The Causes and Consequences of Cancer Health Disparities

Bríd M. Ryan, PhD, MPH
Laboratory of Human Carcinogenesis, Center for Cancer Research, NCI
ryanb@mail.nih.gov

TRACO 2018

October 12, 2018
Overview

- **Part 1:** Discussion of key cancer health disparities in the US
- **Part 2:** Discussion of key factors that contribute to disparities
- **Part 3:** Looking forward
Race and Ethnicity

- **Race:** Biological differences between groups assumed to have different bio-geographical ancestries or genetic makeup.

- **Ethnicity:** A multi-dimensional construct reflecting biological factors, geographical origins, historical influences, shared customs, beliefs and traditions among populations that may not have common genetic origin.

- Both are important factors to consider in trying to research, understand and diminish cancer disparities.
Health Disparities in the United States

Racial differences in life expectancy in the United States

**Black men life expectancy:**
6.5 years shorter

**Black women life expectancy:**
5 years shorter

**Contributing Factors**

Adapted from JAMA 2007 297:11 1227
Cancer Disparities: Definition

The NCI defines "cancer health disparities" as:

"differences in the incidence, prevalence, mortality, and burden of cancer and related adverse health conditions that exist among specific population groups in the United States.”
Cancer Disparities: Definition

Excess Burden of Cancer in the African-American Community

“African-Americans have the highest death rates from all cancer sites combined, and from malignancies of the lung, colon and rectum, breast, prostate, and the cervix of all racial groups in the United States”
Cancer Disparities

From: Number of Deaths per 100,000 Persons by Race/Ethnicity & Sex: Cancer of Any Site
Younger age at diagnosis for most cancers

Robbins et al., J Natl Cancer Inst (2015) 107 (3)
Younger age at diagnosis for most cancers

Cancers mainly diagnosed at younger age in black men and women
  NHL, anal cancer, Kaposi sarcoma and soft tissue

Etiologic heterogeneity
  Cause of the cancer differs across groups, causes cancer at different ages
  Subtypes can be caused by different factors – can contribute to disparities

Timing or intensity of exposure
  For example, exposure to tobacco could occur earlier in one population

Timing, prevalence and frequency of early cancer detection
  Screening, or through follow after an incidental finding

NCI Early Onset Malignancy Initiative
  The Center for Cancer Genomics (CCG) in collaboration with the Division of Cancer
  Prevention’s NCI Community Oncology Research Program (NCORP) invited the twelve
  Minority/Underserved NCORP sites to participate in this project
Cancer Health Disparities: Second cancers

African Americans also have a higher risk of certain second cancers
Site-specific risk of second primary cancer in women with endometrial cancer according to race (1973-2007)

<table>
<thead>
<tr>
<th>Second Cancer Site</th>
<th>White (n = 10,584) SIR (95% CI)</th>
<th>Black (n = 463) SIR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sites (N = 11,047)</td>
<td>0.85 (0.84–0.87)</td>
<td>1.19 (1.08–1.31)</td>
</tr>
<tr>
<td>Solid tumors (N = 9744)</td>
<td>0.85 (0.83–0.87)</td>
<td>1.19 (1.08–1.31)</td>
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<tr>
<td>Digestive system (N = 2854)</td>
<td>0.97 (0.93–1.01)</td>
<td>1.37 (1.16–1.61)</td>
</tr>
<tr>
<td>Colon and rectum (N = 1949)</td>
<td>1.02 (0.97–1.07)</td>
<td>1.53 (1.24–1.87)</td>
</tr>
<tr>
<td>Liver (N = 40)</td>
<td>0.58 (0.41–0.80)</td>
<td>1.17 (0.32–2.99)</td>
</tr>
<tr>
<td>Pancreas (N = 356)</td>
<td>0.88 (0.79–0.98)</td>
<td>0.97 (0.56–1.55)</td>
</tr>
<tr>
<td>Respiratory system (N = 1382)</td>
<td>0.72 (0.68–0.76)</td>
<td>1.09 (0.84–1.39)</td>
</tr>
<tr>
<td>Breast (N = 3448)</td>
<td>0.98 (0.95–1.01)</td>
<td>1.01 (0.82–1.23)</td>
</tr>
<tr>
<td>Female genital system (N = 448)</td>
<td>0.65 (0.59–0.71)</td>
<td>1.48 (1.03–2.07)</td>
</tr>
<tr>
<td>Urinary system (N = 801)</td>
<td>1.19 (1.11–1.28)</td>
<td>1.80 (1.25–2.52)</td>
</tr>
</tbody>
</table>

