Inequalities and deterioration in average lifespan among adults in Mexico, 1990-2015:A retrospective demographic cause-of-death analysis

José Manuel Aburto[1], Tim Riffe[2], and Vladimir Canudas-Romo[3]

[1]University of Southern Denmark
[2]Max Planck Institute for Demographic Research
[3]School of Demography, Australian National University

May 3, 2018

Abstract

Objective: To quantify the effect of medically amenable conditions, diabetes, ischemic heart diseases, lung cancer, cirrhosis, suicides, homicides and road traffic accidents on longevity in Mexico during 1990-2015. Design: Retrospective demographic analysis using publicly available aggregated data.

Setting: Vital statistics from the Mexican civil registration system. Participants: Aggregated national data (from 91.2 million people in 1995 to 119.9 million in 2015) grouped in 64 populations (32 Mexican-states by sex) with data on causes of death.

Main outcome measures: Cause-specific contributions to the gap in life expectancy in three age groups (0-14, 15-49 and 50-84) with a low-mortality benchmark based on the lowest observed mortality in Mexico.

Results: The population below age 15 shows improvements in survival. Average survival below 15 over states was 14.82 (95% confidence interval, 14.76 to 14.88) and 14.78 years (14.70 to 14.86) in 2015, for females and males respectively. However, the adult population aged 15 to 49 shows deterioration among males after 2006 in almost every state due to an increase in homicides and a slow recovery thereafter. Out of 35 potential years, females and males live on average 34.57 (34.48 to 34.67) and 33.80 (33.34 to 34.27), respectively. Adults aged 50 to 84 show an unexpected decrease in the low mortality benchmark, indicating nationwide deterioration in both females and males with average survival of 28.59 (27.43 to 29.75) and 26.52 (25.33 to 27.73) out of 35, respectively. State gaps from the benchmark were mainly caused by ischemic heart diseases, diabetes, cirrhosis and homicides. We find large health disparities between states, particularly for the adult population after 2005.

Conclusions: Mexico has succeeded in reducing mortality and between-state inequalities in children. However, the adult population is becoming vulnerable as it has not been able to reduce the burden of conditions amenable to health services and violence. This has led to large health disparities between Mexican states in the last 25 years.

Supplemental material

Appendix Table 1. Definitions of cause-of-death categories using the 9th and 10th revision of the International Classification of Diseases.

Category	ICD-10	ICD-9
I. Amenable to medical service		
I.A. AM-Infectious & respiratory diseases : intestinal infections, tuberculosis, zoonotic bacterial diseases, other bacterial diseases, septicemia, poliomyelitis, measles, rubella, infectious hepatitis, ornithosis, rickettsioses/ arthropod-borne, syphilis (all forms), yaws, respiratory diseases, influenza & pneumonia, chronic lower respiratory diseases	A00-A09, A16-A19, B90, A20-A26, A28, A32, A33, A35, A36, A37, A40-A41, A80, B05-B06, B15-B19, A70, A68, A75, A77, A50-A64, A66, J00-J08, J20-J39, J60-J99, J09-J18, J40-J47	001-009, 010-018, 32, 33, 37, 137, 020-027, 38, 45, 55-56, 70, 73, 080-082, 087, 090-099, 102, 460-479, 500-519, 480-488, 490-496
I.B. AM-Cancers: malignant neoplasm of colon, skin, breast, cervix, prostate, testis, bladder, kidney-Wilm's tumor only, eye, thyroid carcinoma, Hodgkins disease, leukemia	C16,C18-C21, C43-C44, C50, C53, C61, C62, C67, C64, C69, C73, C81, C91-C95	153-154, 172-173, 174, 180, 185, 186, 188-189, 190, 193, 201, 204-208
I.C. AM-Circulatory: active/acute rheumatic fever, chronic rheumatic heart disease, hypertensive disease, cerebrovascular disease	I00-I02, I05-I09, I10-I13, I15, I60-I69	390-392, 393-398, 401-405, 430-438
I.D. AM-Birth: maternal deaths (all), congenital cardiovascular anomalies, perinatal deaths (excluding stillbirths)	O00-O99, Q20-Q28, P00-P96	630-676, 745-747, 760-779
I.E. AM-Other: disease of thyroid, epilepsy, peptic ulcer, appendicitis, abdominal hernia, cholelithiasis & cholecystitis, nephritis, benign prostatic hyperplasia, misadventures to patients during surgical or medical care, cisticerchosis	E00-E07, 40-G41, K25-K27, K35-K38, K40-K46, K80-K81, N00-N07, N17-N19, N25-N27, N40, Y60-Y69, Y83-Y84, B69	240-246, 345, 531-533, 540-543, 550-553, 574-575.1, 580-589, 600, E870-E876, E878-E879
II. Diabetes	E10-E14	250
III. Ischemic Heart Diseases (IHD)	I20-I25	410-414, 429.2
IV. Lung cancer	C33-C34	162
V. Cirrhosis	K70	571.1-571.3
VI. Homicides	X85-Y09	E960-E969
VII. Road traffic accidents	V01-V99	E810-E819
VIII. Suicide and self-inflicted injuries	E950-E959	X60-X84, Y87.0
IX. Residual Causes : HIV/AIDS; other cancers and other heart diseases	B20-B24, U03; C00-D48; I00-I99 if not listed above; R00-R99	042-044;140-239; 390-459 if not listed above; 780-799

Temporary Life Expectancy

Temporary life expectancy between ages x_1 and x_2, for $x_1 < x_2$, is defined as the average years of life lived between these ages according to a given set of mortality rates (Arriaga 1984). We denote this quantity as ${}_{(x_2-x_1)}e_{x_1}$, and its benchmark based on minimum death rates for every age and cause of death among the Mexican states for each year as ${}_{(x_2-x_1)}e^{\star}_{x_1}$. Defined in terms of the lifetable survival function, $\ell(x)$:

$$ {}_{(x_2-x_1)}e_{x_1} = \frac{\int_{x_1}^{x_2} \ell(x)\,\mathrm{d}x}{\ell(x_1)} \tag{1} $$

If full survival is achieved, the life expectancy is $x_2 - x_1$. For example, if we set $x_1 = 0$ and $x_2 = 15$, and no person dies between the ages 0 and 15, on average the population lives 15 full years.

Decomposition method

The decomposition method used in this paper relies on a model of demographic functions based on continuous change (Horiuchi et al. 2008). Suppose P (e.g. temporary life expectancy between ages 15 and 49) is a differentiable function of n covariates (e.g. each age-cause specific mortality rate) denoted by the vector $\boldsymbol{A} = [x_1, x_2, \ldots, x_n]^T$. We assume that $\boldsymbol{A}$ is a differentiable function between P_1 and P_2, then the difference in P between P_1 and P_2 can be expressed as follows:

$$ P_2 - P_1 = \sum_{i=1}^{n} \int_{x_i(P_1)}^{x_i(P_2)} \frac{\partial P}{\partial x_i} dx_i = \sum_{i=1}^{n} c_i, \tag{2} $$

