Cancer Outcomes: Does Zip Code Trump Genetic Code?

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What Determines the Health of a Population?

- Genes and Biology
- Health Behaviors
- Medical Care
- Social/Societal Characteristics; Total Ecology
US Cancer Death Rate 1900 to 2010

Age Adjusted to year 2000 Standard
Trends in Cancer Death Rates* Among Males, US, 1930-2012

*Age-adjusted to the 2000 US standard population.

NOTE: Due to International Classification of Diseases coding changes, numerator information for colorectal and lung cancers has changed over time.

Source: National Center for Health Statistics, Centers for Disease Control and Prevention, 2015.
Trends in Cancer Death Rates* Among Females, US, 1930-2012

- Age-adjusted to the 2000 US standard population.
- Uterus includes uterine corpus and uterine cervix combined.
- Includes intrahepatic bile duct.

NOTE: Due to International Classification of Diseases coding changes, numerator information for colorectal, lung, and uterine cancers has changed over time.

Source: National Center for Health Statistics, Centers for Disease Control and Prevention.
Total Number of Cancer Deaths Averted from 1991 to 2012 in Males and 1992 to 2012 in Females

- **Males**: 1,199,200 Cancer Deaths Averted
- **Females**: 512,100 Cancer Deaths Averted

The blue line represents the actual number of cancer deaths recorded in each year, and the red line represents the number of cancer deaths that would have been expected if cancer death rates had remained at their peak.
Cancer Incidence Rates* by Race and Ethnicity, 2008-2012

*Age-adjusted to the 2000 US standard population. †Data based on Indian Health Service Contract Health Service Delivery Area counties. Rates exclude data from Kansas. ‡Persons of Hispanic origin may be of any race.

Cancer Death Rates* by Race and Ethnicity, US, 2008-2012

*Per 100,000, age-adjusted to the 2000 US standard population. †Data based on Indian Health Service Contract Health Service Delivery Area counties. ‡Persons of Hispanic origin may be of any race.

Sources: National Center for Health Statistics, Centers for Disease Control and Prevention, 2015.
Cancer health disparities are differences in the incidence, prevalence, mortality, and burden of cancer and related adverse health conditions, beyond what would be expected under equitable circumstances, that exist among specific population groups in the United States.

These population groups may be characterized by gender, age, race/ethnicity, education, income, social class, disability, geographic location, or sexual orientation.

1 Adapted from the National Cancer Institute, Division of Cancer Control and Population Sciences
Contributors to Cancer Disparities

Patient variables
- Attitudes, expectations, preferences
- Risk Behaviors
  - Diet
  - Obesity
  - Physical inactivity
  - Alcohol
  - Tobacco
- Environmental exposures
- Genetics / Tumor biology
Contributors to Cancer Disparities

• Clinician factors
  » Screening
  » Early diagnosis
  » Treatment

• System variables
  » Accessibility
  » Financial
  » Administrative
Contributors to Cancer Disparities

Social Determinants of Health

- Work settings
- Social norms
- Early childhood development
- Literacy
- Neighborhoods
- Access to healthcare
- Job training
- Public safety
- Social support
- Access to nature
- Economic stability
- Transportation
- Socioeconomic status
- Food security
- Housing design
- Education
- Physical barriers
- Food availability
- Safe housing

Prevention | Early Detection | Diagnosis/Incidence | Treatment | Post-Treatment Quality of Life | Survival and Mortality
Social Determinants and Cancer Disparities

• Key Social Determinants
  - Zip Code/Neighborhood
  - Income/SES
  - Education
  - Insurance status

These social determinants influence all of the previously mentioned individual and clinical factors, and may ultimately play the largest role in cancer risk and outcomes.
Zip Code and Health
Zip Code

• Rapidly growing body of evidence demonstrating the profound impact of “place” on health and health outcomes

• Dr Francis Collins, NIH director, recently tweeted that our ZIP code at birth is our “ZNA, "the blueprint for our behavioral and psychosocial make-up,” critical determinants of health.
“Super Zips”

- Zip codes in the U.S. with the highest per capita income and college graduation rates.
- Term coined by sociologist Charles Murry of American Enterprise Institute.
- 650 Super Zips identified - typical household income is $120,272, and 68 percent of adults hold college degrees.
- Compares with $53,962 and 27 percent college educated in remaining 23,925 Zips
- One of largest clusters of Super Zips surrounds Washington, DC
Short Distance to Large Disparities

- A short, 10 stop outbound ride on the DC metro could mean 9 extra years of life
- Life span disparities reflect differences in wealth, education and environment.
- Differences are even more dramatic—sometimes double—if you compare black and white.
Racial Segregation: Detroit

Source: U.VA Weldon Cooper Center for Public Service
Racial Segregation: Philadelphia

Source: U.VA Weldon Cooper Center for Public Service
Segregation by Race/Income/Education: St. Louis

Source: https://forthesakeofall.org/
Zip Code and Life Expectancy: St. Louis

18 yr difference b/w highest and lowest LE zip codes

Source: https://forthesakeofall.org/
Zip Code and Race: St. Louis

Source: https://forthesakeofall.org/
Zip Code and Poverty: St. Louis

Source: https://forthesakeofall.org/
Zip Code and Cancer Deaths: St. Louis

**Race**

- The concentration of African American population
- Percent African American population by ZIP code

- 1% – 5% (Lowest)
- 6% – 44% (Middle)
- 45% – 97% (Highest)
- No data

**Poverty**

- The concentration of poverty
- Percent of all residents living in poverty by ZIP code

