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The Structural Violence Trap: Disparities in Homicide, Chronic Disease Death, and Social Factors Across San Francisco Neighborhoods

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- BACKGROUND:** On average, a person living in San Francisco can expect to live 83 years. This number conceals significant variation by sex, race, and place of residence. We examined deaths and area-based social factors by San Francisco neighborhood, hypothesizing that socially disadvantaged neighborhoods shoulder a disproportionate mortality burden across generations, especially deaths attributable to violence and chronic disease. These data will inform targeted interventions and guide further research into effective solutions for San Francisco's marginalized communities.
- STUDY DESIGN:** The San Francisco Department of Public Health provided data for the 2010–2014 top 20 causes of premature death by San Francisco neighborhood. Population-level demographic data were obtained from the US American Community Survey 2015 5-year estimate (2011–2015). The primary outcome was the association between years of life loss (YLL) and adjusted years of life lost (AYLL) for the top 20 causes of death in San Francisco and select social factors by neighborhood via linear regression analysis and heatmaps.
- RESULTS:** The top 20 causes accounted for N = 15,687 San Francisco resident deaths from 2010–2014. Eight neighborhoods (21.0%) accounted for 47.9% of city-wide YLLs, with 6 falling below the city-wide median household income and many having a higher percent population Black, and lower education and higher unemployment levels. For chronic diseases and homicides, AYLLs increased as a neighborhood's percent Black, below poverty level, unemployment, and below high school education increased.
- CONCLUSIONS:** Our study highlights the mortality inequity burdening socially disadvantaged San Francisco neighborhoods, which align with areas subjected to historical discriminatory policies like redlining. These data emphasize the need to address past injustices and move toward equal access to wealth and health for all San Franciscans. (J Am Coll Surg 2022;234:32–46. © 2022 by The Author(s). Published by Wolters Kluwer Health, Inc. on behalf of the American College of Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \[CCBY-NC-ND\]](https://creativecommons.org/licenses/by-nc-nd/4.0/), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.)
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Supplemental digital content for this article is available at <http://links.lww.com/XCS/A0>.

Abbreviations and Acronyms

ACS	American Community Survey
AYLL	adjusted years of life lost
CDPH	California Department of Public Health
HIV	human immunodeficiency virus
MHI	median household income
PBPL	Percent Below Poverty Level
SDoH	social determinants of health
SFDPH	San Francisco Department of Public Health
SoMa	South of Market
YLL	years of life lost

Health disparities exist worldwide and are a persistent crisis within American communities.^{1,2} Specifically, health outcomes are worse in historically marginalized or excluded groups based on sex, race/ethnicity, socioeconomic status, and other social characteristics.^{3,4} There has been widespread recognition of the complex effects and interactions that area-based social determinants of health (SDoH) exert on individual health,^{5,6} where SDoH denote “employment, income, housing, transportation, child care, education, discrimination, and the quality of the places where people live, work, learn, and play, which influence health.”³ Disadvantaged communities are frequently characterized by a lack of opportunity, discrimination, violence, limited access to critical services, and inequality.^{7,8} All of these factors contribute to chronic stress that can act as an added mediator to worse health outcomes.⁸

Evidence shows that neighborhoods do not form spontaneously. Many are rooted in structural racism propagated by federally discriminatory policies like “redlining,” where areas with racial minority residents were labeled as high risk for lending by the Home Owners’ Loan Corporation, leading to longstanding inequities in wealth and opportunity across generations that are extremely difficult to overcome.^{3,9,10} The connections between poor health and inequality are clear,⁸ as is the distinctly unequal opportunity to escape disadvantage given the strong link between an individual’s odds for upward mobility and living in areas with less income inequality, less residential segregation, greater social capital and family stability, and better primary schools.¹¹ We have also come to appreciate the multifaceted relationship between health and disease and that population health is not only the sum of individual risks.^{12,13} Understanding the complex contributions of economic, societal, and biologic factors to diseases and location-related mortality disparities is essential to eradicating them.¹³ Although past studies have explored these disparities,^{14,15} an examination of the burden of premature deaths, area-based social factors,

and historical discrimination at the neighborhood level remains understudied.

In 2017, a person living in San Francisco could expect to live around 83 years. This number conceals significant variation not only by sex and race, but also based on where one lives. Data from 2012 through 2016 indicate that a person living in the Tenderloin neighborhood could expect to live 73.7 years, whereas a person in Twin Peaks may live 93.6 years.¹⁴ To further explore this disparity, we sought to examine premature deaths and various area-based social factors at the neighborhood level in the city of San Francisco. We hypothesized that populations living in socially disadvantaged neighborhoods shoulder a disproportionate burden of deaths, with deaths attributable to chronic disease and violence going hand in hand, with younger populations and multiple generations affected, creating a lack of wealth/health trap that is difficult to overcome. We also hypothesized that there would be overlap between the most affected neighborhoods today and areas impacted by historical discriminatory policies. These data will shed light on the proximate causes of persistent downstream health disparities affecting our San Francisco communities, providing evidence-based targets for cross-sectoral interventions and further research into effective solutions that enable every San Franciscan the same opportunity for health and wealth.

METHODS

IBR approval was not required owing to the data being deidentified and/or publicly available. This is an epidemiologic, ecological, cross-sectional study using group-level data.

Data

San Francisco death data for years 2010 through 2014 at the neighborhood level were provided by the San Francisco Department of Public Health (SFDPH) in Excel (Microsoft, Redmond, WA), originating from the California Department of Public Health (CDPH). Deaths were mapped using a sequence of geocoding methods, including the San Francisco Emergency Alert System service (over 90% of deaths mapped in first pass, gold standard in San Francisco), Google Maps, latitude and longitude provided by the CDPH, or manually. Provided measures for the top 20 causes of premature death city-wide, based on years of life lost (YLL), included cause of death counts, YLL, adjusted years of life lost (AYLL), and average years of life lost stratified by neighborhood. YLL calculations were based on the 2000–2011 World Health Organization Standard Life Table, and standard population weights were calculated from the US 2000 standard

population. American Community Survey (ACS) data were used for population denominators. Adjusted YLL were age-adjusted and standardized to the 2000 population and annualized. Methods for these calculations have previously been described.¹⁵

Population-level demographic data were obtained from the ACS 5-year estimate for 2015 (includes years 2011 through 2015). Variables assessed included age, sex, race/ethnicity, education level, employment status, median household income (MHI), and percent below poverty level (PBPL). SFDPH mapped census tracts to San Francisco neighborhoods (Fig. 1) using the census tract neighborhood crosswalk 2010, and census data were averaged across census tracts at the neighborhood level in Excel (Microsoft, Redmond, WA).

Statistical analysis

The main outcomes of interest were the burden of AYLLs for the top 20 causes of death by San Francisco neighborhood, and the association between AYLLs and select social factors at the neighborhood level, with a specific focus on chronic diseases and violence. Homicide (assault) deaths were used as an indicator of violence. The US Centers for Disease Control and Prevention define chronic diseases

as “conditions that last 1 year or more and require ongoing medical attention or limit activities of daily living or both.”¹⁶ The chronic disease category included: ischemic heart diseases, cerebrovascular disease, hypertensive disease, chronic obstructive pulmonary disorder, cancer (lung/trachea/bronchial, colon/rectal, liver, pancreas, breast, lymphoma/multiple myeloma), dementia/Alzheimer’s, diabetes mellitus, human immunodeficiency virus (HIV), and drug and alcohol use disorders. Golden Gate Park, Lincoln Park, and McLaren Park were excluded from analysis because they are parks vs neighborhoods and their YLL and AYLL were likely affected by low populations and death counts. Eighteen (0.11%) deaths were excluded. There were N = 109 (0.69%) deaths that could not be geocoded to place of residence and were removed from the neighborhood-level analysis. All deaths were included in citywide calculations.