Digestive system: esophagus, stomach, small intestine, colon and rectum, liver, gallbladder, and pancreas.
Respiratory system: lung and bronchus.
Female genital system: ovary, cervix, vagina, and vulva.
Urinary system: urinary bladder, ureter, kidney, and renal pelvis.

*Int J Gynecol Cancer. 2011 21(2): 309–315*
Survival Health Disparities by Cancer Site

1. African Americans have the highest rate of cancer specific mortality
2. Racial differences are not reducing over time (overall)
3. Breast cancer—disparities might be increasing
4. Prostate cancer—disparities might be improving

AA = African-American; EA = European-American

Aizer et al., Cancer 2014, 120: 1532-9
Zeng et al., Jama Oncology 2015 1: 88-96
Some of the reasons for disparities in cancer mortality: Lack of early detection?
Barriers to screening exist in some populations, including minority and rural.

Breast cancer mammography use similar in equal access to care setting (Cancer 2013 119(19):3531-8).

Colorectal cancer screening is lower among African Americans even in an equal access to care setting (Cancer. 2013; 4(3): 270–280).

Uptake of screening for other cancers, such as HPV, may also be lower in minority populations.

But mortality differences exist even in cancers where there is no validated screening modality (liver, esophagus, etc).
Table 2  Numbers and per cent of lung cancers diagnosed in the NCI-MD case–control study from 1998 to 2015 that fall within guidelines for lung cancer screening

<table>
<thead>
<tr>
<th>Criteria</th>
<th>NLST*</th>
<th></th>
<th>USPSTF†</th>
<th></th>
<th>CMS‡</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>EA</td>
<td>AA</td>
<td>EA</td>
<td>AA</td>
<td>EA</td>
<td>AA</td>
</tr>
<tr>
<td>All (n=1141 EA, n=517 AA)</td>
<td>381 (33.4%)</td>
<td>161 (31.1%)</td>
<td>449 (39.4%)</td>
<td>176 (34.0%)</td>
<td>421 (36.9%)</td>
<td>171 (33.1%)</td>
</tr>
<tr>
<td>p Value</td>
<td>0.355</td>
<td></td>
<td>0.036</td>
<td></td>
<td>0.134</td>
<td></td>
</tr>
<tr>
<td>Men (n=600 EA, n=270 AA)</td>
<td>231 (38.5%)</td>
<td>98 (36.3%)</td>
<td>269 (44.8%)</td>
<td>110 (40.7%)</td>
<td>255 (42.5%)</td>
<td>105 (38.9%)</td>
</tr>
<tr>
<td>p Value</td>
<td>0.392</td>
<td></td>
<td>0.119</td>
<td></td>
<td>0.168</td>
<td></td>
</tr>
<tr>
<td>Women (n=541 EA, n=247 AA)</td>
<td>150 (27.7%)</td>
<td>63 (25.5%)</td>
<td>180 (33.3%)</td>
<td>66 (26.7%)</td>
<td>167 (30.9%)</td>
<td>66 (26.7%)</td>
</tr>
<tr>
<td>p Value</td>
<td>0.350</td>
<td></td>
<td>0.007</td>
<td></td>
<td>0.083</td>
<td></td>
</tr>
</tbody>
</table>

Bold signifies statistical significance.
Data based on smoking status, pack-years of smoking, time since quitting and age.
*NLS criteria: aged 55–74, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
†USPSTF criteria: aged 55–80, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
‡CMS criteria: aged 55–77, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
AA, African American; CMS, Centers for Medicare & Medicaid Services; EA, European Americans; NLST, National Lung Screening Trial; USPSTF, US Preventive Services Task Force.

Some of the reasons for disparities in cancer mortality: Access to care?

