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CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

Cancer may be considered as a group of related diseases characterized by abnormal growth, invasion of normal tissue, and a spread to other parts of the body. Cancer may arise in any site or tissue and may invade any type of cells in the body (158). Cancer is one of the major causes of death throughout the world. In the United States, deaths from cancer are second to cardiovascular diseases (4, 158, 159).

Changes in mortality from a disease during a period of time are of interest to the epidemiologist. The age adjusted national death rate from cancer in the United States has increased from 112 deaths per 100,000 population in 1930 to 127 in 1964 (158, 159). This increase in cancer is accounted for by a dramatic increase in lung cancer and a slight increase in leukemia and cancer of the pancreas (262). Except for a decline in the age adjusted death rates for stomach and uterine cervix, cancer death rates for other sites have tended to level off in the last few years (158, 159, 262). When such changes occur within a short period of time a search for one or more factors in the human environment is warranted (158).

Another interesting piece of data is the geographic variation of cancer from one country to another or from one region to another within a country (262). These variations are probably a reflection of differences in living conditions and environmental factors (158). For instance, in 1960-61, Japan and Chile reported the lowest age adjusted death rates for cancers of the oral cavity, skin, colon and rectum, breast, prostate, and leukemia, while reporting at the same time the highest age adjusted death rates for cancers of the stomach and uterine cervix (262). For the same time period, England and Scotland experienced the highest rates for cancer of the lung and a very low rate for leukemia and cancer of the stomach. Israel reported the highest leukemia mortality and the lowest age adjusted death rates for cancer of the cervix. Other age adjusted death rates among twenty-four countries reported for 1960-61 seem to vary with the geographic area of the world (262).

During the past several years there has been an increase in interest concerning possible association between certain environmental factors and malignant disease. Clues to etiology are sought by studying the incidence and frequency of the disease in different communities. The reported variations in death rates are investigated by studying the association of the disease with some aspect of the human environment, the personal habits, or the genetic constitution of the population under study (158).

The deaths from malignant disease have been classified by the World Health Organization into numerous sites of origin in the body (130). Therefore, in this study only those sites of major importance will be discussed in detail.

Cancer of the Lung and Respiratory System

The mortality from lung cancer has been on the increase in the last twenty years until it is now the most common death-producing cancer among men (262). The death rate for cancer of the lung almost doubled in the United States, from 12.2/100,000 in 1950 to 24.0/100,000 in 1964 (158). This extraordinary rise has not been recorded for any other site of cancer (258). Curwin et al. reported a similar increase in lung cancer mortality for England and Wales, but not for cancer of the larynx, where the disease has shown little changes in the last twenty years (46).

Improvement in diagnosis, aging, and increase in size of the population have accounted for part of the rising trend, but the evidence leaves no doubt that a true increase in lung cancer has taken place (258). Special interest has been focused upon cigarette smoking and air pollution as the newest features of the human environment of etiological importance in this form of cancer (258, 158, 159).

Cigarette consumption has increased markedly in the United States since the turn of the century. Published reports by the office of the Surgeon General indicate that nearly seventy million people in the United States consume tobacco regularly. The per capita consumption has increased from 138 cigarettes per year in 1910 to a peak of 3,986 in 1961 (258). In 1955, a population survey showed that 68 percent of the United States males and 32.4 percent of the females, eighteen years of age and over, were regular smokers of cigarettes (258). In contrast with the sharp increase in cigarette consumption, the per capita use of tobacco in other forms has gone down. Per capita consumption of cigars declined from 117 in 1920 to 55 in 1962. Consumption of pipe tobacco has also declined from 2.5 pounds per person in 1916 to a little more than half a pound in 1962. Use of chewing-tobacco has also declined from about 4 pounds per person in 1900 to half a pound in 1962 (258).

Comparisons based on smoking histories produced large differences in lung cancer risk. The report of the advisory committee to the Surgeon General indicated that twenty-eight studies were conducted using different methods and techniques; all are in agreement that the risk of lung cancer rises with the amount smoked (258). Hammond and Horn (107) studied the smoking histories of 187,000 American white males and found that men who had ever smoked suffered a five-fold increase in lung cancer mortality. The risk increased with the amount of cigarettes smoked. An increase of 640 percent for smokers of under half a pack to an increase of 1960 percent for smokers of more than two packs a day was also reported. Similar observations were made by Dorn (63) in a study of 200,000 male policy holders of a United States government life insurance company. Doll and Hill (61) found the risk of dying from lung cancer among British physicians who smoked to be 1190 percent greater, and 2270 percent greater among heavy smokers. Haenszel et al., in two different studies, using the same methods and techniques, showed a higher risk, increasing with the amount smoked, for cigarette smokers, in all population groups for a 10 percent sample of all white male lung cancer deaths for the year 1958, and for all white female lung cancer deaths for the years 1958-1959 in the United States (101, 106).

