Epidemiology of Cancer

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With thanks to Dr Kirsten Moysich for some slides
Epidemiology

- the branch of medicine that deals with the incidence, distribution, determinants and control of diseases and other factors relating to health

- Epidemiology is the study of the **frequency** and **pattern** of health events in a population
Outline

• Cancer Incidence
• Cancer Mortality
• Geographic Variation
• Racial Variation
• Risk Factors
• Screening
Cancer Incidence

The number of newly diagnosed cases for a specific cancer or for all cancers combined during a specific time period
Cancer Prevalence

The number of current cases for a specific cancer or for all cancers combined during a specific time period.
Surveillance, Epidemiology, and End Results (SEER) Program
## 2016 Estimated Stats

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated New Cases in 2016</td>
<td>1,685,210</td>
</tr>
<tr>
<td>% of All New Cancer Cases</td>
<td>100.0%</td>
</tr>
<tr>
<td>Estimated Deaths in 2016</td>
<td>595,690</td>
</tr>
<tr>
<td>% of All Cancer Deaths</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

![Graph showing New Cases and Deaths](http://seer.cancer.gov/statfacts/html/all.html)

### Percent Surviving 5 Years

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2012</td>
<td>66.9%</td>
</tr>
</tbody>
</table>

# 2016 Estimated Stats

<table>
<thead>
<tr>
<th>Common Types of Cancer</th>
<th>Estimated New Cases 2016</th>
<th>Estimated Deaths 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Breast Cancer (Female)</td>
<td>246,660</td>
<td>40,450</td>
</tr>
<tr>
<td>2. Lung and Bronchus Cancer</td>
<td>224,390</td>
<td>158,080</td>
</tr>
<tr>
<td>3. Prostate Cancer</td>
<td>180,890</td>
<td>26,120</td>
</tr>
<tr>
<td>4. Colon and Rectum Cancer</td>
<td>134,490</td>
<td>49,190</td>
</tr>
<tr>
<td>5. Bladder Cancer</td>
<td>76,960</td>
<td>16,390</td>
</tr>
<tr>
<td>6. Melanoma of the Skin</td>
<td>76,380</td>
<td>10,130</td>
</tr>
<tr>
<td>7. Non-Hodgkin Lymphoma</td>
<td>72,580</td>
<td>20,150</td>
</tr>
<tr>
<td>8. Thyroid Cancer</td>
<td>64,300</td>
<td>1,980</td>
</tr>
<tr>
<td>10. Leukemia</td>
<td>60,140</td>
<td>24,400</td>
</tr>
<tr>
<td>Cancer of Any Site</td>
<td>1,685,210</td>
<td>595,690</td>
</tr>
</tbody>
</table>

Age-Adjusted Delay-Adjusted SEER Incidence Rates
By Sex
All Sites, All Ages, All Races,
1975–2013 (SEER 9)

Age adjusted to the 2000 US census
Age adjusted to the 2000 US census
Age-Adjusted U.S. Mortality Rates By Cancer Site
Ages < 20, All Races, Both Sexes
1975–2012

Age adjusted to the 2000 US census
Cancer Mortality

The number of deaths for a specific cancer or for all cancers combined during a specific time period.
### US Mortality, 2014

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause of Death</th>
<th># of deaths</th>
<th>% of all deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Heart Diseases</td>
<td>614,348</td>
<td>23.4</td>
</tr>
<tr>
<td>2.</td>
<td>Cancer</td>
<td>591,699</td>
<td>22.5</td>
</tr>
<tr>
<td>3.</td>
<td>Chronic lower respiratory diseases</td>
<td>147,101</td>
<td>5.6</td>
</tr>
<tr>
<td>4.</td>
<td>Accidents (unintentional injuries)</td>
<td>136,053</td>
<td>5.2</td>
</tr>
<tr>
<td>5.</td>
<td>Cerebrovascular diseases</td>
<td>133,103</td>
<td>5.1</td>
</tr>
<tr>
<td>6.</td>
<td>Alzheimer disease</td>
<td>93,541</td>
<td>3.6</td>
</tr>
<tr>
<td>7.</td>
<td>Diabetes mellitus</td>
<td>76,488</td>
<td>2.9</td>
</tr>
<tr>
<td>8.</td>
<td>Influenza &amp; pneumonia</td>
<td>55,227</td>
<td>2.1</td>
</tr>
<tr>
<td>9.</td>
<td>Nephritis, nephrotic synd, nephrosis</td>
<td>48,146</td>
<td>1.8</td>
</tr>
<tr>
<td>10.</td>
<td>Intentional harm (suicide)</td>
<td>42,773</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Change in the US Death Rates* by Cause, 1950 & 2005

