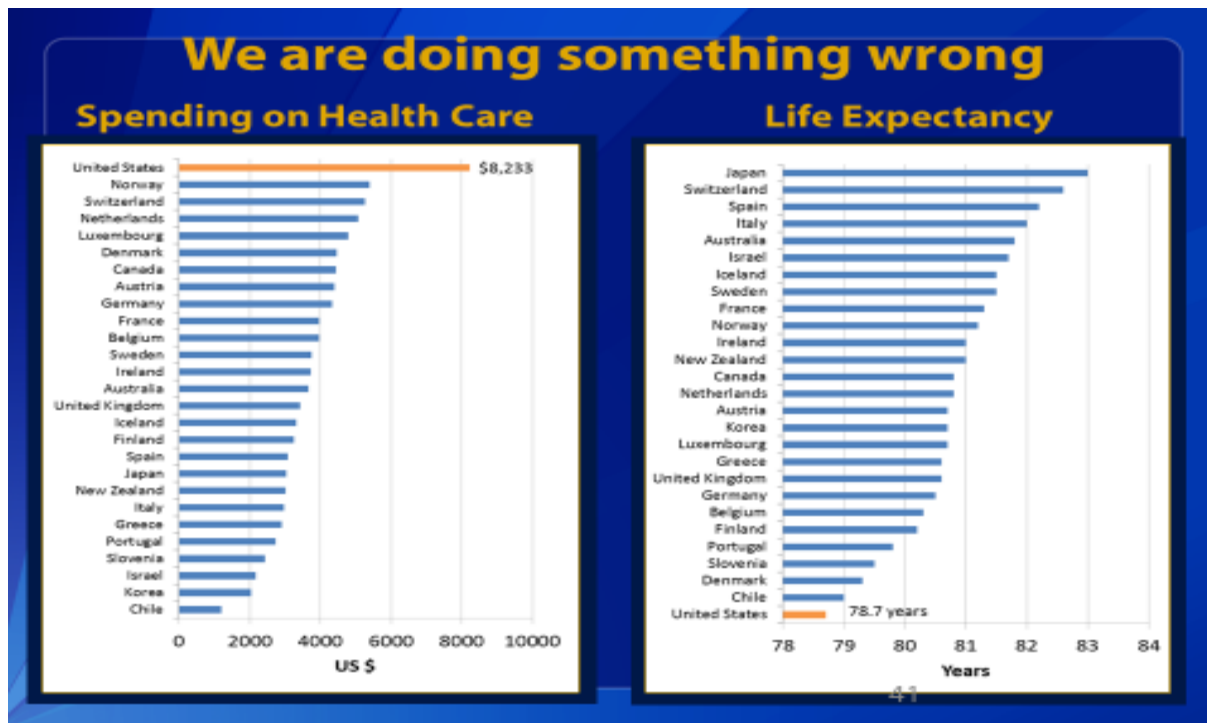
1. Identify and monitor community hot spots of health disparities.
2. Visually examine the degree to which life expectancy and associated contributing factors vary across populations and geographies.
3. Raise public awareness about the importance of place-based factors in creating health and health disparities including those not traditionally associated with public health (i.e., education, housing, transportation, community development, and employment).
4. Facilitate research on the relative contribution of specific behavioral, social, and environmental factors in creating health.
5. Catalyze multisector collaborations and empower communities to more effectively address upstream factors, reduce disparities, and improve community health.

II. Introduction

Disparities in Life Expectancy at the Country, County, and Local Levels

Disparities in life expectancy estimates between the United States and other countries in the context of health expenditures have attracted increasing attention during the past few years. In 2010, the United States ranked 40th for male and 39th for female life expectancy at birth among 187 countries [8] [9], even though the United States spends almost twice as much per capita on health care than does any other country (Figure 1) [9][10]. All Americans, even the most educated, affluent, and well-insured, live sicker lives than those in other developed countries [11 -14]. More disturbing, the gap appears to be widening. Comparisons of historical trends of life expectancy between the United States and other countries found that, since ranking seventh in life expectancy during the 1950s, the United States has dropped more than 25 places, with the most rapid relative declines occurring during the past three decades among women [12] [15]. According to a 2012 Annual Review of Public Health article, this lag in U.S. health status results from “structural factors related to inequality and conditions of early life” [9].

Figure 1: Health Care Spending and Life Expectancy, by Country



Results of multiple studies suggest the primary driver of poor relative national level performance is profound disparities in life expectancy across U.S. counties [15-17]. For example, life expectancy at birth in some top performing counties— females in Marin County, California (85.0 years) and Montgomery County, Maryland (84.9 years) and males in Fairfax County, Virginia (81.7 years), and Gunnison County, Colorado (81.7 years)—is comparable with life expectancy in countries where populations live the longest including Japan and Switzerland. In contrast, life expectancy estimates for males in McDowell County, West Virginia (63.9 years), and Bolivar County, Mississippi (65.0), and for females in Perry County, Kentucky (72.7), and Tunica County, Mississippi (73.4), were lower than

estimates for Algeria, Bangladesh, and Nicaragua [18]. Researchers from the Institute of Health Metrics and Evaluation have compared the U.S. estimate of life expectancy to the 10 best performing countries in the world and calculated the number of years it would take to achieve the calculated best estimate given the historical trend (Figure 2). Applying the same methodology, the researchers estimated the number of years each U.S. county is either ahead or behind the 10 countries with the highest life expectancy (Figure 3) [18]. Importantly, the top performing counties have seen steady gains over time, whereas estimated life expectancy in the worst performing counties have virtually stagnated over the past 25 years [19].