(A) Breast cancer ($n = 17,939$)

(B) Cervical cancer ($n = 1,832$)

(C) Colorectal cancer ($n = 7,445$)

(D) Lung cancer ($n = 8,185$)

Cancer Medicine 2013; 2(3): 403–411
Factors affecting disparities in cancer mortality

“Stage at diagnosis had the largest effect on racial/ethnic survival disparities, but earlier detection would not entirely eliminate them. The influences of neighborhood socioeconomic status and marital status suggest that social determinants, support mechanisms, and access to health care are important contributing factors.”

A

B

JCO 2018 36(1):25-33
Some of the reasons for disparities in cancer mortality: Access to care?
Some of the reasons for disparities in cancer mortality: Access to care?

Multiple myeloma
Increased incidence among African Americans but adverse disparities in outcome not observed
African Americans may have a more indolent form of MM

AA patients with myeloma have better survival than EA patients

Waxman et al. *Blood* 2010
Some of the reasons for disparities in cancer mortality: Access and uptake of care?

- Even among those with Medicare, AA are less likely to receive treatment for lung cancer (Cancer 2008 112 900-908)

- African American renal cancer patients are less likely to receive surgical treatment (nephrectomy) and die more often from competing causes than European American patients (J Clin Oncol 2007, 25: 3589 – 3595)
Some of the reasons for disparities in cancer mortality: Access and uptake of care?

In a setting of equal access to care, African Americans with colon cancer are as less likely to receive surgery and chemotherapy as European Americans.
Perception and Behavior

African Americans were more likely to hold beliefs about lung cancer that could interfere with prevention and treatment (Health Information National Trends Survey)

- 3 times less likely to get a lung cancer check up
- 2 times more likely to expect symptoms before diagnosis
- 2 times less likely to agree that getting checked for lung cancer could help find the disease early
- Perceptions expressed unlikely to affect lung cancer incidence – more related to outcome
Potential factors that influence uptake of care

- Personal beliefs
- Fear
- Culture
- Patient-doctor relationship
- Patient bias
- Provider bias
- Patient-doctor communication
- Co-morbid conditions
Similar access to care does not equate to equal access to quality care

In a “regular” medical setting, studies show that racial disparity in specialist consultation as well as subsequent treatment with multimodality therapy for metastatic colorectal cancer exists.

Adapted from JNCI 2013 105(23):1814-20
For some cancers, disparities persist even in equal access to care settings

JNCI 91:17, 1999
JNCI Monographs, No. 35, 2005
Is biology a contributing factor?

  - Intrinsic differences in tumor biology influencing disease aggressiveness?
  - Differences in response to therapy?

![Graph showing association between race and survival in a clinical trial setting](image)
Biological factors that contribute to cancer disparities

- What role, if any, does biology play in cancer health disparities?
African Americans are more likely to be diagnosed with Aggressive Prostate Cancer
Genetic susceptibility

• Racial differences in prevalence of 8q24 prostate cancer susceptibility variants (~ 50%)
  • Admixture mapping identified 8q24 as a locus of increased risk for African-American men when compared to European-American men (PNAS 2006, 103: 14068-73)
  • Risk alleles are more common among African-American men, leading to the highest population attributable risk conferred by 8q24 in this population (Nat Genet 2007, 39: 638 – 44 & 954 – 6)
  • Excess of African ancestry at 8q24 (Hum Genet 2009 Nov;126(5):637-42)
  • Risk variants rs114798100 and rs111906923 are only found in men of African descent (JNCI 2016 108 (7))

• Racial differences in prevalence of 17q21 prostate cancer susceptibility variants (~ 10%)
  • Risk alleles of a new locus, rs7210100 are more common in populations of African descent (Nat Gen 2011, 43: 570-573)
Germline Genetics

- **8q24 is associated with higher grade, more aggressive prostate cancers**
  - Risk alleles are more common among AA men, *(Powell et al., J Urology 2010, 183: 1792 – 7)*
- **Faster disease progression in AA men (vs. EA men)** *(Powell et al., J Urology 2010, 183: 1792 – 7)*
Germline Genetics: Admixture

African and European ancestry in self-identified African Americans can vary widely.

