KANSAS

Age-Standardization of Kansas Death Rates: Implications of the Year 2000 Standard

Research Summary

Center for Health and Environmental Statistics
Kansas Department of Health and Environment
Landon State Office Building - 900 SW Jackson, Topeka, KS 66612-1220
http://www.kdhe.state.ks.us/ches/

This Research Summary Was Prepared By:

Kansas Department of Health and Environment
Clyde D. Graeber, Secretary

Center for Health and Environmental Statistics
Lorne A. Phillips, Ph.D., Director and State Registrar

Office of Health Care Information
Elizabeth W. Saadi, Ph.D., Director

Prepared by: Joy Crevoiserat, B.A.

Edited by: Karen Sommer, M.A.
Greg Crawford, B.A.

Data for This Report Were Collected by:

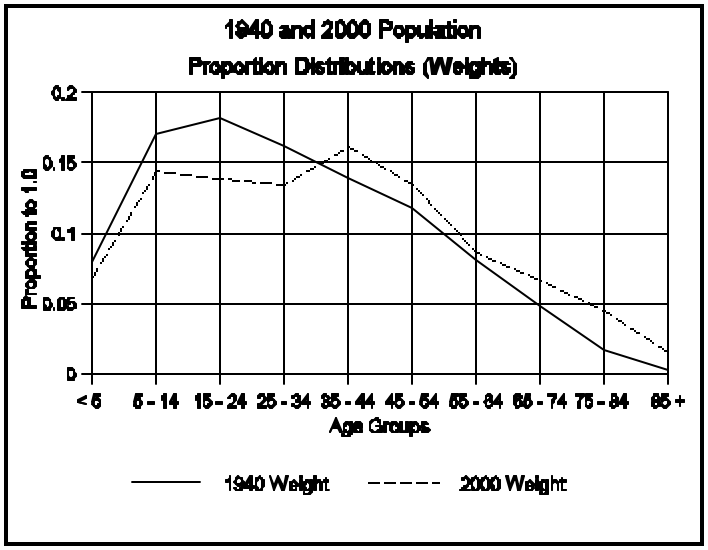
Office of Vital Statistics
Gabriel Faimon, M.P.A., Director

Introduction

Death rates in reports from the Kansas Department of Health and Environment Office of Health Care Information have traditionally been calculated as crude rates, *i.e.* number of occurrences per 100,000 population, or as age-adjusted rates, defined as "the death rate that would occur if the observed age specific death rates were present in a population with an age distribution equal to that of a standard population.".[1] Age adjusting of rates allows comparison of rates between populations with varying age distributions. For example, a comparison of crude death rates between two states with equal populations, one with a higher proportion of older individuals, would probably show a much higher rate for that state simply because of the greater risk of death as people age. To equalize the effects of variations in population, a series of weights is given to the different age groups, applied as a multiplying factor to each age-specific death rate. The sum of these weighted age-specific rates is the age-adjusted rate.

Since 1943, the Centers for Disease Control and Prevention, National Center for Health Statistics (NCHS), and the states have used the 1940 United States population as the standard population. Over the years, various groups have used more recent populations as standards, but without universal application there could not be comparison of rates. That is, rates based on one standard are not comparable to those based on another. In 1991 and 1997 NCHS sponsored workshops to consider implementing a more up-to-date standard, reflecting the aging of the population since 1940. The result was a recommendation, approved by the Secretary of the Department of Health and Human Services, to use the projected year 2000 population proportions as the standard for calculating age-adjusted death rates, effective September, 1998.[2] (Figure 1 and Appendix, Table 3)