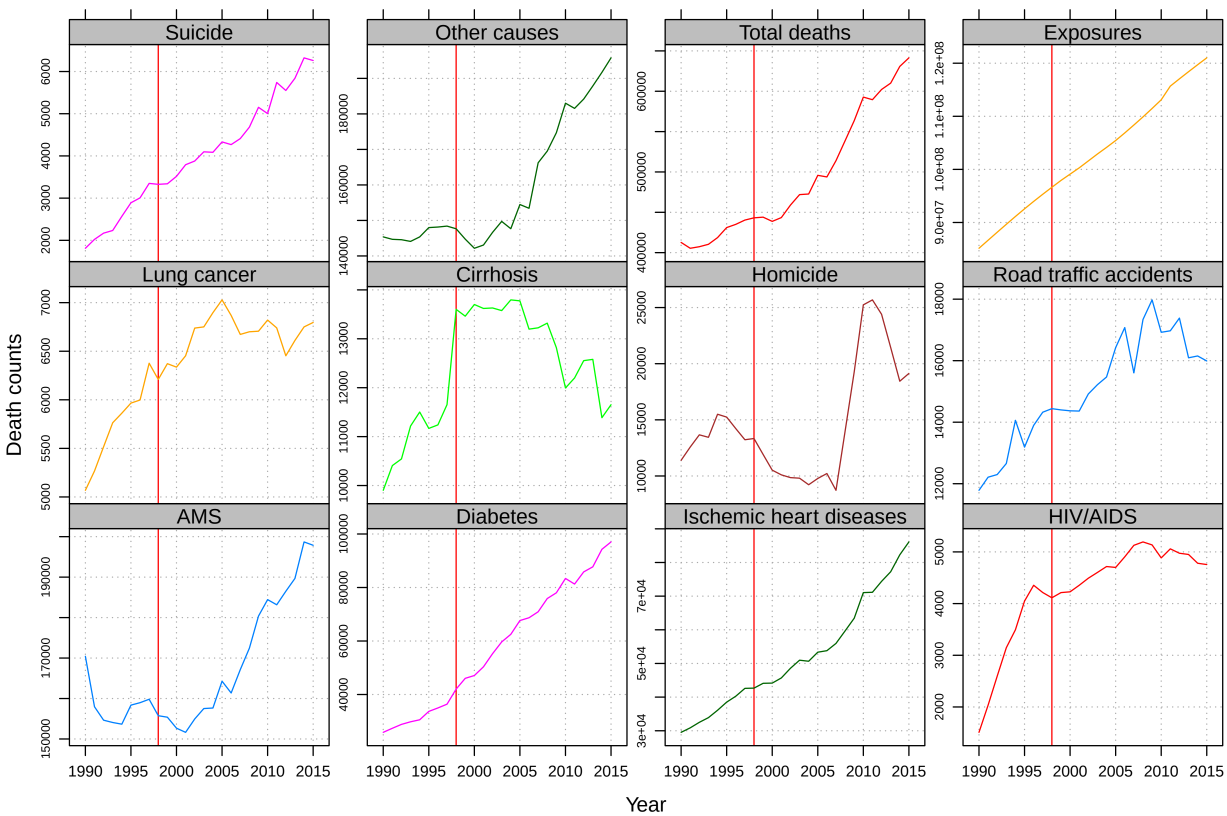
where c_i is the total change in P produced by changes in the i-th covariate, x_i. The c_i's in equation (2) were computed by numerical integration following the algorithm suggested by Horiuchi et al. (2008). This method has the advantage of assuming that covariates change gradually along the time dimension.

References

Arriaga, E. E. (1984). Measuring and explaining the change in life expectancies. *Demography*, 21(1):83–96.

Horiuchi, S., Wilmoth, J. R., and Pletcher, S. D. (2008). A decomposition method based on a model of continuous change. *Demography*, 45(4):785–801.

Figure 1: Cause-specific death counts (different y-scale for each cause), 1990-2010.



Note: AMS "amenable to medical service". The red line indicates the change from ICD 9 to ICD 10.

Figure 2: Inequality in life expectancy between states for youngest (0-14), young adults (15-49), and older adults (50-84) by sex, 1990-2015.

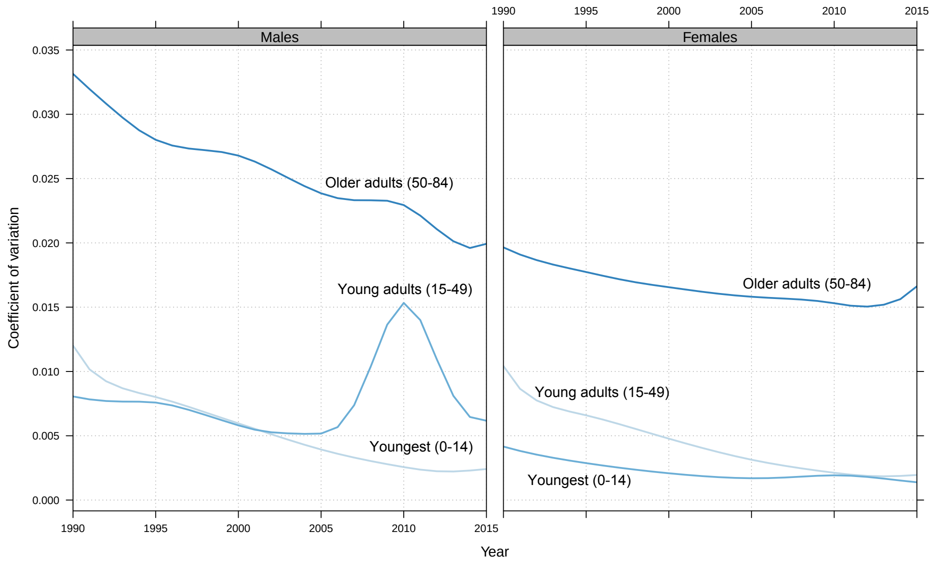
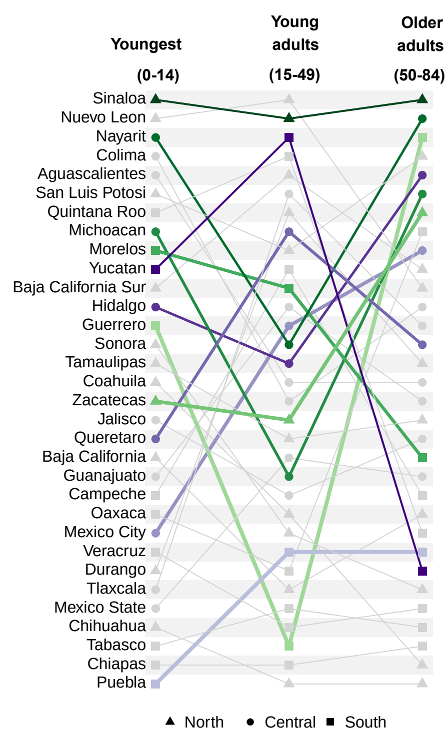
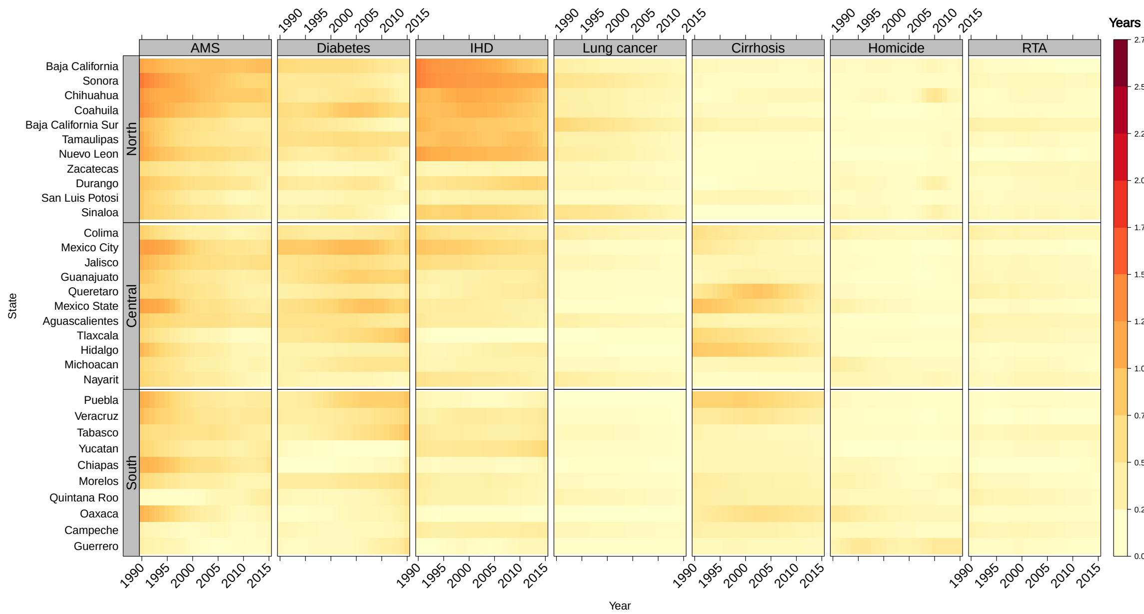


Figure 3: State ranking for average female life expectancy 2010-15 for the youngest (0-14), young adults (15-49), and older adults (50-84).