West African Ancestry Among Self-Reported African Americans

Ryan, unpublished
Germline Genetics

• Increased proportion of Native American ancestry is associated with increased risk of childhood acute lymphoblastic leukemic

• Screening implications

• Also related to treatment—Children with more than 10% Native American ancestry need an additional round of chemotherapy to respond to the treatment (Yang et al., Nature Genetics 2011 43(3); 237-241)

• Ancestry informative markers provide a greater granularity to studying race in genetic and genomics studies
Somatic Genetics

A

![Diagram showing mutations in EPHA6 and FLCN genes.]

B

<table>
<thead>
<tr>
<th>Hugo_Symbol</th>
<th>Tumor_ID</th>
<th>Race</th>
<th>Colon cancer Stage</th>
<th>Screen</th>
<th>Variant_Class</th>
<th>Protein_Change</th>
<th>Tumor_Mutant allele frequency</th>
<th>PPH2_Class</th>
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<td>AA</td>
<td>Stage IV</td>
<td>Discovery</td>
<td>Missense</td>
<td>R203W</td>
<td>0.20</td>
<td>Deleterious</td>
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<td>Stage IV</td>
<td>Discovery</td>
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<td>Nonsense</td>
<td>R527*</td>
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<td></td>
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</tbody>
</table>

Guda PNAS 2015 112:4 1149-1154
Somatic Genetics

- Global heterogeneity in acquired mutational events in prostate tumors: Evidence of a different disease etiology?

- High frequency of oncogenic TMPRSS2:ERG gene fusion events in European/European-American patients (about 50%), intermediate frequency in African-American patients (24%-31%), but rather uncommon in Asian patients (2%-16% among Chinese, Japanese patients)

- Common PTEN loss in European/European-American patients (30%-50%) but uncommon in Asian and African-American patients (5%-15%)
Somatic Genetics

- Breast, head and neck, and endometrial cancers of African Americans have higher levels of chromosomal instability than those of European Americans

- The frequency of genetic alterations in the PI3K pathway in AA patients is lower

Cancer Cell 2018 34(4):549-560
Molecular subtype

- Population differences in molecular subtypes and disease grade
- Race/ethnic disparity in prevalence of basal-like/triple-negative breast tumors

<table>
<thead>
<tr>
<th>Variables</th>
<th>Black</th>
<th></th>
<th>White</th>
<th></th>
<th>Crude</th>
<th>Adjusted&lt;sup&gt;a&lt;/sup&gt;</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>OR  95% CI</td>
<td>OR  95% CI</td>
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<tr>
<td>1</td>
<td>153</td>
<td>30.7</td>
<td>218</td>
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<tr>
<td>2</td>
<td>263</td>
<td>52.7</td>
<td>187</td>
<td>41.0</td>
<td>2.00 (1.52–2.65)</td>
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<tr>
<td>3</td>
<td>83</td>
<td>16.6</td>
<td>51</td>
<td>11.2</td>
<td>2.32 (1.55–3.47)</td>
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<td>Mitotic activity</td>
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<td>25.6</td>
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<td>3</td>
<td>89</td>
<td>18.1</td>
<td>44</td>
<td>9.8</td>
<td>2.36 (1.59–3.52)</td>
<td>2.05 (1.34–3.14)</td>
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<td>Tubular formation&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>77.6</td>
<td>266</td>
<td>63.9</td>
<td>1.00</td>
<td>1.00</td>
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<td>Moderate and well</td>
<td>109</td>
<td>22.4</td>
<td>150</td>
<td>36.1</td>
<td>0.51 (0.38–0.69)</td>
<td>0.57 (0.42–0.77)</td>
</tr>
<tr>
<td>Grade</td>
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<td></td>
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<td>295</td>
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<td>57.7</td>
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<tr>
<td>3</td>
<td>96</td>
<td>19.2</td>
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<td>13.9</td>
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<td>1.58 (1.02–2.45)</td>
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<td>Estrogen receptor</td>
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<tr>
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<td>Positive</td>
<td>231</td>
<td>55.5</td>
<td>247</td>
<td>63.3</td>
<td>0.72 (0.55–0.96)</td>
<td>0.78 (0.58–1.05)</td>
</tr>
</tbody>
</table>
However, breast cancer survival disparity in US is irrespective of some tumor subtypes (JNCI 2009, 101: 993-1000)
- Lung tumors from African Americans a greater representation of stem cell pathways.
Cell biology

