Effect of Increased Access to Health Care on Mortality from Cardiovascular Disease in Rural Tennessee

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THE INFLUENCE OF THE INTRODUCTION of a health care delivery system on mortality due to cardiovascular diseases (CVD) in Campbell County, Tenn., was explored in this study. (Cardiovascular diseases include diseases of the heart (excluding rheumatic fever)—hypertensive heart and renal diseases, ischemic heart diseases, hypertension, cerebrovascular accidents, arteriosclerosis, and other diseaes of arteries, arterioles, and capillaries.)

The health care system is organized around locally developed clinics, staffed by physician and nurse practitioner teams. The clinics, which became fully operational in 1972, are operated primarily by nurse practitioners, who are given standing treatment orders by a physician. The physician visits the clinics regularly and during these visits evaluates patients referred by the nurse practitioner. Under this system, the residents of Campbell County are afforded increased access to regular medical care. The general hypothesis investigated is that access to health care is likely to result in earlier detection of CVD, more regular supervision, and a reduction in the number of deaths due to CVD.

Scott county, a neighboring county, was used as a control because it did not have a similar clinic system. It was selected according to the methodology described by Whelpton and Campbell in a report of the National Office of Vital Statistics (*1*).

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Although the relationship between poverty and ill health is not as marked as in the past, higher rates of disease and mortality still persist among those with the lowest incomes. To some extent, the less favorable health status among the poorer segments of the U.S. population reflects not only inadequate personal health services but also poor sanitary practices, poor nutrition, lack of proper housing, and resulting increased susceptibility to morbidity (*2–4*).

Reports of the National Health Surveys of the National Center for Health Statistics consistently show lower rates of utilization of ambulatory and preventive health services by the poor. The number of physician visits for preventive health services is substantially lower for low-income families than for the higher-income families. Consistent differences in the kinds and extent of personal health services used by the poor clearly indicate that access to medical care contributes significantly to the determination of health status. In addition, many of the conditions common to poorer sectors of the population are amenable to treatment.

The National Health Survey of 1966 found that almost 14 percent of the low-income households sought care at hospital clinics or emergency rooms, in contrast to 6 percent of those with higher income. Low-income families are also disproportionately "overrepresented" among hospital patients, which may reflect failure to receive treatment at earlier stages of disease and disability. In rural areas, private physicians frequently are the only source of care available. However, because of the scarcity of physicians in such areas, many families must do without professional treatment, except in extreme emergencies, or must travel to urban areas for medical care (*4*).

Campbell and Scott Counties, located in northeastern Tennessee, are relatively isolated and low-income areas.

In 1969, 36.2 percent of the families in Campbell County and 42.1 percent in Scott County were below the poverty level, compared with 18.2 percent for the entire State (*5*). Poverty level assumes that a family is classified as poor if its total income amounts to less than three times the cost of the "economy" food plan (*6*).

Most of Campbell County is located in a rural area known as the Kentucky-Tennessee Valley. Although the area is united geographically, it is politically divided into four counties and two States. Fragmentation and geographic isolation historically have been considered significant factors in this area's difficulties in maintaining adequate health care systems (*7*). Scott County is located west of and contiguous with Campbell County. Although less heavily populated, Scott County has a population age-sex distribution similar to that of Camp-

Table 1. Number of hospitals, hospital beds, and physicians, Campbell and Scott Counties, selected years

Year	Number of hospitals		Number of hospital beds		Number of physicians and year	
	Campbell	Scott	Campbell	Scott	Campbell	Scott
1966....	3	1	124	60	15 (1965)	7 (1965)
1968....	2	1	105	60	11 (1969)	6 (1969)
1971....	2	1	132	61	13 (1972)	5 (1972)
1975....	2	1	132	99	16 (1976)	6 (1976)

SOURCES: References 5a, 8–10, table 20.19.

Table 2. Number of underground and strip mining operations in bituminous coal fields, Campbell and Scott Counties, selected years

Year	Campbell County		Scott County	
	Underground	Strip	Underground	Strip
1966........	18	11	13	2
1967........	19	15	10	3
1971........	9	25	2	20
1973........	7	13	3	14

SOURCES: References 5a (table 15.10), 8 (table 15.11), and 9 (table 15.10).