Median AYLL and interquartile ranges by cause of death were calculated across neighborhoods and graphed using Stata/SE 15 for Mac (StataCorp, College Station, TX). Univariable linear regression analysis was performed to assess the association between select neighborhood social factors and AYLLs for each of the top 20 causes of death in San Francisco, as well as chronic diseases and total AYLLs. Independent variables included PBPL, percent population unemployed, percent population under

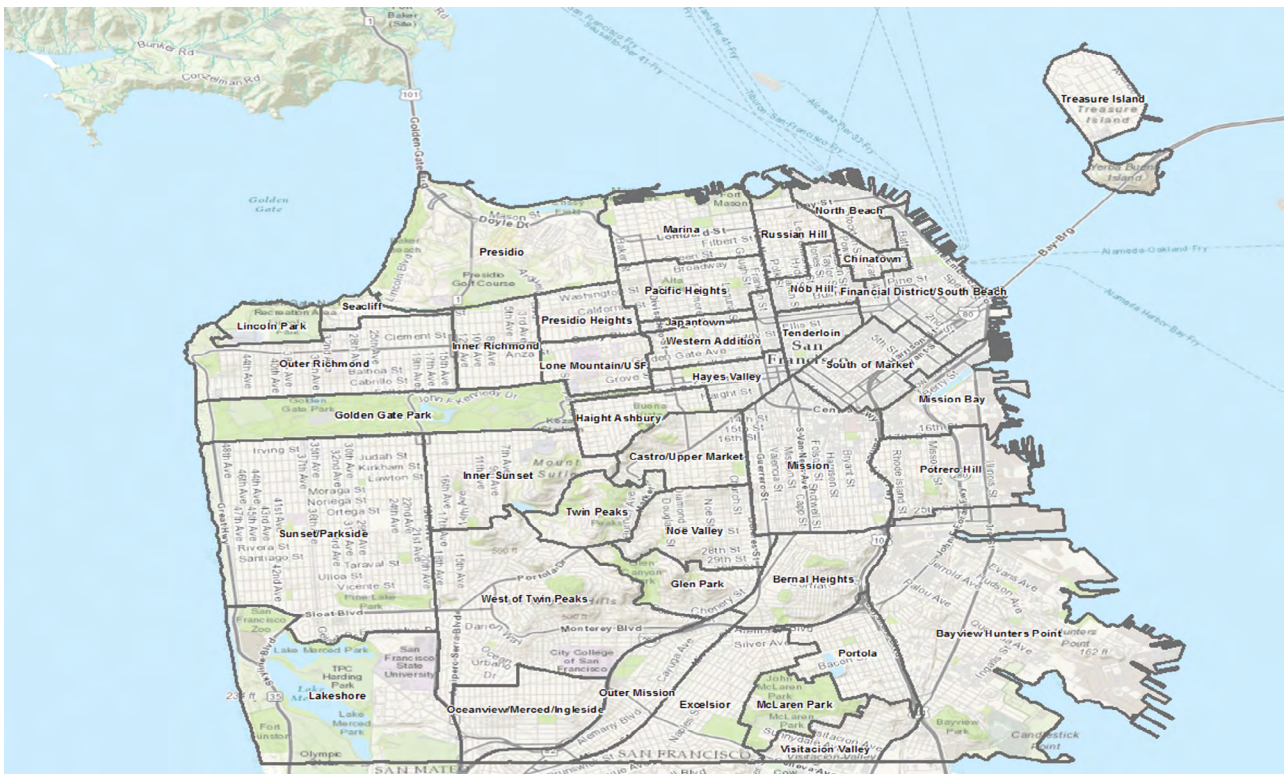


Figure 1. Map of San Francisco neighborhoods. Image provided courtesy of the San Francisco Department of Public Health

60 years of age, percent population male, percent population Black, and percent population with less than a high school education. Changes in y were scaled to standard deviations of x .

We also sought to explore the overlap between present-day neighborhoods with the highest AYLLs and areas subjected to historical discriminatory housing practices or “redlining,” which was mapped using PowerPoint (Microsoft, Redmond, WA). The 1937 City and County of San Francisco Home Owner’s Loan Corporation (HOLC) Residential Security Map¹⁷ was used to inform boundaries of previously “redlined” or D - fourth grade areas at the street level for transcription to a map of current San Francisco neighborhoods. If any portion of a current San Francisco neighborhood had an area of red it was considered historically redlined.

RESULTS

Citywide demographics

San Francisco had 840,763 residents according to the 2015 5-year ACS. Most identified as White (48.73%) or Asian (33.83%), followed by Latinx any race (15.30%), Black (5.57%), two races (4.63%), Asian Pacific Islander (0.43%), or American Indian or Alaska Native (0.34%). Highest achieved education levels varied widely across the city for those aged 25 years and older, with most having a Bachelor’s degree or higher (54.02%), followed by 20.31% with some college or associate’s degree, 12.93% with less than a high school diploma, and 12.61% with a high school diploma. For the civilian labor force 16 years and older, 6.65% were unemployed. Citywide MHI was \$81,953, and the PBPL was 13.24%. Additional demographics at the neighborhood level are provided in [Table 1](#).

Citywide deaths

From 2010 through 2014, the top 20 causes of death in San Francisco based on YLL accounted for $N = 15,687$ resident deaths, contributing a total of 211,662 YLL and 4,381.32 AYLL ([Table 2](#)). Top causes of death by AYLL are shown in [Table 3](#). The highest average YLLs by cause of death included homicide (26.15 years), drug use disorders (22.89), suicide (22.86), HIV (22.11), and alcohol-attributable diseases and disorders (21.34). During the study period there were $N = 206$ homicides, contributing 5,387.43 (2.5%) YLL and ranking 18th based on AYLL (125.86) yet first for average YLL per death. There were $N = 14,231$ deaths attributable to chronic diseases (90.7% of all deaths), accounting for 186,424.88 (88.1%) YLL, 3,828.79 AYLL, and 13.10 average YLL per death.

Neighborhood demographics

San Francisco neighborhoods varied in their demographic make-up ([Table 1](#)). Thirteen neighborhoods (34.2%) had higher percent population Black than the citywide level, and 12 (31.6%) had more than 50% minority race (any race other than White, including 2 races). Eighteen (47.4%) fell under the citywide MHI, 15 (39.5%) were above the citywide PBPL, and 6 (15.8%) met the federal definition of “poverty area” with PBPL’s greater than 20%.^{18,19} Eleven (28.9%) had more individuals without a high school diploma than the citywide level, and 4 (10.5%) met the definition of an “undereducated area” where at least 25% of persons aged 25 years old or older have not completed high school.¹⁹ For the civilian labor force 16 years and older, 6.65% of the population were unemployed, with 15 neighborhoods (39.5%) above the citywide level of unemployment. Four neighborhoods had higher percent Black, without high school diploma, unemployment, PBPL, and lower MHI measurements when compared with citywide levels: Tenderloin, Visitacion Valley, Bayview/Hunters Point, and Oceanview.

Neighborhood deaths

The top causes and distribution of deaths varied at the neighborhood level ([Tables 2 and 3](#) and [Figs. 2 and 3](#)). Sunset/Parkside was the largest contributor based on total deaths ($N = 1,639$) and YLLs (18,603.18), whereas Treasure Island had the highest overall average YLL per death across all causes (24.37) and the Tenderloin had the most total AYLLs (9,995.56). The highest number of deaths were attributable to ischemic heart disease ($N = 355$) in the Sunset. By neighborhood, ischemic heart disease was also the most frequent top cause of death ($N = 33$, 86.8% of neighborhoods), YLL ($N = 30$, 78.9%), and AYLL ($N = 27$, 71.0%; [Figs. 2 and 3](#) and [Table 3](#)). Drug use disorders in the Tenderloin were responsible for the highest overall YLL and AYLL (3,730.94 and 2,026.10, respectively). Average YLL per death for all causes ranged from 9.62 (Seacliff) to 24.37 (Treasure Island). Average YLL per death by cause ranged from 6.79 (multiple neighborhoods and causes) to 31.09 (Presidio, unintentional injury). The most common cause of highest average YLL across all neighborhoods was homicide ($N = 24$ neighborhoods, 63.1%).

