## **Biostatistics**

Week #3 (3/17/2020)



# **Chapter 4 Rates and Standardization**



#### Introduction

- Two important categories are commonly referred in describing the health status of a population:
  - Demographic (人口統計學的) data: size of the population and its composition by gender, race and age.
  - Vital statistics: births, deaths, marriages, divorces and occurrence of disease.



完成

...including population <u>density</u>, <u>ethnicity</u> (種族), <u>education level</u>, <u>health</u> of the populace (民眾), <u>economic status</u>, <u>religious affiliations</u> and other aspects of the population.

- One case in interpreting those statistics, we may need to compare, for example, the <u>death count</u> of 1991 vs the <u>death count in 1992</u>.
- If there were 100 deaths in 1991, and 110 deaths in 1992, can we say that there were <u>more</u> deaths in 1992? (These are called the <u>raw numbers</u> of death.)
- To be more precise, what would be in your mind when using the phrase "more deaths"?

## 4.1 Rates

- While rate is normally interpreted as the change of a given physical quantity (e.g., movement along x-axis in kilometer) per unit time (e.g., in one hour), it is also useful in population statistics.
- Here a <u>rate</u> is defined as the number of cases of a particular outcome of interest (e.g., death) that occur <u>over a given period of time</u> divided by <u>the size of the population</u> in that time period.

## Mortality (or Death) Rate

- The number of deaths that occur during some time period (e.g., a calendar year) divided by the total population at risk during that period of time.
  - The denominator (分母 or 除數) is "total population at risk", not "total population".
  - For example, the mortality rate for one particular cause, such as lung cancer or influenza infection, etc.
- For example, the mortality rate in 1991 in US is 860.3 per 100,000 population.

### **Mortality vs Morbidity**

- Morbidity refers to the disease state of an individual, or <u>the incidence of illness</u> in a population. [more specific to a given disease]
- Mortality refers to the state of being mortal, or <u>the incidence of death</u> (number of deaths) in a population.

## **Infant Mortality Rate**

- The other example is the "infant mortality rate" the number of deaths during a calendar year among infants (< 1 yr) divided by the total number of live births during that year.</li>
- That is, all infants are "at risk" of mortality when are less than 1 year old.

## Table 4.1 – Infant mortality <u>rates</u> for selected countries, 1992

Nation	Mortality Rate per 1,000 Live Births
Australia	7
Brazil	54
Canada	7
China	35
Ethiopia	123
France	7
India	83
Japan	4
USA	9

- While the rates shown in Table 4.1 (called crude rates) provide a summary measure for an entire population; they disregard differences caused by age, gender, race, and other characteristics.
- More often showing rates based on <u>specific</u> grouping will be more useful than simply seeing one crude rate. (See Table 4.2 for example)

**TABLE 4.2**Total deaths and death rates by age, race, and sex, United States, 1992

TABLE	4.2
(Contin	nued

ac statemento casa	disoli A cri	All Races			White				Black		Am	erican In	dian	Asian o	r Pacific Is	lander
Age	Both Sexes	Male	Female	Both Sexes	Male	Female	Ago	Both Sexes	Male	Female	Both Sexes	Male	Female	Both Sexes	Male	Female
Age	Beaes	Maic			Mate	Temate	Age	Sexes	Male	remaie	Sexes	10000	remate	Sexes	Male	remaie
			Num									Number				
All ages	2,175,613	1,122,336	1,053,277	1,873,781	956,957	916,824	All ages	269,219	146,630	122,589	8953	5181	3772	23,660	13,568	10,092
Under 1 year	34,628	19,545	15,083	22,164	12,625	9539	Under 1 year	11,348	6298	5050	393	221	172	723	401	322
1–4 years	6764	3809	2955	4685	2690	1995	1–4 years	1799	965	834	127	67	60	153	87	66
5–9 years	3739	2231	1508	2690	1605	1085	5–9 years	894	529	365	54	33	21	101	64	37
10–14 years	4454	2849	1605	3299	2093	1206	10-14 years	982	633	349	61	48	13	112	75	37
15–19 years	14,411	10,747	3664	10,308	7440	2888	15–19 years	3583	2923	660	206	155	51	314	229	85
20–24 years	20,137	15,460	4677	14,033	10,696	3337	20-24 years	5399	4246	1153	279	212	67	426	306	120
25–29 years	24,314	18,032	6282	17,051	12,825	4226	25–29 years	6559	4695	1864	293	228	65	411	284	127
30–34 years	34,167	24,863	9304	24,450	18,210	6240	30–34 years	8836	6083	2753	378	253	125	503	317	186
35–39 years	42,089	29,641	12,448	30,127	21,690	8437	35–39 years	10,965	7308	3657	403	272	131	594	371	223
40–44 years	49,201	33,354	15,847	35,886	24,726	11,160	40–44 years	12,213	7949	4264	366	246	120	736	433	303
45–49 years	56,533	36,622	19,911	43,451	28,343	15,108	45–49 years	11,753	7493	4260	431	280	151	898	506	392
50–54 years	68,497	42,649	25,848	53,689	33,681	20,008	50–54 years	13,252	8021	5231	487	308	179	1069	639	430
55–59 years	94,582	58,083	36,499	75,750	47,042	28,708	55–59 years	16,727	9824	6903	668	392	276	1437	825	612
60–64 years	146,409	88,797	57,612	122,213	74,994	47,219	60–64 years	21,669	12,380	9289	719	408	311	1808	1015	793
65–69 years	211,071	124,228	86,843	180,788	107,427	73,361	65–69 years	27,011	14,946	12,065	818	454	364	2454	1401	1053
70–74 years	266,845	149,937	116,908	234,117	132,273	101,844	70–74 years	29,124	15,580	13,544	849	457	392	2755	1627	1128
75–79 years	301,736	158,257	143,479	270,238	142,422	127,816	75–79 years	27,875	13,782	14,093	799	422	377	2824	1631	1193
80–84 years	308,116	141,640	166,476	279,507	128,484	151,023	80–84 years	25,260	11,253	14,007	721	354	367	2628	1549	1079
85 years and over	487,446	161,236	326,210	448,984	147,419	301,565	85 years and over	33,856	11,646	22,210	900	370	530	3706	1801	1905
Not stated	474	356	118	351	272	79	Not stated	114	76	38	1	1	1 7 5	8	7	1
HI A TENNEY TO			Death	rate							- 1	Death rate	9			"TO HE
All ages	852.9	901.6	806.5	880.0	917.2	844.3	All ages	850.5	977.5	736.2	417.7	487.7	348.9	283.1	332.7	235.8
Under 1 year	865.7	956.6	770.8	701.8	780.9	618.7	Under 1 year	1786.0	1957.9	1609.7	939.2	1057.5	821.2	439.8	477.7	400.2
1–4 years	43.6	48.0	39.0	38.1	42.6	33.3	1–4 years	73.2	77.6	68.7	72.0	74.7	69.3	26.9	29.9	23.8
5–9 years	20.4	23.7	16.8	18.3	21.3	15.2	5–9 years	32.1	37.5	26.6	25.1	30.1	19.8	15.4	19.1	11.5
10-14 years	24.6	30.7	18.2	22.8	28.2	17.2	10–14 years	35.3	44.9	25.4	28.3	44.0	*	16.9	22.2	11.3
15-19 years	84.3	122.4	44.0	75.6	106.0	43.3	15-19 years	135.5	218.4	50.5	110.8	163.7	55.9	49.7	70.6	27.6
20-24 years	105.7	159.4	50.1	91.0	135.4	44.3	20-24 years	200.7	321.0	84.3	149.7	218.0	75.2	57.4	80.8	33.1
25-29 years	120.5	178.0	62.5	103.2	153.3	51.9	25-29 years	241.3	361.7	131.3	160.2	245.2	72.4	53.8	75.4	32.8
30-34 years	153.5	224.0	83.3	132.4	195.8	68.1	30-34 years	316.0	464.4	185.2	203.2	275.3	132.8	61.4	79.9	44.1
35–39 years	199.5	282.8	117.2	171.2	245.5	96.3	35–39 years	427.0	609.6	267.1	240.8	334.0	152.4	77.6	101.5	55.8
40-44 years	261.6	359.1	166.5	226.3	312.2	140.6	40-44 years	570.7	803.2	370.7	257.3	355.9	164.1	110.4	139.6	85.0
45-49 years	368.0	485.7	254.6	328.6	432.5	226.5	45-49 years	762.4	1065.7	508.0	391.5	522.4	267.3	184.9	219.6	153.5
50-54 years	568.2	728.1	417.1	518.6	663.4	379.3	50–54 years	1054.9	1419.3	757.0	577.6	759.7	408.9	295.2	366.5	229.0
55–59 years	902.1	1156.5	668.2	835.1	1071.5	613.4	55–59 years	1579.0	2103.6	1165.4	997.2	1229.3	786.3	500.4	620.6	396.8
60-64 years	1402.2	1815.2	1038.2	1334.9	1729.7	979.7	60-64 years	2204.1	2924.3	1659.5	1303.7	1574.4	1063.8	729.6	948.4	563.3
65–69 years	2114.8	2775.4	1577.7	2042.6	2688.5	1511.0	65-69 years	3075.9	4029.1	2378.8	1819.9	2219.3	1486.3	1189.4	1576.7	896.4
70–74 years	3146.8	4109.3	2419.9	3073.0	4012.4	2356.4	70–74 years	4278.6	5724.9	3315.3	2541.5	3145.9	2076.5	1872.3	2486.2	1380.5
75–79 years	4705.9	6202.4	3716.8	4662.2	6148.8	3672.7	75–79 years	5596.3	7502.0	4482.7	3434.9	4410.5	2753.2	3001.3	3882.7	2290.5
80-84 years	7429.1	9726.0	6186.1	7391.0	9700.5	6146.1	80–84 years	8400.8	10,969.8	7070.5	5133.1	6753.1	4168.6	5156.3	6461.7	3997.0
85 years and over	14,972.9	17,740.4	13,901.0	15,104.2	17,956.2	14,015.9	85 years and over	14,278.6	16,717.1	13,264.1	7726.0	9381.3	6878.7	10,841.3	12,628.8	9561.8