Figure 1

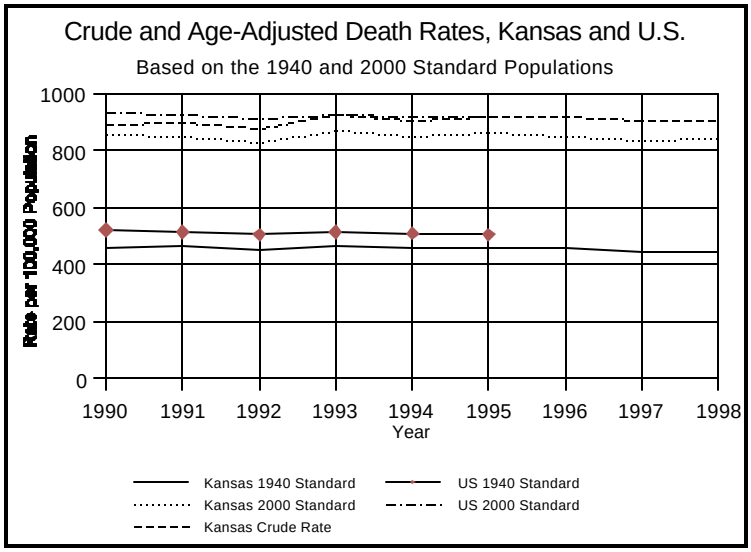


[1] National Vital Statistics Reports, Vol. 47, No. 3, Oct. 7, 1998, p. 3

[2] Ibid., p. 10

It is to be expected that the change to the year 2000 standard will result in an increase in the magnitude of age-adjusted death rates, since more weight is given to older age groups. In comparing the deaths which occurred in Kansas from 1990 to 1998, using both standards, the average age-adjusted death rate for total deaths using the 2000 standard (851.3 per 100,000 population) was almost twice as high as the rate using the 1940 standard (456.0). (Figure 2 and Appendix, Table 4) The age-adjusted rate using the year 2000 standard approximates the crude death rate more closely than does that using the older standard.

Figure 2



U.S. Rates from National Vital Statistics Reports, Vol. 47, No. 3, Oct. 7,1998 — only through 1995

Why use age-adjusted death rates?

The easiest death rate to calculate is the crude death rate, the number of deaths occurring within a certain population divided by the number of individuals in that population, usually multiplied by 1,000 to yield a rate per 1,000 population or by 100,000 for a rate per 100,000 population. This rate is the most accurate measure of what is occurring in the real population, but may be misleading when comparing one population group to another or when comparing one group with shifting population densities over time.

A closer analysis can be accomplished by breaking populations down into age groups and calculating age-specific death rates. An age-specific death rate for the 15-24 year-old age-group, for example, would be the number of deaths within that age-group divided by the population in that age group, again multiplied by either 1,000 or 100,000.

Take as an example the hypothetical populations in Table 1. There are one hundred individuals in population A and in population B, also 10 deaths in both populations. Therefore, the crude death rate for both is 100 deaths per 1,000 population. However, population A and B have very different age compositions. For A, age-specific death rates are zero below age 60, then 166.7 per 1,000 population for the 60-79 and 79+ age groups. By contrast, age-specific death rates in population B are 100 per 1,000 population for all age groups.

Table 1

Hypothetical Comparison of Death Rates

Populations A and B

Age	A Deaths	A Population	B Deaths	B Population
< 20	0	10	2	20
20 - 39	0	10	2	20
40 - 59	0	20	2	20
60 - 79	5	30	2	20
80 +	5	30	2	20

As can be seen in this extremely simplified example, comparison of death rates between these two populations is complicated by the differences in age distribution between them. For real populations, comparison of series of age-specific rates becomes prohibitively cumbersome. What is needed is some kind of index to collapse the series of age-specific death rates for one population into one rate. It is important to note that such a rate is not meaningful by itself or in comparison to rates calculated using any other index, but only in comparison to rates calculated using the same index.

Direct standardization

The index which has been used since 1943 , with universal acceptance, has been the 1940 United States population, as reported by the U.S. Census Bureau. The new index, or standard, implemented by the U.S. Department of Health and Human Services effective September, 1998, will be the Census Bureau's projected population for the year 2000.

Most age-adjustment is accomplished by direct standardization (a discussion of indirect standardization is beyond the scope of this paper), in which the age-specific death rate for each age-group is multiplied by a weight representing the proportion of the standard population in that age group. The sum of those products is the resultant age-adjusted death rate.

Following is an example of the calculations involved in the direct standardization of death rates using the 1940 and 2000 standard populations. For the 1940 and 2000 weights used, see the appendix, Table 3. Note that the weight for each age-group is the proportion of the population in that age group in relation to 1, *i.e.* the weight is 1/100 of the percent of individuals in the age group.

