Rate Adjustment

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Statistical technique to compare rates among populations with differing underlying structures (age, sex, education, etc).

There are two ways to adjust (standardize) rates:

- DIRECT adjustment
- INDIRECT adjustment

We use rate adjustments to remove differences or potential confounding factors in population data.

For example:

If we believe that death rate differences between cities are due to factors such as age, socioeconomic status, etc., we can adjust for these factors.
Rate adjustment = statistical technique to account for the differing structures of the populations being compared. Result: eliminates the effect of differences between populations (e.g., age), but does not represent real rates.

Two ways to adjust (correct, standardize) rates:

**Direct adjustment:** Use specific rates from study population and a standard population. Multiply age/sex/race SES-specific rates from study pop. x standard pop (also age/sex/race/SES-specific).

The direct adjustment method takes the internal rates (from our study) and applies them to some external (or standard) population to determine expected number of deaths.


\[
\text{SMR} = \frac{\# \text{ observed deaths}}{\# \text{ expected deaths}} \times 100
\]

**Note:** Indirect adjustment is done when national or other reference rates are unavailable - only reference rates are available. Used commonly in occupational studies to compare observed numbers of deaths among workers exposed to some agent to what would be expected in general population.

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**Why do we adjust?**

Crude death rates between cities/counties/states/countries may look different but are different only because of confounding by a third variable, e.g.,

**Consider:**
- Crude death rate State A
- Crude death rate State B

- age is related to death rate
- age is related to living in State A or B.

Confounding causes a distortion in the results that is due to the influence of a third factor (e.g., age). Confounder MUST be related to both the exposure (living in A or B) and the outcome (death).

**Example:**
- Crude death rate in Florida = 14.3/1,000/yr
- Crude death rate in Alaska = 3.4/1,000/yr

**Question:** Is the death rate really 4 times lower in Alaska than in Florida?

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**Purpose of adjusting rates**

When we wish to compare mortality/morbidity rates:

- Between populations
- At different time periods in a single population

we need to take into account possible differing structures of the underlying populations by age, sex, race, SES, etc.

A higher crude mortality rate in one population may reflect the fact that this population is older than another population, or has a lower overall SES structure.
Direct Adjustment

Need:  (1) Age-specific morbidity/mortality rates for each pop. to compare
(2) Number of people in each age stratum in one pop, both or another, standard pop,
i.e., U.S. population, std. million pop.

Note: age-specific strata for death rates and age-specific population strata must match
-- e.g., traditional strata used: 1-4, 5-9, 10-14, 15-19, etc; or 1-9, 10-19, 20-29, etc.

For each population to be compared:
(A) Multiply each age-specific rate by the standard population in each age stratum. This
generates the number of deaths you would expect to see in each age stratum in the “normal”
or standard pop.
(B) Sum the expected number of deaths to obtain the total expected number of deaths.

Direct adjustment (age), method (p2)

(C) Divide the total number of expected deaths by the total standard population to obtain the
age-adjusted death rate

Generate an age-adjusted death rate for each of the populations you are comparing.

(D) Now compare the age-adjusted death rates between the populations and

Differences in mortality experience can now be compared by getting rid of the confounding
effect of age. Differences now are INDEPENDENT of age. We have ADJUSTED for the effects
of age.

Statistical Notation for Direct Adjustment

\[ \sum_{i=1}^{n} \left( \frac{\text{(study rate) (standard population)}}{\text{total standard population}} \right) \]

= Total expected # deaths in standard population
= Total # people in standard population
## Direct adjustment

### Important notes:
- Adjusted (standardized) rates are fictitious numbers*
- Their magnitude is related to the size of the standard population chosen
- They are used only for comparison purposes.

* Standard population can be one of the two pops being compared, both populations combined, or a third population. It doesn’t really matter which one is chosen, since it is used as the “great equalizer” in all cases.

### Age-adjusted mortality rates (direct adjustment)

<table>
<thead>
<tr>
<th>Age</th>
<th>Population</th>
<th>Deaths</th>
<th>Std Pop.</th>
<th>Exp. Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0-14</td>
<td>100</td>
<td>90</td>
<td>3</td>
<td>190</td>
</tr>
<tr>
<td>(Rate/1000)</td>
<td>(40.0)</td>
<td>(33.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-24</td>
<td>100</td>
<td>90</td>
<td>4</td>
<td>190</td>
</tr>
<tr>
<td>(Rate/1000)</td>
<td>(50.0)</td>
<td>(44.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-44</td>
<td>110</td>
<td>90</td>
<td>5</td>
<td>200</td>
</tr>
<tr>
<td>(Rate/1000)</td>
<td>(54.5)</td>
<td>(55.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-64</td>
<td>90</td>
<td>100</td>
<td>7</td>
<td>190</td>
</tr>
<tr>
<td>(Rate/1000)</td>
<td>(77.8)</td>
<td>(60.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥65</td>
<td>300</td>
<td>90</td>
<td>10</td>
<td>390</td>
</tr>
<tr>
<td>(Rate per 1000)</td>
<td>(100)</td>
<td>(200)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>700</td>
<td>460</td>
<td>36</td>
<td>1160</td>
</tr>
</tbody>
</table>

Crude Rate * = 74.3% (78.3%)

Adjusted Rate (A) = 81.8/1160 = 70.5/1000

Adjusted Rate (B) = 115.2/1160 = 99.3/1000

* per 1,000

### When to adjust

<table>
<thead>
<tr>
<th>Distribution of characteristic</th>
<th>Rate*</th>
<th>Adjust</th>
<th>Do not adjust</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Same</td>
<td>Different</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2. Different</td>
<td>Same</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3. Different</td>
<td>Different</td>
<td>X</td>
<td>*Stratum-specific</td>
</tr>
</tbody>
</table>

Notes:
- In situation 3, use caution – adjusted rate may mask important stratum-specific differences in rates. Best to present stratum-specific rates and briefly mention results of adjustment.
- Also, if several stratum-specific rates differ in opposite directions (e.g., if in two age strata, Pop I has higher death rates, while in 2 other age strata, Pop II has higher death rates), adjustment may not be indicated; stratum-specific rates should be emphasized.
Things to Remember:
Age-adjusted mortality rates:

- Age-specific rates from a population are adjusted/standardized using a standard population
- Adjusted (standardized) rates are fictitious numbers
- Their magnitude is related to the size of the standard population chosen
- They are used only for comparison purposes

Self-Reflective Questions

- Why is rate adjustment important?
  - It is a means of controlling for confounding when comparing mortality/morbidity rates of two or more populations

- How do I directly adjust my rates?
  - Multiply stratum-specific rates for each population by stratum counts in the standard population to give stratum-specific expected counts
  - Add each of the stratum-specific expected counts to give total expected counts for each population to be compared
  - Divide each total expected count by the total count in the standard population to obtain ‘stratum-adjusted’ rates.