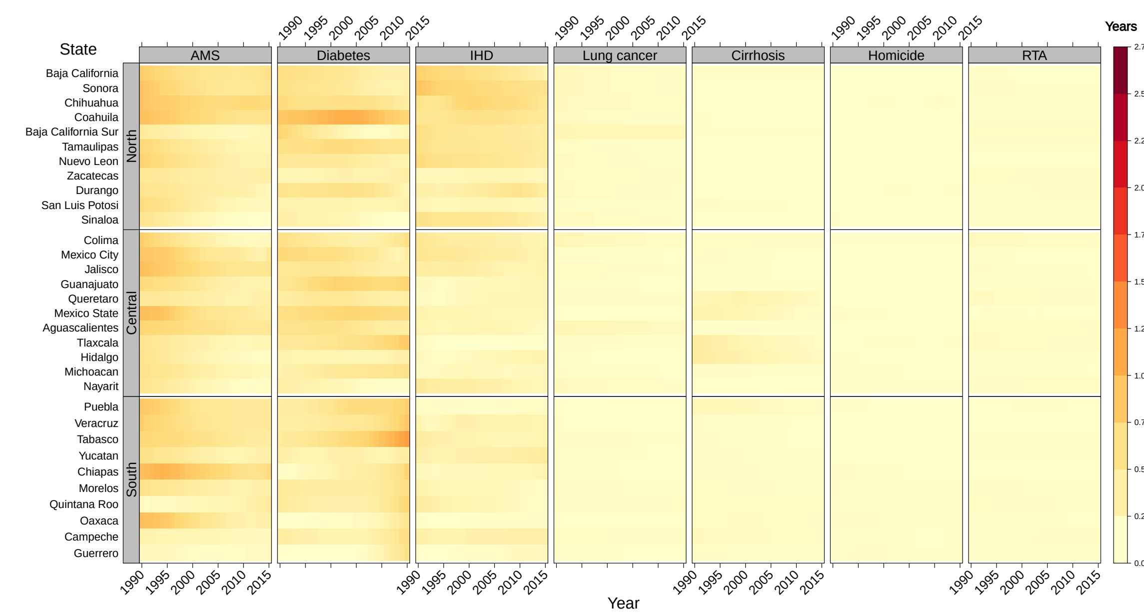
Source: calculations based on INEGI and CONAPO files.

Figure 4: Cause-specific contributions to state differences from low mortality benchmark for older male adults (ages 50-84), 1990-2015. States grouped into three regions. Reproduced from manuscript Figure 4 to have color scale comparable with other Supplementary figures. In subsequent figures 5-9 the color was rescaled to make them comparable over age groups in the supplemental material, the maximum value observed was 2.6 years caused by homicides in Chihuahua in 2010.



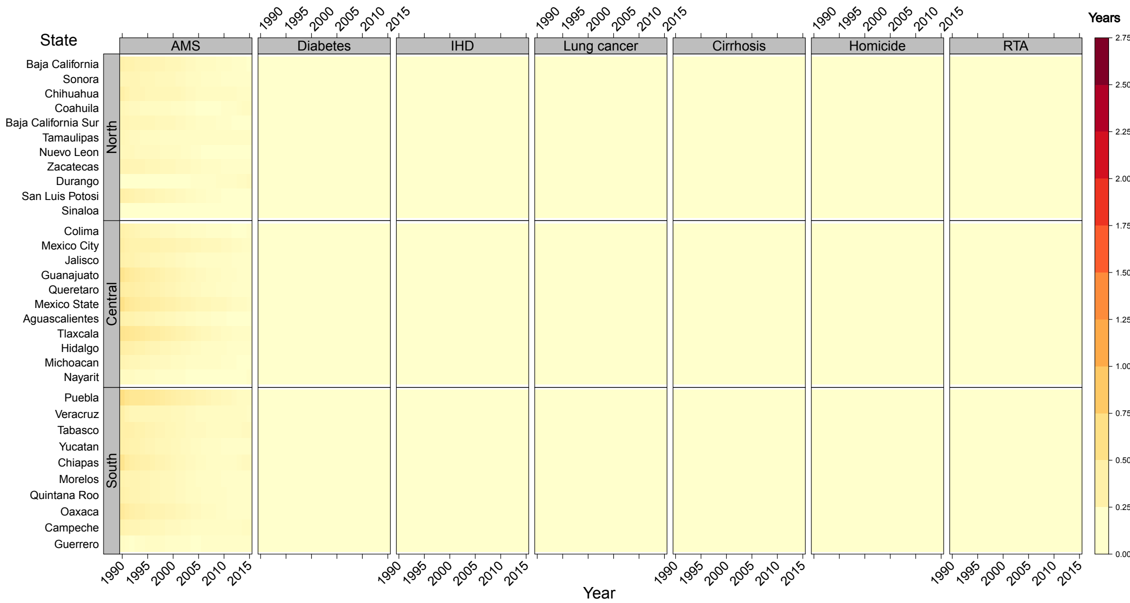
Note: AMS is "amenable to medical service", IHD is "isquemic heart diseases", and RTA is "road traffic accidents". Source: own calculations.

Figure 5: Cause-specific contributions to state differences from low mortality benchmark for older female adults (ages 50-84), 1990-2015.



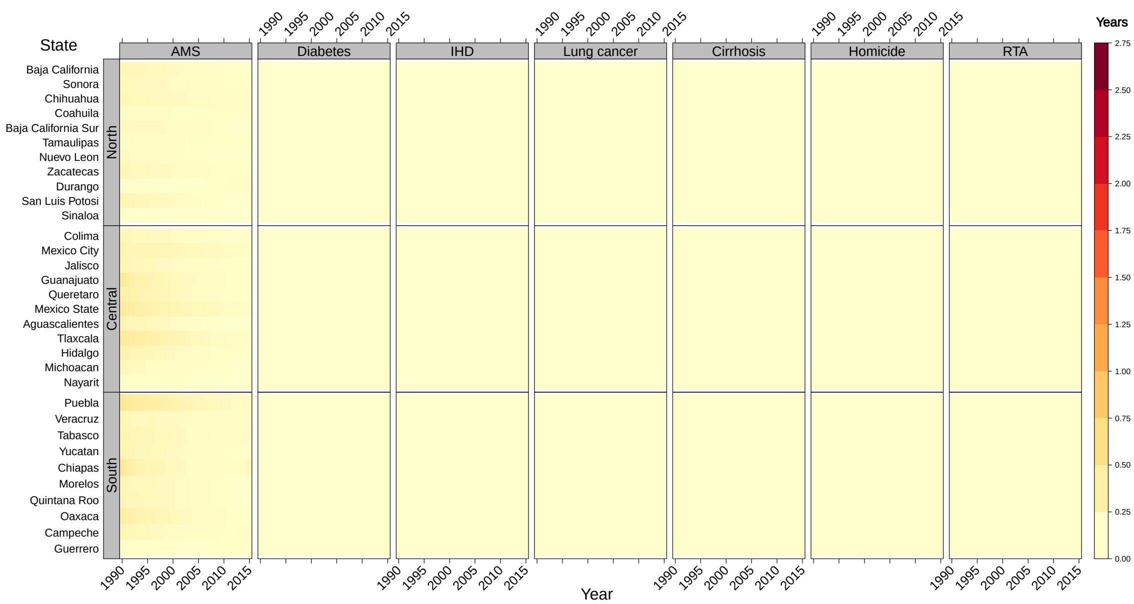
Note: AMS is "amenable to medical service", IHD is "isquemic heart diseases", and RTA is "road traffic accidents". Source: own calculations.