- Identification of an Interferon signature in prostate cancer tumors from African American men
- The signature is linked with a germline mutation

Table 1. IFNL4 rs368234815-ΔG allele is associated with occurrence of IRDS in prostate tumors

<table>
<thead>
<tr>
<th>IFNL4 genotype, N (%)</th>
<th>Fisher's exact test</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>All tumors, N = 44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TT/TT or TT/ΔG</td>
<td>ΔG/ΔG</td>
<td>P</td>
</tr>
<tr>
<td>IRDS-negative</td>
<td>23 (92%)</td>
<td>2 (8%)</td>
</tr>
<tr>
<td>IRDS-positive</td>
<td>8 (42%)</td>
<td>11 (58%)</td>
</tr>
<tr>
<td>Only tumors from AA men, n = 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRDS-negative</td>
<td>6 (75%)</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>IRDS-positive</td>
<td>4 (27%)</td>
<td>11 (73%)</td>
</tr>
</tbody>
</table>

²Adjusted for age at diagnosis and pathological stage.

Biological differences can translate to a need for different biomarkers

Inflammation proteins are higher at the time of diagnosis-potential use for early detection
Cancer-associated inflammation profile is different in African and European Americans

<table>
<thead>
<tr>
<th></th>
<th>African Americans (N = 255)</th>
<th>European Americans (N = 566)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases/Controls</td>
<td>OR (95% CI)*</td>
</tr>
<tr>
<td><strong>IL-1β</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12/57</td>
<td>1.00 (referent)</td>
</tr>
<tr>
<td></td>
<td>20/35</td>
<td>2.28 (0.87 – 5.99)</td>
</tr>
<tr>
<td></td>
<td>24/41</td>
<td>2.58 (1.02 – 6.50)</td>
</tr>
<tr>
<td></td>
<td><strong>29/37</strong></td>
<td><strong>3.61 (1.46 – 8.95)</strong></td>
</tr>
<tr>
<td><strong>IL-10</strong></td>
<td><strong>16/55</strong></td>
<td><strong>1.00 (referent)</strong></td>
</tr>
<tr>
<td></td>
<td>16/41</td>
<td>1.35 (0.53 – 3.40)</td>
</tr>
<tr>
<td></td>
<td>31/38</td>
<td>4.11 (1.69 – 9.99)</td>
</tr>
<tr>
<td></td>
<td><strong>22/36</strong></td>
<td><strong>2.19 (0.88 – 5.24)</strong></td>
</tr>
</tbody>
</table>

* Adjusted for age (continuous), sex, smoking pack-years (continuous), smoking status (never, former quit ≤15 years, former quit >15 years, and current),
Geographical factors contribute to cancer disparities

The number of people who get cancer is called cancer incidence. In the United States, the rate of getting cancer varies from state to state.

**Highest**
- Kentucky
- Rhode Island
- Delaware
- Louisiana
- New Jersey

**Lowest**
- New Mexico
- Arizona
- Wyoming
- Alaska
- Virginia
Cancer Health Disparities: Contributing Factors are Multifactorial

- Exposures, Behavior and Lifestyle
- Social Determinants
- Access to Care
- Genetic Susceptibility & Biology
Geographical factors contribute to cancer disparities

• A low socioeconomic status (SES) neighborhood confers additional incidence or mortality risk beyond individual SES (*J. Epidemiol. Community Health* 2003, 57:444-52)
  • Unequal burden of pollution
  • Access to preventative services (eg tobacco cessation)
  • Areas with the highest percentage of African Americans have the highest exposure to cancer-associated pollutants (*Environ Health Perspect.* 2005 113(6): 693–699)

• Rural populations are more likely to have increased cancer incidence, unequal burden of pollution
  • Forego medical care and prescriptions due to cost
  • Report fair/poor health and health-related unemployment
  • Experience psychosocial distress
Rural cancer disparities included higher rates of tobacco associated, HPV associated, lung and bronchus, cervical and colorectal cancers across most population groups.

- HPV-associated cancer incidence rates increased in rural areas (APC=0.724, p<0.05) while temporal trends remained stable in urban areas.