Table 2

Sample Calculation of Age-Adjusted Death Rates (per 100,000 population)

Total Deaths, Kansas, 1998

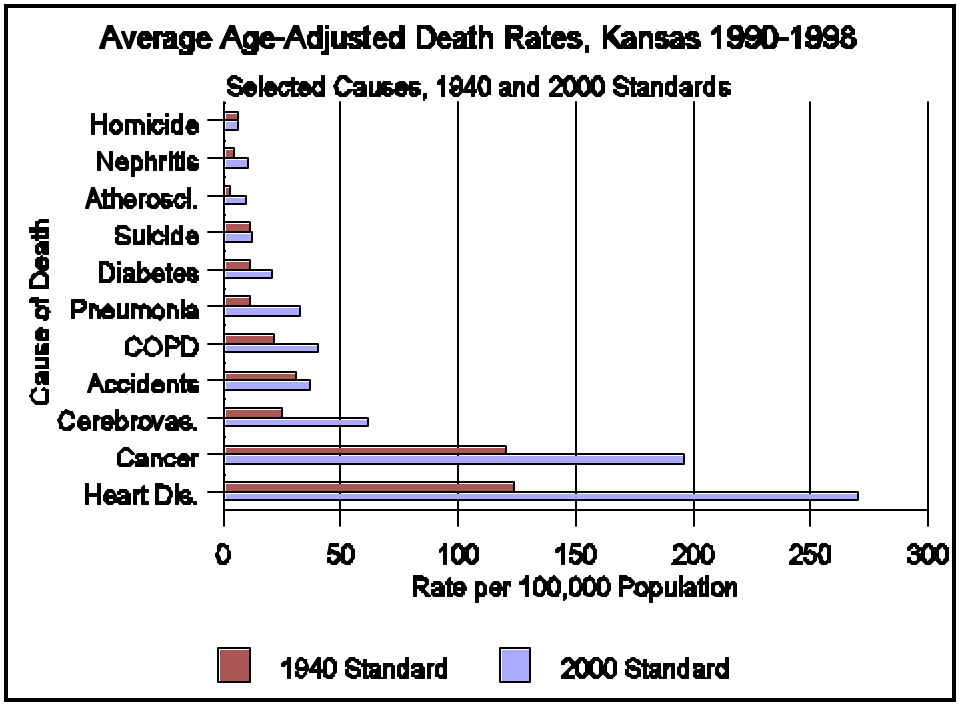
	A	B	C	D	E	F	G
Age Group	1998 Kansas Population	No. of Deaths	Age-Specific Rates	Yr. 1940 Weight	Age-Spec. X 1940 Wt.	Yr. 2000 Weight	Age-Spec. X 2000 Wt.
Total	2,629,067	23,926	910.06				
< 1	36,485	263	720.84	0.015343	11.06	0.013818	9.96
1 - 4	145,620	62	42.58	0.064718	2.76	0.055317	2.36
5 - 14	388,661	88	22.64	0.170355	3.86	0.145565	3.30
15 - 24	388,563	354	91.10	0.181677	16.55	0.138646	12.63
25 - 34	347,009	360	103.74	0.162066	16.81	0.135573	14.06
35 - 44	426,432	720	168.84	0.139237	23.51	0.162613	27.46
45 - 54	328,727	1,183	359.87	0.117811	42.40	0.134834	48.52
55 - 64	213,457	2,007	940.24	0.080294	75.50	0.087247	82.03
65 - 74	177,971	4,224	2,373.42	0.048426	114.94	0.066037	156.73
75 - 84	125,597	6,837	5,443.60	0.017303	94.19	0.044842	244.10
85 +	50,545	7,828	15,487.19	0.002770	42.90	0.015508	240.18
				yr. 1940 age-adj. rate =	444.5	yr. 2000 age-adj. rate =	841.3

Numbers in column C are arrived at by the following formula: C = (B/A)*100,000, to yield the age-specific death rate per 100,000 population for each age-group. For total deaths, this would be the crude death rate, 910.1 deaths per 100,000 population in this example. To arrive at the 1940-based age-adjusted death rate, each rate in column C is multiplied by the corresponding weight in column D, producing the numbers in column E. The age-adjusted death rate is defined as the sum of those numbers in column E, in this case 444.5 deaths per 100,000 year-1940-standard population. This number can also be thought of as the expected number of deaths per 100,000 population which would occur in the standard 1940 population *if* the actual age-specific death rates were observed in it. Similarly, the year-2000-based age-adjusted death rate is calculated by multiplying age-specific rates (column C) by year-2000 weights (column F), then summing column G (841.3 deaths per 100,000 population.

Effects and limitations of age-adjusting death rates

It has been seen that the year-2000 age-adjusted death rates for total deaths in Kansas, 1990-1998, were roughly twice as high as those based on the 1940 standard (figure 2). However, the effect of switching to the new standard will vary greatly when calculating rates for different causes of death. Those causes of death, such as heart disease and cancer, which occur at higher rates among older population groups will show the greatest increase because of the increased weight given to those age groups. Meanwhile, rates for other causes, such as suicide and homicide, will be virtually unchanged (Figure 3 and Appendix, Table 4).