Evidence from controlled case history studies is consistent with the forward study results on estimates of the magnitude of differences in lung cancer mortality between male smokers and nonsmokers (16, 59, 210, 235, 308).

In three different retrospective studies of female lung cancer patients and controls, the excess risk for smokers exceeded that for nonsmokers. Among the female smokers, the risk increased with the amount smoked (59, 104, 301).

There has been little change in the last few years among females dying from lung cancer. Perhaps differences in smoking habits between males and females account for this lack of change (158). Several investigators think that it is an indication of male and female susceptibility to the development of lung cancer with exposure being the same for both sexes (158, 159, 104, 301). Lilienfeld (158) reported the ratio of male and female lung and bronchus cancer incidence to be 9.8:1 and proposed three hypotheses to explain these differences: an increased exposure of males to exogenic environmental factors, an increased predisposition of males with exposure being the same for both sexes, or both factors may be involved.

The ratio of male and female incidence around the world is in the order of 5-7:1, with several countries deviating from this figure (Finland with 12:1 and Israel with 2-3:1) (234, 262). Sex ratios vary with histological type (158). For group I cases, squamous, large and small cell carcinomas, the sex ratio is 42:1; for group II cases, adenocarcinomas and adenomas, the corresponding ratio is 1.2:1 (158). When the incidence of lung cancer is considered among nonsmokers, the male-female ratio is reduced to about 40 percent excess among males, a ratio typical for many other diseases (158).

The ratio of males to females appears to be highest in Scotland, England, and Finland, and is five times that of Sweden, Norway and Japan (262). In recent years an upward trend in rates for males has been reported in all countries (158, 159).

The relationship of lung cancer to smoking warrants a look at the socioeconomic distribution as it relates to differences in the frequency of cigarette smoking. Graham and associates (95) studied a sample of 4,456 adults in Buffalo in regard to their smoking habits. There was a slight increase among men in cigarette smoking with decrease in socioeconomic status. The finding was not as marked as that observed for lung cancer incidence. Among females there was a consistent decrease in the frequency of cigarette smoking with decreasing socioeconomic status. Though the amount of cigarettes smoked was not taken into account the writers suggested a socioeconomic factor other than cigarette smoking to be associated with the occurrence of lung cancer in Buffalo. Dorn and Cutler (64) took a cancer morbidity survey in ten metropolitan areas in the United States and found the white male risk to vary inversely with social class; the risk in the lowest income group doubled that in the highest income group. For white females the low income class had a 25 percent increase in risk when compared with all other classes. Clemmesen and his associates showed the risk for people living in the low rental areas of Copenhagen, Denmark to be 75 percent greater than the high rental areas (34). In 1950 the Registrar General's Decennial Supplement for England and Wales classified deaths by social class and found the risk for males to vary inversely with social class; the lowest social class lung cancer risk exceeds that of the highest by 45 percent (280).

The ever-increasing urban exposure to air pollution has been suggested as a factor in explaining the current epidemic of lung cancer (158, 258). Hammond and Horn showed the mortality of males residing in cities 50,000 population and over to be 60 percent higher than in rural areas. The differential increased when adenocarcinomas were excluded (107). For Connecticut, the incidence was 57 percent higher among urban males and 24 percent higher among urban females over rural males and females (220). The increase in Iowa for urban males was 2.8 times that of the rural population. For females the urban excess amounted to 47 percent (102). Haenszel et al. found a higher risk among residents of urban areas and metropolitan communities for both males and females (101, 106). The risk was higher for the United States farm born and the foreign born residing in metropolitan areas (98). Curwen and Kenneway reported the mortality for males in London and other large cities in England to be twice that of rural areas (46). For females, the excess risk for large cities was about 50 percent higher; however there appear to be no consistent differences between urban and rural areas for nonsmokers among lung cancer patients (46). Hoffman and Gilliam (123) showed the mortality by place of residence in the United States to be 85 percent higher in urban areas for males and 31 percent higher for females.