Table 3. Population changes, Campbell and Scott Counties, 1950–80

Decade	Campbell County			Scott County		
	Net migration	Percent population change	Year and population	Net migration	Percent population change	Year and population
1950–60............	−11,752	−18.7	1950: 34,369	−5,018	−11.2	1950: 17,362
1960–70............	−4,587	−6.8	1960: 27,936	−2,790	−4.2	1960: 15,413
1970–80............	199	1.3	1970: 26,045	504	8.0	1970: 14,762
			1980: 26,394			1980: 15,939

NOTE: 1980 population projections may be underestimates.
SOURCES: References 5, 8 (table 16.7), and 12.

bell County. The geography of the area is such that residents of the two counties rely on different sources for their health care. In recent years, the numbers of hospitals and physicians in the two counties have changed little, as shown in table 1 (*5a,8–10*).

Coal mining has been the major industry in Campbell and Scott Counties since the early 1900s. Initially, the deep mining techniques used required large numbers of personnel, which helped to maintain a relatively stable employment rate. When less costly strip mining was introduced the number of deep mines began to diminish, which resulted in fewer mining jobs and led to an out-migration pattern (*8–10*), as shown in table 2.

The populations of both counties continued to decline during the 1960s, but the rate of decline between 1960 and 1970 was lower than between 1950 and 1960 (*11*). The population changes, with projections to 1980, are shown in table 3 (*5,8,12*).

Although the total population has decreased in both counties since 1950, most of the age groups over 35 have increased since 1970, indicating some stabilization of the migration trend. However, the increased number of persons in the higher risk age groups places an additional burden on the counties' health care systems.