Figure 2: Historic and Projected Life Expectancy of the Longest-lived Countries, by Year, 1950 to 2050

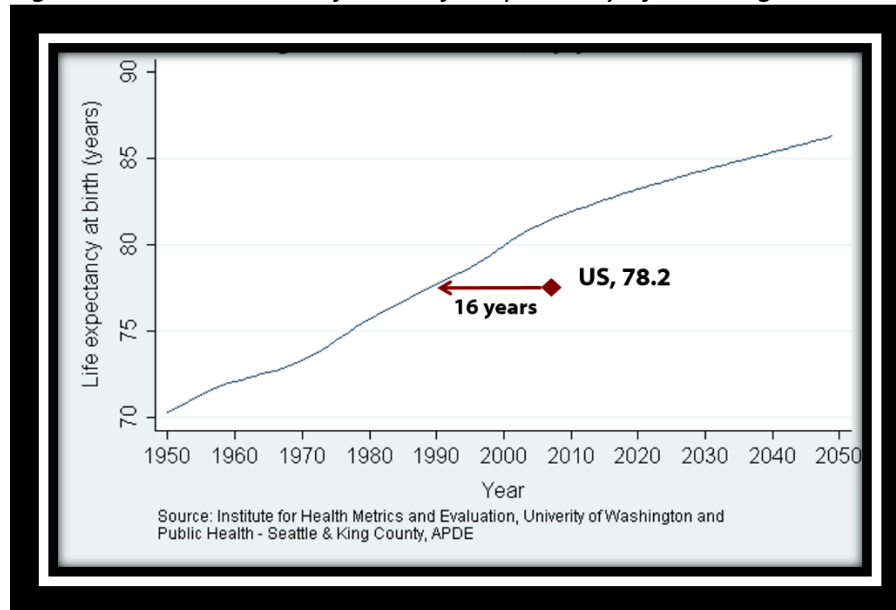
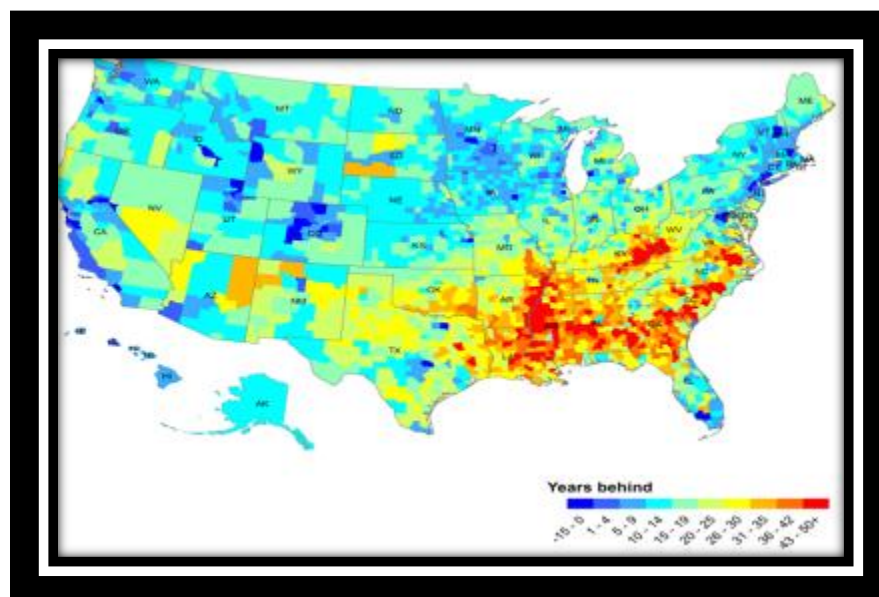


Figure 3: Life Expectancy by U.S. County and by the 10 Countries with the Highest Life Expectancy



Legislative and Public Attention

Similarly, the Robert Wood Johnson Foundation has generated public attention on community-level health disparities by funding a series of maps in 20 U.S. cities depicting dramatic differences in life expectancy. Figure 4 shows disparities by as much as 25 years within New Orleans.

New Orleans Life Expectancy

New Orleans, LA
*The average life expectancy for babies born to mothers in New Orleans can vary by as much as **25 years** across neighborhoods just a few miles apart.*

A map of New Orleans, Louisiana, illustrating the variation in life expectancy across different neighborhoods. The map uses colored circles to represent life expectancy ranges: blue for 80 years or more, orange for 66-79 years, red for 71-79 years, and purple for 55 years or less. Major highways like I-10, I-55, and US-90 are shown. The Mississippi River is visible on the right side. A scale bar at the bottom left indicates distances up to 10 miles.

Neighborhood	Life Expectancy Range (Years)
LAKELAND	80 YEARS OR MORE
FAIRBOURNE	80 YEARS OR MORE
SEVENTH WARD	66 YEARS
MAISON	66 YEARS
NEW ORLEANS, LOUISIANA	66 YEARS
MID CITY	66 YEARS
BERT TOWN	71 YEARS
TULANE SQUARE	71 YEARS
BLU COOPER	71 YEARS
BROADMOOR	71 YEARS
CENTRAL CITY	71 YEARS
FRENCH QUARTER	55 YEARS OR LESS
INDEPENDENCE	55 YEARS OR LESS
NEW ORLEANS	75 YEARS

Source: Robert Wood Johnson Foundation

Accessed from RWJF Website www.rwjf.org/en/about-rwjf/newsroom/features-and-articles/Commission/resources/city-maps.html