It was pointed out by Stock that an inverse correlation existed between the annual amount of sunshine recorded and lung cancer mortality in twenty large British towns. He concluded that either smokiness of the atmosphere is an important factor in producing cancer of the lung or sunshine is an important factor in preventing lung cancer (272). Stock and Campbell suggested that the effects of tobacco and atmospheric pollution are additive. This would mean that smoking is more dangerous to a town dweller than to a country dweller (269).

In California, Los Angeles and the Bay area plus San Diego had higher mortality for cancer of the lung than the remaining mixed urban and rural counties. These differences were relatively greater among nonsmokers. However, when controlling for smoking and length of residence, the risk of pulmonary cancer in Los Angeles, where photochemical air pollution levels are highest, was not greater than in other major metropolitan areas of California (20). Mills _et al_. found that urban men who drove more than 13,000 miles per year to have significantly higher lung cancer incidence, except for those in the heavy smoking category (209).

In Pittsburg, lung cancer was not distributed uniformly among the urban population, although specific atmospheric contaminants were known to be uniformly distributed throughout the various sections of the city. Two economically identical downtown sections had unusually different lung cancer rates (90). Stock suggested the possibility of the wind direction playing an important part in shifting smoking density from one area to another, thus accounting for the rate variation within an urban population (272).

Occupation mortality reveals differences in disease prevalence with occupation (289). In two different studies among the Schneeberg and Joachimsthal miners, lung cancer deaths accounted for 75 and 40-50 percent of the total deaths (174). Lung cancer rates are 29 times greater among employees of six chromate plants in the United States (17). The risk is five times greater among all nickel workers in nickel producing districts of South Wales (53), and 15 times greater among workers employed twenty years or more in dusty areas of Asbesto plants (56). The mortality among the retired employees of a London gas company ages 60 years and over for a ten year period studied was 80 percent increase in risk. Those engaged in the actual work had an excess risk of 100 percent (55). The standard mortality ratio among males 20-64 years of age in England and Wales during the period 1949-53 was highest for metal molders, elevator operators, tailors, furriers, shoemakers and shoe repairers (280). In the United States for the year 1950 the standard mortality ratio was highest for gas producer men, showmen, and boiler scalers (289). The standard mortality ratio among the same group was lowest for farm people, medical personnel, teachers and clergy in both the United States and England and Wales (280, 289). Cooks and painters appear to have an increased risk of lung cancer mortality in California (70).

Several studies have been conducted in which migrants were compared with the native population. The results are of epidemiologic interest. Eastcott (73), Haenszel (98), and Dean (51) found an excess risk, up to 50 percent, among British migrants to the United States, South Africa and New Zealand as compared with the experience of the native born. On the other hand, migrants from Norway to the United States show a lower rate, by 31 percent, than the United States native born, but a higher rate than that experienced in Norway (98). These and other studies on migrants to the United States show an intermediate lung cancer rate to prevail between the "home" and the "host" countries (98).

A study on lung cancer among the Seventh Day Adventists, a sect that prohibits the use of tobacco and alcohol among their members, revealed a very low rate of lung cancer (312). Most of the lung cancer deaths were among older people converted to the faith at an older age, and with a previous history of smoking. Two different studies showed the mortality from lung cancer among Jewish males to be lower than that among Catholic and Protestant males (313, 244). The studies reveal that the proportion of men smoking cigarettes to be lowest among Jews and highest among Catholics. Among cigarette smokers, Jewish men smoked fewer cigarettes. More Jews smoked pipes and/or cigars only. Also the proportion of men occupationally exposed to gas, dust, or fumes was smallest among Jews (313, 244).

Several studies indicate much higher than expected lung cancer death rate connected with previous history of chronic bronchitis (26, 47), influenza (47) and mustard gas poisoning (26).

A number of investigators have suggested that genetic factors may play a role in lung cancer etiology (10, 86, 27, 80). Also, it has been postulated that there may be a biological basis for the habit of smoking (108, 219, 160, 67). Fisher (80) and Fribert (86) found a higher degree of concordance with respect to smoking among monozygotic than dizygotic twins. Several studies have shown that smokers tend to aggregate in families (124, 15, 234).

Fisher proposed the hypothesis that both lung cancer and smoking habits are determined by a "common genotype" and there is no direct causal relationship between smoking and lung cancer (80). However, the results of a study by Tokuhata did not support Fisher's common genotype hypothesis. He was able to demonstrate familial aggregations of lung cancer independently of smoking, and familial aggregations of smokers independently of lung cancer (281, 282).