**TABLE 4.2**Total deaths and death rates by age, race, and sex, United States, 1992

Age   Script   Age   Script   Age   Script   Age   Script   Age   Script   Age   Script   Age	at all train to rate	cheale & ore	All Races	ranger or co	ir ndi magni	White				Black		Am	erican In	dian	Asian or	Pacific Is	lander
All ages 2,175.613 1,122.336 1,053.277 1,873.781 956.957 916.824   All ages 2,175.613 1,122.336 1,053.277 1,873.781 956.957 916.824   All ages 3,4628 19,454 15,0583 22,164 12,625 9539   1.4 years 64.63 80 9 255 46.85 2690 1995   1.4 years 676.63 360 2255 46.85 2690 1995   1.4 years 13739 2231 1508 2690 1605 1085   1.5 9 years 3739 2231 1508 2690 1605 1085   1.5 19 years 14.411 10,747 3664 10,308 7440 2888   1.5 19 years 14.411 10,747 3664 10,308 7440 2888   1.5 19 years 2,0137 15,460 4677 14,033 10,606 3337   2.5 2-3 years 2,0137 15,460 4677 14,033 10,606 3337   2.5 2-3 years 2,0137 15,460 3677 1,2825 42,00   1.5 19 years 3,4167 24,863 930 24,450 12,169 8437   1.5 19 years 3,4167 24,863 930 24,450 12,169 8437   1.5 19 years 4,020 1 33,354 15,447 35,866 24,726 11,769   1.5 19 years 9,4582 5,868 5,868 3,868 3,868 1,2008   1.5 19 years 9,4582 5,868 5,868 3,868 3,868 1,2008   1.5 19 years 3,064,07   1.6 1,400 8,127 5,761 12,213 74,994 47,219   1.6 1,400 8,127 5,700 8,141 1,416 1,			mitggrovgi	myti moon	0.0000000000000000000000000000000000000	10							Marring	21,			
All ages	Age	Sexes	Male	Female	Sexes	Male	Female	Age	Sexes	Male	Female	Sexes	Male	Female	Sexes	Male	Female
Substitute   1,4   Substitute   1,5   Substitute   1,5   Substitute   1,4   Substitute				Num	ber								Number				
	All ages	2,175,613	1,122,336	1,053,277	1,873,781	956,957	916,824	All ages	269,219	146,630	122,589	8953	5181	3772	23,660	13,568	10,092
5-9 years	Under 1 year	34,628	19,545	15,083	22,164	12,625	9539	Under 1 year	11,348	6298	5050	393	221	172	723	401	322
10-14 years	1–4 years	6764	3809	2955	4685	2690	1995	1–4 years	1799	965	834	127	67	60	153	87	66
15-19 years   14-411   10-747   3-664   10.308   7-440   28-88   15-19 year   20.137   15-460   46-77   14.033   10.696   3337   20-24 years   24.314   18.032   6282   17.851   12.825   4226   25-29 years   24.314   18.032   6282   17.851   17.852	5–9 years	3739		1508	2690	1605	1085	5–9 years	894	529	365	54	33	21	101	64	37
20-24 years 20,137   15,460   4677   14,033   10,696   3337   20,-24 year		4454	2849	1605	3299	2093	1206	10-14 years	982	633	349	61	48	13	112	75	37
25-29 years	15–19 years	14,411	10,747	3664	10,308	7440	2888	15-19 yea							314	229	85
30-34 years 34,167 24,863 920,641 12,448 30,127 21,090 8437 35-39 year									6960						426	306	
35-39 years	25–29 years	24,314						25-29 yea	200						411	284	127
40-44 years 49-201 33.354 15.847 55.886 24.726 11.160 49-44 years 56.53 36.62 19.911 43.451 23.33 15.198 50.639 25.54 years 68.497 42.649 25.848 53.689 33.681 20.008 50.54 years 94.582 58.083 36.499 75.761 21.2213 74.994 47.219 60.64 years 211.071 12.4228 86.843 18.0788 107.427 73.361 65.69 years 211.071 12.4228 86.843 18.0788 107.427 73.361 65.69 years 211.071 12.4228 86.843 18.0788 107.427 73.361 65.69 years 301.736 158.257 143.479 270.238 142.422 12.7816 79.74 years 301.736 16.64.76 27.95.70 12.848 151.023 80.844 years 10.64.74 10.65.75 11.88 10.7427 79.75 11.88 10.7427 79.95 years 10.74 years 10.75 15.74 years 10.74 years 10.74 years 10.74 years 10.74 years 10.75 15.94 ye	30–34 years		24,863	9304				30-34 yea							503	317	186
45-49 years 68,497 42,696 25,848 53,689 33,681 20,008 59-54 years 68,497 42,696 25,848 53,689 33,681 20,008 59-54 years 68,497 42,696 42,848 43,848 419,37 57,612 122,213 74,994 47,219 66-64 years 210,71 124,228 86,843 180,788 107,427 73,361 70-74 years 266,845 140,937 116,908 234,117 132,273 101,844 70-74 years 301,751 182,427 143,479 72,038 144,409 182,749 180,484 181,184 181,184 181,185 181,023 180,484 181,184 181,185 181,023 180,484 181,184 181,185 181,023 180,484 181,184 181,185 181,023 180,484 181,184 181,185 181,023 180,484 181,185 181,023 180,484 181,185 181,023 181,185 181,023 181,185 181,023 181,185 181,023 181,185 181,023 181,185 181,023 181,185 181,023 181,185 181,18								190000000000000000000000000000000000000	_								
50-54 years							10/10/10/10/00 (ast 100 colors								, , ,		
55-59 years 94.582 \$8.083 36.499 \$7.576 \$47.042 28.708 66-69 year 146.409 \$8.797 \$7.612 122.213 74.994 \$47.219 \$65-69 year 211.071 124.228 \$8.543 180.788 107.427 73.361 70-74 years 266.845 149.937 116.908 234.117 132.273 101.844 70.74 years 301.736 158.257 143.479 270.238 142.422 127.81																	
60-64 years   146,409   88,797   57,612   22,213   74,994   47,219   66-64 years   211,071   124,228   86,843   180,788   107,427   73,361   70-74 years   266,845   149,937   116,908   234,117   132,273   101,844   70-74 years   301,736   158,257   143,479   279,507   128,844   151,023   80-84 years   308,116   141,640   166,476   279,507   128,844   151,023   80-84 years   308,116   141,640   166,476   279,507   128,844   151,023   80-84 years   487,466   161,236   326,210   448,984   147,419   301,565   85 years and over   487,446   161,236   326,210   448,984   147,419   301,565   85 years and over   487,446   480   390,0   38.1   42,66   33.3   42,66   33.3   42,66   34,66   480   39,0   38.1   42,66   33.3   42,66   34,66   48,06   39,7   18.2   22.8   28.2   17.2   10-14 years   24,6   30.7   18.2   22.8   28.2   17.2   10-14 years   24,64   30.7   18.2   22.8   28.2   17.2   10-14 years   24,64   30.7   159,4   50.1   91,00   135,4   44.3   31-9 years   105,7   159,4   50.1   91,00   135,4   44.3   30-34 years   153,5   224,0   83.3   132,4   195,8   68.1   30-34 years   153,5   224,0   83.3   132,4   195,8   68.1   30-34 years   153,5   28,24   147,1   518,6   663,4   379,3   55-59 years   199,5   282,8   117.2   171.2   245,5   96,3   35-39 years   199,5   28,28   117.2   171.5   516,6   663,4   379,3   55-59 years   157,9   210,36   165,4   97.2   128,9   375,4   147,1   1518,6   663,4   379,3   55-59 years   157,9   210,36   165,4   97.2   128,9   375,4   147,1   1518,6   663,4   379,3   55-59 years   157,9   210,36   145,5   145,																	