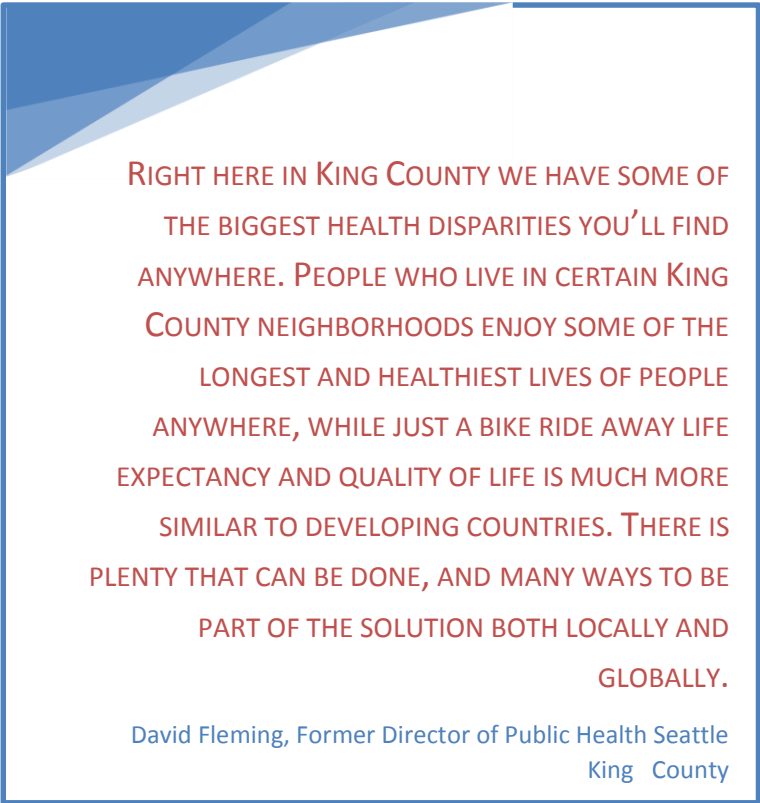
III. SCALE Project Description

In addition to the increased legislator and public attention to community-level health disparities, several recent developments have increased the demand for assessing and improving local population health. First, the voluntary public health accreditation standards, launched in 2011, require a comprehensive community health assessment and community improvement plan as prerequisites for state and local health departments seeking accreditation. Second, Section 9007 of the Affordable Care Act requires that the >3,000 nonprofit hospitals complete a community health needs assessment every 3 years and adopt an implementation strategy to meet identified needs. One specific requirement of the accreditation

standards and the Internal Revenue Service regulations is identification of and engagement with community members or their representatives from populations experiencing health disparities within their jurisdictions.

Several health departments have successfully used sub-county estimates of life expectancy at birth to identify and explore local hot spots of health disparities and to raise public awareness and catalyze multisector partnerships and collective actions. Case studies from 2 such health departments, Public Health—Seattle & King County and the Los Angeles County Department of Public Health are included in this Guide.

To address the needs of the nonprofit hospitals and to scale the successes demonstrated by these two large local health departments, in October 2014, the Centers for Disease Control and Prevention (CDC) and the Council of State and Territorial Epidemiologists (CSTE) recruited staff from Public Health—Seattle & King County and Los Angeles County Department of Public Health and six state health departments (Florida, Massachusetts, Maine, New York, Washington, and Wisconsin) for Phase I of a 3-year effort to develop resources and tools that could enable examination of neighborhood-level life expectancy in the United States in the context of known behavioral, social, and environmental risk and protective factors.



RIGHT HERE IN KING COUNTY WE HAVE SOME OF THE BIGGEST HEALTH DISPARITIES YOU'LL FIND ANYWHERE. PEOPLE WHO LIVE IN CERTAIN KING COUNTY NEIGHBORHOODS ENJOY SOME OF THE LONGEST AND HEALTHIEST LIVES OF PEOPLE ANYWHERE, WHILE JUST A BIKE RIDE AWAY LIFE EXPECTANCY AND QUALITY OF LIFE IS MUCH MORE SIMILAR TO DEVELOPING COUNTRIES. THERE IS PLENTY THAT CAN BE DONE, AND MANY WAYS TO BE PART OF THE SOLUTION BOTH LOCALLY AND GLOBALLY.

David Fleming, Former Director of Public Health Seattle
King County

SCALE Project Goal

The goal of the Sub-County Assessment of Life Expectancy (SCALE) project is to develop, pilot, and disseminate a stakeholder-driven, easy-to-use Guide for Calculating Life Expectancy Estimates at the Sub-County Level (The Guide).

The resulting census tract estimates and maps will enable the following future public health practice and research applications:

1. Identify and monitor community hot spots of health disparities.
2. Visually examine the degree to which life expectancy and associated contributing factors vary across populations and geographic locations.
3. Raise public awareness about the importance of place-based factors in creating health and health disparities including those not traditionally associated with public health (i.e., education, housing, transportation, community development, and employment)
4. Facilitate research on the relative contributions of specific behavioral, social, and environmental factors to life expectancy.
5. Catalyze multisector collaborations and empowered communities to more effectively address upstream determinants of health, reduce disparities, and improve community health.

SCALE Phase I Project Process and Methods

The SCALE project is divided into two phases. Phase I, which focused on development of this draft Guide and the associated software tools, was accomplished through a stakeholder-driven iterative process that brought together subject-matter experts with multidisciplinary representatives from public health agencies, including representative with expertise in epidemiology, community health, summary measures of population health, geospatial analysis and mapping, and small-area estimates and analysis. Activities in Phase I included the following:

- Development of project and project evaluation plan.
- Review and abstraction of the life expectancy methods literature.
- Selection of methods for Phase I.
- Calculation of comparable estimates by health departments.
- Collective review of calculation results.
 - Assessment of minimum population size
 - Assessment of census tracts with anomalies
- Finalization of Phase I draft Guide

SCALE Phase II Project Description

- **Pilot testing the draft Guide and tools from Phase I with new Pilot states and large localities**

The Phase I Workgroup recruited 25 states and localities to pilot test the draft Guide and tools developed in Phase I. An introduction webinar in late July 2015 explained the Phase II Pilot purpose and expectations; summarized the Phase I Workgroup process, decisions, and products; and distributed the draft Guide and software options to Pilot sites. Technical assistance will be provided to

the Phase II Pilot sites as needed. Monthly conference calls are being held to discuss issues, and Pilot site members are able to access a SharePoint site with resources. The Phase II Pilot will run until December 2015, and the Workgroup will collect feedback from the Pilot states and localities to incorporate into the draft Guide and software options in early 2016.