* Age-adjusted to 2000 US standard population.
Sources: 1950 Mortality Data - CDC/NCHS, NVSS, Mortality Revised.
Age-Adjusted U.S. Mortality Rates
By Sex
All Sites, All Ages, All Races, 1975-2013

Year of Death:
- 1975
- 1980
- 1985
- 1990
- 1995
- 2000
- 2005
- 2010
- 2013

Rate per 100,000:
- Below 50
- 50-100
- 100-200
- Above 200

Total Number of Cancer Deaths Averted from 1991 to 2009 in Men and 1992 to 2009 in Women

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 Death Rates* Among Men, US, 1930-2009

*Age-adjusted to the 2000 US standard population.
National Center for Health Statistics, Centers for Disease Control and Prevention.
Cancer Death Rates* Among Women, US, 1930-2009

*Age-adjusted to the 2000 US standard population.
National Center for Health Statistics, Centers for Disease Control and Prevention.
Trends in Five-year Relative Cancer Survival Rates (%), 1975-2008

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All sites</td>
<td>49</td>
<td>56</td>
<td>68</td>
</tr>
<tr>
<td>Breast (female)</td>
<td>75</td>
<td>84</td>
<td>90</td>
</tr>
<tr>
<td>Colon</td>
<td>51</td>
<td>61</td>
<td>65</td>
</tr>
<tr>
<td>Leukemia</td>
<td>34</td>
<td>43</td>
<td>58</td>
</tr>
<tr>
<td>Lung &amp; bronchus</td>
<td>12</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>Melanoma</td>
<td>82</td>
<td>88</td>
<td>93</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>47</td>
<td>51</td>
<td>71</td>
</tr>
<tr>
<td>Ovary</td>
<td>36</td>
<td>38</td>
<td>43</td>
</tr>
<tr>
<td>Pancreas</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Prostate</td>
<td>68</td>
<td>83</td>
<td>100</td>
</tr>
<tr>
<td>Rectum</td>
<td>48</td>
<td>58</td>
<td>68</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>73</td>
<td>79</td>
<td>80</td>
</tr>
</tbody>
</table>

Geographic Variation
Estimated Numbers of New Cases and Deaths – by Sex and Site - 2000

Estimated Numbers of New Cases of the 12 Most Common Cancers in Developed and Developing Countries – Males - 2000

Estimated Numbers of New Cases of the 12 Most Common Cancers in Developed and Developing Countries – Females - 2000

Geographic Variation

Exposure to Carcinogens
Incidence of Lung Cancer: Age-Standardized Rates Males -2000

Incidence of Lung Cancer: Age-Standardized Rates Females - 2000

Cancer Mortality Rates by County (Age-adjusted 1970 US Population)
Lung, Trachea, Bronchus, and Pleura: White Males, 1970-94

US = 69.40/100,000
- 91.04-150.47 (highest 10%)
- 83.81-91.03
- 78.16-83.80
- 73.80-78.15
- 69.41-73.79
- 65.15-69.40
- 60.75-65.14
- 54.51-60.74
- 46.12-54.50
- 13.17-46.11 (lowest 10%)

Sparse data (43 counties: 0.01% of deaths)
Incidence of Liver Cancer: Age-Standardized Rates - 2000

Prevalence of Hepatitis B Virus Surface Antigen Carriers

Geographic Variation

Lifestyle Factors
Incidence of Breast Cancer: Age-Standardized Rates - 2000

Incidence of Colorectal Cancer: Age-Standardized Rates - 2000

Relative risk of mortality from cancer of the stomach, liver, and colon among Japanese men in Japan, Japanese men in California, and sons of Japanese immigrants compared with white men in California
Racial Variation
Age-Adjusted U.S. Mortality Rates By Race and Sex
All Sites, All Ages, 1975–2012

Age adjusted to the 2000 US census
Prostate Cancer, by Race

Incidence

Mortality
Multiple Myeloma, by Race & Sex

Incidence

Mortality
Non-Hodgkin Lymphoma, by Race & Sex

**Incidence**

**Mortality**
Risk Factors

Un-modifiable
Age and Disease

- # 1 risk factor for most diseases, including cancer
  - chronic exposure to etiologic agent
  - exposure to multiple etiologic agents
  - latent period
  - decreased immune function
  - increased comorbidity
Age and Cancer Incidence
Projections of Cancer Cases between 2000 and 2050