Homicide was in the actual top 20 causes of death based on YLL for 47.1% ($N = 16$) neighborhoods that registered a homicide death, with average YLL per death ranging from 18.37 (Russian Hill) to 29.20 (Treasure Island). Neighborhoods with the highest AYLL for homicide included Bayview/Hunters Point, Potrero Hill, SoMa, Visitacion Valley, Oceanview, and Western Addition, all

Table 1. San Francisco Neighborhood Social Factors

Neighborhood*	Population, n	Sex m, %	Age <60 y, %	Race/ethnicity, Black, %	Education, less than HS, %†	Unemployed, %†	MHI, \$	PBPL
Chinatown	14,336	48.99	64.17	0.75	52.25‡	8.86‡	20,508.74§	29.87‡
Tenderloin	28,820	61.30	78.52	9.81‡	23.67‡	8.40‡	21,863.07§	31.67‡
SoMa	18,093	56.15	76.01	12.28‡	17.33‡	6.22	39,761.31§	27.16‡
Treasure Island	3,187	53.84	95.36	18.61‡	10.92	12.14‡	40,740.74§	51.84‡
Lakeshore	13,469	47.19	85.08	6.77‡	6.79	12.36‡	48,057.85§	32.40‡
Visitacion Valley	17,793	48.05	79.81	13.06‡	28.32‡	13.78‡	49,394.98§	18.09‡
Bayview/Hunters Point	37,246	48.85	84.31	27.66‡	26.08‡	12.50‡	52,430.94§	21.75‡
Western Addition	21,366	48.69	72.61	20.34‡	9.61	8.16‡	54,446.53§	19.22‡
Japantown	3,633	43.41	57.64	5.64‡	11.08	5.12	62,647.06§	19.17‡
Nob Hill	26,382	51.53	79.52	2.92	11.94	4.63	63,184.43§	15.95‡
Excelsior	39,640	50.84	78.98	2.38	24.22‡	8.88‡	67,659.03§	9.52
Outer Richmond	45,120	48.14	74.72	1.79	12.32	4.57	69,897.40§	10.18
Oceanview	28,261	49.36	78.88	13.53‡	21.93‡	11.51‡	70,546.38§	15.34‡
Portola	16,269	48.22	76.96	4.53	29.61‡	6.72‡	74,589.25§	12.69
North Beach	12,550	54.43	75.57	0.93	10.36	6.70‡	74,777.45§	14.98‡
Outer Mission	23,983	48.05	78.40	1.29	19.20‡	8.33‡	76,383.87§	8.93
Mission	57,873	56.00	83.30	3.06	16.51‡	7.38‡	77,526.79§	15.80‡
Inner Richmond	22,425	47.79	78.07	2.02	10.68	6.20	78,530.81§	14.02‡
Hayes Valley	18,043	59.68	87.71	13.44‡	6.21	4.65	82,195.19	12.66
Sunset/Parkside	80,525	47.59	75.41	0.83	14.24‡	6.44	84,652.72	10.08
Lone Mountain/USF	17,434	46.46	85.09	6.86‡	5.89	6.02	86,388.04	11.77
Twin Peaks	7,310	59.66	74.60	4.30	2.92	3.44	89,896.80	5.25
Bernal Heights	25,487	51.07	84.14	4.88	10.59	8.46‡	98,285.80	9.20
Inner Sunset	28,962	48.04	80.50	1.94	6.10	3.97	101,763.75	9.24
Mission Bay	9,979	53.81	91.91	5.10	4.20	4.89	106,508.88	13.51‡
Russian Hill	18,179	47.50	76.97	0.93	8.84	2.20	107,953.48	8.75
Glen Park	8,119	51.99	76.78	6.40‡	3.79	5.23	115,550.85	8.36
FiDi/South Beach	16,735	52.67	81.90	1.85	5.75	5.93	117,239.54	11.95
Presidio Heights	10,577	45.55	79.59	2.51	4.63	7.32‡	117,532.73	8.32
Pacific Heights	24,737	48.51	78.60	3.24	2.24	3.76	117,699.39	6.56
Haight Ashbury	17,758	53.93	87.98	3.10	2.14	5.15	119,121.06	9.45
Castro/Upper Market	20,380	63.00	82.31	2.92	2.54	4.09	120,645.31	7.11
Marina	24,915	46.42	84.87	1.01	2.52	4.87	123,461.93	5.85
Noe Valley	22,769	50.40	83.34	2.85	2.84	5.09	126,117.02	5.66
West of Twin Peaks	37,327	50.64	74.17	3.27	5.68	5.42	126,595.13	6.28
Seacliff	2,491	46.13	74.59	0.52	2.04	5.01	143,506.49	7.31
Potrero Hill	13,621	52.32	88.62	5.59‡	4.58	6.20	147,671.10	9.69
Presidio	3,681	51.24	98.48	0.00	0.00	1.27	161,615.04	4.11
All¶	840,763	50.89	79.81	5.57	12.93	6.65	81,953.04	13.24

*Ordered by increasing median household income.

†Denominator, population categories provided by US Census American Community Survey.

‡More than citywide level.

§Below citywide level.

||More than 20% PBPL, federal definition of poverty area.¹⁸

¶Including all people living in San Francisco.

FiDi, Financial District; HS, high school; MHI, median household income; PBPL, percent below poverty level; SoMa, South of Market; USF, University of San Francisco

Table 2. Expected Years of Life Lost (YLL) and Age-Adjusted YLL (AYLL) for Top 20 Causes of Death by San Francisco Neighborhood, 2010–2014

Neighborhood*	Deaths, n	YLL	YLL %†	Average YLL‡	AYLL§	AYLL ratio
Chinatown	592	6,499.54	3.1	10.98	4458.40	1.4
Tenderloin¶	1029	17,956.07	8.5	17.45	9995.56	3.1
SoMa¶	638	10,099.42	4.8	15.83	8546.52	2.7
Treasure Island	14	341.14	0.2	24.37	2986.68	0.9
Lakeshore	176	2,644.27	1.2	15.02	4658.98	1.4
Visitacion Valley	387	5,447.82	2.6	14.08	5741.27	1.7
Bayview/Hunters Point¶	797	12,174.00	5.7	15.27	6947.49	2.2
Western Addition	552	7,428.04	3.5	13.46	5432.32	1.7
Japantown	99	1,198.09	0.6	12.10	4858.79	1.5
Nob Hill	549	7,304.21	3.4	13.30	4988.00	1.5
Excelsior¶	696	8,911.68	4.2	12.80	3970.62	1.3
Outer Richmond¶	943	11,108.18	5.2	11.78	3592.07	1.1
Ocean View	513	6,995.76	3.3	13.64	4235.82	1.3
Portola	345	4,373.74	2.1	12.68	4580.13	1.4
North Beach	281	3,629.73	1.7	12.92	4465.32	1.4
Outer Mission	451	5,666.26	2.7	12.56	4018.60	1.2
Mission¶	848	13,482.28	6.4	15.90	5174.88	1.6
Inner Richmond	372	4,571.72	2.1	12.29	3540.19	1.1
Hayes Valley	223	3,714.30	1.7	16.66	5392.34	1.7
Sunset/Parkside¶	1639	18,603.18	8.8	11.35	3370.70	1.0
Lone Mountain/USF	206	2,495.98	1.2	12.12	3497.41	1.1
Twin Peaks	138	1,815.66	0.8	13.16	3689.85	1.1
Bernal Heights	398	5,453.30	2.6	13.70	4567.62	1.4
Inner Sunset	389	4,824.47	2.3	12.40	3162.91	1.0
Mission Bay	76	1,242.73	0.6	16.35	3351.69	1.0
Russian Hill	378	4,184.48	2.0	11.07	3602.49	1.1
Glen Park	147	1,932.97	0.9	13.15	4079.52	1.3
FiDi/South Beach	175	2,645.95	1.2	15.12	3701.05	1.1
Presidio Heights	168	1,936.19	0.9	11.52	2900.20	0.9
Pacific Heights	289	3,555.10	1.7	12.30	2541.04	0.8
Haight Ashbury	163	2,535.71	1.2	15.56	4225.27	1.3
Castro/Upper Market	282	4,375.01	2.1	15.51	3874.31	1.2
Marina	314	3,564.39	1.7	11.35	3028.40	0.9
Noe Valley	292	3,926.27	1.8	13.45	3706.12	1.1
West of Twin Peaks¶	785	9,022.00	4.3	11.49	3360.37	1.0
Seacliff	41	394.44	0.2	9.62	2109.32	0.6
Potrero Hill	159	2,566.86	1.2	16.14	4981.92	1.5
Presidio	16	334.41	0.1	20.90	3204.11	Ref
All#	15,687	211,661.99	100	13.49	4381.32	1.4

*Ordered by increasing median household income.