- **Visualization of life expectancy estimates**

From October 2015 until February 2016, CDC's Geospatial Research, Analysis, and Services Program (GRASP) will use best practices to develop options for maps of life expectancy estimates generated from the Phase I Workgroup. A consensus-based process, including GRASP and interested Phase I and II members, will be used to review the options and identify the final maps that will be available to health departments and the public. The final Guide, which should be available in June 2016, will include the process and rationale for selecting map options. A similar process will be used to identify the most effective public health messages.

- **Exploration of methods for expanding geographic coverage**

Estimates calculated from the SCALE Phase I method will be unstable below a certain population size. To expand the sub-county geographic coverage, SCALE Phase I and II Pilot participants will be invited to collaborate with CSTE and CDC beginning in October 2015 to explore the advantages and limitations of the following three methodologic options:

1. Geographic aggregation: combining contiguous census tracts with similar demographic characteristics until an adequate population is reached.
2. Temporal aggregation: expanding the number of years from the 5-year interval used for the Phase I Pilot to 7 or 10 years.
3. Bayesian or other small-area estimate methods: generating modeled life expectancy estimates using census tract information.

IV. Standard Approaches for Calculating Life Expectancy

Definition of Life Expectancy

Life expectancy (LE) is a summary mortality measure often used to describe the overall health status of a population. For any given population, life expectancy can be calculated at any age (e.g., birth, age 50 years, age 65 years). The SCALE project focuses on life expectancy at birth, which is defined as the estimated number of years a newborn can expect to live if current age-specific death rates in that population remained the same over time [1].

In the United States, life expectancy is a commonly used indicator of population health and health disparities. Because all states require deaths to be routinely and systematically reported, information from the death certificates (race/ethnicity, age, and address) can readily be used to calculate reliable and comparable life expectancy estimates.

Overview of approaches considered to develop the life expectancy tool

Several types of methods exist for estimating life expectancy. These include methods based on stable population concepts, biological theories of aging, estimation of population by age, regression equation methods that exploit the relationship between life expectancy and other demographic indices, construction of abridged life tables and methods that combine traditional complete life table construction techniques with smoothing or graduation methods [22] [Bravo and Malta 2010]. For Phase I, the SCALE Workgroup primarily focused on the abridged life table method.

Life Tables

A life table shows the probabilities of a member of a particular population who survives to or dies at a particular age or in a particular age group. In the United States, two types of life tables are used: the cohort (or generation) life table and the period (or current) life table. The cohort life table is based on age-specific death rates observed through consecutive calendar years and reflects the mortality experience of an *actual* cohort from birth until no one from the group is alive [23]. The period life table represents the mortality experience of a *hypothetical* birth cohort if it experienced throughout its entire life the mortality conditions of the period of interest. The period life table can be considered “a snapshot of current mortality experience and shows the long-range implications of a set of age-specific death rates that prevailed in a given year” [23].

CDC’s National Center for Health Statistics publishes complete period life tables annually at http://www.cdc.gov/nchs/products/life_tables.htm. Given the routine nature of a nationally published period life table, the Workgroup settled on using this as the basis for Phase I of the SCALE project.

Abridged Life Table

A *complete life table* contains data for every year of age, whereas an *abridged life table* typically contains data by 5- or 10-year age intervals. Phase I of the SCALE project uses abridged life table with 5-year age intervals except for the first interval, which is set at 0–1 year, and the last interval, which is defined as 85+ years, in recognition of the fact that sub-county geographies would have too many zeros using single ages. The abridged life table method can be used for any geographic area, including census tracts, ZIP codes, city boundaries, or other geopolitical units.

Adjusted Chiang II Methods

The long-established Chiang method for estimating life expectancy by using a period (current) life table has been widely used internationally [24] [7]. The Chiang method and its variations assume that deaths are spread evenly throughout each age period, except for persons <1 year of age, for whom deaths are highly skewed toward the first 28 days of life. For all other age groups, Chiang assumes a 0.5 age interval; the <1 group is valued at 0.1. One major concern about the Chiang method is age groups for which no deaths occur, which causes a miscalculation in standard error. Therefore, researchers have developed alternative methods to address this issue, including the Chiang II method and the adjusted Chiang II method [10].

The adjusted Chiang II method was proposed to modify the assumption in the Chiang I method of a zero variance for the final age band. The adjusted Chiang II method uses the formula by Silcocks to adjust for variance in the final age band [3].

Addressing small-area methodologic issues

Small Populations/Minimum Population Size

Several authors have examined the impact of small populations on life expectancy. Variations on the suggested minimum population size range from 3,750 to 7,000, and additional information can be found in Appendix A. Several researchers have suggested that life table estimates overestimate life expectancy for populations less than 5000 years of life at risk [1] [25] [26]. For the SCALE Phase I project, several Workgroup members are assessing the minimum population size for SCALE applications by generating estimates for all tracts, and examining standard error and special conditions of the tract to assess whether a unique feature of the tract (e.g., nursing home residents, incarcerated populations, university students) affected the life expectancy estimate. Others used an R-based tool to aggregate tracts to the minimum population size.