65-69 years 211,071 124,228 88,843 180,788 107,427 73,361 65-69 year 266,845 149,937 116,908 234,117 132,273 101,844 75-79 years 301,736 158,257 143,479 270,238 142,422 127,816 75-79 years 301,736 158,257 143,479 270,238 142,422 127,816 75-79 years 301,736 158,257 143,479 270,238 142,422 127,816 75-79 years 308,8116 141,640 166,476 279,507 128,484 151,023 80-84 years 308,116 141,640 166,476 279,507 128,484 151,023 80-84 years 308,116 141,640 166,476 279,507 128,484 151,023 80-84 years 10.75 162,77 179,000 180,000								55–59 yea									
10-74   years   266,845   149,937   116,908   234,117   132,273   101,844   70-74   years   301,736   158,257   143,479   270,238   142,422   127,816   75-79   years   308,116   141,640   166,476   279,507   128,484   151,023   80-84   years   3706   1801   1905   332,7   235,8   332,7   235,8   332,7   33								60-64 yea									
18,27   143,47   270,238   143,47   270,238   143,47   270,238   143,47   270,238   151,023   880-84 years   308,161   141,640   161,236   326,210   448,984   147,419   301,565   85 years and over   487,446   161,236   326,210   448,984   147,419   301,565   85 years and over   474   356   118   351   272   79   Not stated   474   356   118   351   272   79   Not stated   474   356   18   351   272   79   Not stated   474   356   18   351   272   79   Not stated   474   474   475								65–69 yea	77								
18,27   143,47   270,238   143,47   270,238   143,47   270,238   143,47   270,238   151,023   880-84 years   308,161   141,640   161,236   326,210   448,984   147,419   301,565   85 years and over   487,446   161,236   326,210   448,984   147,419   301,565   85 years and over   474   356   118   351   272   79   Not stated   474   356   118   351   272   79   Not stated   474   356   18   351   272   79   Not stated   474   356   18   351   272   79   Not stated   474   474   475					100010000			70–74 yea	11. 22	经债务							
State   Stat																	
Noi stated 474 356 118 351 272 79 Not stated Death rate All ages .								80–84 yea									
Chider 1 year   Section								85 years a		- 4							
Chider 1 year   Section	Not stated	474	356	118	351	272	79	Not stated	nac		VCB	ш.			8	7	1
Under 1 year	THE RESIDENCE TO			Death	rate												
1-4 years 43.6 48.0 39.0 38.1 42.6 33.3 1-4 years 5-9 years 20.4 23.7 16.8 18.3 21.3 15.2 5-9 years 24.6 30.7 18.2 22.8 28.2 17.2 10-14 years 24.6 30.7 18.2 22.8 28.2 17.2 10-14 years 84.3 122.4 44.0 75.6 106.0 43.3 15-19 years 105.7 159.4 50.1 91.0 135.4 44.3 20-24 years 105.7 159.4 50.1 91.0 135.4 44.3 20-24 years 120.5 178.0 62.5 103.2 153.3 51.9 25-29 year 120.5 178.0 62.5 103.2 153.3 51.9 25-29 year 130.3 49 years 153.5 224.0 83.3 132.4 195.8 68.1 30-34 year 159.5 9years 199.5 282.8 117.2 171.2 245.5 96.3 35-39 year 199.5 240.8 14.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 2	All ages	852.9	901.6	806.5	880.0	917.2	844.3	All ages .	- A 14	Participant	100				283.1	332.7	235.8
1-4 years 43.6 48.0 39.0 38.1 42.6 33.3 1-4 years 5-9 years 20.4 23.7 16.8 18.3 21.3 15.2 5-9 years 24.6 30.7 18.2 22.8 28.2 17.2 10-14 years 24.6 30.7 18.2 22.8 28.2 17.2 10-14 years 84.3 122.4 44.0 75.6 106.0 43.3 15-19 years 105.7 159.4 50.1 91.0 135.4 44.3 20-24 years 105.7 159.4 50.1 91.0 135.4 44.3 20-24 years 120.5 178.0 62.5 103.2 153.3 51.9 25-29 year 120.5 178.0 62.5 103.2 153.3 51.9 25-29 year 130.3 49 years 153.5 224.0 83.3 132.4 195.8 68.1 30-34 year 159.5 9years 199.5 282.8 117.2 171.2 245.5 96.3 35-39 year 199.5 240.8 14.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 2	Under 1 year	865.7	956.6	770.8	701.8	780.9	618.7	Under 1 y		COL	20 10				439.8	477.7	400.2
10-14 years 24.6 30.7 18.2 22.8 28.2 17.2 10-14 years 15-19 years 84.3 122.4 44.0 75.6 106.0 43.3 15-19 years 105.7 159.4 50.1 91.0 135.4 44.3 20-24 year 105.7 159.4 50.1 91.0 135.4 44.3 20-24 year 125-29 years 120.5 178.0 62.5 103.2 153.3 51.9 25-29 year 153.5 224.0 83.3 132.4 195.8 68.1 30-34 year 153.5 224.0 83.3 132.4 195.8 68.1 30-34 year 169.5 282.8 117.2 171.2 245.5 96.3 35-39 year 199.5 282.8 110.4 110.4 139.6 85.0 110.4 139.6 130.5 130	1–4 years	43.6	48.0	39.0	38.1	42.6	33.3								26.9	29.9	23.8
15-19 years 84.3 122.4 44.0 75.6 106.0 43.3 15-19 yes 20-24 years 105.7 159.4 50.1 91.0 135.4 44.3 20-24 year 25-29 year 120.5 178.0 62.5 103.2 153.3 51.9 25-29 year 30-34 years 153.5 224.0 83.3 132.4 195.8 68.1 30-34 year 199.5 282.8 117.2 171.2 245.5 96.3 35-39 year 199.5 282.8 117.2 171.2 245.5 96.3 35-39 year 261.6 359.1 166.5 226.3 312.2 140.6 40-44 year 264-49 years 368.0 485.7 254.6 328.6 432.5 226.5 45-49 year 250-59 years 902.1 1156.5 668.2 835.1 1071.5 613.4 55-59 years 1579.0 2103.6 1165.4 997.2 1229.3 786.3 500.4 620.6 396.8 60-64 years 1402.2 1815.2 1038.2 1334.9 1729.7 979.7 60-64 years 2204.1 2924.3 1659.5 1303.7 1574.4 1063.8 729.6 948.4 563.3 65-69 years 214.8 2775.4 1577.7 2042.6 2688.5 1511.0 65-69 years 3075.9 4029.1 2378.8 1819.9 219.3 1486.3 1189.4 1576.7 896.4 70-74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70-74 years 4278.6 5724.9 3315.3 2541.5 3134.5 2076.5 1872.3 2486.2 1380.5 75-79 years 4705.9 6202.4 3716.8 4662.2 6148.8 3672.7 75-79 years 5596.3 7502.0 4482.7 3434.9 4410.5 2753.2 3001.3 3882.7 2290.5 80-84 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0	5–9 years	20.4	23.7	16.8	18.3	21.3	15.2	5–9 years	Char	10 may 10 mg	100				15.4	19.1	11.5
15-19 years 84.3 122.4 44.0 75.6 106.0 43.3 15-19 yes 20-24 years 105.7 159.4 50.1 91.0 135.4 44.3 20-24 year 25-29 year 120.5 178.0 62.5 103.2 153.3 51.9 25-29 year 30-34 years 153.5 224.0 83.3 132.4 195.8 68.1 30-34 year 199.5 282.8 117.2 171.2 245.5 96.3 35-39 year 199.5 282.8 117.2 171.2 245.5 96.3 35-39 year 261.6 359.1 166.5 226.3 312.2 140.6 40-44 year 264-49 years 368.0 485.7 254.6 328.6 432.5 226.5 45-49 year 250-59 years 902.1 1156.5 668.2 835.1 1071.5 613.4 55-59 years 1579.0 2103.6 1165.4 997.2 1229.3 786.3 500.4 620.6 396.8 60-64 years 1402.2 1815.2 1038.2 1334.9 1729.7 979.7 60-64 years 2204.1 2924.3 1659.5 1303.7 1574.4 1063.8 729.6 948.4 563.3 65-69 years 214.8 2775.4 1577.7 2042.6 2688.5 1511.0 65-69 years 3075.9 4029.1 2378.8 1819.9 219.3 1486.3 1189.4 1576.7 896.4 70-74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70-74 years 4278.6 5724.9 3315.3 2541.5 3134.5 2076.5 1872.3 2486.2 1380.5 75-79 years 4705.9 6202.4 3716.8 4662.2 6148.8 3672.7 75-79 years 5596.3 7502.0 4482.7 3434.9 4410.5 2753.2 3001.3 3882.7 2290.5 80-84 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0	10-14 years	24.6	30.7	18.2	22.8	28.2	17.2	10-14 yea	-75 7	оезш	S				16.9	22.2	11.3