†YLL % = YLL/total YLL for city.

‡Average YLL = YLL/deaths.

§Age-standardized YLL rate per 100,000 persons per year.

||Presidio neighborhood (highest median household income) is reference group for ratio comparison.

¶Contributes >4% of YLL for city.

#Includes n = 109 nongecoded deaths and n = 18 deaths from nonincluded park neighborhoods Golden Gate, McLaren, Lincoln.

AYLL, age-adjusted years of life lost; FiDi, Financial District; SoMa, South of Market; USF, University of San Francisco; YLL, years of life lost

Table 3. Adjusted Years of Life Lost for Top 5 Causes of Death, Homicide, and Chronic Disease by San Francisco Neighborhood

Neighborhood*	COD #1	AYLL COD#1	COD#2	AYLL COD#2	COD#3	AYLL COD#3	COD#4	AYLL COD#4	COD#5	AYLL COD#5	Homicide rank	AYLL homicide	AYLL chronic disease†
Chinatown	CVA	578.10	CAD	538.38	Lung Ca	501.83	Liver Ca	355.74	HTN	343.83	20	38.40	3967.84
Tenderloin	Drug	2026.10	CAD	1095.69	HTN	853.25	EtOH	772.67	Lung Ca	709.39	14	261.48‡	8644.10‡
SoMa	Drug	1485.40	CAD	949.78	HIV	757.72	HTN	653.27	EtOH	627.83	7	475.47‡	7230.37‡
Treasure Island	Drug	573.54	Liver Ca	549.74	HIV	413.56	Unintentional	412.88	Lymph	308.52	10	62.81	2275.54
Lakeshore	CAD	747.01	Drug	534.48	Lung Ca	416.67	Suicide	398.23	CRC	388.10	16	103.14	4100.83‡
Visitacion Valley	CAD	873.84	Lung Ca	663.67	CVA	615.72	Drug	428.3	Homicide	354.36	5	354.36‡	4919.34‡
Bayview/Hunters Point	CAD	940.67	Lung Ca	678.63	HTN	627.52	CVA	616.84	Homicide	590.60	5	590.60‡	5892.64‡
Western Addition	CAD	697.11	HTN	592.18	CVA	504.79	Lung Ca	476.92	Drug	424.84	7	305.10‡	4610.38‡
Japantown	Lung Ca	718.64	Liver Ca	582.43	Unintentional	566.68	CAD	564.27	Drug	515.80	—	0	4279.95‡
Nob Hill	CAD	741.94	Lung Ca	479.99	HTN	455.30	Drug	418.05	CVA	395.74	20	29.35	4562.82‡
Excelsior	CAD	746.45	Lung Ca	565.37	CVA	370.15	HTN	238.81	EtOH	197.26	19	45.79	3564.14
Outer Richmond	CAD	741.51	CVA	327.67	Lung Ca	327.41	HTN	241.58	Pancreas	190.39	19	33.84	3214.01
Oceanview	CAD	717.49	Lung Ca	379.61	Homicide	352.17	CVA	340.17	HTN	231.01	3	352.17‡	3484.85
Portola	CAD	627.82	Lung Ca	563.38	CVA	412.67	CRC	341.29	Breast Ca	320.96	13	145.78‡	4086.52
North Beach	CAD	655.32	Lung Ca	568.05	EtOH	450.12	HTN	410.29	Drug	312.67	19	61.64	4057.94
Outer Mission	CAD	656.51	CVA	422.39	Lung Ca	344.11	CRC	273.87	HTN	265.74	20	51.22	3539.51
Mission	CAD	685.75	Drug	574.46	HTN	458.71	EtOH	378.18	CVA	332.73	19	95.88	4612.49‡
Inner Richmond	CAD	671.63	Lung Ca	449.99	CVA	359.79	HTN	302.85	CRC	220.75	20	41.74	3131.12
Hayes Valley	CAD	731.47	Lung Ca	558.26	HTN	519.48	Drug	391.17	CVA	377.94	11	225.96‡	4890.48‡
Sunset/Parkside	CAD	612.63	Lung Ca	446.84	CVA	266.95	HTN	206.13	CRC	171.23	19	26.61	3016.30
Lone Mountain/USF	CAD	414.82	CVA	411.07	Lung Ca	305.79	HTN	304.04	CRC	299.56	19	30.91	3227.00
Twin Peaks	CVA	379.05	CAD	330.90	HTN	323.83	Lung Ca	309.97	Suicide	276.51	18	56.58	3180.74
Bernal Heights	CAD	678.12	Lung Ca	452.79	HTN	432.19	CVA	353.35	Alzheimer	284.82	16	130.15‡	4024.73
Inner Sunset	CAD	484.34	Lung Ca	421.73	HTN	232.67	CVA	230.90	Lymph	195.68	20	32.90	2851.52
Mission Bay	Liver Ca	419.45	PNA/flu	382.75	Lung Ca	381.81	HIV	322.35	HTN	250.42	16	68.10	2803.40
Russian Hill	CAD	558.35	Lung Ca	409.95	CVA	313.92	Suicide	260.72	HTN	258.83	19	61.41	3122.19
Glen Park	CAD	885.73	Lung Ca	478.89	CVA	320.70	Pancreas	292.23	PNA/flu	239.05	19	61.48	3575.03
FiDi/South Beach	CAD	660.07	HTN	396.77	Lung Ca	386.40	CVA	347.00	COPD	269.20	19	47.31	3263.32
Presidio Heights	CAD	444.89	Lung Ca	359.43	CVA	300.71	Breast Ca	218.00	Alzheimer	212.43	—	0	2639.13
Pacific Heights	CAD	331.22	Lung Ca	300.05	Suicide	238.75	Pancreas	202.94	EtOH	193.88	20	9.33	2160.24
Haight Ashbury	Lung Ca	639.18	CAD	532.00	Pancreas	369.97	CVA	339.73	CRC	294.97	19	31.18	3926.07

(Continued)

Table 3 Continued

Neighborhood*	COD#1	AYLL COD#1	COD#2	AYLL COD#2	COD#3	AYLL COD#3	COD#4	AYLL COD#4	COD#5	AYLL COD#5	Homicide rank	AYLL homicide	AYLL chronic disease†
Gastro/Upper Market	CAD	617.25	Lung Ca	452.79	HTN	390.20	Suicide	336.45	HIV	309.69	15	79.28	3280.47
Marina	CAD	491.11	Lung Ca	349.25	CVA	290.46	HTN	260.07	Alzheimer	213.41	19	10.66	2828.32
Noe Valley	CAD	628.57	Lung Ca	394.43	HTN	349.11	Suicide	319.41	Alzheimer	245.18	16	92.19	3165.82
West of Twin Peaks	CAD	511.26	Lung Ca	394.22	CVA	287.44	Alzheimer	224.61	Suicide	214.61	20	12.7	2938.47
Seacliff	Lung Ca	650.99	CAD	346.68	Dementia	282.56	HTN	248.84	Liver Ca	166.77	—	0	2109.32
Potrero Hill	CAD	709.78	Lung Ca	574.34	Homicide	518.82	HTN	338.19	Lymph	326.83	3	518.82‡	4087.15
Presidio	HTN	604.50	Drug	604.50	Suicide	479.59	HIV	421.92	Breast Ca	339.16	—	0	2623.36
AllS	CAD	649.65	Lung Ca	448.45	CVA	342.64	Drug	331.49	HTN	331.15	18	125.86	3828.79

*Ordered by increasing median household income.

