JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

Direct age adjustment

Skills-building Example

Direct Age Standardization

- Direct age standardization applies the MRs from the population of interest to a **standard population** to calculate the **expected number of deaths in the standard population**,
  - The expected number of deaths are then summed to get the age-adjusted MRs
  - The age-adjusted MRs are comparable to other populations because the effect of the age distribution of the population of interest is removed in the age-adjusted MR

The Standard Population

- For US comparisons
  - **2000 US standard population** (1998)
    - Replaced the 1940 US standard population, the 1970 civilian non-institutional population and the 1980 US resident population
    - More older individuals as the population "aged"

- For International comparisons
  - **WHO standard population** is based on the world average (2001) population between 2000-2025
    - Terminal age group is ≥100 years
    - Has fewer children and more adults aged ≥70 years than the **Segi world standard**
    - Younger than the **Scandinavian (European) standard**

Anderson, et al. Age Standardization of Death Rates: Implementation of the Year 2000 Standard. National Vital Statistics Reports 1998:47(3):1-17.
Ahmad, et al. Age Standardization of Rates: A New WHO Standard. GPE Discussion Paper Series: No 31., 2001.

Mortality Racial/Ethnic Disparities, Maryland, 2013

- Example: Investigate disparities in mortality rates by race in Maryland

- Data
  - Maryland Vital Statistics Annual Report 2013 (http://dhmh.maryland.gov/vsa/documents/13annual.pdf)
    - Numbers of deaths (*Table 41*)
    - Population at risk for death (*Table 3*)
  - Data are stratified by age, sex, and race/ethnicity

Number of Deaths by Race/Ethnicity, Maryland, 2013

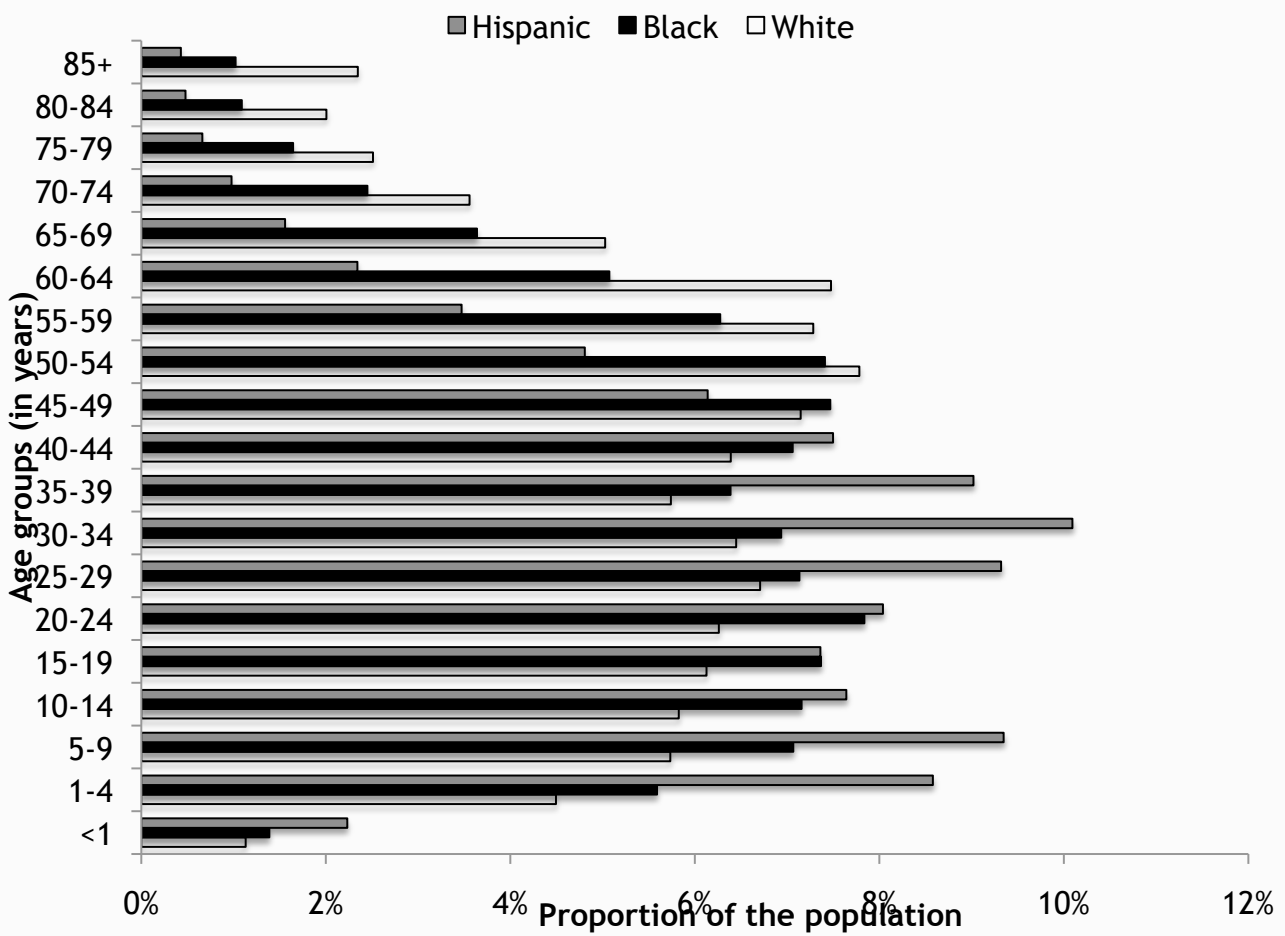
Age (in years)	White	Black	Hispanic
<1	150	250	49
1-4	26	34	8
5-14	29	36	7
15-24	263	229	31
25-34	461	367	50
35-44	609	499	65
45-54	1,801	1,344	69
45-64	3,561	2,300	100
65-74	5,071	2,488	102
75-84	7,718	2,444	111
≥85	11,643	2,364	149