25-29 years 120.5 178.0 62.5 103.2 153.3 51.9 25-29 years 153.5 224.0 83.3 132.4 195.8 68.1 30-34 years 153.5 224.0 83.3 132.4 195.8 68.1 30-34 years 199.5 282.8 117.2 171.2 245.5 96.3 35-39 years 261.6 359.1 166.5 226.3 312.2 140.6 40-44 years 261.6 359.1 166.5 226.5 45-49 years 260.5 45-49 years 260.5 45-49 years 260.5 45.49 y	15-19 years	84.3	122.4	44.0	75.6	106.0	43.3								49.7	70.6	27.6
35-39 years 199.5 282.8 117.2 171.2 245.5 96.3 35-39 year 40-44 years 261.6 359.1 166.5 226.3 312.2 140.6 40-44 year 368.0 485.7 254.6 328.6 432.5 226.5 45-49 year 568.2 728.1 417.1 518.6 663.4 379.3 50-54 year 902.1 1156.5 668.2 835.1 1071.5 613.4 55-59 years 1579.0 2103.6 1165.4 997.2 1229.3 786.3 50.4 60-64 years 1402.2 1815.2 1038.2 1334.9 1729.7 979.7 60-64 years 2204.1 2924.3 1659.5 1303.7 1574.4 1063.8 729.6 948.4 563.3 65-69 years 2114.8 2775.4 1577.7 2042.6 2688.5 1511.0 65-69 years 3075.9 4029.1 2378.8 1819.9 2219.3 1486.3 1189.4 1576.7 896.4 70-74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70-74 years 4278.6 5724.9 3315.3 2541.5 3145.9 2076.5 1872.3 2486.2 1380.5 75-79 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0		105.7	159.4	50.1	91.0	135.4	44.3	20-24 yea	N 1	A					1 / SESSION (SA)	80.8	
35-39 years 199.5 282.8 117.2 171.2 245.5 96.3 35-39 year 40-44 years 261.6 359.1 166.5 226.3 312.2 140.6 40-44 year 368.0 485.7 254.6 328.6 432.5 226.5 45-49 year 568.2 728.1 417.1 518.6 663.4 379.3 50-54 year 902.1 1156.5 668.2 835.1 1071.5 613.4 55-59 years 1579.0 2103.6 1165.4 997.2 1229.3 786.3 50.4 60-64 years 1402.2 1815.2 1038.2 1334.9 1729.7 979.7 60-64 years 2204.1 2924.3 1659.5 1303.7 1574.4 1063.8 729.6 948.4 563.3 65-69 years 2114.8 2775.4 1577.7 2042.6 2688.5 1511.0 65-69 years 3075.9 4029.1 2378.8 1819.9 2219.3 1486.3 1189.4 1576.7 896.4 70-74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70-74 years 4278.6 5724.9 3315.3 2541.5 3145.9 2076.5 1872.3 2486.2 1380.5 75-79 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0	25–29 years	120.5	178.0	62.5	103.2	153.3	51.9	25–29 yea	J-J	4 V)	ears						
40-44 years 261.6 359.1 166.5 226.3 312.2 140.6 40-44 year 368.0 485.7 254.6 328.6 432.5 226.5 45-49 year 568.2 728.1 417.1 518.6 663.4 379.3 50-54 year 59.9 years 902.1 1156.5 668.2 835.1 1071.5 613.4 55-59 years 1579.0 2103.6 1165.4 997.2 1229.3 786.3 500.4 620.6 396.8 60-64 years 1402.2 1815.2 1038.2 1334.9 1729.7 979.7 60-64 years 2204.1 2924.3 1659.5 1303.7 1574.4 1063.8 729.6 948.4 563.3 65-69 years 2114.8 2775.4 1577.7 2042.6 2688.5 1511.0 65-69 years 3075.9 4029.1 2378.8 1819.9 2219.3 1486.3 1189.4 1576.7 896.4 70-74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70-74 years 4278.6 5724.9 3315.3 2541.5 3145.9 2076.5 1872.3 2486.2 1380.5 75-79 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0	30–34 years							30–34 yea							1 10000000	79.9	
50-54 years 568.2 728.1 417.1 518.6 663.4 379.3 50-54 year 55-59 years 902.1 1156.5 668.2 835.1 1071.5 613.4 55-59 years 1579.0 2103.6 1165.4 997.2 1229.3 786.3 500.4 620.6 396.8 60-64 years 1402.2 1815.2 1038.2 1334.9 1729.7 979.7 60-64 years 2204.1 2924.3 1659.5 1303.7 1574.4 1063.8 729.6 948.4 563.3 65-69 years 2114.8 2775.4 1577.7 2042.6 2688.5 1511.0 65-69 years 3075.9 4029.1 2378.8 1819.9 2219.3 1486.3 1189.4 1576.7 896.4 70-74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70-74 years 4278.6 5724.9 3315.3 2541.5 3145.9 2076.5 1872.3 2486.2 1380.5 75-79 years 4705.9 6202.4 3716.8 4662.2 6148.8 3672.7 75-79 years 5596.3 7502.0 4482.7 3434.9 4410.5 2753.2 3001.3 3882.7 2290.5 80-84 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0	35–39 years	199.5	282.8				96.3	35–39 yea	e 11	dia.					- 12 / AVAINE		
50-54 years 568.2 728.1 417.1 518.6 663.4 379.3 50-54 year 55-59 years 902.1 1156.5 668.2 835.1 1071.5 613.4 55-59 years 1579.0 2103.6 1165.4 997.2 1229.3 786.3 500.4 620.6 396.8 60-64 years 1402.2 1815.2 1038.2 1334.9 1729.7 979.7 60-64 years 2204.1 2924.3 1659.5 1303.7 1574.4 1063.8 729.6 948.4 563.3 65-69 years 2114.8 2775.4 1577.7 2042.6 2688.5 1511.0 65-69 years 3075.9 4029.1 2378.8 1819.9 2219.3 1486.3 1189.4 1576.7 896.4 70-74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70-74 years 4278.6 5724.9 3315.3 2541.5 3145.9 2076.5 1872.3 2486.2 1380.5 75-79 years 4705.9 6202.4 3716.8 4662.2 6148.8 3672.7 75-79 years 5596.3 7502.0 4482.7 3434.9 4410.5 2753.2 3001.3 3882.7 2290.5 80-84 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0	40–44 years	261.6	359.1				140.6	40-44 yea	<b>&gt;</b>	93 W	BOURS.						
55-59 years	*							43-49 yea		2.30							
60-64 years 1402.2 1815.2 1038.2 1334.9 1729.7 979.7 60-64 years 2204.1 2924.3 1659.5 1303.7 1574.4 1063.8 729.6 948.4 563.3 65-69 years 2114.8 2775.4 1577.7 2042.6 2688.5 1511.0 65-69 years 3075.9 4029.1 2378.8 1819.9 2219.3 1486.3 1189.4 1576.7 896.4 70-74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70-74 years 4278.6 5724.9 3315.3 2541.5 3145.9 2076.5 1872.3 2486.2 1380.5 75-79 years 4705.9 6202.4 3716.8 4662.2 6148.8 3672.7 75-79 years 5596.3 7502.0 4482.7 3434.9 4410.5 2753.2 3001.3 3882.7 2290.5 80-84 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0	50–54 years	568.2	728.1	417.1	518.6	663.4	379.3	50-54 yea							295.2	366.5	
65-69 years								55–59 years									
70–74 years 3146.8 4109.3 2419.9 3073.0 4012.4 2356.4 70–74 years 4278.6 5724.9 3315.3 2541.5 3145.9 2076.5 1872.3 2486.2 1380.5 75–79 years 4705.9 6202.4 3716.8 4662.2 6148.8 3672.7 75–79 years 5596.3 7502.0 4482.7 3434.9 4410.5 2753.2 3001.3 3882.7 2290.5 80–84 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80–84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0								60-64 years									
75-79 years 4705.9 6202.4 3716.8 4662.2 6148.8 3672.7 75-79 years 5596.3 7502.0 4482.7 3434.9 4410.5 2753.2 3001.3 3882.7 2290.5 80-84 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0	65–69 years							65–69 years	3075.9	4029.1	2378.8	1819.9	2219.3	1486.3			
80-84 years 7429.1 9726.0 6186.1 7391.0 9700.5 6146.1 80-84 years 8400.8 10,969.8 7070.5 5133.1 6753.1 4168.6 5156.3 6461.7 3997.0								70–74 years									
								75–79 years		7502.0	4482.7	3434.9					
85 years and over 14,972.9 17,740.4 13,901.0 15,104.2 17,956.2 14,015.9 85 years and over 14,278.6 16,717.1 13,264.1 7726.0 9381.3 6878.7 10,841.3 12,628.8 9561.8								80–84 years		5.550025003							
	85 years and over	14,972.9	17,740.4	13,901.0	15,104.2	17,956.2	14,015.9	85 years and over	14,278.6	16,717.1	13,264.1	7726.0	9381.3	6878.7	10,841.3	12,628.8	9561.8