Figure 6: Cause-specific contributions to state differences from low mortality benchmark for male youngest population (ages 0-14), 1990-2015.



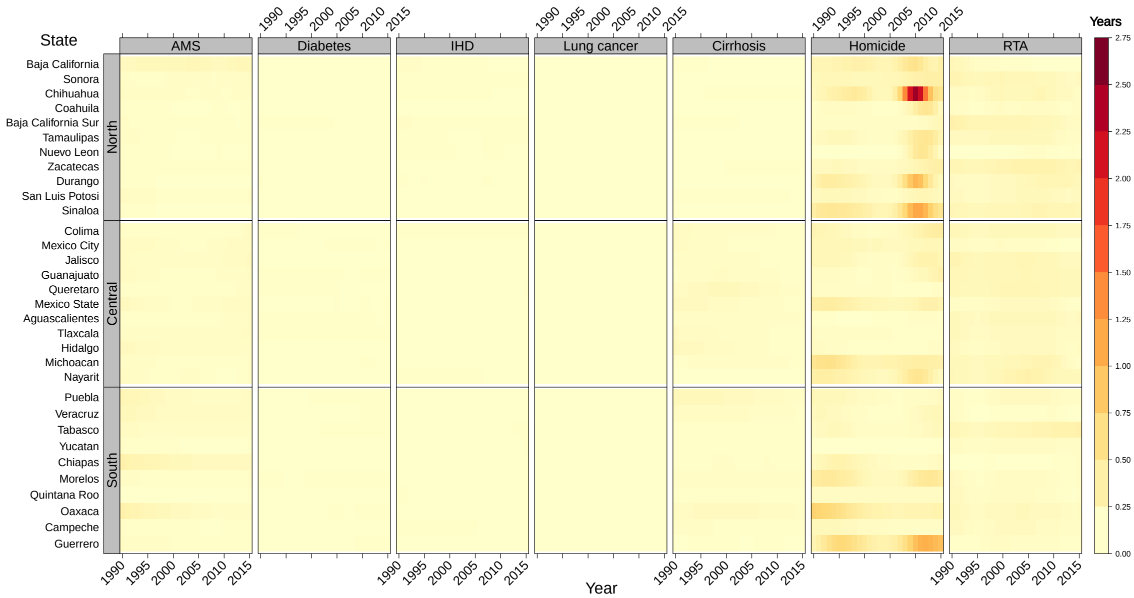
Note: AMS is "amenable to medical service", IHD is "isquemic heart diseases", and RTA is "road traffic accidents". Source: own calculations.

Figure 7: Cause-specific contributions to state differences from low mortality benchmark for female youngest population (ages 0-14), 1990-2015.



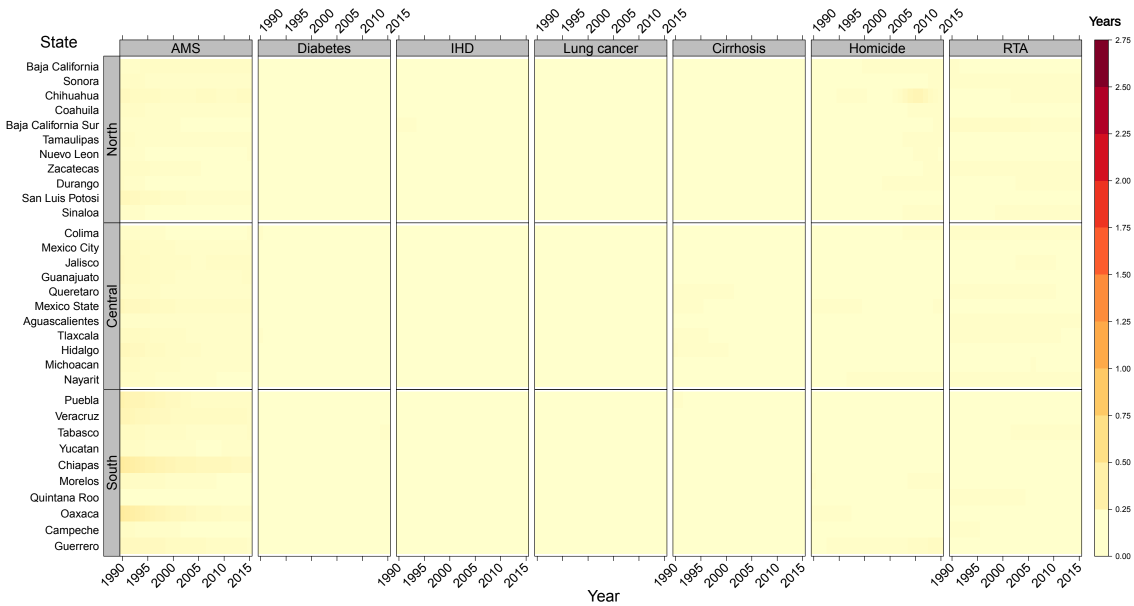
Note: AMS is "amenable to medical service", IHD is "isquemic heart diseases", and RTA is "road traffic accidents". Source: own calculations.

Figure 8: Cause-specific contributions to state differences from low mortality benchmark for male young adults (ages 15-49), 1990-2015.



Note: AMS is "amenable to medical service", IHD is "isquemic heart diseases", and RTA is "road traffic accidents". Source: own calculations.

Figure 9: Cause-specific contributions to state differences from low mortality benchmark for female young adults (ages 15-49), 1990-2015.



Note: AMS is "amenable to medical service", IHD is "isquemic heart diseases", and RTA is "road traffic accidents". Source: own calculations.

Figure 10: State specific gap with low mortality benchmark for selected years between ages 0-14. Source: own calculations.