- 1% – 8% (Lowest)
- 9% – 18% (Middle)
- 19% – 54% (Highest)
- No data

**Cancer death rates**

- Cancer death rates per 100,000 for all residents by ZIP code

- 129 – 170 (Lowest)
- 171 – 212 (Middle)
- 213 – 359 (Highest)
- No data

Sources:
- St. Louis County 2018
- Chronic Disease MICA 2009–2010
- American Community Survey 2011–2013 5-year estimates
Lifestyle/Behavior “Choices”

Environmental factors influence individual choices. Poor and minority communities:

- Are provided with fewer opportunities for safe recreational physical activity (“Park Deserts”);
- Often have limited access to fresh fruit and vegetable and healthy food choices (“Food Deserts”)
Zip Code and Availability of Healthy Food

Poverty

B) The concentration of poverty
Percent of all residents living in poverty by ZIP code

- 1% – 8% (Lowest)
- 9% – 18% (Middle)
- 19% – 44% (Highest)
- No data

Source: American Community Survey 2007-2011 5-year estimates

Source: CDC, Division of Nutrition, Physical Activity and Obesity
Notes: The Modified Retail Food Environment Index (mRFEI) evaluates the availability of quality, nutritious retail foods. Indicator statistics are available by state and by US census tract; data was extracted from University of Missouri’s CARES 2013
Lifestyle/Behavior “Choices”

Environmental factors influence individual choices. Poor and minority communities:

- Are provided with fewer opportunities for safe recreational physical activity (“Park Deserts”);
- Often have limited access to fresh fruit and vegetable and healthy food choices (“Food Deserts”);
- Are disproportionately targeted with advertising and businesses that “normalize” unhealthy behaviors
SES and Cancer Outcomes
Wealth Disparities

FIGURE 1. MEDIAN NET WORTH BY RACE, 1984-2009
Wealth Disparities

FIGURE 2: WHAT’S DRIVING THE INCREASING RACIAL WEALTH GAP

- Number of Years of Homeownership
- Household Income
- Unemployment
- College Education
- Financial Support/Inheritance
Cancer Surgery Outcomes by Patient SES

Reames et al, JAMA Surg 2014
Cancer Surgery Outcomes by Hospital SES

Reames et al, JAMA Surg 2014
Insurance and Cancer
Proportion of cancer patients presenting with localized, regional, or distant disease by insurance status (SEER 2007-2010)

Walker et al, JCO 2014
ORs and 95% CIs for not undergoing cancer-directed surgery and/or receiving radiation therapy for patients with nonmetastatic disease

Walker et al, JCO 2014
Cause-specific survival by insurance status for patients with one of 10 most deadly cancers

Walker et al, JCO 2014
Social Determinants and Colorectal Cancer
Trends in Colorectal Cancer Death Rates* by Race/Ethnicity and Sex, US, 1975-2010

Mortality, Male

Mortality, Female

Rate per 100,000 people

Year of death


White*
Black*
API†
Hispanic†‡

White*
Black*
API†
Hispanic†‡
AI/AN Age-adjusted CRC Death Rates and Joinpoint Trend Lines in CHSDA Counties, 1990-2009, Males
AI/AN Age-adjusted CRC Death Rates and Joinpoint Trend Lines in CHSDA Counties, 1990-2009, Females
Annual colorectal cancer death rates by educational attainment and race/ethnicity, US, 2008 to 2010
Why is CRC Screening Important?

• Decline in incidence and mortality due to:
  – Screening → earlier detection → improved survival
  – Screening → polyp removal → prevention

• Estimated that screening may have prevented 550,000 cases of colorectal cancer in the US over the past three decades

Yang, Cancer 2014
CRC screening rates by education and income (NHIS 2010)
CRC Screening Rates by Income

Source: MMWR 2012
Screening Rates: Insurance
• Large geographic disparities in CRC death rates persist
• Spatial identification of high-risk areas can facilitate targeted screening interventions to close this gap
• Spatial mapping identified three distinct hotspots in the contemporary United States where colorectal cancer death rates were elevated.
Hotspot analysis of county-level CRC death rates during the past four decades.
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Hotspots with higher CRC death rates

Hotspot #1

- 94 counties in the Lower Mississippi Delta [Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee.
- Rates here were 40% higher than the non-hotspot U.S. rates
Hotspot #2 - West Central Appalachia

107-county area spanning:
- Kentucky (60 counties)
- Ohio (22)
- West Virginia (19)
- Indiana (6)

Demographics:
- 89% white (2009-2011)
- ≥20% poverty in most counties in central Appalachia
- Uninsured rate is more than 19% in the majority of counties; as high as 25% in many counties

CRC screening in all states in this region are below national median
- West Virginia ranks in the lowest quartile of all states.
- Screening rates in Ohio Appalachia may be as low as 49%.
Contributing factors to geographic disparities

High prevalence of CRC risk factors
- Adult obesity higher than US median in all hotspot states except Virginia
- Dietary patterns, particularly in the Delta, conducive to CRC development (e.g., high red meat consumption)

Limited access to CRC screening and treatment services
- High rates of poverty, low levels of education & health literacy, high proportion of uninsured = limited health care access
- Rural areas = fewer clinical specialists available for CRC screening and treatment
- Only 6 of 12 hotspot states (AR, IL, IN, KY, OH, and WV) have expanded Medicaid as part of the Affordable Care Act
CRC deaths that could be avoided annually in each state by eliminating racial/ethnic, socioeconomic, and geographic inequalities (age 50 to 64 years)

Jemal et al, JCO 2014
Equality doesn’t mean Equity
“You’ll be happy to know that race played no part in this decision.”