Standard error and confidence intervals

Because LE can be a tightly grouped dataset, determining a meaningful difference between LE ranges is important. Most of the reviewed papers did not discuss a specific standard error. The SCALE Phase I Workgroup settled on a standard error of ± 2 .

Zero Cells

Based on the population, population distribution, and death rates, zero cells can occur in age groups, especially when small geographic units, such as census tract, are used. Depending on the method used, this can impact the results generated. A zero death count gives an estimate of zero for an age interval, which causes underestimation of the variation; the more zeros and the more underestimation that occur, the larger the underestimation of standard error [25]. Several corrections have been suggested to address the concern, including small substitutions of values for zero and expected numbers of deaths [1] [7] [23] [25].

Age 85+ Year Category

A death count of zero in the 85+ year age category would strongly affect life expectancy because the Chiang calculation would give the cohort an infinite survival, raising the life expectancy estimate and

standard error. Several suggested corrections can be used: a national death rate for the country [29] or a national age-specific death rate for the country [7] [25].

Populations

Routinely generated population estimates occur from such entities as the National Center for Health Statistics (NCHS), but only on a county-wide level. Many Workgroup participants did not have access to sub-county population estimates, and therefore, the 2010 Census data was chosen as a mid-point for LE.

Method Chosen

The Phase I SCALE Workgroup chose the adjusted Chiang II method because 1) it adjusts for the variance in the final age band and 2) it addresses age bands with zero deaths.

Simulation results also suggested that use of the adjusted Chiang II method provides the closest approximations to reference life expectancy and standard errors by not imputing any values into age groups with zero deaths [1].

An environmental scan of tools by the Workgroup led to discovery of an existing Life Expectancy Tool, created by the South East England Public Health Observatory (SEPHO) group (<http://www.sepho.org.uk/viewResource.aspx?id=6626>). This tool, which also uses an adjusted Chiang II method, is well documented. The Workgroup extensively tested and validated SAS® (SAS Institute Inc. Cary, NC, USA.), Stata (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX, USA: StataCorp LP.), and an in-house Excel tool for calculation of life expectancy. Given the extensive documentation of the SEPHO tool, similarities between results, ease of use, and accessibility, the Workgroup unanimously recommended it as a tool for SCALE Phase I but also plan to make the SAS and Stata tools available as well.

V. Step-by-Step Guide for Using the SEPHO Excel tool

Data Required for Using this Tool

Two types of data are needed: death certificate data, geocoded to the desired sub-county geography (ZIP code, tract, city) and population estimates for the same geographic area, both broken down into 19 age groups (<1, 1–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85+).

Preparing the data

The data (number of deaths and number of populations) need to be arranged in the 19 age groups listed above. This fits the abridged life table format.

For multiple small areas, there should be two spreadsheets: one each for the number of deaths and the number of populations. In each spreadsheet, each row represents a small area, and each column represents an age group.

An area code (or area identifier) is required to calculate life expectancy for individual areas.

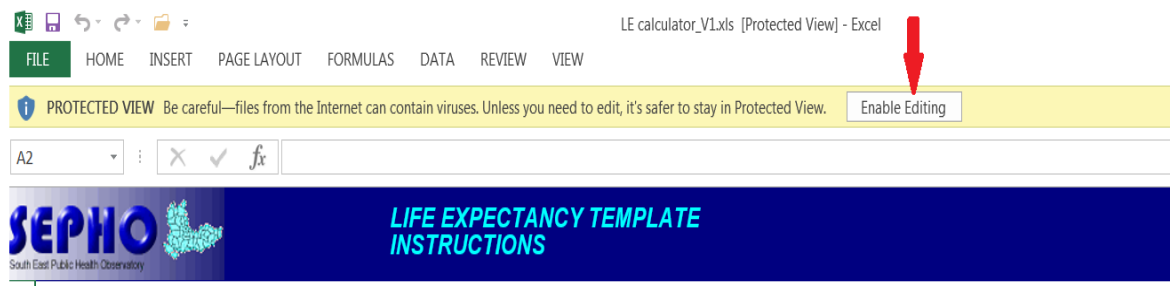
SEPHO tool Download

1. Download the SEPHO tool from

<http://www.sepho.org.uk/viewresource.aspx?id=8943>.

2. Open the file (Life Expectancy calculator_V1.xls)

If this is the first time you are opening the file, depending on the security setting of your Microsoft Office, you might need to click “Enable Editing” (to which the red arrow pointed).



The screenshot shows the Excel interface for the 'LE calculator_V1.xls' file. The ribbon includes FILE, HOME, INSERT, PAGE LAYOUT, FORMULAS, DATA, REVIEW, and VIEW. A yellow warning bar at the top states: 'PROTECTED VIEW Be careful—files from the Internet can contain viruses. Unless you need to edit, it's safer to stay in Protected View.' A red arrow points to the 'Enable Editing' button on the right side of this bar. Below the bar, the formula bar shows 'A2'. The main content area has a blue header with the SEPHO logo and the text 'LIFE EXPECTANCY TEMPLATE INSTRUCTIONS'. Below this, there is a table of contents with links to 'Technical Notes' and 'Life Table - Single Area'. The 'Life Table - Multiple Areas' section lists various metrics: Deaths, Population Years At Risk, Death Rate In Interval, Interval Width, Fraction of Last Age Interval Of Life, Probability Of Dying In Interval, Probability Of Surviving Interval, Number Alive At Start Of Interval, Number Dying In Interval, Number Of Years Lived In Interval, Total Number Of Years Lived, Life Expectancy At Start Of Interval, and Variance Of Proportion Surviving In Interval. To the right of these links, there is a 'Notes' section. The first note states: 'This file contains two templates for calculating life expectancy: The first consists of one worksheet and demonstrates a life table for a single area (Life Table - Single Area). The second consists of multiple worksheets which apply the life table methodology to producing life expectancies for multiple areas (Life Table - Multiple Areas). The final life expectancy figures produced using the multiple areas template can be found on the sheet 'Summary'. On this sheet it is possible to select life expectancy figures either at birth, or at different age intervals.' The second note states: 'The calculator will automatically prompt the user to insert additional rows to enable figures to be calculated for multiple small areas. This will occur whenever the spreadsheet is opened with macros enabled and with only one small area row.' The third note states: 'This process can be bypassed by disabling macros on opening the spreadsheet, and will not occur for spreadsheets which have been saved with more than one small area row.'