TABLE 4.2

(Continued)

TABLE 4.2

Total deaths and death rates by age, race, and sex, United States, 1992 All Races

TABLE 4.2

White

(Continued)

Black

American Indian

Asian or Pacific Islander

and spirituling and culture			II COLLEGE PLANT	of the Charles	US LUMBER				Diuck		7	CI ICUII II		- ROMAN OF	z detile zo	
Age	Both Sexes	Male	Female	Both Sexes	Male	Female	Age	Both Sexes	Male	Female	Both Sexes	Male	Female	Both Sexes	Male	Female
-		Completello	Numi	ber		19						Number				
All ages	2,175,613	1,122,336	1,053,277	1873,781	956,957	916,824	All ages	269,219	146,630	122,589	8953	5181	3772	23,660	13,568	10,092
Under 1 year	34,628	19,545	15,083	22,164	12,625	9539	Under 1 year	11,348	6298	5050	393	221	172	723	401	322
1–4 years	6764	3809	2955	4685	2690	1995	1–4 years	1799	965	834	127	67	60	153	87	66
5–9 years	3739	2231	1508	2690	1605	1085	5–9 years	894	529	365	54	33	21	101	64	37
10–14 years	4454	2849	1605	3299	2093	1206	10–14 years	982	633	349	61	48	13	112	75	37
15–19 years	14,411	10,747	3664	10,308	7440	2888	15–19 years	3583	2923	660	206	155	51	314	229	85
20–24 years	20,137	15,460	4677	14,033	10,696	3337	20–24 years	5399	4246	1153	279	212	67	426	306	120
25–29 years	24,314	18,032	6282	17,05	12,825	4226	25–29 years	6559	4695	1864	293	228	65	411	284	127
30–34 years	34,167	24,863	9304	24,450	18,210	6240	30–34 years	8836	6083	2753	378	253	125	503	317	186
35–39 years	42,089	29,641	12,448	30,127	21,690	8437	35–39 years	10,965	7308	3657	403	272	131	594	371	223
40–44 years	49,201	33,354	15,847	35,886	24,726	11,160	40–44 years	12,213	7949	4264	366	246	120	736	433	303
45–49 years	56,533	36,622	19,911	43,451	28,343	15,108	45–49 years	11,753	7493	4260	431	280	151	898	506	392
50–54 years	68,497	42,649	25,848	53,689	33,681	20,008		13,252	8021	5231	487	308	179	1069	639	430
55–59 years	94,582	58,083	36,499	75,750	47,042	28,708	50–54 years	16,727	9824	6903	668	392	276	1437	825	612
60-6	74,502	50,005	30,437	73,730	47,042	20,700	55–59 years	10,727	9024	0903	000	392	270	1437	023	793
65–6 70–7 75–7		1	All R	aces						И	hit	e				1053 1128 1193
80–8 85 ye																1079 1905
Not s	oth						300 84	Both	1							1
All a	exes		Ma	ile	I	<sup>7</sup> ema	de 5	šexe	s	10.1	Mal	e	F	ema	ile	235.8
Unde																400.2 23.8
1–4 years	20.4	23.7	16.8	18.3	21.3	15.2	5–9 years	32.1	37.5	26.6	25.1	30.1	19.8	15.4	19.1	11.5
10-14 years	24.6	30.7	18.2	22.8	28.2	17.2	10-14 years	35.3	44.9	25.4	28.3	44.0	*	16.9	22.2	11.3
15-19 years	84.3	122.4	44.0	75.6	106.0	43.3	15–19 years	135.5	218.4	50.5	110.8	163.7	55.9	49.7	70.6	27.6
20-24 years	105.7	159.4	50.1	91.0	135.4	44.3	20-24 years	200.7	321.0	84.3	149.7	218.0	75.2	57.4	80.8	33.1
25-29 years	120.5	178.0	62.5	103.2	153.3	51.9	25–29 years	241.3	361.7	131.3	160.2	245.2	72.4	53.8	75.4	32.8
30–34 years	153.5	224.0	83.3	132.4	195.8	68.1	30–34 years	316.0	464.4	185.2	203.2	275.3	132.8	61.4	79.9	44.1
35–39 years	199.5	282.8	117.2	171.2	245.5	96.3	35–39 years	427.0	609.6	267.1	240.8	334.0	152.4	77.6	101.5	55.8
					212.2					370.7	257.3	355.9	164.1	110.4	139.6	
40-44 Vears	261.6	359.1	166.5	226.3	312.2	140.0	40-44 years	2/11/	8013		231.3			110.4	1.39.0	85.0
40–44 years	261.6 368.0	359.1 485.7	166.5 254.6			140.6 226.5	40–44 years	570.7 762.4	803.2 1065.7							555-555
45–49 years	368.0	485.7	254.6	328.6	432.5	226.5	45–49 years	762.4	1065.7	508.0	391.5	522.4	267.3	184.9	219.6	153.5
45–49 years 50–54 years	368.0 568.2	485.7 728.1	254.6 417.1	328.6 518.6	432.5 663.4	226.5 379.3	45–49 years 50–54 years	762.4 1054.9	1065.7 1419.3	508.0 757.0	391.5 577.6	522.4 759.7	267.3 408.9	184.9 295.2	219.6 366.5	153.5 229.0