Data Source: Maryland Vital Statistics Annual Report, 2014. Table 41. (http://dhmh.maryland.gov/vsa/documents/13annual.pdf)

Age Distributions by Race/Ethnicity, Maryland, 2013 - I

	White		Black		Hispanic	
Age (in years)	n	%	n	%	n	%
<1	41,877	1%	25,599	1%	11,887	2%
1-4	166,391	4%	103,105	6%	45,679	9%
5-9	212,268	6%	130,343	7%	49,762	9%
10-14	215,669	6%	132,004	7%	40,685	8%
15-19	226,796	6%	135,886	7%	39,188	7%
20-24	231,746	6%	144,555	8%	42,798	8%
25-29	248,308	7%	131,567	7%	49,616	9%
30-34	238,696	6%	127,928	7%	53,731	10%
35-39	212,503	6%	117,798	6%	48,021	9%
40-44	236,535	6%	130,226	7%	39,918	7%
45-49	264,579	7%	137,743	7%	32,683	6%
50-54	288,128	8%	136,673	7%	25,593	5%
55-59	269,632	7%	115,737	6%	18,483	3%
60-64	276,753	7%	93,572	5%	12,470	2%
65-69	186,129	5%	67,108	4%	8,297	2%
70-74	131,710	4%	45,203	2%	5,207	1%
75-79	92,967	3%	30,347	2%	3,523	1%
80-84	74,275	2%	20,093	1%	2,550	0%
85+	86,883	2%	18,850	1%	2,283	0%

Age Distributions by Race/Ethnicity, Maryland, 2013 - II



Crude MR per 1,000

White
Both Sexes

WORK IT OUT >>

Age (in years)	Deaths	Population	Crude MR per 1000	US 2000 Std Pop	Expected number of deaths (cross product)
<1	150	41,877		0.013818	
1-4	26	166,391		0.055317	
5-9		*212,268*			
10-14		*215,669*			
5-14	29	427,937		0.145565	
15-19		*226,796*			
20-24		*231,746*			
15-24	263	458,542		0.138646	
25-29		*248,308*			
30-34		*238,696*			
25-34	461	487,004		0.135573	
35-39		*212,503*			
40-44		*236,535*			
35-44	609	344,370		0.162613	
45-49		*264,579*			
50-54		*288,128*			
45-54	1,801	406,592		0.134834	

Crude MR per 1,000

MR=# of deaths / population at risk
*='Deaths' / 'Population' * 1000*
*=B10/C10*1000 (spreadsheet program*
for age <1 year)

White
Both Sexes

Age (in years)	Deaths	Population	Crude MR per 1000	US 2000 Std Pop	Expected number of deaths (cross product)
<1	150	41,877	3.58	0.013818	
1-4	26	166,391	0.16	0.055317	
5-9		*212,268*			
10-14		*215,669*			
5-14	29	427,937	0.07	0.145565	
15-19		*226,796*			
20-24		*231,746*			
15-24	263	458,542	0.57	0.138646	
25-29		*248,308*			
30-34		*238,696*			
25-34	461	487,004	0.95	0.135573	
35-39		*212,503*			
40-44		*236,535*			
35-44	609	344,370	1.77	0.162613	
45-49		*264,579*			
50-54		*288,128*			
45-54	1,801	406,592	4.43	0.134834	