We can summarize the epidemiology of lung cancer by stating that the disease is influenced by many host and environmental factors, and no attribute or a single factor must be present at all times and preceeds the development of this disease.

Cancer of the Cervix Uterus

Despite a consistent decline in age adjusted death rates, thousands of women continue to die annually from cancer of the cervix (158, 159). The disease is a major killer among the white females in the United States, and the leading killer of cancer among non-white females (158). Cancer of the cervix has been reported for every age group (259), from every continent and among every race and ethnic group (159). The frequency of the disease varies from one region to another (262). Different age peaks have been reported for cancer of the cervix. In Denmark (31) and Sweden (167), the disease reaches a peak at ages 45-49 and 50-54, while in Connecticut (90) and Tennessee (71) a peak is reached at age 85 among the white females.

Reports by Terris and Oalman showed widely discrepent age adjusted death rates for cervical carcinoma in different population groups (277), the rates being lowest among Jewish women and extremely high among the Puerto Rican females in New York City (100). White women in the southern cities of the United States experience a greater risk than do northern women (65). Higher rates are found for poorer sections of

Pittsburg (220) and Copenhagen (36). Stock showed a correlation between cancer of the cervix and 1) social class distribution and 2) overcrowding (271). Reports from England indicate an increase of risk in dying from cervical cancer with a decrease in socioeconomic status (89). The rates were lowest among wives of professionals and highest among wives of unskilled laborers (271).

Excessive risk appears among urban women in Iowa (102) and Copenhagen (36). The probability of developing cancer of the cervix is greater in married than in single women (34, 169, 193, 207). Early age of marriage and instability of marriage are associated with an increased incidence of the disease (172, 103). Other variables such as illegitimate birth, syphilis, early sexual relations, multiple sexual partners, and prostitution are associated with cancer of the cervix (171, 91, 156, 306, 230, 198).

Martin found three factors to be related to the occurrence of cervical cancer: the near absence of the disease among species other than man, among nuns, and among virgins (198). He also found more case women than controls to have had early coitus, early marriage, broken marriage, and remarriage. Gagnon found no cases of cervical carcinoma in a population of 13,000 nuns and suggested that this rarity of cancer of the cervix in nuns to be due to infrequency of cervicitis among them (88). Lombard and Potter indicated an association between cervical laceration and cervical cancer (172, 173).

Several studies have proposed to explain the very low incidence among Jewish females as due to the fact that all Jewish husbands are circumcised, while only a portion of non-Jewish whites are circumcised

(100, 122). Such an explanation that circumcision is directly or indirectly related to cancer of the cervix was supported by a report from India which showed higher incidence of cervical carcinoma in Hindus, uncircumcised, as opposed to Moslems where the men are circumcised (221, 139).

Stamler et al. (261) found carcinoma of the cervix mortality at all ages to be significantly higher in nonwhite that in white women. Such data demonstrate a major socioeconomic gradient to be associated with the disease. Tokuhata (283) found the incidence of genital hygiene and obstetric care in cervical cancer patients and the hygienic standards of their husbands to be generally low.

Snuff and chewing tobacco habits have been related to cancer of the cervix, and may provide a possible explanation of differences in cervical cancer mortality between whites and nonwhites (283). For instance, more Negro women use snuff and chew tobacco than white women (283), and furthermore, use of chewing tobacco and snuff has declined in the United States in recent years (283). The relationship of snuff and chewing tobacco is seen most frequently in women older than 40 years of age, marrying more than once, divorced, separated, or widowed (105).

Terris et al. (277, 278) found carcinoma of the cervix to be associated with marital status, separation and divorce, multiple marriages, early age of first marriage, and age at first coitus. No association was found with the number of coital partners and frequency of coitus. Dorn and Cutler (64) and Haenszel and Hillhouse (100) found the age adjusted incidence in ten United States cities and New York to be twice as high among the ever married than the never married for both whites and nonwhites. Martin proposed that squamous cell carcinoma of the cervix shares many characteristics with communicable venereal disease (198). Several studies have shown that Moslem (306), Amish (44), Jewish (100, 138) and Seventh Day Adventist women (153, 312) experience a very low incidence of cancer of the cervix. They all seem to be religiously oriented groups who marry within their faiths, and thus appear to present a barrier to the introduction of any venereally infectious agent (198). Rotkin (231) found minimal differences between patients and controls for coital positions and frequency of coitus, number of pregnancies and masturbatory technique. All patients had coitus with at least one partner. More controls were found to have used diaphragms, cervical jellies and rhythmic methods of contraception, and to have experienced intercourse with only circumcised males.