45–49 years	368.0 568.2 902.1	485.7 728.1 1156.5	254.6 417.1 668.2	328.6 518.6 835.1	432.5 663.4 1071.5	226.5 379.3 613.4	45–49 years	762.4 1054.9 1579.0	1065.7 1419.3 2103.6	508.0 757.0 1165.4	391.5 577.6 997.2	522.4 759.7 1229.3	267.3 408.9 786.3	184.9 295.2 500.4	219.6 366.5 620.6	153.5 229.0 396.8
45–49 years	368.0 568.2 902.1 1402.2	485.7 728.1 1156.5 1815.2	254.6 417.1 668.2 1038.2	328.6 518.6 835.1 1334.9	432.5 663.4 1071.5 1729.7	226.5 379.3 613.4 979.7	45–49 years	762.4 1054.9 1579.0 2204.1	1065.7 1419.3 2103.6 2924.3	508.0 757.0 1165.4 1659.5	391.5 577.6 997.2 1303.7	522.4 759.7 1229.3 1574.4	267.3 408.9 786.3 1063.8	184.9 295.2 500.4 729.6	219.6 366.5 620.6 948.4	153.5 229.0 396.8 563.3
45–49 years 50–54 years 55–59 years 60–64 years 65–69 years	368.0 568.2 902.1 1402.2 2114.8	485.7 728.1 1156.5 1815.2 2775.4	254.6 417.1 668.2 1038.2 1577.7	328.6 518.6 835.1 1334.9 2042.6	432.5 663.4 1071.5 1729.7 2688.5	226.5 379.3 613.4 979.7 1511.0	45–49 years	762.4 1054.9 1579.0 2204.1 3075.9	1065.7 1419.3 2103.6 2924.3 4029.1	508.0 757.0 1165.4 1659.5 2378.8	391.5 577.6 997.2 1303.7 1819.9	522.4 759.7 1229.3 1574.4 2219.3	267.3 408.9 786.3 1063.8 1486.3	184.9 295.2 500.4 729.6 1189.4	219.6 366.5 620.6 948.4 1576.7	153.5 229.0 396.8 563.3 896.4
45–49 years 50–54 years 55–59 years 60–64 years 65–69 years 70–74 years	368.0 568.2 902.1 1402.2 2114.8 3146.8	485.7 728.1 1156.5 1815.2 2775.4 4109.3	254.6 417.1 668.2 1038.2 1577.7 2419.9	328.6 518.6 835.1 1334.9 2042.6 3073.0	432.5 663.4 1071.5 1729.7 2688.5 4012.4	226.5 379.3 613.4 979.7 1511.0 2356.4	45–49 years	762.4 1054.9 1579.0 2204.1 3075.9 4278.6	1065.7 1419.3 2103.6 2924.3 4029.1 5724.9	508.0 757.0 1165.4 1659.5 2378.8 3315.3	391.5 577.6 997.2 1303.7 1819.9 2541.5	522.4 759.7 1229.3 1574.4 2219.3 3145.9	267.3 408.9 786.3 1063.8 1486.3 2076.5	184.9 295.2 500.4 729.6 1189.4 1872.3	219.6 366.5 620.6 948.4 1576.7 2486.2	153.5 229.0 396.8 563.3 896.4 1380.5
45–49 years 50–54 years 55–59 years 60–64 years 65–69 years 70–74 years 75–79 years	368.0 568.2 902.1 1402.2 2114.8 3146.8 4705.9	485.7 728.1 1156.5 1815.2 2775.4 4109.3 6202.4	254.6 417.1 668.2 1038.2 1577.7 2419.9 3716.8	328.6 518.6 835.1 1334.9 2042.6 3073.0 4662.2	432.5 663.4 1071.5 1729.7 2688.5 4012.4 6148.8	226.5 379.3 613.4 979.7 1511.0 2356.4 3672.7	45–49 years	762.4 1054.9 1579.0 2204.1 3075.9 4278.6 5596.3	1065.7 1419.3 2103.6 2924.3 4029.1 5724.9 7502.0	508.0 757.0 1165.4 1659.5 2378.8 3315.3 4482.7	391.5 577.6 997.2 1303.7 1819.9 2541.5 3434.9	522.4 759.7 1229.3 1574.4 2219.3 3145.9 4410.5	267.3 408.9 786.3 1063.8 1486.3 2076.5 2753.2	184.9 295.2 500.4 729.6 1189.4 1872.3 3001.3	219.6 366.5 620.6 948.4 1576.7 2486.2 3882.7	153.5 229.0 396.8 563.3 896.4 1380.5 2290.5
45–49 years 50–54 years 55–59 years 60–64 years 65–69 years 70–74 years	368.0 568.2 902.1 1402.2 2114.8 3146.8	485.7 728.1 1156.5 1815.2 2775.4 4109.3	254.6 417.1 668.2 1038.2 1577.7 2419.9	328.6 518.6 835.1 1334.9 2042.6 3073.0	432.5 663.4 1071.5 1729.7 2688.5 4012.4	226.5 379.3 613.4 979.7 1511.0 2356.4	45–49 years	762.4 1054.9 1579.0 2204.1 3075.9 4278.6	1065.7 1419.3 2103.6 2924.3 4029.1 5724.9	508.0 757.0 1165.4 1659.5 2378.8 3315.3	391.5 577.6 997.2 1303.7 1819.9 2541.5 3434.9 5133.1	522.4 759.7 1229.3 1574.4 2219.3 3145.9	267.3 408.9 786.3 1063.8 1486.3 2076.5	184.9 295.2 500.4 729.6 1189.4 1872.3	219.6 366.5 620.6 948.4 1576.7 2486.2	153.5 229.0 396.8 563.3 896.4 1380.5