†Chronic disease = CAD, Lung Ca, CVA, HTN, COPD, CRC, Liver Ca, Alzheimer, Pancreas, DM, Breast Ca, Dementia, HIV, Lymphoma, Drug, ErOH (excluded: PNA/flu, Suicide, Homicide, Unintent)

‡Top 10 highest burdens of AYLL for homicide and chronic disease, respectively

§Including n = 109 non-geocoded deaths and n = 18 deaths from non-included park neighborhoods Golden Gate, McLaren, Lincoln AYLL, adjusted years of life lost; Breast Ca, breast cancer; CAD, ischemic heart disease; COD, cause of death; COPD, chronic obstructive pulmonary disorder; CRC, cancer colon/rectum; CVA, cerebrovascular accident; Drug, Drug use disorder; ErOH, alcohol-attributable diseases and disorders; FiDi, Financial District; HIV, human immunodeficiency virus; HTN, hypertensive diseases; Liver Ca, liver cancer; Lung Ca, lung/trachea/bronchial cancer; Lymph, lymphoma/multiple myeloma; Pancreas, pancreas cancer; PNA/flu, influenza and pneumonia; SoMa, South of Market, Unintent, unintentional, non-transport accidents; USE, University of San Francisco

high outliers when compared with the median across neighborhoods (Fig. 2 and Table 3). Neighborhoods with the highest AYLL for chronic diseases included the Tenderloin, SoMa, Bayview/Hunters Point, Visitacion Valley, and Hayes Valley, with the first three neighborhoods being high outliers (Table 3).

Eight neighborhoods (21.0%) accounted for 47.9% of citywide YLLs, with top contributors being Sunset, Tenderloin, and Mission (Table 2). However, these calculations do not take into account population age-adjustment. There was significant overlap amongst neighborhoods that fell within the top 10 for total AYLL and top 10 AYLL owing to homicide (70%) and chronic diseases (90%; Fig. 4A). Six neighborhoods were within the top 10 across all 3 categories: Tenderloin, SoMa, Bayview/Hunters Point, Visitacion Valley, Western Addition, and Hayes Valley. Two neighborhoods (SoMa and Tenderloin) were high outliers for the total burden of AYLLs (Table 2). When focusing on specific causes of death, certain neighborhoods repeatedly appeared as high outliers with more AYLLs when compared with the median across neighborhoods, including the Tenderloin (N = 9 outliers), SoMa (N = 5), Potrero Hill (N = 3), Bayview (N = 3), and Treasure Island (N = 3; Fig. 2).

The effects of these disease processes can be seen across generations, as indicated by average YLL per death ranges spanning 13.09 years (Seacliff) to 21.11 years (Lakeshore). Lowest average YLLs were from dementia, Alzheimer’s disease, HIV, and influenza/pneumonia, whereas highest averages were overwhelmingly from homicide, making it a leading cause of premature death in San Francisco.

Relationship between deaths and social factors

Certain area-based social factors were shown to be associated with higher neighborhood AYLL burdens (Figs. 3–5 and Supplemental Digital Content 1, available at <http://links.lww.com/XCS/A0>). When examining all causes of death, a neighborhood’s AYLL burden tended to rise with increasing percent population male (630.30 AYLLs per 1 standard deviation change in percent population male, p = 0.02), Black (791.22; p = 0.00), unemployed (542.63; p = 0.08), less than high school education (671.25; p = 0.04), and PBPL (697.93; p = 0.01). This held true for AYLL attributable to homicide and chronic disease across the same social factors. A neighborhood’s percent population Black was associated with the largest increase in AYLL for all deaths (791.22; p = 0.00) and those specifically attributable to chronic disease (613.56; p = 0.01) and homicide (113.72; p = 0.00). Figure 5 graphically shows that neighborhoods with higher percent population Black and PBPL were frequently burdened with more AYLLs, such

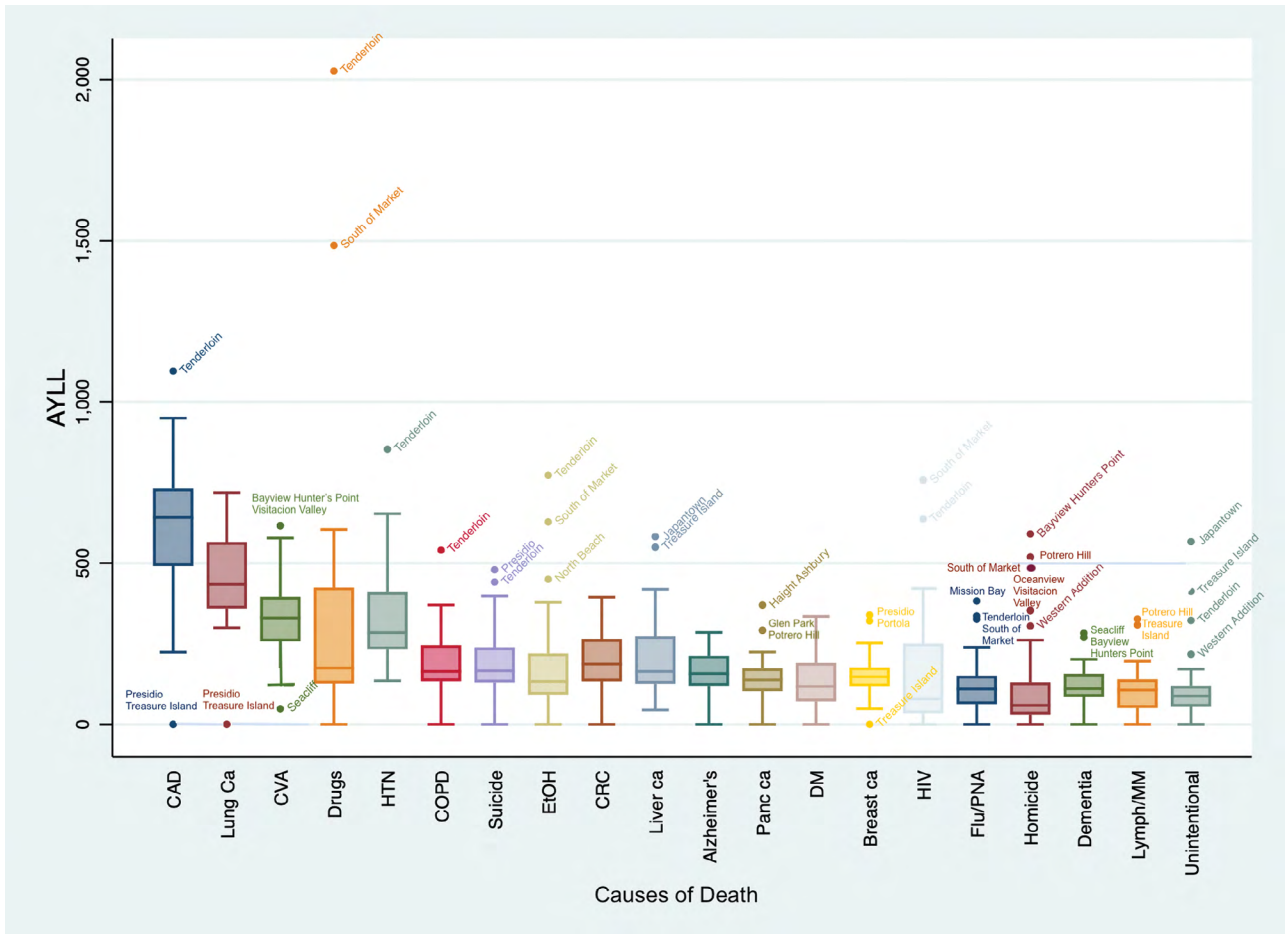


Figure 2. Adjusted years of life lost for the top 20 causes of death in San Francisco by neighborhood. AYLL, adjusted years of life lost; Breast Ca, breast cancer; CAD, ischemic heart disease; COPD, chronic obstructive pulmonary disorder; CRC, cancer colon/rectum; CVA, cerebrovascular accident; DM, diabetes mellitus; Drugs, drug use disorder; EtOH, alcohol-attributable diseases and disorders; HIV, human immunodeficiency virus; HTN, hypertensive diseases; Liver Ca, liver cancer; Lung Ca, lung/trachea/bronchial cancer; Lymph/MM, lymphoma/multiple myeloma; Panc Ca, pancreas cancer; flu/PNA, influenza and pneumonia; Unintentional, unintentional, nontransport accidents.