The finding that early marriage is more frequent in cervical cancer patients is confirmed by the results of all investigators.

Cancer of the Breast

One of the most interesting aspects of this site of malignant disease is the stability of the trend of mortality rates over the past several years (158, 159). Segi et al. reported on the age adjusted death rate of breast cancer in several countries, with a most strikingly low death rate for Japan (243). In a later study, Wynder et al. (305) suggested this to be a result of the fact that Japanese mothers nurse their children for a period of two years, much longer than any other country. They hypothesized that such a lengthy period would depress ovarian function and exert protective effects on the development of breast cancer.

However, since both male and female breast cancer death rates were reported to be low for Japan and Finland, it was suggested that the possibility of a factor in the human environment may be responsible for these low rates (241, 162).

Lilienfeld reported the proportion of women susceptible to cancer of the breast decreases after age 40-45 (162). Such an age coincides with the average age of onset of menopause (163). Dewaard _et al_. (52) suggested that excessive estrogenic activity may be the underlying factor in the etiology of this malignancy. Lilienfeld reported an increased frequency of breast cancer among those who never married when compared with those who have married (162). Wynder _et al_. reported that breast cancer patients marry at a later age and have fewer children than women in general (305). Several studies report on the excess incidence of female breast cancer among single women (162, 163, 241, 158, 159, 243, 305). Logan observed breast cancer to be more frequent among married women without children than among married women with children (169). Nuns are noted to have an increased incidence of cancer of the breast (88). Clemmesen and Nielson found breast cancer to be more frequent in towns where the fertility is low (36).

Walshe reported that a relationship existed between errors of lactation and breast cancer (291). Segi found a longer period of nursing by breast cancer patients than by controls (242). No such differences existed for whites and Negroes in the United States and England (305).

Positive results were found in six studies conducted to answer the question of familial aggregation (131, 223, 257, 298, 212, 179). A twofold excess frequency of breast cancer among mothers and sisters of patients suggests the influence of genetic factors. In two other studies the familial aggregation results were negative (6, 217).

It was observed that the incidence and mortality from breast cancer were higher in the upper socioeconomic groups than in the lower ones (95), higher in urbanized areas of the United States (155), higher among Jewish groups (216), and higher among the United States native born than the foreign born (98).

Though similar disease frequencies are reported throughout the Western hemisphere, the whites experience higher rates than the non-whites (305). Studies from Hawaii (355) indicate breast cancer to be less frequent in the Japanese population there. Clemmesen and Nielson found cancer of the breast to be more common in Copenhagen than the rest of Denmark (31). In Israel, breast cancer is more commonly reported among women of oriental background (29).

Breast cancer correlates positively with cancer of the endometrium, but correlates negatively with cancer of the cervix (212, 91).

MacMahon (182) found the frequency of artificial menopause to be significantly lower in the breast cancer patients than in the controls. No significant differences were found with respect to menstrual activity, fetal death, smoking histories, or frequency of major illnesses and operations (305).

Cancer of the Gastrointestinal Tract

The mortality from cancer of the stomach is decreasing in the United States (4, 158, 159, 262). Incidence rates from Upstate New York and Connecticut show similar decreasing trends. However, in the last few years, gastric cancer incidence in Connecticut appears to be leveling off

(38, 90). Gastric cancer is found more frequently in males than in females (158, 159, 262). Actually, the rates for males double those of females (262). Regional mortality rates indicate lower gastric cancer mortality in the South for both sexes and higher rates for both sexes in the Middle Atlantic States (308).

Japan, Austria, and Finland experience the highest mortality rates for cancer of the gastric tract and the caucasian population of Australia, New Zealand, Canada, and the United States experience the lowest rates (262). South American countries appear to have high rates in general (226). In Hawaii, the Japanese have the highest rates (255).

Studies by Cohart (38) and Graham (95) in the United States, Clemmesen and Nielson in Denmark (36) and the British Registry General (89) show an increase in gastric cancer with a decrease in socioeconomic status. Urban areas report slightly higher rates than rural areas (308).