# of Cases Expected to ↑ due to Growing and Aging Population

Source: SEER program, NCI and US Census Bureau
Risk Factors – Un-modifiable

- Family history of cancer
- Reproductive factors
- Physical / ethnic characteristics
- Residential or occupational characteristics
Risk Factors – Un-modifiable

• Family history of cancer
  – Colon cancer
    • Adenomous polyposis coli (APC), hereditary non-polyposis colon cancer (HNPCC)
  – Breast cancer
    • BRCA1, BRCA2, ATM
  – Ovarian cancer
    • BRCA1, BRCA2
  – Prostate Cancer
Risk Factors – Un-modifiable

• Reproductive factors
  – Breast cancer
    • Age at menarche, age at menopause, age at first birth, parity, breastfeeding
  – Ovarian cancer
    • Parity, breast feeding
  – Endometrial cancer
    • Age at menopause, infertility, breast feeding
Risk Factors – Un-modifiable

• Physical / ethnic characteristics
  
  – Melanoma
    • Skin type, eye color

  – Breast and ovarian cancer
    • Ashkenazi Jewish ethnicity

  – Prostate cancer
    • African-American ethnicity
Risk Factors – Un-modifiable

• Residential or occupational characteristics
  – Leukemia, thyroid cancer, breast cancer, lung cancer
    • Radiation exposure
  – Bladder cancer
    • Dye workers (Benzidine)
  – Lung cancer
    • Asbestos workers
  – Liver cancer
    • Vinyl chloride manufacture
Risk Factors

Modifiable
Tobacco Use

- Major preventable cause of disease and premature death in the US

- Increased risk for cancer of the lung, mouth, larynx, pharynx, esophagus, pancreas, kidney, bladder, and uterine cervix, colorectal and acute myeloid leukemia

- 30% of all cancer deaths and 87% of lung cancer deaths can be attributed to tobacco

- In 2014, tobacco use is responsible for 1 in 5 deaths or about 480,000 deaths per year – 159,260 of these from lung cancer

Tobacco Use in the US, 1900-2004

Per capita cigarette consumption

Male lung cancer death rate

Female lung cancer death rate

Per Capita Cigarette Consumption

Year


Age-Adjusted Lung Cancer Death Rates*

0 25 50 75 100

*Age-adjusted to 2000 US standard population.
Trends in Cigarette Smoking, Adults 18 and Older, US, 1965-2011


*Smoked cigarettes on one or more of the 30 days preceding the survey. Whites and African Americans are non-Hispanic.
Source: Youth Risk Behavior Surveillance System, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 2012.

*Smoked cigarettes on one or more of the 30 days preceding the survey. Whites and African Americans are non-Hispanic.

Source: Youth Risk Behavior Surveillance System, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 2012.
ACS Guidelines on Nutrition and Physical Activity for Cancer Prevention

• Eat a variety of healthful foods, with an emphasis on plant sources
  – Eat five or more servings of vegetables and fruit each day
  – Choose whole grains in preference to processed (refined) grains and sugars
  – Limit consumption of red meats, especially high-fat and processed meats
  – Choose foods that help maintain a healthful weight
Trends in Consumption of Five or More Recommended Vegetable and Fruit Servings for Cancer Prevention, Adults ≥18, US, 1994-2005

Note: Data from participating states and the District of Columbia were aggregated to represent the United States.
ACS Guidelines on Nutrition and Physical Activity for Cancer Prevention

• Adopt a physically active lifestyle
  – Engage in at least moderate activity for 30 minutes or more on 5 or more days of the week
  – 45 minutes or more of moderate to vigorous activity on 5 or more days per week may further enhance reductions in the risk of breast and colon cancer

Note: Data from participating states and the District of Columbia were aggregated to represent the United States. Educational attainment is for adults 25 and older.


ACS Guidelines on Nutrition and Physical Activity for Cancer Prevention

- Maintain a healthful weight throughout life
  - Balance caloric intake with physical activity
  - Lose weight if currently overweight or obese
## Obesity Definition

<table>
<thead>
<tr>
<th>Category</th>
<th>BMI Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>BMI &lt;18.5</td>
</tr>
<tr>
<td>Normal weight</td>
<td>BMI 18.5 - 24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>BMI 25.0 – 29.9</td>
</tr>
<tr>
<td>Obese class I</td>
<td>BMI 30.0 – 34.9</td>
</tr>
<tr>
<td>Obese class II</td>
<td>BMI 35.0 – 39.9</td>
</tr>
<tr>
<td>Obese class III</td>
<td>BMI &gt;40</td>
</tr>
</tbody>
</table>

Obesity Trends

*Overweight is defined as at or above the 95th percentile for body mass index by age and sex based on reference data.