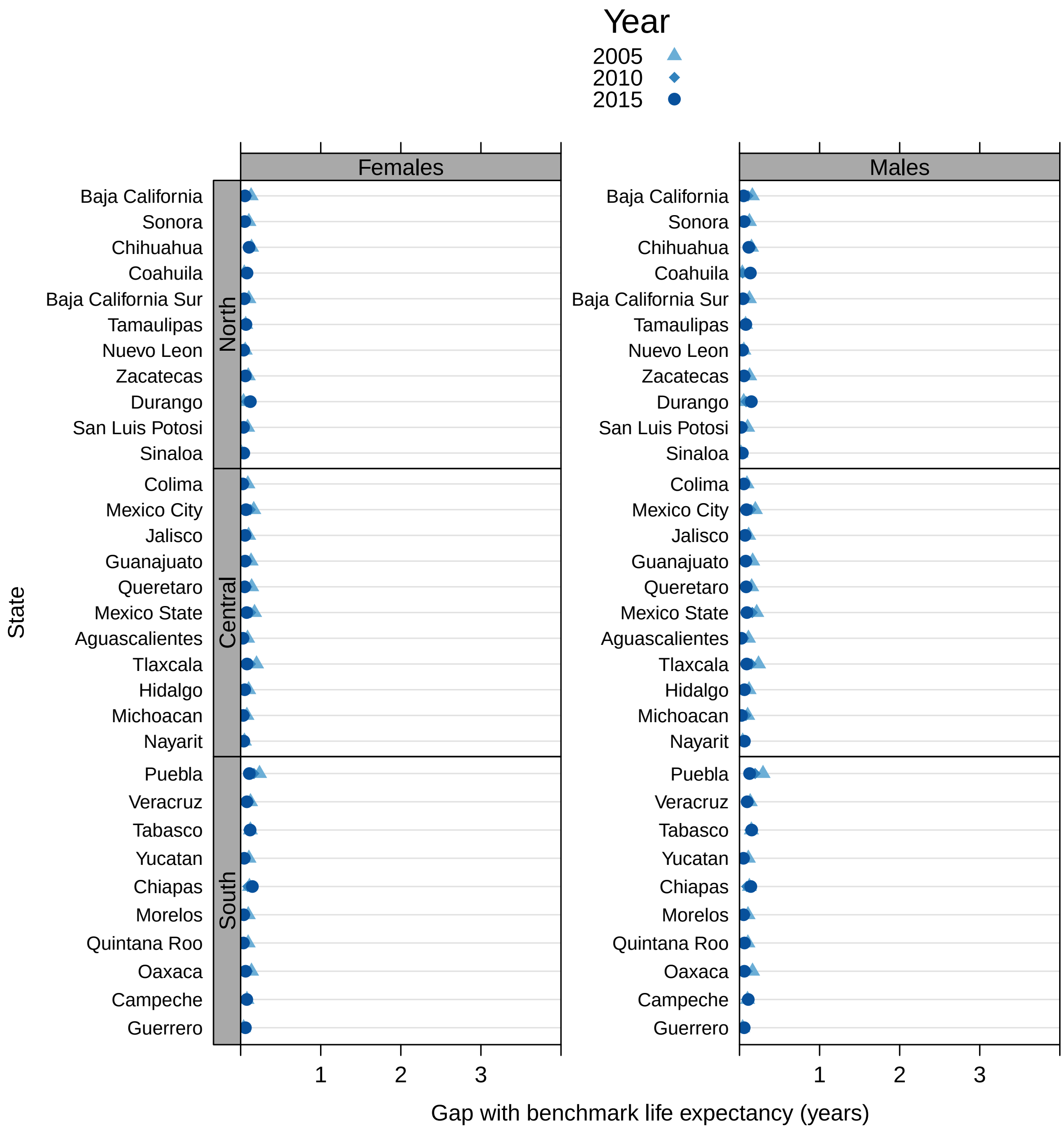


Figure 11: State specific gap with low mortality benchmark for selected years between ages 15-49. Source: own calculations.

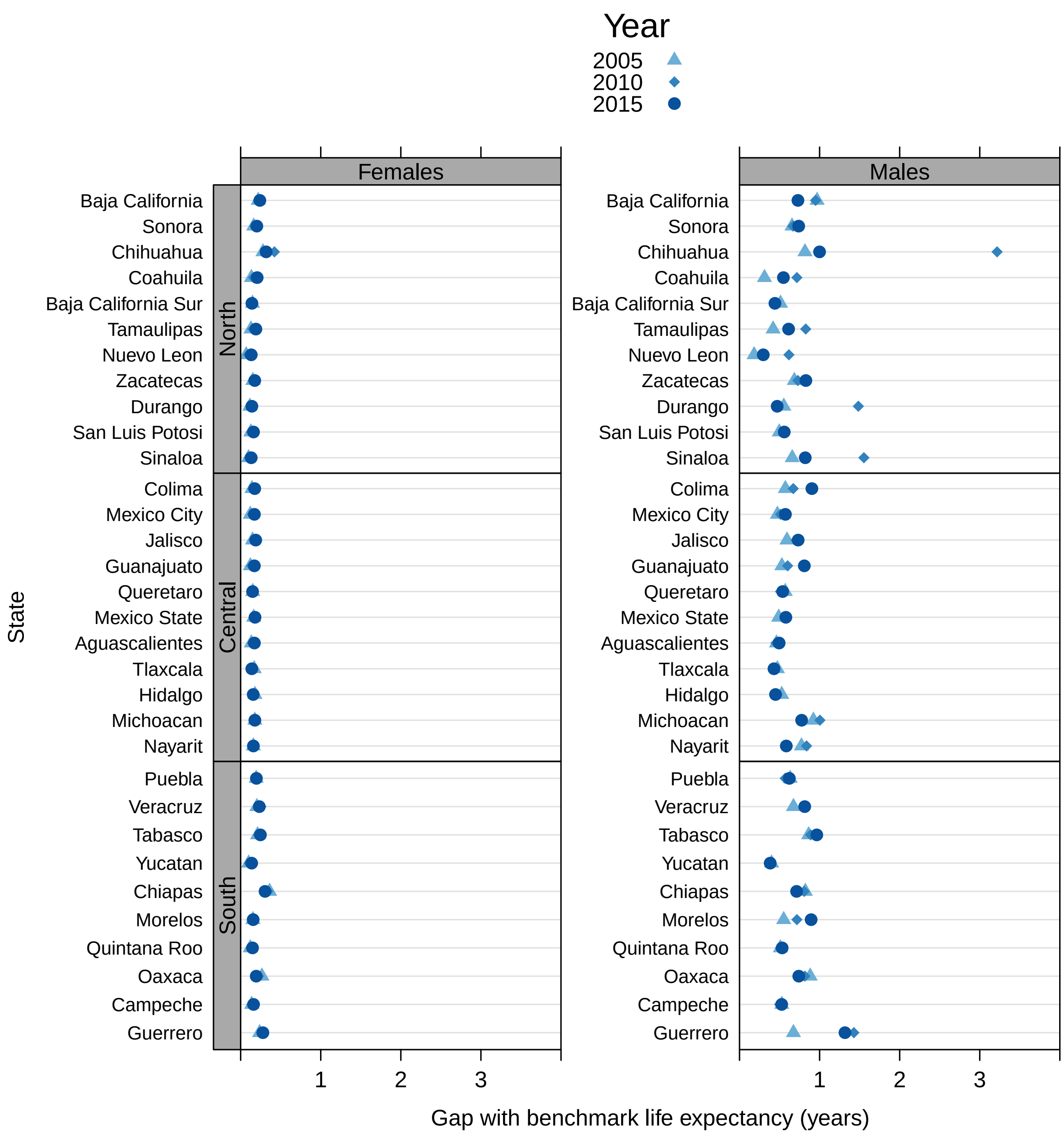


Figure 12: State specific gap with low mortality benchmark for selected years between ages 50-84. Source: own calculations.