Figure 3



Although the change in standard results in a change in magnitude of the age-adjusted death rate, for most causes of death the trend is preserved. For example, from 1990-1998, the age-adjusted death rate (1940) for heart disease declined 15.8 percent, while the ADR (2000) for heart disease declined 15.4 percent. Similarly for the other leading causes of death shown in figure 3, trends upward or downward were preserved. For all selected causes of death, the magnitude of percent change (1990-1998) based on the 1940 standard was within 9 points of that based on the 2000 standard (Appendix, Table 4).

One potential disadvantage of using age-adjusted death rates is that they "may mask important information if the age-specific rates in the populations being compared do not have a consistent relationship".[3] For example, if age-specific death rates increase in younger populations while

[3] Ibid., p. 3

declining in older populations (or vice versa) the age-adjusted death rate may remain relatively unchanged, thereby not indicating the underlying trends in mortality. "In cases where age standardization may mask important age-specific trends or differences, presentation of age-adjusted rates should be supplemented with age-specific rates".[4]

The disadvantage of using age-adjusted death rates calculated by the year-2000 standard will be the need to recalculate rates for past years, which used the 1940 standard, in order for them to be comparable to rates calculated in the future. The advantage will be that Kansas' rates will be comparable to those of the United States and other states, which should be implementing the new standard.

[4] Ibid.

Appendix

Table 3
1940 and Projected Year 2000 U.S. Populations and Proportion Distributions by Age

Age-Group	1940 Population	Proportion Distribution (Weights)	2000 Population	Proportion Distribution (Weights)
Total	131,669,275	1.000000	274,634,000	1.000000
< 1 year	2,020,174	0.015343	3,795,000	0.013818
1 - 4 years	8,521,350	0.064718	15,192,000	0.055317
5 - 14 years	22,430,557	0.170355	39,977,000	0.145565
15 - 24 years	23,921,358	0.181677	38,077,000	0.138646
25 - 34 years	21,339,026	0.162066	37,233,000	0.135573
35 - 44 years	18,333,220	0.139237	44,659,000	0.162613
45 - 54 years	15,512,071	0.117811	37,030,000	0.134834
55 - 64 years	10,572,205	0.080294	23,961,000	0.087247
65 - 74 years	6,376,189	0.048426	18,136,000	0.066037
75 - 84 years	2,278,373	0.017303	12,315,000	*0.044842
85 + years	364,752	0.002770	4,259,000	0.015508

* rounded up to add to 1.000000
Source: National Vital Statistics Reports, Vol. 47, No.3, Oct. 7, 1998; and U.S. Census Bureau

Table 4
Age-Adjusted Death Rates* and Percent Change Based on the 1940 and year 2000 Standard Populations
Selected Causes of Death
Kansas, 1990-1998