## Total deaths and death rates by age, race and sex in US, 1992

	All Races			W	hite	Black	<i> </i>   <i> </i>	Am In	As / PI
Age	Both sexes	Male	Female						
All ages									
Under 1									
1~4 years									
5~9 years									
85 & older									

Am In: American Indian

As & PI: Asian & Pacific Islander

## 4.2 Standardizing Rates

- We see from Table 4.2 that in some cases rate comparison based on specific grouping can better describe the vital statistics than a crude rate.
- When crude rates are <u>compared</u>, however, the difference in underlying populations (age, sex, etc.) may alter the <u>true relationship</u> that is displayed from the crude rates themselves. (We will later call these (age, sex, etc.) <u>confounding variables</u>, or simply confounders.)

## **Confounding Variables**

 Confounding variables are two variables that are confounded<sup>1</sup> when their effects on a response variable cannot be distinguished from each other.

<sup>1</sup> to confuse and surprise somebody

http://score.kings.k12.ca.us/lessons/wwwstats/confounding.variables.html

- For example, a soccer coach wanted to improve the team's playing ability, so he had them **run** two miles a day.
- At the same time the players decided to take vitamins.
- In two weeks the team was playing noticeably better, but the coach and players did not know whether it was from the running or the vitamins.

### **Example 1**

- Two groups of performers are each tested for their performance.
- Subjects in one group are tested in a room with the heat set at 70 degrees (Fahrenheit).
- Subjects in <u>another group</u> are <u>simultaneously</u> tested in <u>a nearby</u> <u>identical room</u> with the heat set at <u>60</u> degrees.

- The obtained differences in performance could be attributed to any of these factors.
  - It could be due to the <u>different</u>
     temperatures in the two rooms.
  - It could be due to the random
     assignment of performers (i.e. different
     sampling by chance). This is a
     confounding factor.

It could, however, be due to some other confounding factors such as differences in ambient illumination that result from unnoticed differences in the orientation of each room with respect to the sun.

- In any experiment, an appropriate

  statistical test can help in the decision as to whether or not to attribute the results to chance [純屬巧合]. (We will see a number of these tests in coming lectures.)
- But only the most careful analysis of the actual conditions of the experiment can suggest whether or not the result might be due to a confounding factor.

## Example 2

Employment Status	Population	Hearing impaired	Rate per 1,000
(I) Currently employed	98,917	552	5.58
(II) Currently unemployed	7,462	27	3.62
(III) Not in the labor force	56,778	368	6.48
Total	163,157	947	5.80

Statistics of hearing impairments due to injury for individuals ≥17 years old. **labor force** = a region's combined civilian workforce, including both the employed and unemployed.

- Judging from this table, <u>can we conclude</u> that group (III) individuals (rate=6.48) are at greater risk of hearing impairment due to injury than group (I) individuals (rate=5.58)?
- Are there any confounders involved?

- To check whether group (I) and (III) have similar underlying demographic structures, we may (empirically) break each group down according to age.
  - 17-44 years old
  - 45-64 years old
  - -65+ years old

Employment Status	Population	Hearing impaired	Rate per 1,000
(I) Currently employed	98,917	552	5.58
(II) Currently unemployed	7,462	27	3.62
(III) Not in the labor force	56,778	368	6.48
Total	163,157	947	5.80

Age	(I) Currently	employed	(III) Not in the labor force			
	Population	%	Population	%		
17-44	67,987	68.7	20,760	36.6		
45-64	27,592	27.9	15,108	26.6		
65+	3,338	3.4	20,910	<u>36.8</u>		
total	98,917	100.0	56,778	/100.0		

 We next consider the <u>age-specific impairment</u> <u>rates</u> as a whole (groups (I)+(II)+(III)):

Age	Population	Impairments	Rate per 1000		
17-44	94,930	441	4.65		Inc
45-64	43,857	308	7.02	}	with
65+	24,370	198	8.12		7
Total	163,157	947	5.80		

Increase with age

$$\frac{(94930)(4.65) + (43857)(7.02) + (24370)(8.12)}{163157} = 5.80$$

A **weighted** average of the age-specific rates

## A brief summary

- Age seems to be a confounder between hearing impairment (impaired or not impaired) and employment status (groups I, II or III).
- As a result, we cannot be sure whether the higher hearing-impairing rate of group (III) is of some inherent characteristic of the members of that group, or whether it is simply the effect of age.

- According to what we have seen so far, it appears:
  - Older people seem to be more susceptible to hearing impairment
  - Group III seems to have significantly more older people
  - This may explain why group III has overall higher impairment rate

#### Using age-specific rates instead of their overall rates

Age	Currently E	Employed	<b>(I)</b>	Not in Labor Force (III)				
	Population	Impair- ments	Rate per 1000	Populati on	Impair- ments	Rate per 1000		
17-44	67,987	346	<u>5.09</u>	20,760	80	3.85		
45-64	27,592	179	6.49	15,108	117	<u>7.74</u>		
65+	3,338	27	8.09	20,910	171	<u>8.18</u>		
Total	98,917	552	5.58	56,778	368	6.48		

- Row #4 is what we have seen in the beginning, representing the overall rate that suggested group (III) contains more hearing-impaired individuals.
- Although rows #2 and #3 also favored group (III), row #1 (age 17-44) indicates otherwise.

#### Conclusion

- Although subgroup-specific rates provide a more accurate comparison, the task may be overwhelming if there are too many subgroups to compare.
- Instead, we may compute a number for each subpopulation, that can be used in <u>adjusting</u> the summary according to differences in <u>population</u> composition.
- This is called <u>rate standardization</u>, that can be often accomplished by either a <u>direct</u> and an <u>indirect</u> method.