- Cancer rates associated with modifiable risks - tobacco, HPV, and some preventive screening modalities (e.g. colorectal and cervical cancers) - were higher in rural compared to urban populations.

Impact: Population-based, clinical, and/or policy strategies and interventions that address these modifiable risk factors could help reduce cancer disparities experienced in rural populations.

Weaver KE et al., Cancer Causes Control, 2013.
Weaver KE et al., Cancer, 2013.
Zahnd et al. CEBP 2017
Rural-Urban Disparities in Cancer Mortality

CDC Surveillance Summaries / July 7, 2017 / 66(14);1–13
Rural-Urban Cancer Disparities

Houston..... Ryan... *Journal Thoracic Oncol* 2018 (13) 4: 497-509
Lung cancer incidence is highest in African Americans despite having the second to lowest prevalence of high intensity smoking.
Tobacco Disparities

• Initiate smoking later (average age at onset, 17.4 years for blacks versus 14.7 years for whites; $p < .05$)

• Smoke fewer cigarettes (14.1 versus 18.4 cigarettes per day)

• Disparities observed in never smokers

• Menthol cigarettes not associated with increased risk of lung cancer relative to non-menthol cigarettes

• Less likely to quit smoking
Tobacco Disparities

Figure 1. Predicted Rates of Lung Cancer among Men Who Currently Smoke 10 Cigarettes per Day (Panel A) or 30 Cigarettes per Day (Panel B) and among Women Who Currently Smoke 10 Cigarettes per Day (Panel C) or 30 Cigarettes per Day (Panel D).
Tobacco Disparities

- Evidence for population differences in the amount of nicotine extracted per cigarette, unclear yet if this explains the disparity in lung cancer incidence.

Figure 1. CYP2A6 activity and TNE stratified by racial/ethnic group. (A) The urinary ratio of total 3-HCOT to cotinine adjusted for age, sex, CPD and TNE; (B) TNE by racial/ethnic group adjusted for age, sex, BMI and CPD (hatched bars) and additionally adjusted for CYP2A6 activity (black bars). *P < 0.04, **P < 0.001, ***P < 0.0001 for difference between this group and Whites.
Racial differences in continued smoking may be attributable to several factors

➢ Socioeconomic vulnerabilities (including poverty, stress, and secondhand smoke exposure)

➢ Although the majority of black smokers express a desire to quit, they are less likely to receive and use evidence-based treatments (e.g., screening for tobacco use and advice to quit, smoking cessation pharmacotherapy, and counseling).

➢ In addition, black smokers are less likely to enroll in smoking cessation trials.

➢ Black smokers are more likely to smoke mentholated cigarettes, which might be harder to quit than nonmentholated cigarettes, which leads to poorer cessation outcomes.

➢ Less accurate knowledge about the risks and prevalence of smoking and about the benefits and risks of effective smoking cessation treatments.
Cancer Health Disparities Summary

RESEARCH PRIORITIES (Joint AACR, ASCO, ACS and NCI statement)

1) Defining and improving data measures for cancer disparities research
2) Addressing disparities in cancer incidence
3) Addressing cancer survival disparities
4) Improving community engagement in cancer research
5) Redesigning cancer clinical trials to acknowledge and address cancer disparities
Rural-Urban Disparities in Cancer Mortality

• The U.S. Preventive Services Task Force recommends population-based screening for colorectal, female breast, and cervical cancers among adults at average risk for these cancers and for lung cancer among adults at high risk.

• Screening adults for tobacco use and excessive alcohol use, offering counseling and interventions as needed; and using low-dose aspirin to prevent colorectal cancer among adults considered to be at high risk for cardiovascular disease based on specific criteria.

• Recommendation for vaccination against cancer-related infectious diseases including human papillomavirus and hepatitis B virus.

• *The Guide to Community Preventive Services* describes program and policy interventions proven to increase cancer screening and vaccination rates and to prevent tobacco use, excessive alcohol use, obesity, and physical inactivity.
Key determinants of disparities

![Diagram showing key determinants of health disparities.](image)

Figure 1. Key determinants of health disparities.

James, SA Epidemiologic Reviews 31(1):1-6
Questions?