Secular Changes in Environment

- Food eaten outside of home
- Food availability
- Portion size shifts
- Food marketing
- Transportation
- Neighborhood safety
- City planning
- TV, video, computer work
- Economy and employment shifts
Health Consequences

• **Overweight & Obesity is associated with:**
  – Heart disease & cerebrovascular accidents
  – Type 2 Diabetes
  – Gallstones or gallbladder disease
  – Osteoarthritis
  – Gout
  – Sleep apnea
  – Hypertension
  – Hyperlipidemia
  – Pregnancy complications
  – Irregular menses
Overweight, Obesity, and Mortality from Cancer in a Prospectively Studied Cohort of U.S. Adults

Eugenia E. Calle, Ph.D., Carmen Rodriguez, M.D., M.P.H., Kimberly Walker-Thurmond, B.A., and Michael J. Thun, M.D.

Body-mass index associated with higher rates of death due to cancer of the esophagus, colon and rectum, liver, gallbladder, pancreas, and kidney, non-Hodgkin's lymphoma, multiple myeloma, stomach, prostate, breast, uterus, cervix, and ovary.

Current patterns of overweight/obesity in the US could account for 14% of all deaths from cancer in men and 20% of those in women.
Screening
Malignant Progression of Human Cancer

Genetic Alteration
Environmental Exposure

Normal Tissue → Premalignant Lesions → Genetic Alteration → Primary Tumor → Genetic Alteration → Metastasis

- Normal Cell
- Premalignant Cell
- Malignant Cell without Metastatic Ability
- Malignant Cell with Metastatic Ability
Screening Guidelines for the Early Detection of Breast Cancer

- Yearly mammograms are starting at age 40
- Clinical breast exam every 3 years for women in their 20s and 30s, and every year for women 40 and older
- Breast self-exam is an option for women starting in their 20s
- Screening MRI is recommended for women with an approximately 20%-25% or greater lifetime risk of breast cancer, including women with a strong family history of breast or ovarian cancer and women treated for Hodgkin Lymphoma

Source: American Cancer Society, [www.cancer.org](http://www.cancer.org)
Screening Guidelines for Early Detection of Colorectal Cancer & Adenomas

Beginning at age 50, men and women should follow one of the following examination schedules:

• Flexible sigmoidoscopy (FSIG) every five years
• Colonoscopy every ten years
• Double-contrast barium enema every five years
• CT colonography every five years
• Fecal occult blood test (FOBT) or a fecal immunochemical test (FIT) every year
• Stool DNA test (interval uncertain)

People who are at moderate or high risk for colorectal cancer should talk with a doctor about a different testing schedule

Source: American Cancer Society, www.cancer.org
Income

Education

Colorectal test use rates for adults aged 50-75 years by poverty income level, 2000-2013

Colorectal test use rates for adults aged 50-75 years by highest level of education obtained, 2000-2013

http://progressreport.cancer.gov/sites/default/files/graphs/
Screening Guidelines for Early Detection of Prostate Cancer

• Prostate-specific antigen (PSA) test and digital rectal examination (DRE) should be offered annually, beginning at age 50, to men who have a life expectancy of at least 10 years

• Men at high risk (African-American men and men with a strong family history) should begin testing at age 45

• For men at average risk and high risk, information should be provided about what is known and what is uncertain about the benefits and limitations of early detection and treatment of prostate cancer so that they can make an informed decision about testing

Source: American Cancer Society, www.cancer.org
Recent* Prostate-Specific Antigen (PSA) Test Prevalence (%), by Educational Attainment and Health Insurance Status, Men 50 Years and Older, US, 2001-2006

*A prostate-specific antigen (PSA) test within the past year. Note: Data from participating states and the District of Columbia were aggregated to represent the United States.

Recent* Digital Rectal Examination (DRE) Prevalence (%), by Educational Attainment and Health Insurance Status, Men 50 Years and Older, US, 2001-2006

*A digital rectal examination (DRE) within the past year. Note: Data from participating states and the District of Columbia were aggregated to represent the United States.

Questions?

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