#### Example 3

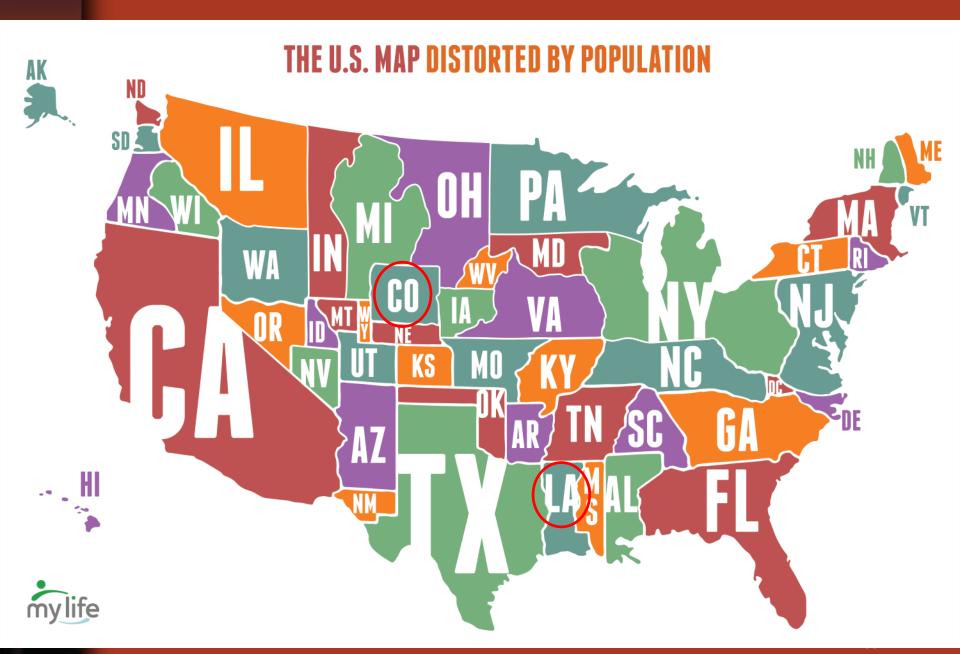
 Given the following table describing the data collected from the two states in the US in 1987.

State	Live Births	Infant Deaths	Rate per 1000
Colorado	53,808	527	9.8
Louisiana	73,967	872	<u>11.8</u>

 ☑ Can we conclude that the infants born in Louisiana are more likely to die before they reach 1 yr of age?



http://www.emapstore.com/usa\_map2.jpg



#### On a Second Thought...

- Louisiana is a southern state that contains a good portion of black population, while in Colorado they are mostly white.
- It is suspicious that <u>race</u> is a confounder in the relationship between <u>state</u> (<u>independent variable</u>) and <u>infant</u> mortality rate (dependent variable).

- That is, high rate (11.8 per 1,000) of Louisiana could be overestimated. (Because of black babies are at a higher risk?)
- As a result, we should explore the underlying distributions of race on two populations (population from either state).

A more accurate comparison between the two states by examining the race-specific infant mortality rates rather than the crude rates

	Colorado			Louisiana		
Race	Live birth	Infant deaths		Live birth		Rate per 1000

total	53,808	527	9.8	73,967	872	勝出 11.8	3
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Here is what we have seen earlier...

A more accurate comparison between the two states by examining the race-specific infant mortality rates rather than the crude rates

	Colorado			Louisiana		
Race	Live birth	Infant deaths	Rate per 1000	Live birth	Infant deaths	Rate per 1000
Black	3,166	52	16.4	29,670	525	勝出 17.7
White	48,805	469	勝出 9.6	42,749	344	8.0
Other	1,837	6	勝出 3.3	1,548	3	1.9
total	53,808	527	9.8	73,967	872	勝出 11.8

It is clear that the Louisiana black infants have a higher death rate than Colorado black infants, while the Colorado white infants have a higher death rate than Louisiana black infants. The latter is also true for other racial groups.

- Although the race-specific rates provide the most detailed information, it would be convenient to be able to summarize the entire situation with a pair of numbers – one for each state – that adjust for differences in racial composition.
- That is, both the "Colorado 9.8" and "Louisiana 11.8" rates are to be adjusted.
- They can be adjusted by <u>standardization</u> method to give a better comparison.

## (1) By Direct Method

- Pretending that, instead of having different distribution in both states, we assume <u>a</u> single standard of the same composition.
- The first thing is to choose a standard distribution to use. Here we use the stat from the US population in the same year.

Race	Live Births	Infant Deaths	Rate per 1000
Black	641,567	11,461	17.9
White	2,992,488	25,810	8.6
Other	175,339	1,137	6.5
Total	3,809,394	38,408	10.1

	Colorado			Louisiana		
Race	Live birth	Infant deaths	Rate per 1000	Live birth	Infant deaths	Rate per 1000
Black	3,166	52	16.4	29,670	525	17.7
White	48,805	469	9.6	42,749	344	8.0
Other	1,837	6	3.3	1,548	3	1.9
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Other	175,339	1,137	6.5
Total	3,809,394	38,408	10.1

From page 37 From page 39

We want to compute the "expected" death from either state's rate using the US population composition. (To 'merge' these two tables.)

U.S.		Colorado		Colorado Louisiana		1
Race	Live Births	Rate per 1000	Expected Deaths	Rate per 1000	<b>Expected</b> Deaths	
Black	641,567	16.4	<b>10,521.7</b> (641,567×16.4/1000)	17.7	11,355.7	
White	2,992,488	9.6	28,727.9	8.0	23,939.9	
Other	175,339	3.3	578.6	1.9	333.1	
Total	3,809,394		39,828.2		35,628.7	

(was 11.8)

Colorado: 
$$\frac{39828.2}{3809394} = 10.5 \text{ per } 1000$$
  
(was 9.8)

Louisiana:  $\frac{35628.7}{2000204} = 9.4 \text{ per } 1000$ 

3809394

The <u>adjusted</u>
Colorado infant
death rate is
actually higher.

## (2) By Indirect Method

- Similar to a direct method, an indirect method also uses a standard composition to re-compute the death rates for both states.
- Instead of <u>using the US population and</u> individual state's rates (direct method), we now <u>use US rates with individual</u> state's population (indirect method) to get the expected death counts.

	Colorado			Louisiana		
Race	Live birth	Infant deaths	Rate per 1000	Live birth	Infant deaths	Rate per 1000
Black	3,166	52	16.4	29,670	525	17.7
White	48,805	469	9.6	42,749	344	8.0
Other	1,837	6	3.3	1,548	3	1.9
total	53,808	527	9.8	73,967	872	11.8

Race	Live Births	Infant Deaths	Rate per 1000
Black	641,567	11,461	17.9
White	2,992,488	25,810	8.6
Other	175,339	1,137	6.5
Total	3,809,394	38,408	10.1

From page 37 From page 39

Use US rates with individual state's population (columns filled in black).

U.S.		Colorado		Louisiana	
Race	Rate per 1000	Live Births	Expected Deaths	Live Births	Expected Deaths
Black	17.9	3,166	<b>56.7</b> (3,166×17.9/1000)	29,670	531.1
White	8.6	48,805	419.7	42,749	367.6
Other	6.5	1,837	11.9	1,548	10.1
Total	10.1	53,808	488.3	73,967	908.8

#### Both adjusted from the same US rate 10.1:

Colorado: 
$$10.1 \times \frac{527}{488.3} = 10.1 \times 1.08 = 10.9 \text{ per } 1000 \text{ (was } 9.8)$$
Louisiana:  $10.1 \times \frac{872}{908.8} = 10.1 \times 0.96 = 9.7 \text{ per } 1000 \text{ (was } 11.8)$ 

Recall that <u>527</u> and <u>872</u> are the actual death counts from either state.

#### Conclusion

 It can be seen, by either way of adjusting these rates, the State of Colorado does have higher infant death rate than the State of Louisiana does, regardless that the 'raw' rates show that infants in Louisiana are more vulnerable.