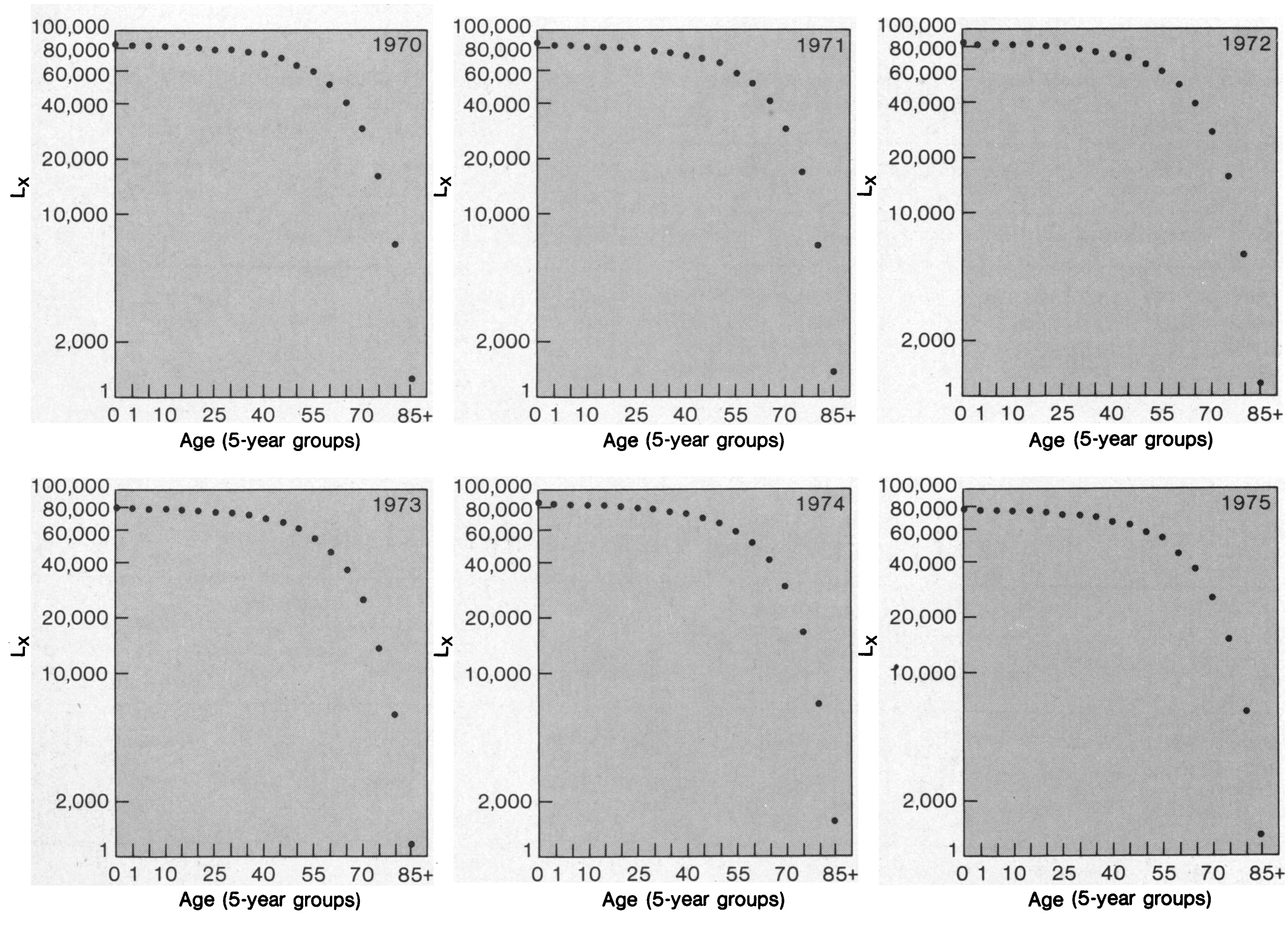
Study Methods and Findings

For this investigation, we used a form of trend analysis.

Table 4. Deaths per 1,000 population, Campbell County and the State of Tennessee, all causes and cardiovascular disease (CVD), 1970–75

	Campbell County		*Tennessee*	
Year	*All causes*	*CVD*	*All causes*	*CVD*
1970	11.98	6.18	9.72	5.18
1971	12.41	5.73	9.47	5.10
1972	11.72	5.68	9.67	5.21
1973	10.24	3.92	9.72	5.21
1974	10.41	4.88	9.45	5.03
1975	9.77	4.35	9.23	4.81

Figure 1. Semilogarithmic plot of L_x, by 5-year age groups and year, Campbell County



The experience with death from all causes and deaths from CVD in Campbell and Scott Counties from 1970 through 1975 were examined by use of a double-decrement life-table technique. It was postulated that the introduction into Campbell County of the clinics staffed by physician and nurse-practitioner teams would lead to a decrease in the number of deaths from CVD. For both counties, change in experience with death from CVD was determined by use of person-years lived, L_x, in the period before the Campbell County clinics were established (1970–72) and after the clinics were fully operational (1973–75). Death rates from all causes and from CVD from 1970 through 1975 are shown in table 4 for Campbell County and the State of Tennessee.

Table 5. Age-specific death rates per 1,000 for selected ages from all causes, Campbell County, State of Tennessee, and Scott County, 1970–75

Year	Age groups														
	Campbell County					State of Tennessee					Scott County (control)				
	0–4	5–24	25–44	45–64	65+	0–4	5–24	25–44	45–64	65+	0–4	5–24	25–44	45–64	65+
1970.........	5.47	2.43	5.20	25.22	144.62	5.41	1.00	2.78	11.13	47.65	5.63	1.56	4.64	25.25	144.30
1971.........	6.40	1.75	5.32	25.59	145.43	4.26	1.03	2.72	10.20	44.23	6.27	1.74	5.28	25.83	145.20
1972.........	5.87	1.77	4.82	28.48	152.29	5.25	1.05	2.72	10.17	44.21	6.04	1.95	4.69	28.36	152.15
1973.........	5.51	2.02	5.48	27.24	154.02	5.11	1.06	2.63	10.26	40.73	6.19	1.98	5.28	27.10	153.98
1974.........	6.15	1.82	5.15	26.90	149.34	4.43	1.02	2.69	9.75	38.86	6.31	1.40	4.97	27.08	149.48
1975.........	5.64	1.93	5.15	27.20	155.98	4.15	0.98	2.57	9.40	38.08	6.06	1.90	4.72	27.01	149.28

Figure 2. Semilogarithmic plot of L_x, by 5-year age groups and year, Scott County