Cause of Death (ICD-9 Code)	1990	1991	1992	1993	1994	1995	1996	1997	1998	Average 1990-1998	% Change 1990-1998
All Causes											
Crude Rate	893.8	896.8	875.8	926.2	907.7	924.7	920.4	907.5	910.1		
1940.....	458.4	466.3	449.1	466.8	456.6	459.3	457.7	445.6	444.5	456.0	-3.0
2000.....	856.4	853.7	828.9	871.8	851.6	863.5	854.3	839.9	841.3	851.3	-1.8
Heart Disease (390-398, 402, 404-429)											
1940.....	135.1	131.8	125.6	130.4	121.1	125.0	118.5	115.6	113.8	124.1	-15.8
2000.....	292.8	282.1	272.9	285.6	266.7	272.6	255.6	252.6	247.8	269.9	-15.4
Malignant Neoplasms (140-208)											
1940.....	122.3	124.4	120.1	120.9	125.5	120.2	120.5	117.3	113.0	120.5	-7.6
2000.....	197.7	200.5	193.6	196.4	202.3	197.7	197.4	191.8	186.5	196.0	-5.7
Cerebrovascular Disease (430-438)											
1940.....	26.3	24.1	24.9	24.5	24.7	25.2	25.5	23.2	24.5	24.8	-6.8
2000.....	64.8	59.1	59.6	62.4	62.5	63.6	64.9	58.8	61.8	61.9	-4.6
Unintentional Injuries (E800-E949)											
1940.....	31.6	32.6	28.7	30.5	30.9	29.2	32.6	31.0	34.1	31.2	7.9
2000.....	36.2	37.1	32.8	36.5	36.1	36.4	39.0	36.7	41.4	36.9	14.4
Chronic Obstructive Pulmonary Diseases (490-496)											
1940.....	19.6	20.6	18.9	22.5	21.2	22.8	21.8	24.0	22.1	21.5	12.8
2000.....	36.6	37.1	35.2	42.4	40.5	41.9	40.9	45.7	42.4	40.3	15.8
Pneumonia and Influenza (480-487)											
1940.....	12.4	11.9	10.9	12.4	12.5	10.9	11.6	11.4	11.7	11.7	-5.6
2000.....	35.5	32.6	30.5	33.5	33.3	30.5	31.1	32.8	32.8	32.5	-7.6
Diabetes mellitus (250)											
1940.....	9.9	11.3	11.3	10.9	10.9	12.3	12.5	11.8	12.6	11.5	27.3
2000.....	17.9	20.2	19.8	19.3	19.0	21.4	22.2	21.1	23.0	20.4	28.5
Suicide (E950-E959)											
1940.....	11.1	11.8	12.0	12.4	10.8	11.4	12.2	11.7	12.0	11.7	8.1
2000.....	12.0	12.4	12.6	13.2	11.2	11.9	13.1	12.3	12.5	12.4	4.2
Atherosclerosis (440)											
1940.....	2.9	3.0	3.4	3.0	3.0	3.3	3.1	2.2	2.6	2.9	-10.3
2000.....	9.2	9.2	11.0	9.8	10.2	10.0	10.5	7.7	8.8	9.6	-4.3
Nephritis, Nephrotic Syndrome and Nephrosis (580-589)											
1940.....	3.7	4.2	4.4	4.6	4.7	4.6	5.1	4.9	5.1	4.6	37.8
2000.....	8.3	9.7	9.6	11.6	10.2	10.0	11.5	11.2	11.9	10.4	43.4
Homicide and Legal Intervention (E960-E978)											
1940.....	4.7	6.6	6.7	8.4	7.8	7.2	6.1	6.7	6.7	6.8	42.6
2000.....	4.4	6.2	6.3	7.7	7.1	6.5	5.5	6.0	6.0	6.2	36.4

* Rate per 100,000 population

Technical Notes

Following the recommendations of the National Center for Health Statistics' second workshop on age adjustment, the Kansas Department of Health and Environment, Center for Health and Environmental Statistics, Office of Health Care Information will:

1. adopt the projected United States year 2000 population as the standard for age adjustment of death rates, beginning with data year 1999.

2. use the year 2000 standard weights to six decimal places, as in the National Vital Statistics Reports, Vol. 47, No. 3, Oct. 7, 1998.

3. use the eleven age groups (less than 1 year, 1-4 years, 5-14 years, 15-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, 65-74 years, 75-84 years, and 85 years and over) for calculating age-adjusted rates using the new standard.

Direct calculation of age-adjusted death rates

Let D_i = the number of deaths in age interval i and
P_i = the population in age interval i.

Then the age specific rate (R_i) per 100,000 for age interval i will be:

$$R_i = (D_i / P_i) * 100{,}000$$

Let SP_i = the population in age interval i of the standard population and
SP = the total standard population.

Then the standard weight (W_i) for age interval i will be:

$$W_i = Sp_i / SP$$

where $0 < W_i < 1$ and the sum of W_i for all age intervals is 1.

The age-adjusted death rate (ADR) per 100,000 population is then given by:

$$ADR = \sum_i (R_i * W_i)$$

Note:

Some analysts may be more familiar with a slightly different, but equivalent method of calculating age-adjusted death rates.

Note that the formula used in this paper:

$$ADR = \sum_i \left(R_i * W_i \right)$$

is equivalent to:

$$ADR = \sum_i \left(R_i * \left(SP_i / SP \right) \right)$$

$$= \sum_i \left(\left(R_i * SP_i \right) / SP \right)$$

$$= \left(\sum_i \left(R_i * SP_i \right) \right) / SP$$

That is, the same rate can be arrived at by multiplying each age-specific rate by the standard population in the same age interval, summing them, then dividing by the total standard population.