Expected Number of Deaths (Cross Product)

Age (in years)	Deaths	Population	Crude MR per 1000	US 2000 Std Pop	Expected number of deaths (cross product)
			White Both Sexes	WORK IT OUT >>	
<1	150	41,877	3.58	0.013818	
1-4	26	166,391	0.16	0.055317	
5-9		*212,268*			
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35-44	609	344,370	1.77	0.162613	
45-49		*264,579*			
50-54		*288,128*			
45-54	1,801	406,592	4.43	0.134834	

Expected Number of Deaths (Cross Product)

='Crude MR per 1000' * 'US 2000 Std Pop'
=D10/E10 (spreadsheet program for age <1 year)

White
Both Sexes

Age (in years)	Deaths	Population	Crude MR per 1000	US 2000 Std Pop	Expected number of deaths (cross product)
<1	150	41,877	3.58	0.013818	0.05
1-4	26	166,391	0.16	0.055317	0.01
5-9		*212,268*			
10-14		*215,669*			
5-14	29	427,937	0.07	0.145565	0.01
15-19		*226,796*			
20-24		*231,746*			
15-24	263	458,542	0.57	0.138646	0.08
25-29		*248,308*			
30-34		*238,696*			
25-34	461	487,004	0.95	0.135573	0.13
35-39		*212,503*			
40-44		*236,535*			
35-44	609	344,370	1.77	0.162613	0.29
45-49		*264,579*			
50-54		*288,128*			
45-54	1,801	406,592	4.43	0.134834	0.60

Age-adjusted Mortality Rate

Age (in years)	Deaths	Population	White Both Sexes Crude MR per 1000	US 2000 Std Pop	Expected number of deaths (cross product)
...	...	...	...	...	...
55-59		*269,632*			
60-64		*276,753*			
55-64	3,561	388,981	9.15	0.087247	0.80
65-69		*186,129*			
70-74		*131,710*			
65-74	5,071	316,674	16.01	0.066037	1.06
75-79		*92,967*			
80-84		*74,275*			
75-84	7,718	167,242	46.15	0.044842	2.07
≥85	11,643	86,883	134.01	0.015508	2.08
Crude MR	31,332	3,292,493			
Age-adjusted MR					

WORK IT OUT >>

Age-adjusted Mortality Rate

Age-adjusted mortality rate
=∑ Cross products for all age-groups
=SUM(F10,F11,F14,F17,F20,F23,F26,F29,F32,F35,F36
(spreadsheet program for White Marylanders, both sexes combine)

White Both Sexes

Age (in years)	Deaths	Population	Crude MR per 1000	US 2000 Std Pop	Expected number of deaths (cross product)
…	…	…	…	…	…
55-59		*269,632*			
60-64		*276,753*			
55-64	3,561	388,981	9.15	0.087247	0.80
65-69		*186,129*			
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80-84		*74,275*			
75-84	7,718	167,242	46.15	0.044842	2.07
≥85	11,643	86,883	134.01	0.015508	2.08
Crude MR	31,332	3,292,493			
Age-adjusted MR					**7.16**

Overall Crude Mortality Rate

			White Both Sexes		
Age (in years)	**Deaths**	**Population**	**Crude MR per 1000**	**US 2000 Std Pop**	**Expected number of deaths (cross product)**
...	...	...	...	...	...
55-59		*269,632*			
60-64		*276,753*			
55-64	3,561	388,981	9.15	0.087247	0.80
65-69		*186,129*			
70-74		*131,710*			
65-74	5,071	316,674	16.01	0.066037	1.06
75-79		*92,967*			
80-84		*74,275*			
75-84	7,718	167,242	46.15	0.044842	2.07
≥85	11,643	86,883	134.01	0.015508	2.08
Crude MR	31,332	3,292,493			
Age-adjusted MR					**7.16**