Technical Notes

Life Table - Single Area

Life Table - Multiple Areas

- Deaths
- Population Years At Risk
- Death Rate In Interval
- Interval Width
- Fraction of Last Age Interval Of Life
- Probability Of Dying In Interval
- Probability Of Surviving Interval
- Number Alive At Start Of Interval
- Number Dying In Interval
- Number Of Years Lived In Interval
- Total Number Of Years Lived
- Life Expectancy At Start Of Interval
- Variance Of Proportion Surviving In Interval

Notes:

This file contains two templates for calculating life expectancy:

The first consists of one worksheet and demonstrates a life table for a single area (*Life Table - Single Area*). The second consists of multiple worksheets which apply the life table methodology to producing life expectancies for multiple areas (*Life Table - Multiple Areas*).

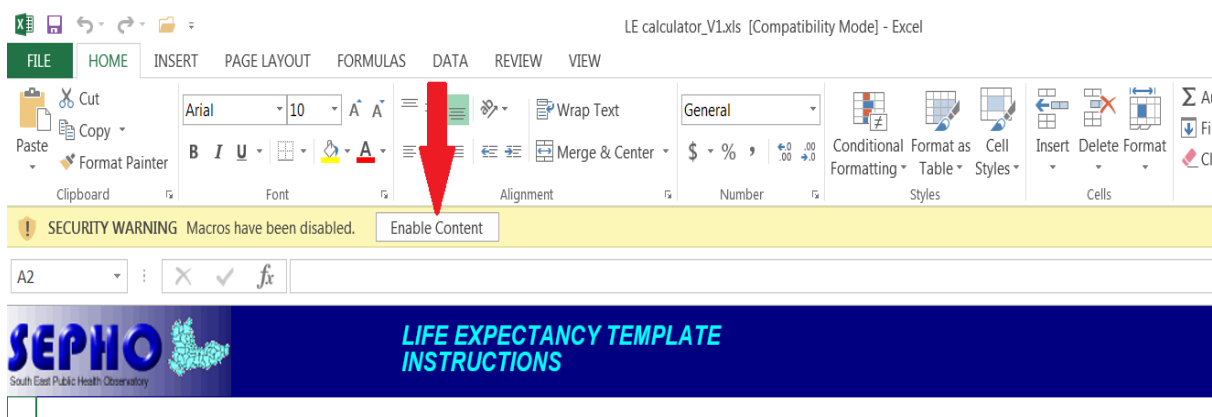
Use the links on the left to jump to each worksheet and follow the instructions to add your own data to the areas shaded in light blue on sheets 'Deaths' and 'Pops' for multiple areas and to the 'LifeTable' sheet for calculation of a single area.

The final life expectancy figures produced using the multiple areas template can be found on the sheet 'Summary'. On this sheet it is possible to select life expectancy figures either at birth, or at different age intervals.

The calculator will automatically prompt the user to insert additional rows to enable figures to be calculated for multiple small areas. This will occur whenever the spreadsheet is opened with macros enabled and with only one small area row.

This process can be bypassed by disabling macros on opening the spreadsheet, and will not occur for spreadsheets which have been saved with more than one small area row.

Again, depending on the security settings of your Microsoft Excel, you might need to enable the Macro by clicking “Enable Content” (where the red arrow points).



[Technical Notes](#)

[Life Table - Single Area](#)

Life Table - Multiple Areas

[Deaths](#)

[Population Years At Risk](#)

[Death Rate In Interval](#)

[Interval Width](#)

[Fraction of Last Age Interval Of Life](#)

[Probability Of Dying In Interval](#)

[Probability Of Surviving Interval](#)

[Number Alive At Start Of Interval](#)

[Number Dying In Interval](#)

[Number Of Years Lived in Interval](#)

[Total Number Of Years Lived](#)

[Life Expectancy At Start Of Interval](#)

[Variance Of Proportion Surviving In Interval](#)

[Weighted Variance Of Proportion Surviving](#)

This file contains two templates for calculating life expectancy:

The first consists of one worksheet and demonstrates a life table for a single area (*Life Table - Single Area*). The second consists of multiple worksheets which apply the life table methodology to producing life expectancies for multiple areas (*Life Table - Multiple Areas*).

Use the links on the left to jump to each worksheet and follow the instructions to add your own data to the areas shaded in light blue on sheets 'Deaths' and 'Pops' for multiple areas and to the 'LifeTable' sheet for calculation of a single area.

The final life expectancy figures produced using the multiple areas template can be found on the sheet 'Summary'. On this sheet it is possible to select life expectancy figures either at birth, or at different age intervals.

Notes:

The calculator will automatically prompt the user to insert additional rows to enable figures to be calculated for multiple small areas. This will occur whenever the spreadsheet is opened with macros enabled and with only one small area row.

