U.S. Population and Increase Deaths from Heart Disease and The Coronary Artery Risk Development in Young Adults (CARDIA) Study:

Impact of Coronary Calcium on Young Adults

Stephen Sidney, MD, MPH
November 18, 2019
Number of deaths from heart disease, 1910-2017
Age-adjusted mortality rate and total number of heart disease deaths, United States, 2000-2017

Total population growth rate (%), United States, 1999-2017

- **1999-2005**: 5.9%
- **2005-2011**: 5.4%
- **2011-2017**: 4.5%
Ages 65 year and older:

80% of heart disease deaths

More than 90% of heart failure deaths
Total population growth rate (%), United States by age groups, 1999-2017
Age-adjusted mortality rate and total number of heart failure deaths, United States, 2000-2017

Percent change of age-adjusted mortality rate and number of deaths, 2011-2017

- Heart disease: -5%
- CHD: -14.9%
- Heart failure: 20%
- Other HD: 8.4%
- Heart failure: 38%
- Other HD: 23.4%

[Diagram showing percent change with bars for mortality rate and number of deaths]
Where Death Rates Are Rising

Heart Disease Roars Back

Younger people and women are more often stricken; obesity and diabetes stall the decline

BY BETSY MCKAY

One of America’s greatest achievements over much of the past century has been a huge decline in death rates from heart disease and strokes. Anti-smoking campaigns, medications to control blood pressure and cholesterol, and surgical advances have extended millions of lives, fundamentally reshaping the U.S. population.

Now, progress has stalled. That’s helping drive down life expectancy in the U.S. after decades in which each generation of Americans could expect to live longer than the one that came before.

The death rate for cardiovascular disease—which includes heart disease and strokes—has fallen just 4% since 2011 after dropping more than 70% over six decades, according to mortality statistics from the Centers for Disease Control and Prevention.

Particularly alarming is that the death rate is actually rising for middle-aged Americans.

The overall cardiovascular disease death rate is an under-recognized contributor to the recent decline in U.S. life expectancy. While that has been driven mostly by deaths...
Number of heart failure deaths, age <65 years, United States, 2011 and 2017

- 2011: 4,497
- 2017: 6,796
Summary

A “silver tsunami” of population growth of the older population (≥65 years of age) is driving an increase in the number of heart disease deaths which are concentrated (80%) in this age group.

The growth in the number of heart failure deaths is particularly concerning and is driven by both the changing demographics and the increasing rate of HF mortality.

The ≥65 years of age population is projected to increased an additional 44% from 2017 to 2030 will exacerbate this growth and created challenges for the provision of the health care of this segment of the population.
CARDIA Study Design

Multicenter cohort study of evolution of CVD risk beginning in young adulthood

Funded in December 1983 by National Heart Lung and Blood Institute

5,115 participants balanced in each center by:

- Age (18-24, 25-30)
- Sex
- Race (AA/W)
- Education (≤HS, >HS)

<table>
<thead>
<tr>
<th>Four Field Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birmingham University of Alabama</td>
</tr>
<tr>
<td>Chicago Northwestern University</td>
</tr>
<tr>
<td>Minneapolis University of Minnesota</td>
</tr>
<tr>
<td>Oakland Kaiser Permanente Northern California, Division of Research</td>
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</tbody>
</table>
CARDIA Examination Status since 1985

# of Participants

% PPTs

# PPTs

### 475 deaths (9.3% of cohort) reported; 411 adjudicated (as of 9/3/2019)

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Black</th>
<th>White</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer</td>
<td>42</td>
<td>34</td>
<td>76</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>47</td>
<td>26</td>
<td>72</td>
</tr>
<tr>
<td>AIDS</td>
<td>27</td>
<td>23</td>
<td>49</td>
</tr>
<tr>
<td>Unintentional injury</td>
<td>18</td>
<td>14</td>
<td>32</td>
</tr>
<tr>
<td>Homicide</td>
<td>31</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Unknown</td>
<td>14</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Suicide</td>
<td>2</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Liver disease</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>10</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Sepsis</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>
## CARDIA Morbidity

<table>
<thead>
<tr>
<th>438 Non-fatal cardiovascular disease endpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td>96 strokes</td>
</tr>
<tr>
<td>97 myocardial infarctions</td>
</tr>
<tr>
<td>80 heart failure</td>
</tr>
<tr>
<td>65 atrial fibrillation/atrial flutter</td>
</tr>
<tr>
<td>44 coronary revascularization</td>
</tr>
</tbody>
</table>
Coronary Artery Calcification

Calcification of R. coronary artery

Calcification of L. anterior descending artery

Axial EBCT
Association of Coronary artery calcification with incident CHD and Death

- Year 15: 3,043 participants, mean age 40.3 years, with assessment for CAC.
- Prevalence of CAC: 309 individuals (10.2%) with geometric mean Agatson score 21.6.
- Follow-up from Y15 for up to 12.5 years with 57 incident CHD events and 108 incident CVD events.

