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

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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

Health Disparities in the United States

Racial differences in life expectancy in the United States

- Black-White Life Expectancy Gap
- Black men life expectancy: 6.5 years shorter
- Black women life expectancy: 5 years shorter

Contributing Factors

- Men
- Women

Adapted from JAMA 2007 297:11 1227
Disparities

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.”
Definition

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”
Incidence Rates by Race/Ethnicity and Sex, U.S., 1999-2012
Younger age at diagnosis for most cancers

Adjusted difference in means, blacks - whites, years

Age at diagnosis younger in blacks | Age at diagnosis older in blacks
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)</th>
<th>Black (n = 463)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sites (N = 11,047)</td>
<td>SIR (95% CI)</td>
<td>SIR (95% CI)</td>
</tr>
<tr>
<td>Solid tumors (N = 9744)</td>
<td>0.85 (0.84–0.87)</td>
<td>1.19 (1.08–1.31)</td>
</tr>
<tr>
<td>Digestive system (N = 2854)</td>
<td>0.85 (0.83–0.87)</td>
<td>1.19 (1.08–1.31)</td>
</tr>
<tr>
<td>Colon and rectum (N = 1949)</td>
<td>0.97 (0.93–1.01)</td>
<td>1.37 (1.16–1.61)</td>
</tr>
<tr>
<td>Liver (N = 40)</td>
<td>1.02 (0.97–1.07)</td>
<td>1.53 (1.24–1.87)</td>
</tr>
<tr>
<td>Pancreas (N = 356)</td>
<td>0.58 (0.41–0.80)</td>
<td>1.17 (0.32–2.99)</td>
</tr>
<tr>
<td>Respiratory system (N = 1382)</td>
<td>0.88 (0.79–0.98)</td>
<td>0.97 (0.56–1.55)</td>
</tr>
<tr>
<td>Breast (N = 3448)</td>
<td>0.72 (0.68–0.76)</td>
<td>1.09 (0.84–1.39)</td>
</tr>
<tr>
<td>Female genital system (N = 448)</td>
<td>0.98 (0.95–1.01)</td>
<td>1.01 (0.82–1.23)</td>
</tr>
<tr>
<td>Urinary system (N = 801)</td>
<td>1.19 (1.11–1.28)</td>
<td>1.48 (1.03–2.07)</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.
Mortality Rates by Race/Ethnicity and Sex, U.S., 1999-2012
Survival Health Disparities by Cancer Site

African Americans have the highest rate of cancer specific mortality

Racial differences are not reducing over time (overall)

Breast cancer—disparities might be increasing

Prostate cancer—disparities might be improving
Contributing factors are multifactorial

Cancer Health Disparities: Contributing Factors are Multifactorial

- Exposures, Behavior and Lifestyle
- Access to Care
- Social Determinants
- Genetic Susceptibility & Biology

Lung Cancer Health Disparities
Geographical factors contribute to cancer disparities

Geographical factors contribute to cancer disparities

Incidences Rates by State
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.

All Cancers Combined
Incidence Rate by State, 2012+

Interval
- Data not available
- 371.4 to 415.3
- 415.4 to 468.4
- 468.5 and 468.4
- 468.5 to 515.1

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

Lowest
- New Mexico
- Arizona
- Wyoming
- Alaska
- Virginia
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 (e.g., 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-urban disparities in cancer incidence

Rural-Urban Disparities in Cancer Incidence

- 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

Rural-Urban Disparities in Cancer Mortality

Rural-urban cancer disparities

Rural-Urban Cancer Disparities

Degree of Disparity by Geographic Location

Houston, K...Ryan, BM Submitted
Tobacco disparities

Tobacco Disparities

Lung cancer incidence is highest in African Americans despite having the second to lowest prevalence of high intensity smoking

Adapted from N Engl J Med 2006; 354:333-342
Tobacco disparities

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

Tobacco Disparities

![Graphs showing predicted rates of lung cancer among men and women who smoke 10 cigarettes per day or 20 cigarettes per day, comparing different racial and ethnic groups.]

Figure 1: Predicted Rates of Lung Cancer among Men Who Currently Smoke 10 Cigarettes per Day (Panel A) or 20 Cigarettes per Day (Panel B) and among Women Who Currently Smoke 10 Cigarettes per Day (Panel C) or 20 Cigarettes per Day (Panel D).

Adapted from *N Engl J Med* 2006; 354:333-342
Tobacco disparities

Tobacco Disparities

- African Americans are at risk for continued smoking and thus poor cessation outcomes
- Lung, pancreatic, bladder, and liver cancer patients at risk of poorer outcomes

Relative Risk of Death and Smoking after Diagnosis

- Never
- Former
- Light (<20)
- Heavy (>20)
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.
Disparities in cancer mortality

Some of the reasons for disparities in cancer mortality: Lack of early detection?