as SoMa, Tenderloin, Bayview/Hunters Point, Western Addition, and Visitacion Valley.

Of the 38 present-day neighborhoods examined in this study, N = 22 (57.9%) contained areas that were previously redlined (Fig. 4). Of these 22 neighborhoods, 6 neighborhoods were within the top 10 for highest YLLs (2 neighborhoods within the top 10 were ungraded: Tenderloin and SoMa), 5 were within the top 10 for highest average YLL per death (4 were ungraded: Tenderloin, SoMa, Mission Bay, and Treasure Island), 8 were within the top 10 for overall AYLL burden, 8 had the most AYLL attributable to homicide, and 7 had the most AYLL attributable to chronic diseases. Across the above categories, 2 of the most affected neighborhoods that were not redlined (SoMa and Tenderloin) were sparsely settled and not included in the 1937 grading (Fig. 4B).

DISCUSSION

Our study highlights the disproportionate burden of deaths shouldered by socially disadvantaged San Franciscans, many of whom live in neighborhoods that align with areas subjected to past discriminatory policies and persistent structural inequities including disinvestment. These neighborhoods had lower MHI and higher PBPL than citywide levels, were largely majority Black or other minority racial/ethnic group and had higher percentages of unemployment and low education. The key drivers of premature deaths in these neighborhoods were chronic diseases and violence, affecting both the young and old, making it difficult for one generation to take care of another and for entire communities to emerge from a cycle of poverty and poor health. Because individual race/ethnicity is accepted as a social construct,²⁰ racial

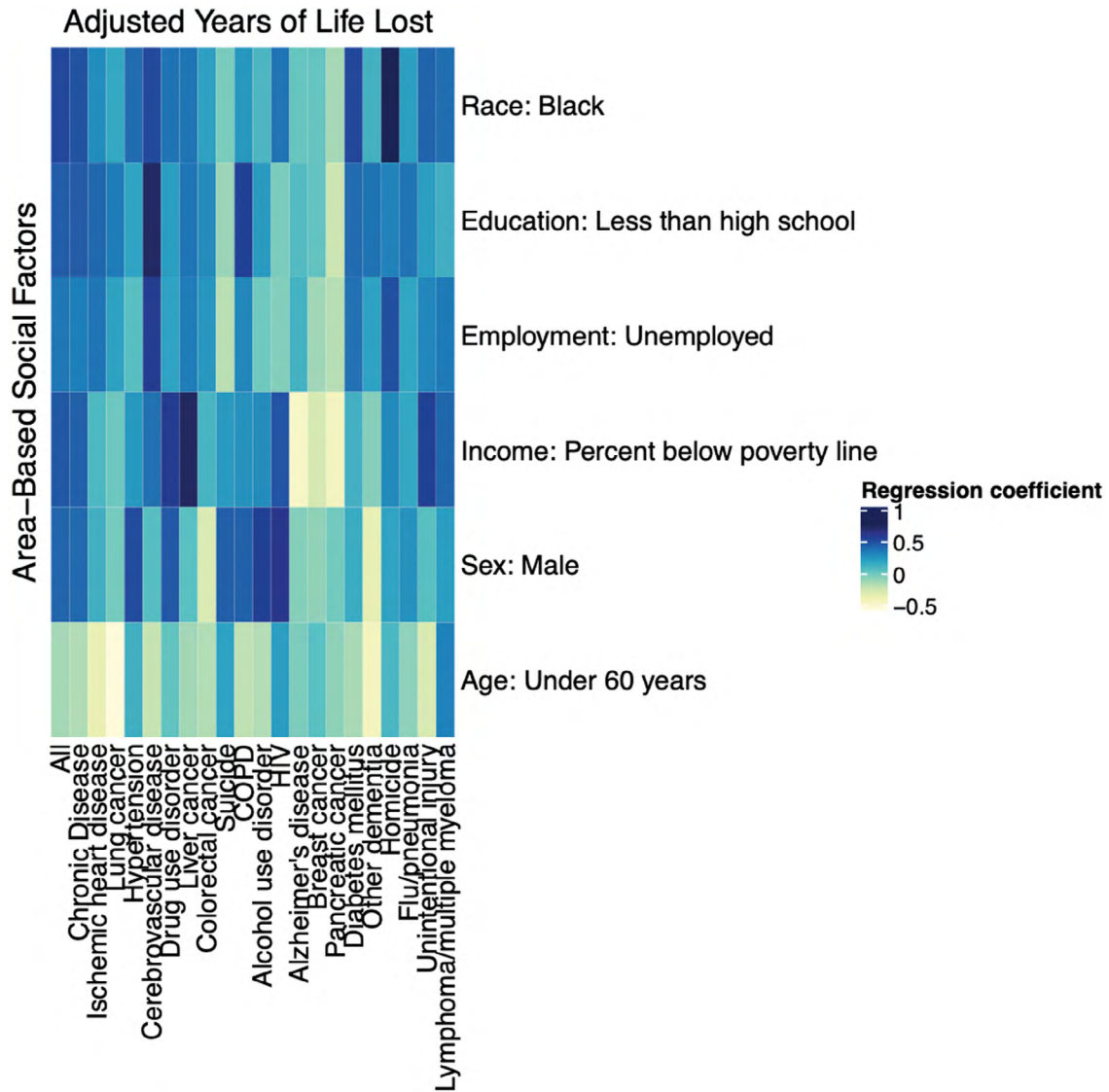


Figure 3. Association between adjusted years of life lost (AYLL) for the top 20 causes of death and select area-based social factors across San Francisco neighborhoods. The causes of death on the x axis are ranked by the sum of AYLL across San Francisco neighborhoods from highest to lowest. COPD, chronic obstructive; pulmonary disorder; HIV, human immunodeficiency virus.

health disparities are the downstream effect of discriminatory and racist policies, such as those tied to place of residence, which caused segregation, displacement, and fragmentation.^{21,22} These disparate health outcomes are persisting with the COVID-19 pandemic disproportionately impacting many of the same disadvantaged communities highlighted in our study.²³

Whereas many studies focus on individual-level social factors when discussing health disparities, there is increased recognition of the significant variation in health outcomes at the neighborhood level²⁴⁻²⁶ and the independent effect place of residence has on its citizens, related

to the “structural” determinants of health.²⁷⁻²⁹ Using data from the Alameda County Study, researchers found an increased 9-year risk of mortality for residents of a federally designated poverty area in Oakland, California, as compared with residents throughout the rest of Oakland, even when controlling for age, sex, race, and numerous other social factors at the individual level.³⁰ Using an index of inequality built on area-based social factors in England, a 15-year study found 1 in 3 premature deaths were attributable to socioeconomic inequality, with obesity, viral hepatitis, drug use, HIV, and tuberculosis as the most unequal contributors.⁷