This process can be bypassed by disabling macros on opening the spreadsheet, and will not occur for spreadsheets which have been saved with more than one small area row.

It is possible to insert small areas manually - select all 17 sheets from 'Deaths' to 'Summary', copy the entire row 15

3. A dialog box titled “SEPHO small area life expectancy calculator” will pop out requesting that the user “[E]nter the number of small areas (e.g., electoral wards) you require in your calculator.” Put in the number of small areas in the box below.
4. Copy the numbers of death by age group to the “Deaths” spreadsheet (if the spreadsheet is not shown, click the right arrow on the bottom left corner to show the “Deaths” spreadsheet). Copy the number of population by age group to the “Pops.”
5. Note that the column “Area code” is required for calculating life expectancy and standard errors at the individual area level. If the area code is not provided, the life expectancy and standard error will be calculated for the aggregation but not for the individual areas.
6. Results will be displayed on the spreadsheet “Summary.” Intermediate results are displayed as well with Life Expectancy at Start of Age interval displayed on spreadsheet “e.”
7. To calculate life table for a single area, copy and paste your data on to the spreadsheet “LifeTable,” results will be displayed on columns “P, U,V,W” for the point estimate of the life expectancy at the start of the age interval, sample standard error, lower bound of the 95% confidence interval, and upper bound of the 95% confidence interval.

More details are available at <http://www.sepho.org.uk/viewResource.aspx?id=8943>

Selecting a Software: Available Options

For a jurisdiction wishing to use a SAS- or Stata-based tool for calculating life expectancy, CDC has a SharePoint site hosting language used for testing purposes and for which limited technical assistance is available. Numerator and denominator data need to be created as described above for the SEPHO tool.

Geocoding Mortality Data

Geocoding definition

Geocoding is the process by which descriptors (e.g., address, city, ZIP code, province) are assigned a place on a map, also known as a geospatial location, creating a georeferenced dataset. Although this section is not designed to be a comprehensive tutorial, it will provide some links for additional information and best practices

(http://naaccr.org/LinkClick.aspx?fileticket=ZKekM8k_IQ0%3d&tabid=239&mid=699). For the SCALE project, geocoding will be the assignment of address information from a death certificate to a 2010 census tract. Because this project is examining geographic disparities in life expectancy, geocoding data is essential to examination of sub-county life expectancy estimates.

Software for geocoding

Several different software options are available for batch geocoding, i.e., when the datasets are processed through and assigned to a geolocation automatically. Any geographic information system (GIS) will have geocoding options. ArcGIS, from ESRI, is one. States that participate in the CDC Building

GIS Capacity for Chronic Disease Surveillance

(http://www.cdc.gov/dhdsp/programs/gis_training/index.htm) should have access to the software.

A geocoding tutorial is accessible on the Web:

<http://help.arcgis.com/en/arcgisdesktop/10.0/pdf/geocoding-tutorial.pdf>.

Google Earth has geocoding capability as well, although it is helpful for the user to know HTML and JavaScript. It requires signing up for Google Earth and getting an API. Tutorial is here. Free API is limited to 2,500 queries a day. http://opengeocode.org/tutorials/googlemap/googlemaps_1.php

Some analytic software packages, such as SAS and R, also have geocoding tools. SAS/GRAPH uses a proc geocode

(<http://support.sas.com/documentation/cdl/en/graphref/63022/HTML/default/viewer.htm#a003121448.htm>) and R has a package on CRAN <http://www.inside-r.org/packages/cran/ggmap/docs/geocode>.

This uses the Google Earth API, but other packages also can be used.

After batch geocoding

No dataset can match all addresses to a location. Exceptions can result from an incorrect street number, misspelling of a street, incorrect post office box, name of building instead of street, incorrect directional mismatch between ZIP code and street, or an incorrect underlying street layer. These exceptions should be manually reviewed and matched when possible. A geocoding match of $\geq 90\%$ is ideal.

Methods to assign unmatched addresses

Addresses that remain unmatched after review can be handled one of two ways. They can be treated as missing, if there is non-differential classification (i.e., if the unmatched cases are similar to the matched cases in terms of demographics) or they can be randomly assigned.

VI. Small-Area Life Expectancy Estimates in Action

Case Studies

Public Health, Seattle & King County

King County, home to 2.1 million residents and 39 cities, is the most populous county in Washington State. Home to businesses such as Microsoft, Amazon, Weyhauser, and sporting other technology hubs, King County health outcomes and risk behaviors tend to compare favorably to other counties; however, health equity work has shown the high performing county rate masks large disparities in health [27]. In 2012, Public Health, Seattle & King County calculated LE at a census tract level for the 398 tracts in King County to begin examining place-based disparities. The 5-year estimates showed a range of 30 years (after suppression of unreliable rates), with a low of 66 years and a high of 96 years. The overall King County LE was 81.6 years. This led to questions about how additional health behaviors and health outcomes would look at a similar geography, and PHSKC embarked on a small area estimation project that showed a consistent pattern of disparities. This work was presented in 2013 at a Federal Reserve Bank meeting, culminating in a place-based initiative called Communities of Opportunity (COO), a public-private partnership with the Seattle Foundation and Living Cities, and is a cross-divisional initiative with PHSKC and the Department of Community and Human Services (DCHS) in King County. COO's goals of improved race, health, and socio-economic equity in King County are rooted in the community, using a collective impact framework that allows the community to shape their own solutions. The COO project is also aligned within the King County Accountable Community of Health.