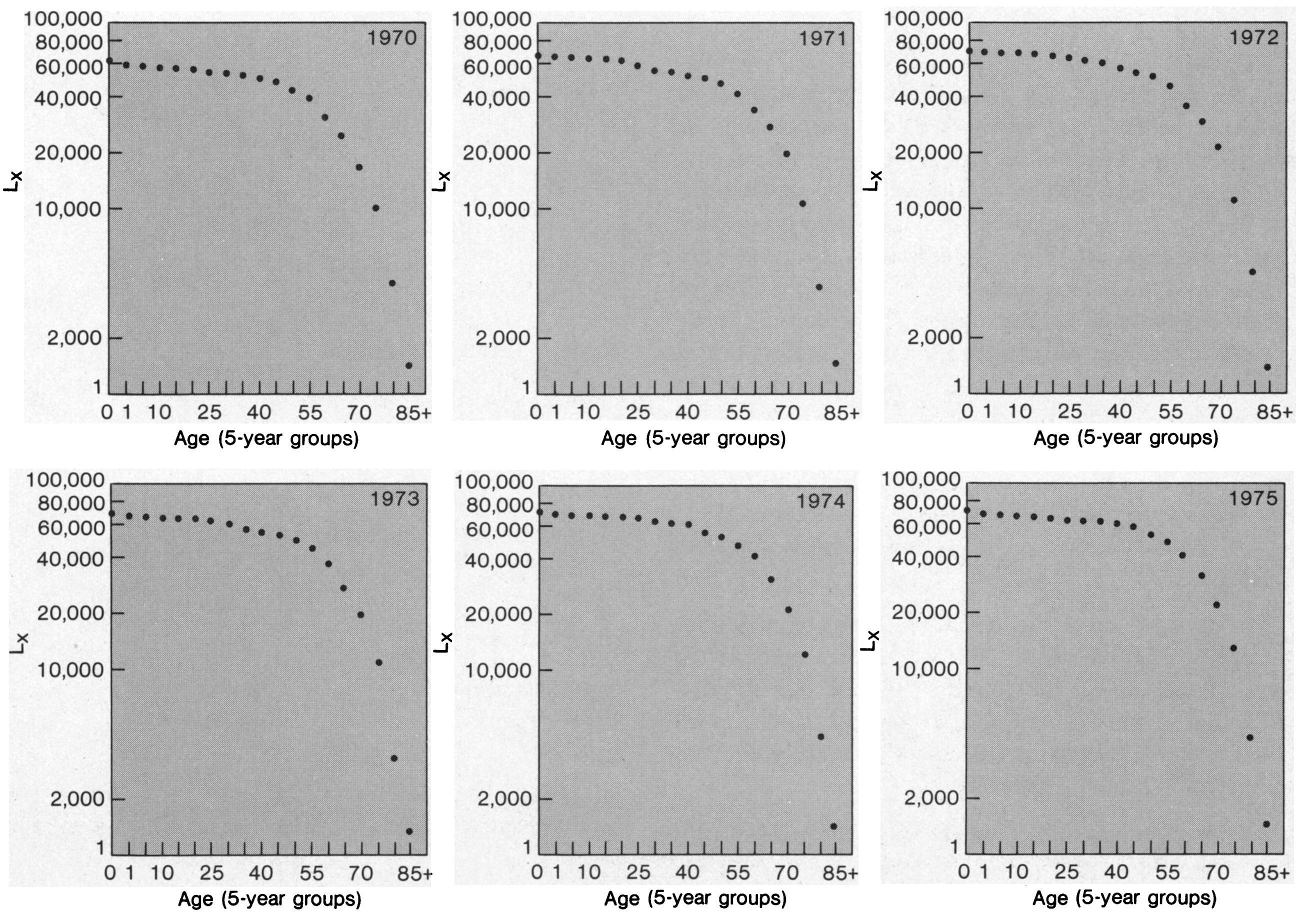


Table 5 shows age-specific death rates from all causes for both counties and the State.

The selective influence of CVD on total deaths in each year also was examined by the double-decrement life-table procedure. The multiple-decrement table permits introduction of more than one source of attrition—in this case, CVD (*13,14*).

To construct life tables, we needed census data on population by age for Campbell and Scott Counties and the State of Tennessee, as well as vital statistics on deaths from all causes and deaths from CVD. When information on deaths from CVD by age for the two counties was not available, we derived estimates by indirectly standardizing deaths in the two counties for a given year, using the State age-specific death rates for that year. Because population data for the two counties were not available for 5-year age groups, we used an interpolative method to derive the needed values. The data for 5-year age groups for the two counties were obtained for 1910 through 1970 from reports of the U.S. Bureau of the Census, and estimates for 1980 were obtained from the Tennessee State Planning Office (*12*). Using the methods of divided differences (Newton's formula), we derived estimates of age distribution for 1971–75 through interpolation (*13*).