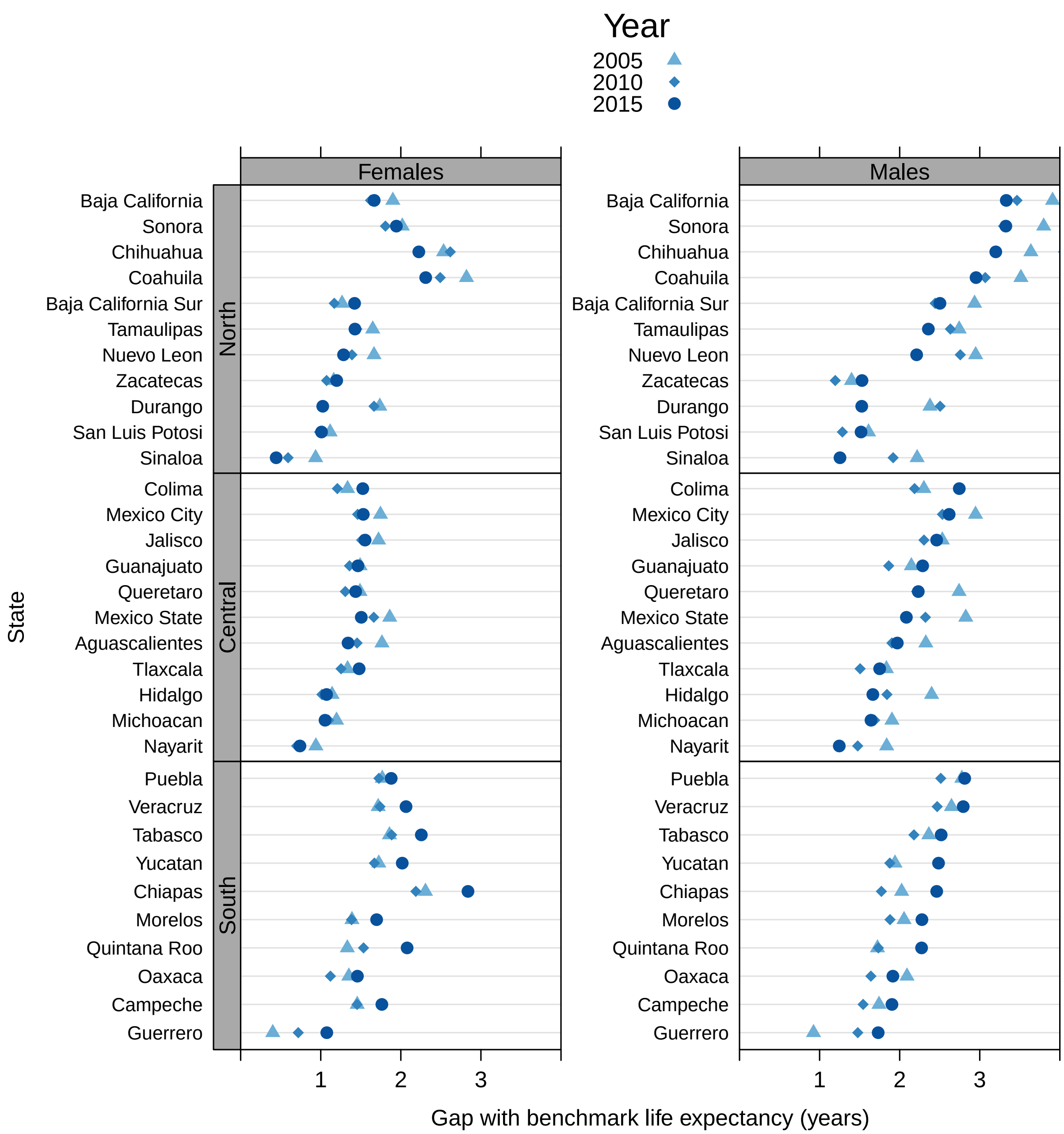


Figure 13: Proportion by cause of death from benchmark mortality for youngest females (ages 0-14). Source: own calculations.

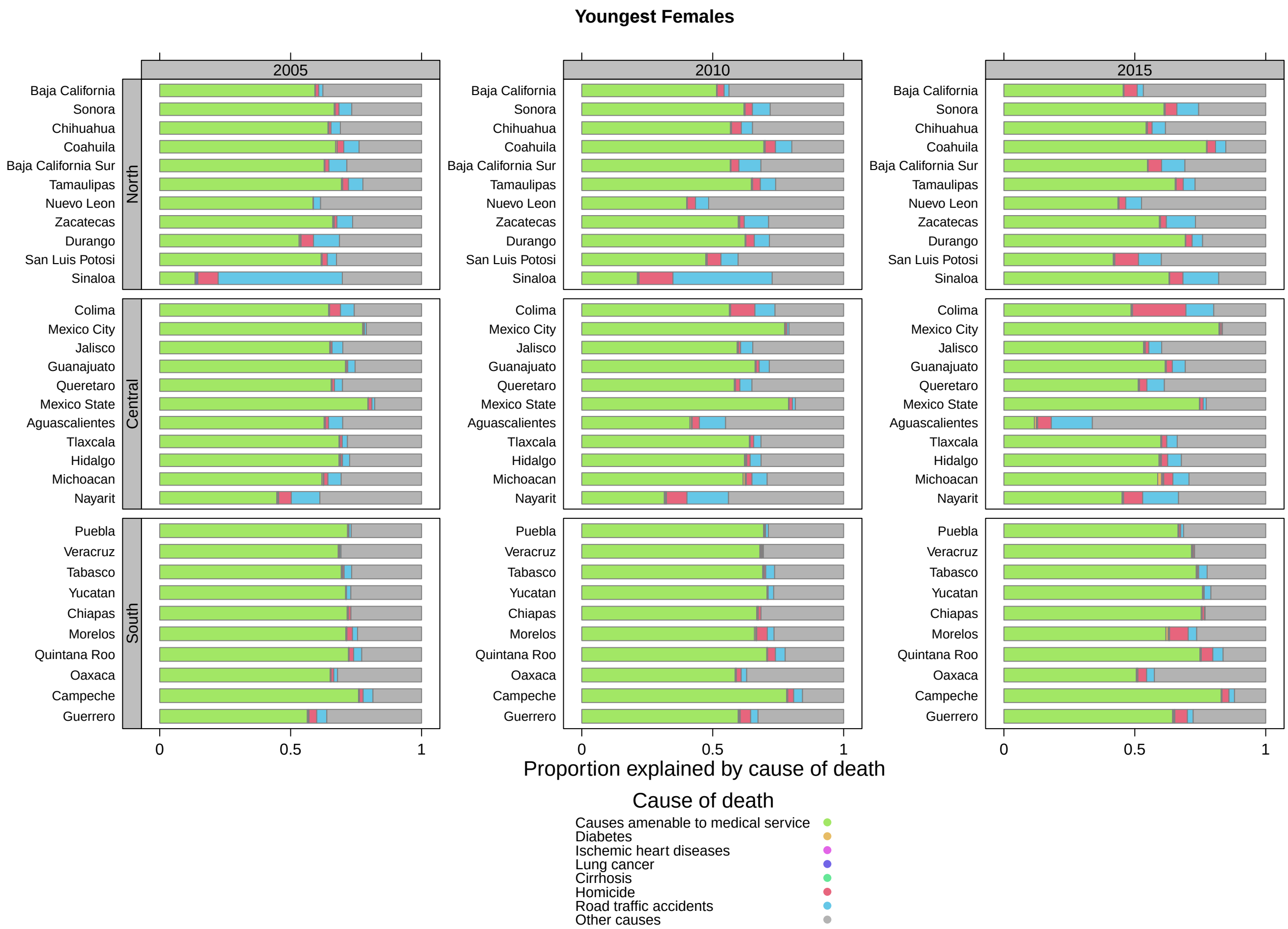


Figure 14: Proportion by cause of death from benchmark mortality for youngest males (ages 0-14). Source: own calculations.