Ref: Carr JC et al. Association of Coronary Artery Calcium in Adults Aged 32 to 46 Years With Incident Coronary Heart Disease and Death. JAMA Cardiol. 2017;2(4):391-399.
eFigure. Cumulative Event-Free Survival for Incident Coronary Heart Disease, Unadjusted Among Participants 32 to 46 Years by CAC Score Categories

Ref: Carr et al. JAMA Cardiol. Published online February 8, 2017.
Incident CHD events by CAC score (odds ratios relative to no CAC)

Table 3. Use of Risk Factors Measured in Early Adult Life to Identify the Population Most at Risk for Developing CAC and Incidence of Coronary Heart Disease

<table>
<thead>
<tr>
<th>CAC Screening Strategy in Middle Age</th>
<th>No. (%)</th>
<th>CHD Incidence, No. (%)</th>
<th>CAC Prevalence, No. (%)</th>
<th>Cohort CAC Found by CAC Screening Strategy, No. (%)</th>
<th>No. Enrolled to Find 1 Case of CAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire eligible cohort</td>
<td>3330 (100)</td>
<td>67 (2.0)</td>
<td>964 (28.9)</td>
<td>964/964 (100.0)</td>
<td>3.5</td>
</tr>
<tr>
<td>Predicted low CAC risk</td>
<td>1665 (50.0)</td>
<td>3 (0.2)</td>
<td>219 (13.2)</td>
<td>219/964 (22.7)</td>
<td>7.7</td>
</tr>
<tr>
<td>Predicted high CAC risk</td>
<td>1665 (50.0)</td>
<td>64 (3.8)</td>
<td>745 (44.7)</td>
<td>745/964 (77.3)</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Ref: Carr JC et al. *JAMA Cardiol.* 2017;2(4):391-399
CHD 10-year risk

- ≤ 4%: 60
- 5%-11%: 544
- ≥12%: 2,432

# participants
Incidence Density of Coronary Heart Disease (CHD) Events per 100 Persons

# Proposed Decision-Making Approach to Selective Use of Coronary Artery Calcium Measurement for Risk Prediction

Using 10-year ASCVD risk estimate plus coronary artery calcium (CAC) score to guide statin therapy

<table>
<thead>
<tr>
<th>Patient’s 10-year atherosclerotic cardiovascular disease (ASCVD) risk estimate:</th>
<th>&lt;5%</th>
<th>5-7.5%</th>
<th>&gt;7.5-20%</th>
<th>&gt;20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consulting ASCVD risk estimate alone</td>
<td>Statin not recommended</td>
<td>Consider for statin</td>
<td>Recommend statin</td>
<td>Recommend statin</td>
</tr>
<tr>
<td>Consulting ASCVD risk estimate + CAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If CAC score =0</td>
<td>Statin not recommended</td>
<td>Statin not recommended</td>
<td>Statin not recommended</td>
<td>Recommend statin</td>
</tr>
<tr>
<td>If CAC score &gt;0</td>
<td>Statin not recommended</td>
<td>Consider for statin</td>
<td>Recommend statin</td>
<td>Recommend statin</td>
</tr>
</tbody>
</table>

Does CAC score modify treatment plan?

- CAC not effective for this population
- CAC can reclassify risk up or down

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The figure shows a modified approach to the guideline-based decision making by incorporating a consideration of coronary artery calcium (CAC) testing to reclassify a patient’s risk up or down where it would make a clinically important change in the clinical decision. Adapted with permission from Nasir et al. (90).
CAC Expert Panel Algorithm

For Individuals Age 40-75, LDL 70-189, and Without Clinical ASCVD

Step 1
Calculate 10 yr Risk Using ACC/AHA ASCVD Risk Calculator

- 10 yr Risk <5%
- 10 yr Risk 5% to <7.5%
- 10 yr Risk >7.5%

Follow ACC/AHA guidelines for low risk

Follow ACC/AHA guidelines for ASCVD Statin Benefit Groups

Step 2
Family history of ASCVD

Coronary Artery Calcium (CAC) Score

CAC = 0
Lifestyle Management
Lifestyle Management
Reassess risk at 4-6 years
Consider pharmacologic lipid Rx

CAC = 1-299 & <75th %
Lifestyle Management
Lifestyle Management
Add pharmacologic lipid Rx

CAC ≥300 or ≥75th %
Association of Coronary artery calcification with incident CHD and Death

Bottom line:

- CAC measured at age 32 – 46 years is predictive of increased CHD over 12.5 years.
- It may be possible to develop an effective strategy for the using of CAC screening utilizing appropriate risk stratification.
Components of Cardiovascular Health (Life’s Simple 7)

- Healthy diet
- Physical activity
- Maintain ideal body weight
- No smoking
- Normal blood pressure
- Normal blood cholesterol
- Normal fasting blood glucose
NHLBI REPOSITORY DATA SETS AVAILABLE TO SCIENTIFIC COMMUNITY

- Description of data on Public CARDIA website:
  http://www.cardia.dopm.uab.edu

- Procedures on how to request data:
  https://biolincc.nhlbi.nih.gov/home/

- For Information or Questions on how to request data:
  biolincc@imsweb.com

- For Other Information or Questions, send an email to:
  CARDIADataquestions@dopm.uab.edu