Studies of familial aggregation show approximately twice as much cancer of the stomach in relatives of patients with the disease than in the controls (129, 180, 308). Rates of gastric cancer in achlorhydria and pernicious anemia patients have exceeded expectations by 4 to 5 times (9).

Haenszel and Graham indicated that the foreign born have significantly higher risks than the native born (98). The Japanese of Japan experience a much higher gastric cancer death rate than the Japanese of Hawaii or those of the West Coast (255).

Segi found that patients with gastric cancer use less salty food, eat irregularly, and use more alcohol than controls (240). Wynder et al. confirmed the association of irregular eating habits with gastric cancer, but found no relationship of ingestion of smoked food with the disease (311) as had been reported by others (270). Higgenson (119) found frequent use of animal fats in relation to high risk of gastric cancer. Acheson and Doll found no excess risk for use of any specific food or drink (2).

It is reported that iron dust workers and users of purgatives experience a high risk from gastric cancer (13). Japanese studies show some correlation between gastric cancer and gastric ulcers (240). Such correlations were not found in the United States (62). Other reports show no association between tobacco smoking, alcohol consumption, and gastric cancer (311).

The high mortality from stomach cancer in Costa Rica is attributed to communities located on elevated plateaus and inhabited by low income people. The authors findings seem to agree with those observed in other studies that showed a high rate of gastric cancer existed in mountainous countries such as Chile, Japan, and Switzerland (274).

The mortality from stomach cancer in Israel among immigrants from East Europe is much higher than among those from Asian or African origin (287).

As for cancer of the colon and rectum, data from Connecticut and Upstate New York show a leveling off of mortality for both males and females since 1955 (309). In the United States and some European countries colon cancer occurs more commonly among women than among men; however, the reverse is true for other areas of the world (4, 158, 159, 243, 262). Rectal cancer, on the other hand, is more common among

American men than women (262). Such reports are consistent with those from other countries (243, 158, 159).

Socioeconomic status does not seem to influence the rates for either cancer of the colon or rectum (309). Jews in New York City experience a higher rate of cancer of the colon than any other religious group (216), whereas there is no religious difference in death rates for cancer of the rectum (309).

In the United States, urban areas experience a much higher incidence of large bowel cancer than do rural areas (38, 62). Large bowel cancer occurs with low frequency in Asiatic countries such as Japan, in Eastern Europe, Africa, and South America (262).

Epidemiologic evidence indicates a negative correlation between gastric and colon cancer mortality suggesting opposing etiological factors (310). However, a positive correlation exists between cancer of the colon and 1) arteriosclerotic heart disease, and 2) familial polyposis (310).

Ulcerative colitis increases the risk for large bowel cancer (178). Wynder and Shigemaster suggested that constipation increases the risk of cancer of the colon (315). The greater prevalence of constipation among American women is consistent with the greater frequency of cancer of the colon among American women (315, 48).

Haenszel and Dawson reported that large bowel cancer is more common in the northern portions of the United States than in the southern or central portions (99). Italio-Americans have a heavier risk of cancer of the colon than other foreign born groups in the United States (98).

Wynder and Shigemaster found a negative correlation between smoking cigarettes and sigmoid colon cancer, but a positive association with cigar smoking (310, 315). These correlations appear to be related to obesity, as female colon cancer patients tended to be slightly heavier than control patients (315). Boyd and Doll found that patients with large bowel cancer had used liquid paraffin and vegetable base purgatives more often than controls (13).

Legan (152) showed that areas of high cancer mortality in England and Wales were found to be areas having the soil rich in organic matter. These high mortality areas were characterized by heavy rainfall and glacial topography which gave rise to water logging and accumulation of peat. The author suggested that a carcinogen may be present in the food plants grown on the soil with high organic content, or that a protective substance may be lacking in such plants. He pointed out the fact that soils with high organic content are deficient in copper.

The high incidence of cancer of the oral cavity in parts of India where betel chewing is common suggests that some component of the quid plays a part in producing cancer of the oral cavity (222).

The report of the Research Committee of the World Health Organization on the etiology of cancer of the gastrointestinal tract indicates that dietary factors, whether in respect to excess or deficiencies have an important influence on the development of both gastric and large bowel cancer. Possibly a total diet high in carbohydrates and low in proteins, fresh fruits and vegetables predisposes gastric cancer (309). Such dietary patterns are consistent with the high rates of gastric cancer reported from Japan, Eastern Europe and South America (262).