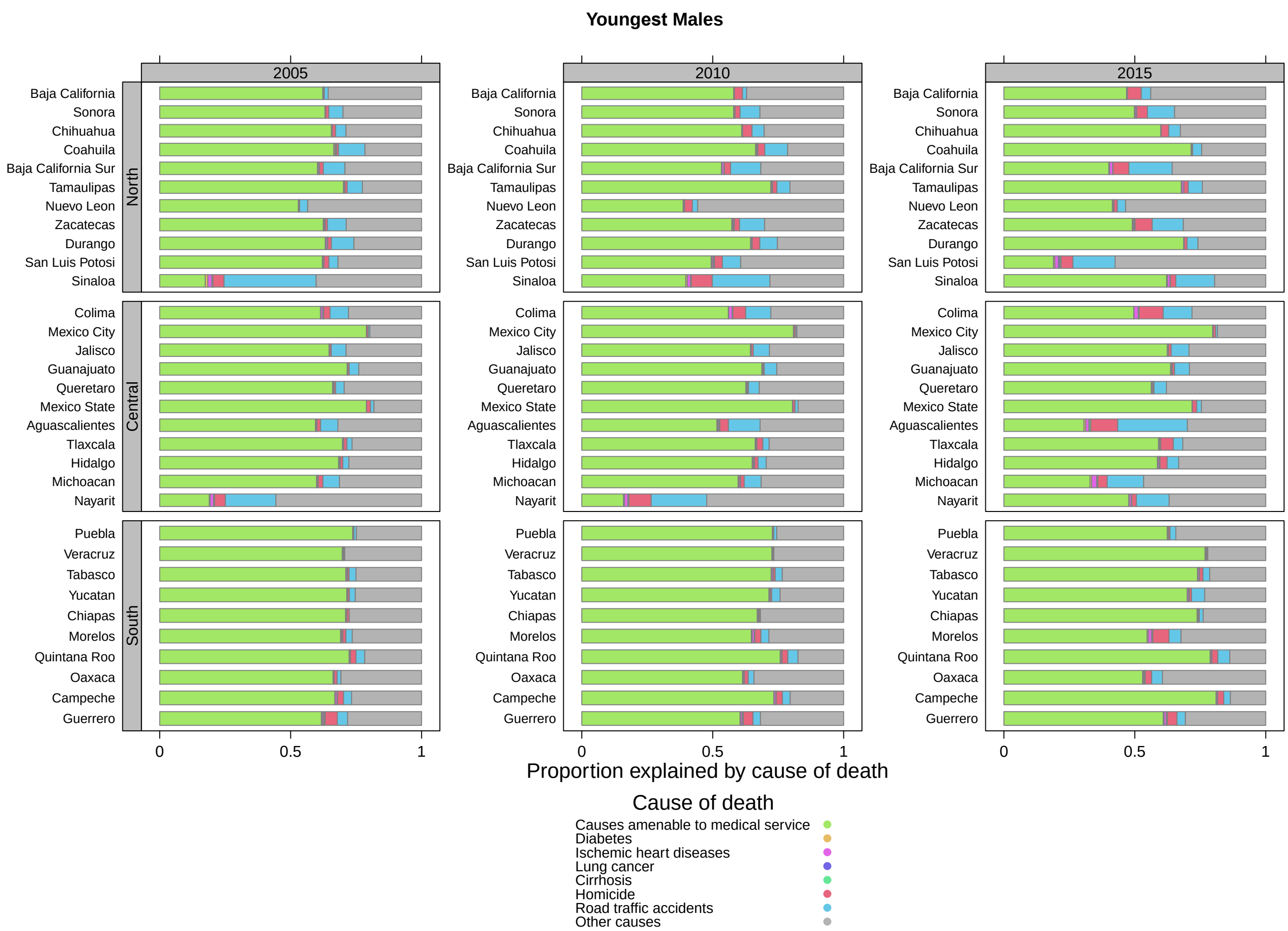


Figure 15: Proportion by cause of death from benchmark mortality for young adult females (ages 15-49). Source: own calculations.

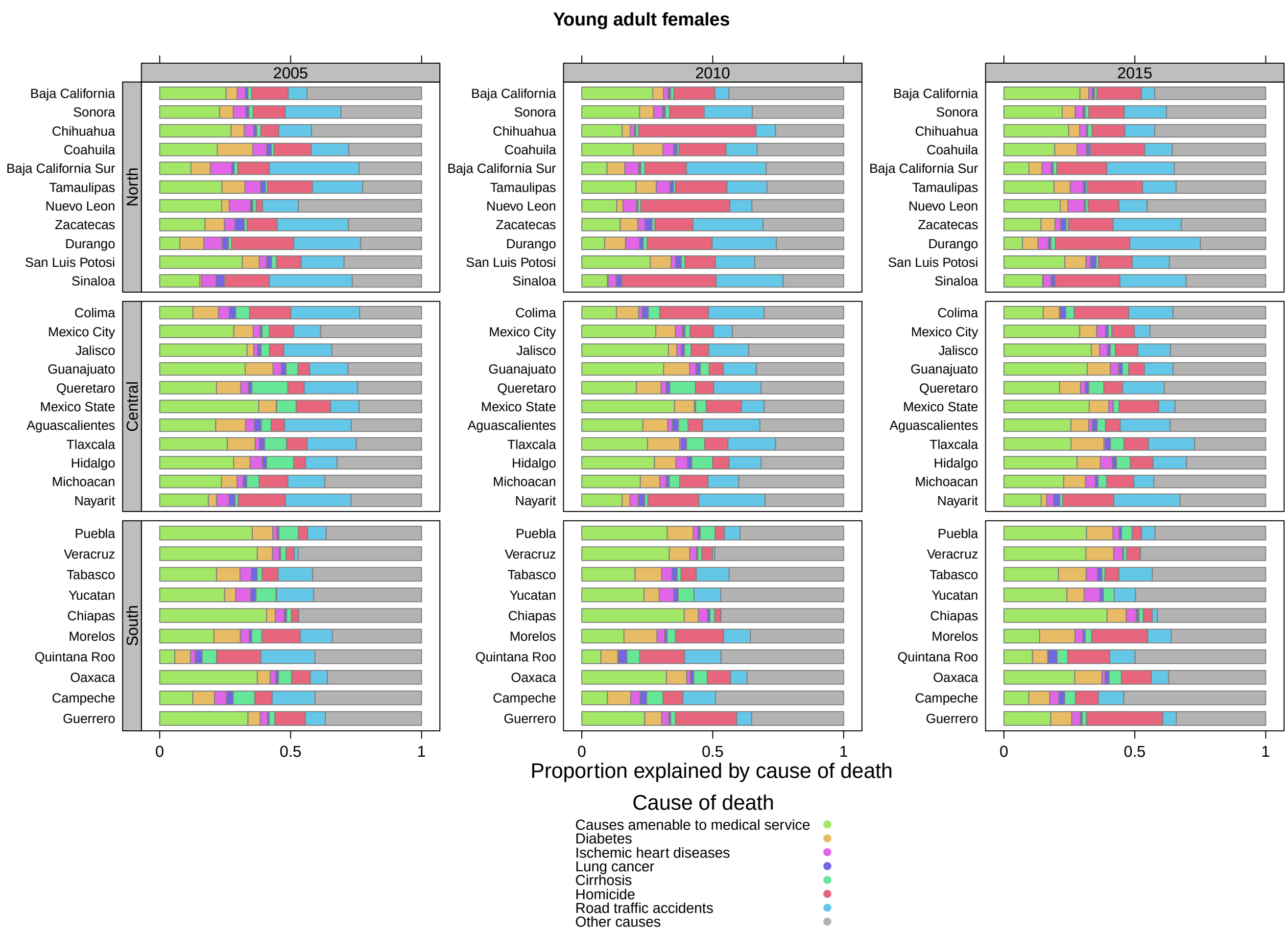


Figure 16: Proportion by cause of death from benchmark mortality for young adult males (ages 15-49). Source: own calculations.