CA CANCER J CLIN 2015;65:5–29
Some of the reasons for disparities in cancer mortality: Access to screening?
Possibly for some cancers

Breast cancer mammography use similar in equal access to care setting (Cancer 2013 Oct 1;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 the differences exist even in cancers where there is no validated screening modality (liver, esophagus, etc)
### Lung Cancer Screening

#### 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>USPSTF†</th>
<th>CMS‡</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EA</td>
<td>AA</td>
<td>EA</td>
</tr>
<tr>
<td>All (n=1141 EA, n=517 AA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p Value</td>
<td>0.355</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men (n=600 EA, n=270 AA)</td>
<td>231</td>
<td>98</td>
<td>269</td>
</tr>
<tr>
<td>p Value</td>
<td>0.392</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women (n=541 EA, n=247 AA)</td>
<td>150</td>
<td>63</td>
<td>180</td>
</tr>
<tr>
<td>p Value</td>
<td>0.350</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bold signifies statistical significance.

Data based on smoking status, pack-years of smoking, time since quitting and age.

*NLST 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.
Access to care

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

Oncologists per 100,000 residents by hospital service area

Chun Chieh Lin et al. JCO doi:10.1200/JCO.2015.61.1559
Uptake of care

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)
Uptake of care

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery, all subjects</td>
<td>0.75</td>
<td>0.37-1.53</td>
</tr>
<tr>
<td>Chemotherapy, all subjects</td>
<td>0.79</td>
<td>0.59-1.04</td>
</tr>
<tr>
<td>Tumor stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>2.52</td>
<td>0.64-9.98</td>
</tr>
<tr>
<td>II</td>
<td>0.98</td>
<td>0.61-1.60</td>
</tr>
<tr>
<td>III</td>
<td>0.55</td>
<td>0.30-1.00</td>
</tr>
<tr>
<td>IV</td>
<td>9.60</td>
<td>4.90-1.58</td>
</tr>
<tr>
<td>Age at diagnosis, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50</td>
<td>1.10</td>
<td>0.47-2.59</td>
</tr>
<tr>
<td>50-64</td>
<td>0.74</td>
<td>0.48-1.15</td>
</tr>
<tr>
<td>≥65</td>
<td>0.93</td>
<td>0.60-1.44</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>0.80</td>
<td>0.56-1.14</td>
</tr>
<tr>
<td>Women</td>
<td>0.74</td>
<td>0.45-1.22</td>
</tr>
</tbody>
</table>

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.

*Dichotomous exposure with non-Hispanic blacks as reference group:
1. Sex, marital status at diagnosis, active duty status at diagnosis, service branch of active duty member/sponsor, color, cancer site, tumor stage, tumor grade, surgery, chemotherapy, recurrence, and comorbidities. Risk adjusted with stratified by race.

*Dichotomous exposure with non-Hispanic whites as reference group:
1. Sex, marital status at diagnosis, active duty status at diagnosis, service branch of active duty member/sponsor, color, cancer site, tumor stage, tumor grade, surgery, chemotherapy, recurrence, and comorbidities. Risk adjusted with stratified by race.

*Dichotomous exposure with non-Hispanic blacks and non-Hispanic whites as reference group:
1. Sex, marital status at diagnosis, active duty status at diagnosis, service branch of active duty member/sponsor, color, cancer site, tumor stage, tumor grade, surgery, chemotherapy, recurrence, and comorbidities. Risk adjusted with stratified by race.

*Dichotomous exposure with non-Hispanic blacks and non-Hispanic whites as reference group:
1. Sex, marital status at diagnosis, active duty status at diagnosis, service branch of active duty member/sponsor, color, cancer site, tumor stage, tumor grade, surgery, chemotherapy, recurrence, and comorbidities. Risk adjusted with stratified by race.

*Dichotomous exposure with non-Hispanic blacks and non-Hispanic whites as reference group:
1. Sex, marital status at diagnosis, active duty status at diagnosis, service branch of active duty member/sponsor, color, cancer site, tumor stage, tumor grade, surgery, chemotherapy, recurrence, and comorbidities. Risk adjusted with stratified by race.

Diseases of the Colon & Rectum Volume 57: 9 (2014)
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
Disparities persist

For some cancers, disparities persist even in equal access to care settings

Hazard Ratio = 1.6 (95% CI = 1.1-2.2)
Is biology a contributing factor?