Life-table methodology assumes a "closed" population, no migration (*15*). Because migration, coincident with the economic ebb and flow of the coal mining industry, has occurred within the populations of Campbell and Scott Counties, some limitation on the precision of the findings is evident. In addition, in small geographic areas with relatively small populations, L_x values obtained tend to be susceptible to sample variability or minor fluctuations in the upper age groups. Despite these limitations, it seems both reasonable and important to consider the impact of a stimulus such as a sudden improvement in the availability of health care on an area where access to health care has been a source of concern in the past. Specifically, identification of high-risk persons may lead to a change in the effect of CVD on the mortality patterns of an area such as Campbell County.

We obtained the L_x values by 5-year age groups after decrementing CVD deaths. These L_x values were plotted for Campbell and Scott Counties for each year through 1975 (figs. 1 and 2). As shown in figure 1, in Campbell County the L_x values for the older ages decreased between 1970–72 and 1973–75.

To assess the possible impact of location (county), age composition (age), and time (year) on the response variable L_x, as well as the various interactions between each of these variables, the data were analyzed by use of a fully articulated analysis of variance design (table 6). The results of this analysis allowed us to delete the three-way interaction term and the two-way interaction term for year and age. Thus, these results suggest that age distributions are different in each county, but the differences are relatively constant across time, as shown by the significant interaction between county and age. Yet, the interactions between county, year, and age and between year and age are not significant. The significant interaction between county and year supports the hypothesis that the clinic system had an impact on L_x values.

Based on the results of the "full" model, we analyzed the data by using a "partially reduced" model in which

Table 6. Results of analysis of variance, county, year, and age, with full, partially reduced, and further reduced models

Model	*Sum of squares*	*df*
Full		
Total	147,758,023,417	227
Full residual	1,078,366,127	152
Full model	146,679,657,290	75
*Partially reduced, C*Y*A, Y*A deleted*		
Total	147,758,023,417	227
Reduced residual	1,227,173,595	188
Reduced model	146,530,849,822	39

$$F_{36,152} = \frac{\text{Full } SS - \text{reduced } SS/df}{\text{Full residual}/df} = \frac{148,807,468}{1,088,366,127} = 0.582$$

Model	*Sum of squares*	*df*
*Further reduced, C*Y deleted*		
Total	147,758,023,417	227
Further reduced residual	1,979,698,697	189
Further reduced model	145,778,324,720	38

$$F_{1,188} = \frac{SS_{C^*Y}}{\text{Reduced residual}/df} = \frac{752,525,102/1}{1,227,173,595/188} = 115.285$$

$$\text{Coefficient of determination} = \frac{SS_{C^*Y}}{\text{Full } SST} = \frac{752,525,102}{147,758,023,417} = 0.005$$

$$\text{Coefficient of determination} = \frac{SS_{C^*Y}}{\text{Further reduced residual}} = \frac{752,525,102}{1,979,698,697} = 0.380$$

we deleted the three-way interaction term and the two-way interaction term for year and age. The results show that all other effects and interactions were significant. Finally, we analyzed the data by using a "further reduced" model, deleting the interaction between county and year. This procedure removed the effects of factors over which the clinic system has no control. The results show that 98.6 percent of the variation in L_x is explained by county, year, age, and differences in age distributions by county.

A ratio of the sum of squares for county and age group divided by the total of the sum of squares shows that approximately 0.5 percent of our ability to predict change in L_x values is due to the effect of the clinics. This value underestimates the impact of the clinics because the clinics have no control over a number of factors.

The ratio of sum of squares for county and year divided by the residuals obtained in the "further reduced" model reveals that a 38 percent variation, that is independent of background factor, is accounted for by the impact of the clinics.

These analyses suggest that the introduction of the clinics changed L_x values (unadjusted) by approximately 0.5 percent. If standardized rates are examined, that is, referenced by county, year, and age, the clinics changed the L_x values by approximately 38 percent.