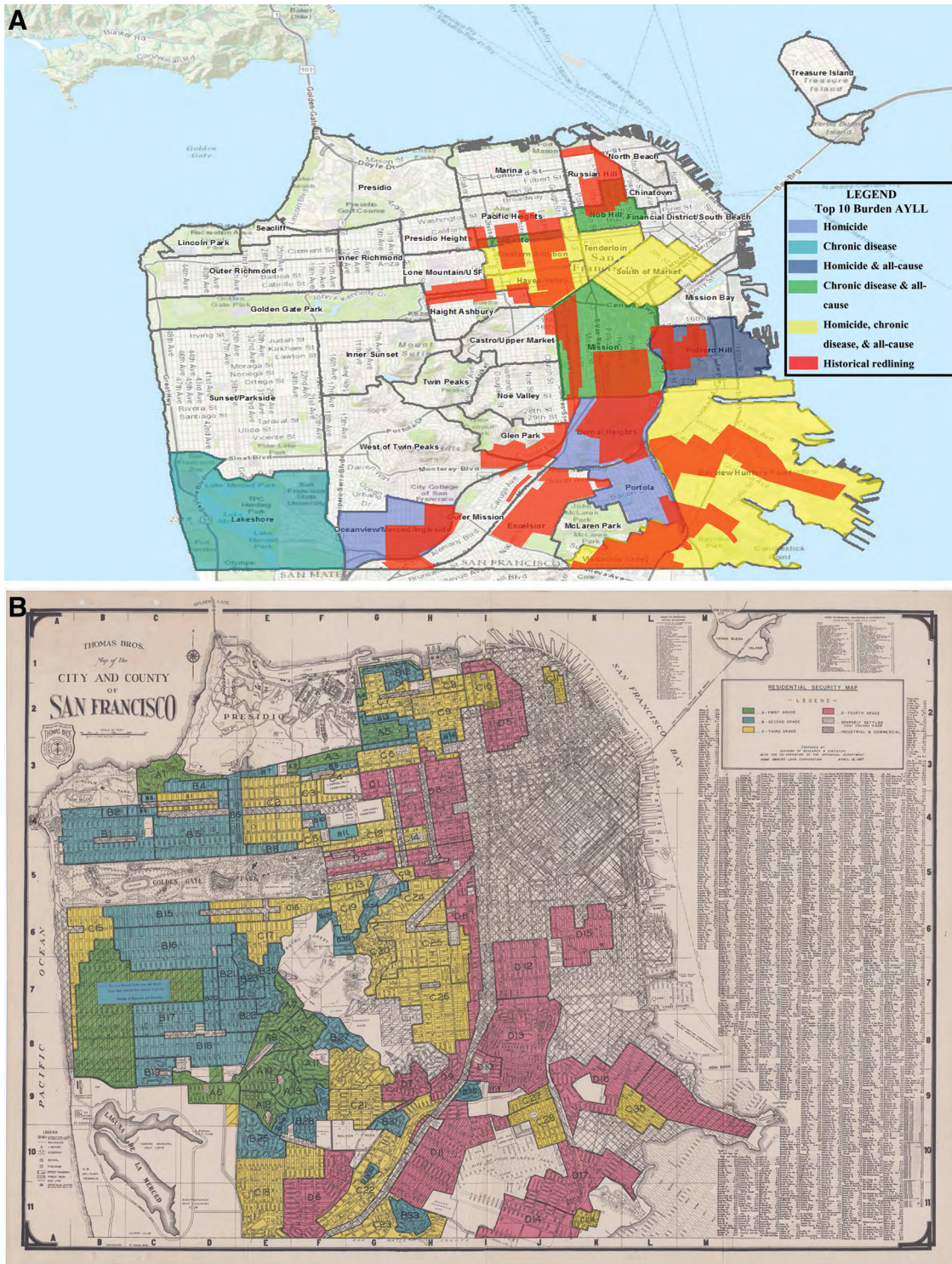


Figure 4. (A) San Francisco neighborhoods with most adjusted years of life lost (AYLL) for homicide, chronic disease, and all-causes for top 20 causes of death juxtaposed with historical redlining. (B) City and County of San Francisco Home Owner's Loan Corporation (HOLC) Residential Security Map (1937).¹⁷ Image provided courtesy of the San Francisco Department of Public Health

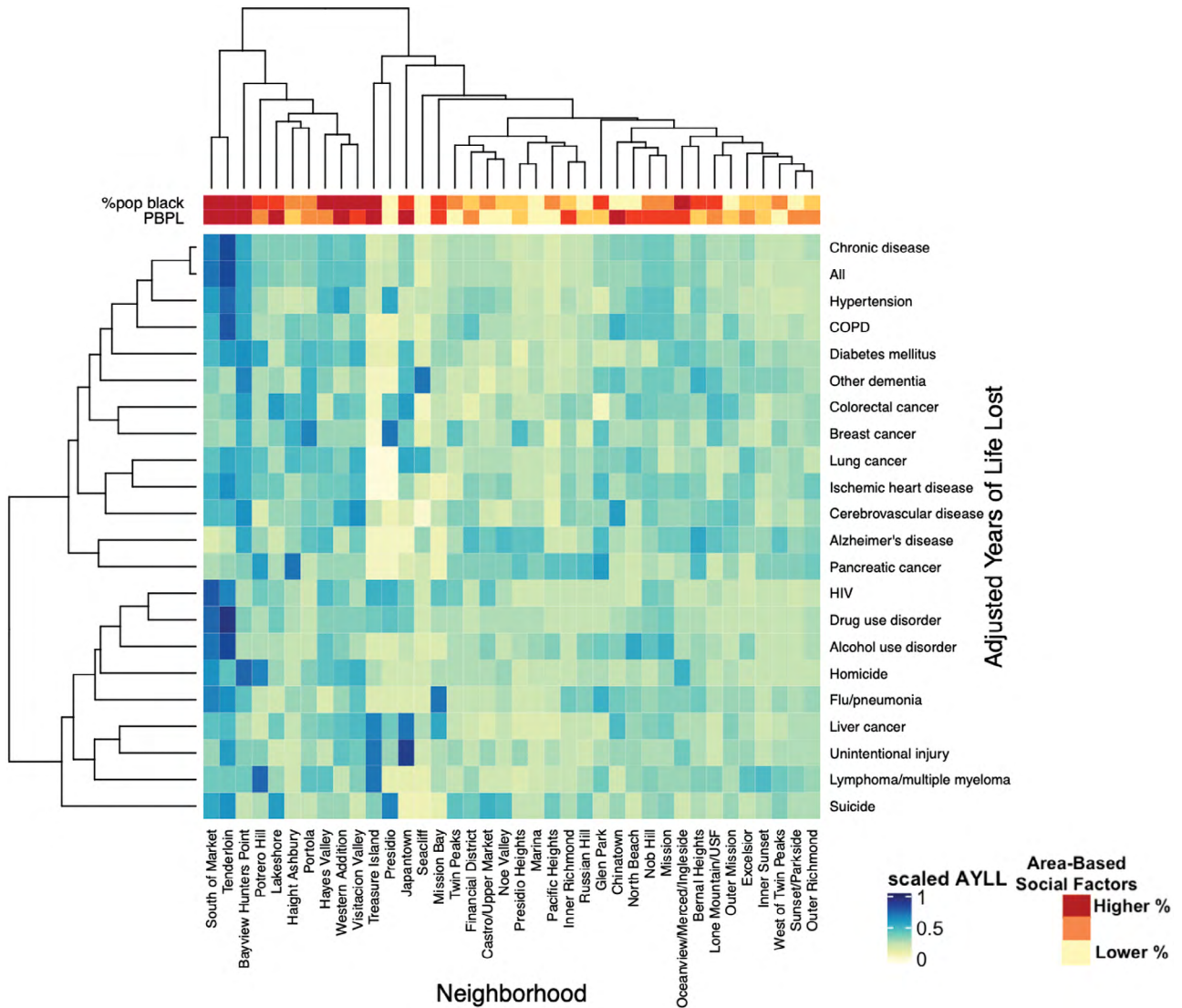


Figure 5. Adjusted years of life lost (AYLL) for the top 20 causes of death, percent population Black (%pop black), and percent population below the poverty level (PBPL) across San Francisco neighborhoods. The hierarchies are generated by the hierarchical clustering algorithm, which clusters similar groups based on a distance matrix. The x axis hierarchical clustering groups similar neighborhoods and the y-axis groups similar AYLLs. COPD, chronic obstructive pulmonary disorder; HIV, human immunodeficiency virus; USF, University of San Francisco.