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

Biological factors that contribute to cancer disparities

- Differences in
  - Genetics
  - Somatic mutations
  - Molecular subtype and gene expression
  - Gene expression and methylations profiles
  - Systems biology
  - Inflammation
  - Cell biology

*Differences in gene expression, molecular subtypes and molecular signatures will reveal differences in tumor biology between African American and European American patients*
Prostate cancer

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

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)

![Racial Differences in Prostate Cancer Aggressiveness by 8q24 Status](chart)
Germline genetics

Germline Genetics

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

West African Ancestry Among Self-Reported African Americans

Ryan, unpublished
Germline genetics

Germline Genetics

West African Ancestry and Lung Cancer Risk by Gender

P = 0.096

Males
Females

OR (95% C.I.)

West African Ancestry

Ryan, unpublished
Germline Genetics

Increased proportion of Native American ancestry is associated with increased risk of childhood acute lymphoblastic leukemia.

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

Somatic Genetics

A

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>
</tr>
</thead>
<tbody>
<tr>
<td>EPHA6</td>
<td>11843</td>
<td>AA</td>
<td>Stage IV</td>
<td>Discovery</td>
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<td>R203W</td>
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<td>P428fs</td>
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<td>Nonsense</td>
<td>R527*</td>
<td>0.80</td>
<td>Deleterious</td>
</tr>
</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%)

Molecular subtype

- Population differences in molecular subtypes and disease grade

Table 2. Prevalence of Breast Cancer Subtypes According to Race and Menopausal Status

<table>
<thead>
<tr>
<th>Tumor Status</th>
<th>All Cases</th>
<th>African American*</th>
<th>Non-African American†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Premenopausal (n = 97)</td>
<td>Postmenopausal (n = 99)</td>
<td>Premenopausal (n = 164)</td>
</tr>
<tr>
<td>Basal-like</td>
<td>38 (39)</td>
<td>14 (14)</td>
<td>26 (16)</td>
</tr>
<tr>
<td>HER2+/ER-</td>
<td>9 (9)</td>
<td>7 (7)</td>
<td>9 (6)</td>
</tr>
<tr>
<td>Luminal A</td>
<td>35 (36)</td>
<td>58 (59)</td>
<td>83 (51)</td>
</tr>
<tr>
<td>Luminal B</td>
<td>9 (9)</td>
<td>16 (16)</td>
<td>30 (18)</td>
</tr>
<tr>
<td>Unclassified</td>
<td>6 (6)</td>
<td>4 (4)</td>
<td>16 (10)</td>
</tr>
</tbody>
</table>

*P<.001, χ² test for basal-like vs other tumor types in premenopausal vs postmenopausal African American women.
†P=.94, χ² test for basal-like vs other tumor types in premenopausal vs postmenopausal non-African American women.
Molecular subtype

Association between race and breast cancer survival among molecular subtypes

However, breast cancer survival disparity in US is irrespective of some tumor subtypes (JNCI 2009, 101:993-1000)
Transcriptome

A

B

C

Mitchell..... Ryan In Press 49
Cell Biology

Cell biology

- 162 genes differently expressed by race/ethnicity (FDR ≤ 5%)
  - Several metastasis-related genes, e.g., CXCR4, MMP9, AMFR

Wallace... Amb, Cancer Res 2008, 68: 927–36
Different biomarkers

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 OR (95% CI)* P</td>
<td>Cases/Controls OR (95% CI)* P</td>
</tr>
<tr>
<td>IL-1β</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/57</td>
<td>1.00 (referent)</td>
<td>61/59</td>
</tr>
<tr>
<td>20/35</td>
<td>2.28 (0.87 – 5.99)</td>
<td>52/77</td>
</tr>
<tr>
<td>24/41</td>
<td>2.58 (1.02 – 6.50)</td>
<td>91/80</td>
</tr>
<tr>
<td><strong>29/37</strong></td>
<td><strong>3.61 (1.46 – 8.95) 0.007</strong></td>
<td><strong>66/80</strong></td>
</tr>
<tr>
<td>IL-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16/55</td>
<td>1.00 (referent)</td>
<td>44/61</td>
</tr>
<tr>
<td>16/41</td>
<td>1.35 (0.53 – 3.40)</td>
<td>63/75</td>
</tr>
<tr>
<td>31/38</td>
<td>4.11 (1.69 – 9.99)</td>
<td>78/80</td>
</tr>
<tr>
<td><strong>22/36</strong></td>
<td><strong>2.19 (0.88 – 5.24) 0.02</strong></td>
<td><strong>85/80</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),
Key determinants of disparities

Figure 1. Key determinants of health disparities.
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

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.