Discussion

It is notable that experience with death from cardiovascular disease changed coincidentally with the introduction of the clinics in Campbell County. Examination of recent demographic trends in Campbell County and Scott County may help to clarify this change.

With the decline of tunnel mining in the 1960s, the economic welfare of Campbell and Scott Counties decreased. Consequently, both counties experienced out-migration—presumably to urban areas for employment opportunities. According to Barclay (*15*), urban migration tends to be the most selective kind of migration. This selectivity is revealed in the distinctive occupational composition of city populations and in the sex and age composition of those who migrate. In most instances, the migrants are predominantly working-age men; thus, the rural areas are left with the burden of more persons in the older age groups than before migration (*8*). Therefore, we can assume that the portion of the population who migrated from the two counties were primarily young and middle-aged adults, who generally are better educated and have a lower risk for CVD than their non-migrant counterparts or older non-migrants. As a result, the populations of the two counties became at increasingly high risk for mortality from cardiovascular diseases.

In the 1970s, the magnitude of net migration rates decreased in the two counties; this decrease indicated a slowing down of out-migration (table 3). Although the changes were relatively small, the 25–34 age group decreased in both counties, and the 45–54 age group decreased in Campbell County. These decreases were attributed to out-migration of persons seeking employment.

In Campbell County, in-migration occurred among persons in the age groups 35–44 and over 55 years. Both of these groups were most likely to be returnees. Some of the younger returnees are assumed to have been unable to find jobs or were unsuccessful in jobs elsewhere. In Scott County, the in-migration trend occurred among all age groups over 30. Persons over 55 years old are likely to be retirees moving back to their native soil. All of these in-migration trends represent factors of higher risk for CVD in both counties.

Because the population remaining after migration took place in the two counties consisted of more high-risk persons in terms of cardiovascular disease, the mortality rate would be expected to increase. When the clinics with the physician-nurse practitioner teams were opened in Campbell County, a regular link to medical management of high-risk patients was established, which proved effective despite adverse population trends.

In the past, the determination of adequacy of primary care resources in medically underserved areas often was focused on the total number and distribution of physicians. Also, evaluation studies examined the roles of new health practitioners such as nurse practitioners and physician's assistants; other studies determined the utilization patterns of clinics (*16–19*). However, questions still persist regarding the cost effectiveness of primary care clinics and new health practitioners.

The Congress has recommended that program planners for health systems agencies give priority to the provision of primary care services in medically underserved areas; the major focus must be on assessing the areas most in need of such services and facilitating development of programs to meet that need. The 1977 Health Systems Plan for East Tennessee stipulates that planning for primary care services should be population based, and the need for services should be evaluated in terms of the general characteristics of the population being served.

The method we have described could be useful in analyzing not only the population for which health services are intended, but also the effect of the health services on that population. The larger the population, the more reliable the obtained L_x will be as an indicator of mortality.

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SYNOPSIS

DIGNAN, MARK B. (University of North Carolina, Greensboro), HALL, MARY B., and HASTINGS, DONALD W.: *Effect of increased access to health care on mortality from cardiovascular disease in rural Tennessee. Public Health Reports, Vol. 94, March-April 1979, pp. 186–192.*

This study explored the influence of the introduction of a health care delivery system on age-specific mortality from cardiovascular disease (CVD) in Campbell County, Tenn. The health care delivery system was organized around locally developed clinics that were staffed by physician and nurse-practitioner teams. Under this system, residents of Campbell County, a rural and relatively isolated area, have been afforded greatly increased access to medical care since the clinics were opened in 1972. It was postulated that the introduction of the health care facilities would lead to a decrease in the number of CVD deaths.

Mortality due to all causes and to CVD for Campbell County from 1970 through 1975 was examined with the use of a double-decrement life-table technique. The change in experience with deaths from CVD was determined by use of person-years lived, L_x, in the periods before (1970–72) and after (1973–75) the clinics were fully operational. The resulting L_x values for the two periods were tested for difference by an analysis of variance procedure. Scott County, a neighboring country that did not have a clinic system similar to that of Campbell County, was used as a control.

Significant differences between L_x values were derived for 1970–72 and 1973–75. In Campbell County, life expectancy increased from 1970 to 1975, whereas in Scott County the trend was reversed.