Physical disability and deaths associated with chronic disease can be intergenerational,^{31,32} and when added to existing barriers from structural racism²¹ this can render entire households economically disadvantaged³³ and reinforces a cycle of worse health outcomes and reduced quality of life.³⁴ Communities plagued by firearm violence have been shown to experience a higher prevalence of preterm birth, asthma, infections, and substance use,³⁵ affecting both the mother and the child. Many battle with concomitant adverse childhood experiences, mental health issues like depression and anxiety, and chronic or toxic stress that are common in poor and unsafe neighborhoods,³⁶⁻³⁸ not

to mention the actual increased risk of severe and/or violent injury or reinjury in socially disadvantaged communities.^{39,40} Although unable to control for individual-level characteristics, our data suggest similar neighborhood social effects on health across generations.

It is clear from our study that specific San Francisco neighborhoods were dually burdened with poor health, as indicated by high AYLL burden, and social disadvantage, including the Tenderloin, SoMa, Bayview/Hunter's Point, Visitacion Valley, Western Addition, and Hayes Valley, some of which have been highlighted in previous studies,^{41,42} with social disadvantage reinforcing if not

driving poor health. Our data show that neighborhoods with scarce educational opportunities, high unemployment, and high levels of poverty had more violent deaths and worse health outcomes, based on AYLL burden, highlighting that without wealth, we cannot have our health. Disinvestment in a community's development and infrastructure, such as lack of roads, green space, financial institutions, grocery stores, and healthcare facilities, has been shown to lead to worse health outcomes,^{43,44} whereas the development of vacant lots leads to less violence and crime and increased perceptions of safety.⁴⁵ Many of the San Francisco neighborhoods highlighted in our study are repeatedly mentioned when discussing food deserts, unhealthy food environments, shortages of health professionals, and low levels of tree canopies, among other community development factors.^{23,46} Many of the same neighborhoods rank poorly on SFDPH's San Francisco Climate and Health Program Community Resiliency Index, a summary of 36 indicators spanning hazards, environment, transportation, community, public realm, housing, economic, health, and demographic categories, with Chinatown, Bayview/Hunter's Point, Downtown/Civic Center (Tenderloin/Hayes Valley), Visitacion Valley, and Treasure Island considered the most vulnerable.⁴⁷

There were select San Francisco neighborhoods that did not follow the patterns outlined above. Despite low social factor rankings, Chinatown did not rank highly in premature deaths. This could be attributable to strong social cohesion and trust within the community from a shared background, which has been associated with improved health outcomes and is suggested by the 80.9% Asian population.⁸ Also of note, the Chinatown area was ungraded on the 1937 HOLC map (Fig. 4B). Although the West of Twin Peaks and Sunset neighborhoods had more advantageous social factors, they shouldered higher YLLs, which could potentially be explained by long-term care facilities in these neighborhoods whose residents were not excluded from the analysis. Future studies will require gathering both individual and area-based social factors to better assess causation. These quantitative data would be enhanced by qualitative, community-based participatory research to further explore the disparities highlighted by our study and to identify and enact effective solutions.

A lot can be acted upon with the current study results. At the hospital level, we can measure a patient's individual SDoH to identify deficits that may be affecting their health. Social care is an essential component of healthcare, as highlighted in a recent study presenting strategies to improve SDoH to attenuate violence.⁴⁸ Additional approaches include implementing trauma-informed care, investing in at-risk communities, and advocacy. Through the Affordable Care Act a hospital is required to look at its

community's needs and identify areas for investment. For example, does the hospital buy its bulk foods from local vendors? Do they have a vocational training program for at-risk communities?⁴⁸ At the city, county, and state level, leaders across sectors must collaborate to remove historical discriminatory policies that continue to disproportionately harm certain communities.

Investigators in other cities who want to use this methodology can start by building relationships with their Departments of Public Health who typically have data on YLL and AYLL. In addition, using the latest census data can serve to overlay important death data with SDoH at the neighborhood level. The combination of these data can set a framework in motion to identify priorities after understanding the impact of chronic diseases and violence on vulnerable populations.

There are several limitations to our study that warrant discussion. Our data lack granularity at the individual-level to control for individual effects, potentially predisposing our conclusions to sociologic fallacy, where we ascribe certain characteristics to the neighborhood instead of the individual.⁴⁹ Neighborhoods also must be considered within the broader context of the cities, counties, and states within which they reside and the policies shaping where people live, as well as changes in place of residence over time. The small effect neighborhoods may have in comparison with individual-level effects for members of discriminated groups must also be considered.²⁹ Our small sample size of 38 neighborhoods could have limited our ability to find statistically significant differences where significant health effects actually existed. However, given our interest in neighborhoods as a relevant social and political construct, as well as the cohesion between our findings and existing literature, we believe the correct level of data was used and we were careful to make statements of association without definite causation.

The data only capture the primary cause of death without comorbidities, suggesting that there is likely a higher burden of disease in these neighborhoods and citywide than we are able to account for. One hundred twenty-seven deaths were removed from the neighborhood-level analysis because of either lack of geocoding or being parks. Although 97 of these deaths were chronic disease-related and 9 were homicides, the majority were drug-related (N = 36) and in total only accounted for 0.81% of overall deaths citywide, which would minimally affect our results. In our decision to select only homicide deaths to represent violence, we could be underestimating the effect of violence in a community. However, we believe this was the most valid approach for our hypothesis given suicide does not represent interpersonal violence, we were unable to further qualify deaths in the category of "injuries of

undetermined intent and their sequelae,” and there was a low number (N = 1) of deaths attributable to legal intervention. We were also limited in gender categories based on census classifications at the time, which will be important to discern and highlight in future analyses owing to worse health disparities for transgender and nonbinary populations.⁵⁰

CONCLUSIONS

Our study highlights the mortality inequity burdening people living in disadvantaged San Francisco neighborhoods. This aligns with areas subjected to historical discriminatory policies like redlining, suggesting social disadvantage and racism are drivers of poor health. These data emphasize the need to address past injustices and move toward equal access to wealth and health for all San Franciscans. This will require cross-sectoral collaboration, commitment, and action to eradicate these deep-seated inequities and to create equal opportunities for all to not only survive but thrive.

Author Contributions

Study conception and design: Boeck, Wei, Robles,

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Analysis and interpretation of data: Boeck, Wei, Robles,

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Drafting of manuscript: Boeck, Wei, Hubbard, Dicker

Critical revision: Boeck, Wei, Robles, Nwabuo, Plevin,

Juillard, Bibbins-Domingo, Hubbard, Dicker

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Invited Commentary

Breaking Down the Inequity Trap in the Golden City

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San Francisco has long been an epicenter for social movements for inclusion and equity. The reason for this, unfortunately, is in part attributable to its long history of exclusion and inequality.¹ As a hub for trade by land and by sea, San Francisco developed a multicultural population, albeit often segregated by ethnicity and social status. Japanese internment opened neighborhoods that were then settled by African Americans seeking refuge from the American south. The ebb and flow within the metroplex changed racial proportions but did not erase segregation or discrimination.

The authors present a timely and novel approach to evaluating the resultant inequity in the social determinants of health in San Francisco.² Their use of a detailed public health database to relate number of deaths to years of life lost is a poignant one. It expands on previous studies