Comparability

Age-adjusted rates (1940 standard) in this report may vary slightly from rates previously published for the following reasons:

1. Age groups “less than 1 year” and “1 - 4 years” were previously grouped together as “less than 5 years”.

2. Age groups “75 - 84 years” and “85 years and over” were previously grouped together as “75 years and over”.

References

Anderson, R.N. and Rosenberg, H.M., Age Standardization of Death Rates: Implementation of the Year 2000 Standard. National Vital Statistics Reports; Vo. 47, No. 3. Hyattsville, MD: National Center for Health Statistics. 1998.

Curtin, Lester R. and Klein, Richard J., Direct Standardization (Age-Adjusted Death Rates). Healthy People 2000 Statistical Notes, No. 6 - Revised, March, 1995. Hyattsville, MD: National Center for Health Statistics. 1995.

Data Users Survey

Center for Health and Environmental Statistics
Kansas Department of Health and Environment

_____ 1. **Your Organization**

____1 Hospital ____ 2 Health Dept ____ 3 Private Company ____ 4 Not-for-Profit ____ 5 City Government
____ 6 State Government ____ 7 Federal Government ____ 8 Church ____ 9 Professional Association
____ 10 Individual ____ 11 Foundation ____ 12 School ____ 13 University
____ 14 Other (please specify) _____

_____ 2. **Your Position**

____ 1 Administrator/Manager ____ 2 Legislator/Council Member ____ 3 Nurse ____ 4 Medical Doctor ____ 5 Planner
____ 6 Data Analysis Staff ____ 7 Epidemiologist ____ 8 Consultant ____ 9-Program Manager____ 10 Program Staff
____ 11 Safety Officer ____ 12 Researcher ____ 13 Other(please specify) _____

_____ 3. **CHES Products used/received/seen (*checking more than one is OK*):**

____ 1 Annual Summary of Vital Statistics
____ 2 Teenage Pregnancy Summary
____ 3 Perinatal Casualty Report
____ 4 Kansas Health Statistics Newsletter
____ 5 Vital Statistics Wallet Card
____ 6 Occupational Injury/Illness Report
____ 7 Annual Census of Fatal Occupational Injuries
____ 8 Abortion Report
____ 9 Population Highlights
____ 10 Age Adjusted Death Rates
____ 11 Zip Code Level Reports
____ 12 Special Reports (ad hoc queries)
____ 13 Adequacy of Prenatal Care Index
____ 14 Health Occupations Data
____ 15 Hospital Data
____ 16 Mailing Labels
____ 17 Others (please specify)_____

_____ 4. **CHES products you would like to use, receive, or see (*more than one is OK*):**

____ 1 Annual Summary of Vital Statistics
____ 2 Teenage Pregnancy Summary
____ 3 Perinatal Casualty Report
____ 4 Kansas Health Statistics Newsletter
____ 5 Vital Statistics Wallet Card
____ 6 Occupational Injury/Illness Report
____ 7 Annual Census of Fatal Occupational Injuries
____ 8 Abortion Report
____ 9 Population Highlights
____ 10 Age Adjusted Death Rates
____ 11 Zip Code Reports
____ 12 Special Reports (ad hoc queries)
____ 13 Adequacy of Prenatal Care Index
____ 14 Health Occupations Data
____ 15 Hospital Data
____ 16 Mailing Labels
____ 17 Others (please specify)_____

_____ 5. **Check all formats in which you are capable of using or receiving the Kansas information:**

____ 1 CD-ROM ____ 2 Paper Copy ____ 3 Hardbound Book ____ 4 HTML (Internet) _____ 5 ascii text
____ 6 spreadsheet file ____ 7 diskette ____ 8 Electronic File Transfer ____ 9 Access from KDHE website
____ 10 Zip Disk ____ 11 Adobe Acrobat (PDF) ____ 12 Other (specify) _____

_____ 6. **Check the format you would most prefer to receive the information:**

____ 1 CD-ROM ____ 2 Paper Copy ____ 3 Hardbound Book ____ 4 HTML (Internet) _____ 5 ascii text
____ 6 spreadsheet file ____ 7 diskette ____ 8 Electronic File Transfer ____ 9 Access from KDHE web server
____ 10 Zip Disk ____ 11 Adobe Acrobat (PDF) ____ 12 Other (specify) _____

Please use the reverse side to provide any comments on health data issues not addressed above. Your thoughts and concerns are important to us. Thanks.

Return to: KDHE Office of Health Care Information, 900 SW Jackson, Room 904, Topeka, KS, 66612
Fax (785)-368-7118