WORK IT OUT >>

Overall Crude Mortality Rate

Age (in years)	Deaths	Population	White Both Sexes Crude MR per 1000	US 2000 Std Pop	Expected number of deaths (cross product)
...	...	...	...	...	...
55-59		*269,632*			
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55-64	3,561	388,981	9.15	0.087247	0.80
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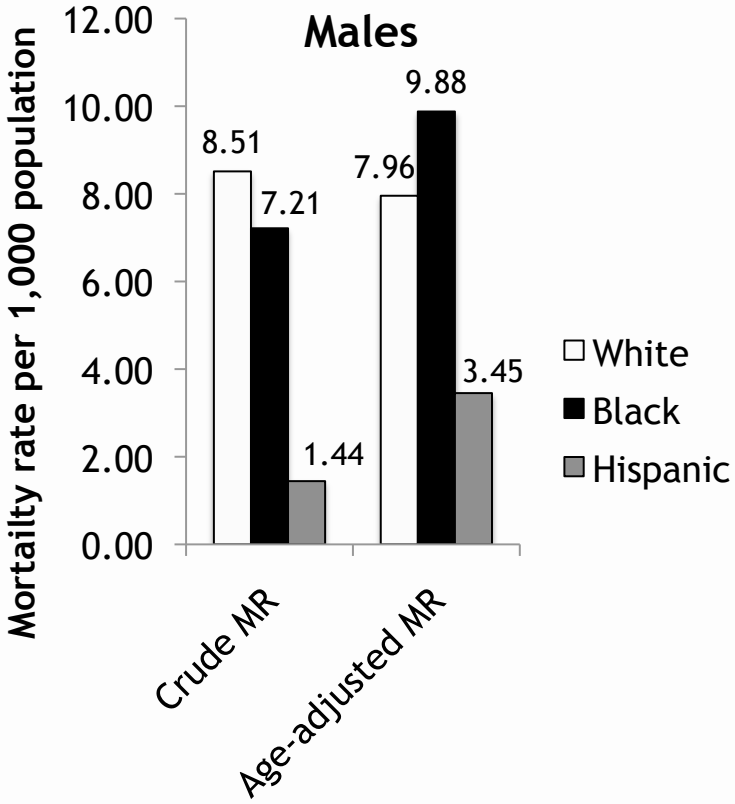
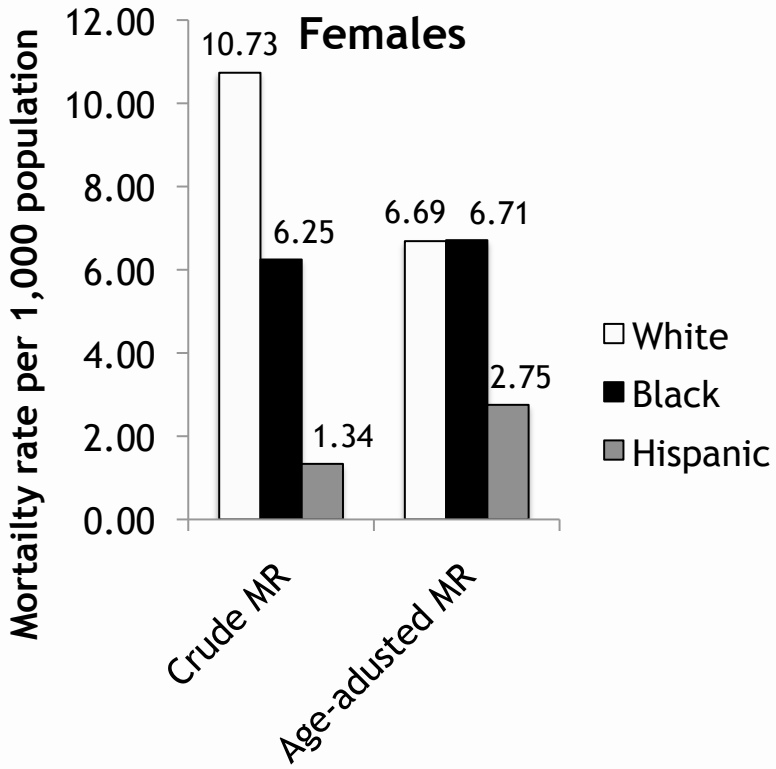
75-79		*92,967*			
80-84		*74,275*			
75-84	7,718	167,242	46.15	0.044842	2.07
≥85	11,643	86,883	134.01	0.015508	2.08
Crude MR	31,332	3,292,493	**9.52**		
Age-adjusted MR					**7.16**

Crude and Age-adjusted Mortality Rates





Direct Age Adjustment

- Technical notes
  - Always report the standard population used
  - Age-adjusted rates are hypothetical (i.e., not observed data) and useful for comparison purposes
  - **If there are <25 total deaths within the age groups of the population of interest, indirect age adjustment should be used**
  - It is not meaningful to age-adjust data for smaller ranges of age groups (i.e., if the total population was 18-24)
  - If age-specific mortality rates do not have a consistent relationship over time, you should not age adjust (i.e., if MR among younger persons increases over time, but MR among older persons decreases)

Calculations for Direct Age Adjustment

- Crude Mortality Rate =
  $\frac{\text{\# of deaths}}{\text{population count}}$ * 1,000

- Expected number of deaths or cross products =
  mortality rate * US 2,000 Std Pop Weight

- Age-adjusted Mortality Rate =
  Σ cross products for all age-groups