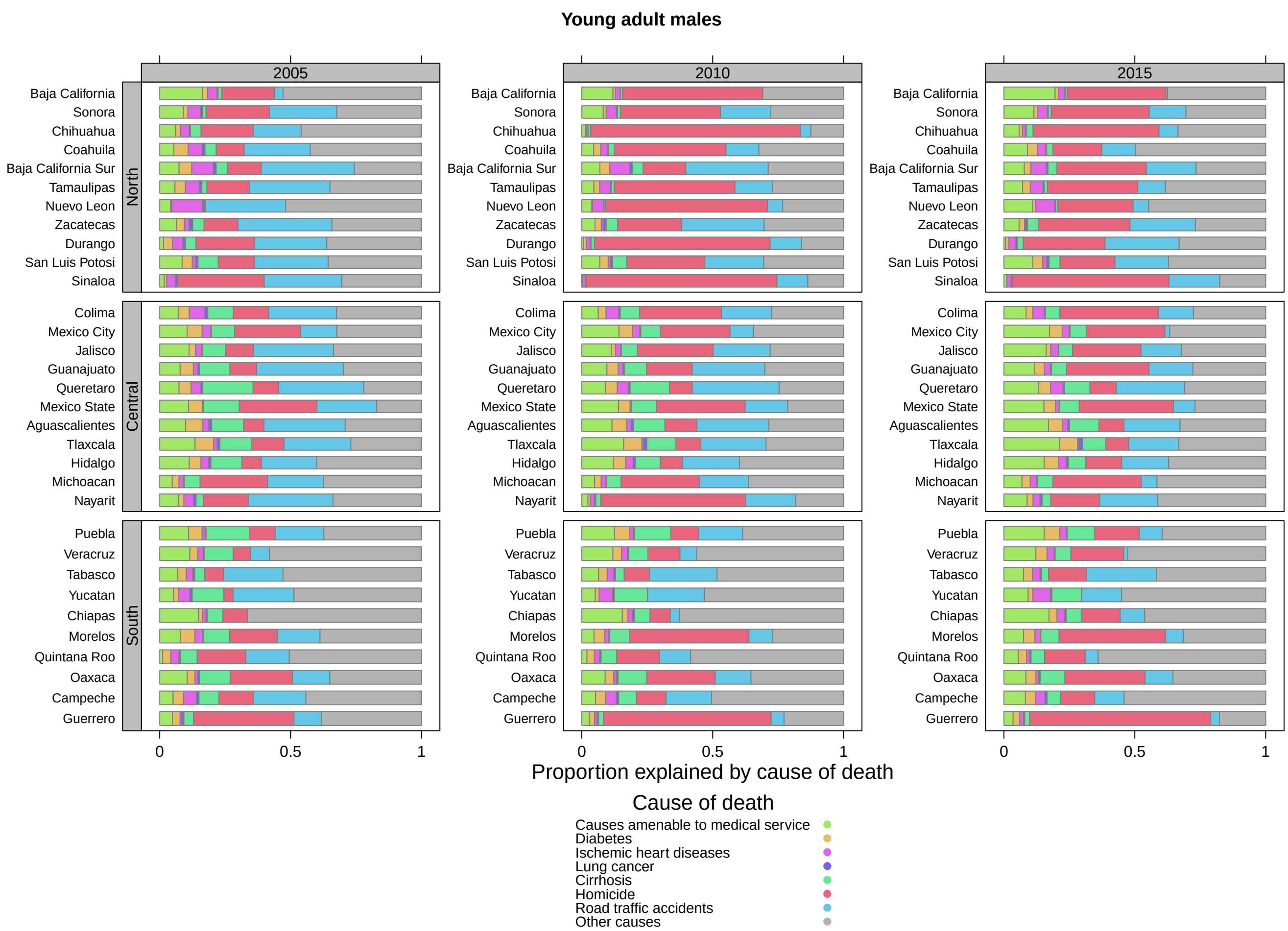


Figure 17: Proportion by cause of death from benchmark mortality for older male adults (ages 50-84). Source: own calculations.

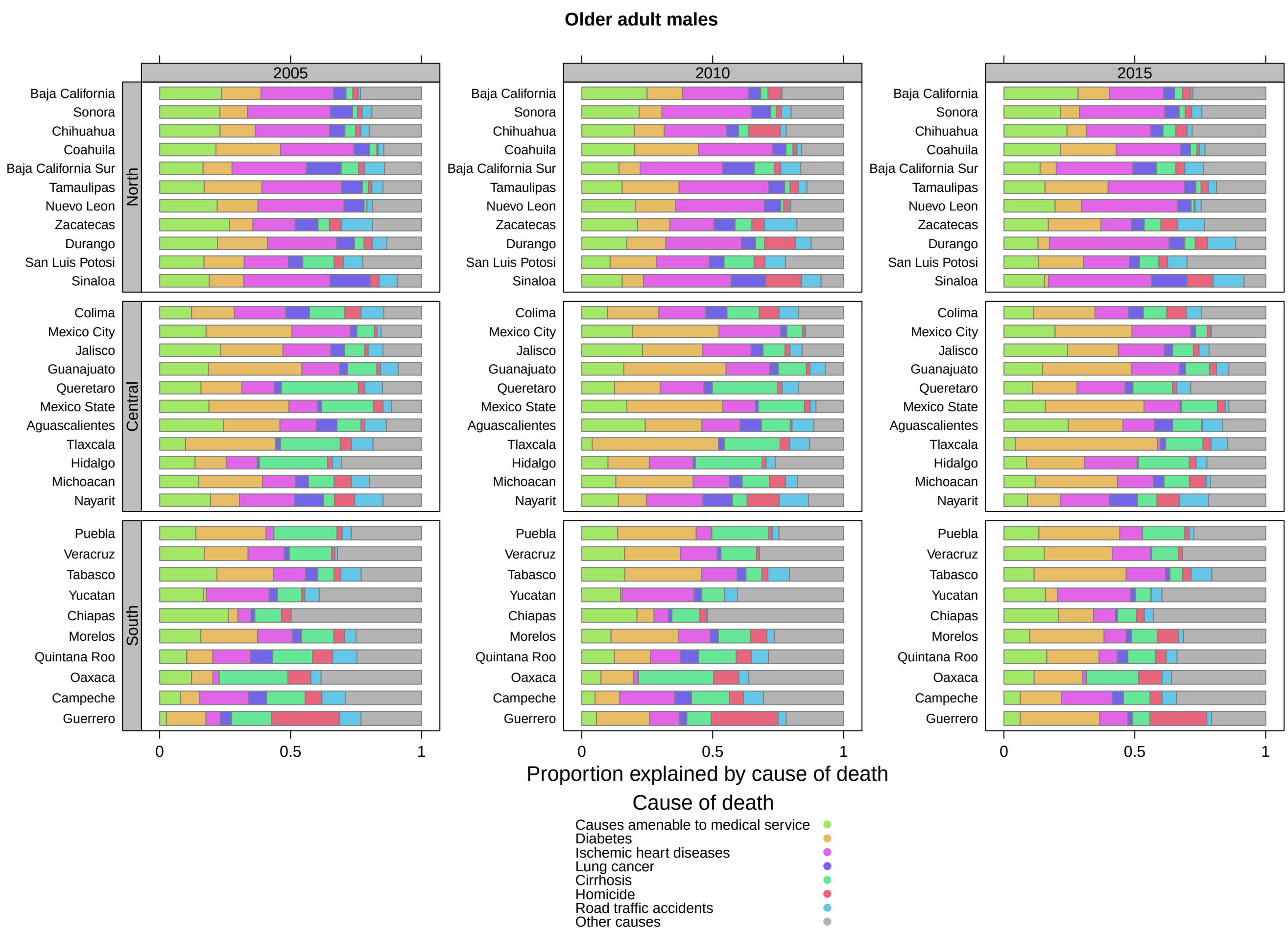


Figure 18: Proportion by cause of death from benchmark mortality for older female adults (ages 50-84). Source: own calculations.