Los Angeles County

In 2009, the Los Angeles County Department of Public Health (LACDPH) calculated life expectancy at birth for 103 cities and communities within the County. In earlier analyses, large and persistent disparities in life expectancy had been observed, and the LACDPH recognized that there was a need to bring increased attention to addressing the underlying social and physical determinants of health in order to make progress in narrowing these disparities. The County's cities and unincorporated communities were viewed as important partners in this effort, and it was hoped that examining life expectancy at the city and community level would bring increased attention and engagement.

Life expectancy across cities and communities varied widely, ranging from 72.4 years to 87.6 years, and was strongly correlated with community-level economic hardship. Cities/communities were ranked by life expectancy and by economic hardship, and this information was published in a report that was published and broadly disseminated to the general public and to city mayors, councilmembers, and city planners, as well as other public health stakeholders. The information resulted in increased engagement with communities, local governments, policymakers, city planners, and other sectors; it also increased recognition of the important impacts of the physical and social environments on health.

REFERENCES

1. Toson, B. and A. Baker, *Life expectancy at birth: methodological options for small populations*. National statistics methodological series, 2003. **33**.
2. Los Angeles Department of Public Health, O.o.H.A.a.E., *Life Expectancy in LA County: How long do we live and why? A cities and community report*. . 2010.
3. Silcocks, P.B.S., D.A. Jenner, and R. Reza, *Life expectancy as a summary of mortality in a population: statistical considerations and suitability for use by health authorities*. Journal of Epidemiology and Community Health, 2001. **55**(1): p. 38-43.
4. Jonker, M.F., et al., *The impact of nursing homes on small-area life expectancies*. Health & Place, 2013. **19**(0): p. 25-32.
5. Harper, S., R. MacLehose, and J. Kaufman, *Trends in the black-white life expectancy gap among US states, 1990-2009*. Health affairs, 2014. **33**(8): p. 1375-82.
6. Adam Smith, J., S. Harper, and N. Auger, *Causes of widening life expectancy inequalities in Québec, Canada, 1989-2004*. Canadian Journal of Public Health, 2011. **102**(5): p. 375-81.
7. Stephens, A.S., et al., *Life expectancy estimation in small administrative areas with non-uniform population sizes: application to Australian New South Wales local government areas*. BMJ open, 2013. **3**(12): p. e003710-e003710.
8. Wang, H., et al., *Age-specific and sex-specific mortality in 187 countries, 1970-2010: a systematic analysis for the Global Burden of Disease Study 2010*. Lancet (London, England), 2012. **380**(9859): p. 2071-94.
9. Avendano, M. and I. Kawachi, *Why do Americans have shorter life expectancy and worse health than do people in other high-income countries?* Annual review of public health, 2014. **35**: p. 307-25.
10. Syme, S.L., *Reducing racial and social-class inequalities in health: the need for a new approach*. Health affairs, 2008. **27**(2): p. 456-9.
11. Banks, J., et al., *Disease and disadvantage in the United States and in England*. JAMA: the Journal of the American Medical Association, 2006. **295**(17): p. 2037-45.
12. Bezruchka, S., *The Hurrier I Go the Behinder I Get: The Deteriorating International Ranking of U.S. Health Status*. Annual review of public health, 2012. **33**(1): p. 157-173.
13. Squires, D., *The global slowdown in health care spending growth*. JAMA: the Journal of the American Medical Association, 2014. **312**(5): p. 485-6.
14. Woolf, S.H. and P. Braveman, *Where health disparities begin: the role of social and economic determinants--and why current policies may make matters worse*. Health Affairs, 2011. **30**(10): p. 1852-9.
15. Ezzati, M., et al., *The reversal of fortunes: trends in county mortality and cross-county mortality disparities in the United States*. PLoS Medicine, 2008. **5**(4): p. e66.
16. Murray, C.J.L., et al., *Eight Americas: investigating mortality disparities across races, counties, and race-counties in the United States*. PLoS Medicine, 2006. **3**(9): p. e260.
17. Cullen, M., C. Cummins, and V. Fuchs, *Geographic and racial variation in premature mortality in the U.S.: analyzing the disparities*. PLoS ONE, 2012. **7**(4): p. e32930.
18. Wang, H., et al., *Left behind: widening disparities for males and females in US county life expectancy, 1985-2010*. Population Health Metrics, 2013. **11**(1): p. 8.
19. *Measuring the Risks and Causes of Premature Death: Summary of Workshops*. 2015, Washington DC: 2015 by the National Academy of Sciences.
20. Hunt, B., G. Tran, and S. Whitman, *Life Expectancy Varies in Local Communities in Chicago: Racial and Spatial Disparities and Correlates*. Journal of Racial and Ethnic Health Disparities, 2015: p. 1-9.

21. Chen, J., et al., *Mapping and measuring social disparities in premature mortality: the impact of census tract poverty within and across Boston neighborhoods, 1999-2001*. Journal of urban health, 2006. **83**(6): p. 1063-84.
22. Chiang, C.L., *A stochastic study of the life table and its applications. II. Sample variance of the observed expectation of life and other biometric functions*. Human biology, 1960. **32**: p. 221-238.
23. Arias, E., *United States life tables, 2008*. National vital statistics reports, 2012. **61**(3): p. 1-64.
24. Chang, C.L., *Introduction to stochastic processes in biostatistics*. 1968.
25. Eayres, D. and E.S. Williams, *Evaluation of methodologies for small area life expectancy estimation*. Journal of epidemiology and community health, 2004. **58**(3): p. 243-9.
26. Scherbov, S. and D. Ediev, *Significance of life table estimates for small populations: Simulation-based study of estimation errors*. Demographic Research, 2011. **24**: p. 527-550.
27. King County Equity and Social Justice Annual Report, November 2014.
<http://www.kingcounty.gov/elected/executive/equity-social-justice.aspx>, last checked 10/2015.