Cancer of the Bladder

International comparisons reveal relatively low rates for cancer of the bladder for both sexes in Japan, and comparatively high rates in England and Wales, Scotland, Denmark and the United States white males (241, 62, 141, 262). Exceptionally high mortality rates reported from Egypt may be related to high frequency of schistosomal infestation (141, 1). The geographic pattern in the United States shows low rates among the nonwhite males residing in the South and among the white females residing in the West (62).

Age specific mortalities show a sharp increase from younger to older persons (62, 141).

There is evidence of elevation in bladder cancer mortality rates among white protestants, both males and females (216) and much lower rates among the Seventh Day Adventists than in the general population (312, 153). Foreign born generally have lower cancer of the bladder mortality than the native born among the white males and females of the United States (98). Lower mortality risk is reported in non-metropolitan counties in the United States (90, 102, 62), Norway (279), Denmark (35), and Finland (78).

In New York City, Wynder found no significant religious differences between bladder cancer patients and controls (314).

Young and Russell found chemical manufacturers and textile dyers to have an excess frequency of bladder cancer and suggested that exposure to coal tar products in the form of aniline was a possible explanation (317). Hueper reviewed several factors in the environment and found that in addition to aromatic amines such as β and α naphthylamine, benzidine, and 4 amino- diphenyl, polycylic aromatic hydrocarbons might be bladder carcinogens (127).

Data from England and Wales show low bladder cancer mortality among farmers and farm laborers, among gas fillers, miners of coal, gas and coke, laborers in coke ovens and gas workers (89). William and Wynder suggested that hair dressing might induce bladder malignancy (295, 314).

Results of 3 retrospective studies by Lilienfeld _et al_. (164, 166), Schwartz (338) and Wynder _et al_. (314) revealed a significant association between cigarette smoking and cancer of the bladder among males. Bladder cancer patients have been found to have started smoking earlier than controls (164, 166, 338, 314).

All investigators report a high male-female ratio for cancer of the bladder. There is no significant evidence for familial aggregation of bladder cancer patients (141, 164, 166).

Cancer of the Prostate Gland

Cancer of the prostate gland is reported in higher frequency among nonwhites than among whites in the United States (142). The reports from Connecticut (90) and a ten city survey (64) are consistent in pointing out an increase in age adjusted incidence for both races in the United States.

Cancer of the prostate mortality is higher among the Americans of Japanese origin than among native Japanese, but still lower than the mortality experienced by whites and nonwhites in the United States (255). Lower frequency is reported for orientals and American Indians than for the general population in the United States (142); and there is a higher prostate cancer rate for both whites and nonwhites of the northern areas of the United States than for the southern areas (96, 142). Also there is a low mortality differential for cancer of the prostate gland reported between urban and rural areas and between metropolitan and non-metropolitan counties of the United States (96, 155, 142).

Prostate cancer occurs with a lower frequency among the foreign born than among the native born (98), and with higher frequency among protestants, and lowest among Jewish males (216). The disease is reported with higher frequency among occidental Jews than among the oriental immigrants to Israel (134).

The ever married experience a higher risk for prostate cancer than the single, and so does the married with children as compared to the married without children (212, 146). A higher frequency of the disease is reported among professional men than among manual workers, agriculture workers, miners, and clerical and kindred workers (89, 317, 36, 95).

Several reports emphasize the relationship between sexual behavior and prostate cancer (142). Other studies report a higher frequency among male relatives of prostate cancer patients than among controls (297). The disease seems to increase geometrically from age 40-50 and up (142).

Leukemia

In recent years epidemiological research has produced evidence implicating ionizing radiation in the etiology of leukemia (21, 112, 148, 184, 185, 192, 194, 195, 203, 252, 264, 288, 208, 157); at the same time evidence for viral etiology in human leukemia is scanty (208, 203, 264).

Some of the observations on leukemia mortality have shown a childhood peak due to acute lymphocytic leukemia at 3-4 years of age among whites in the United States and England with a small peak in adolesence (43). Males experience a higher rate than females (151, 43). An increase in leukemia deaths since 1921 has been observed in all age groups over three years of age (92).

Brooklyn Jews experience a two fold increase over whites in the same city (189), and there is a greater rate in Israel among the native born and European immigrants than among Asian or African immigrants (49). A near absence of chronic lymphocytic leukemia among Chinese in Singapore (259) and among Japanese is reported (148).

Henshaw and Hawkins reported leukemia rate among physicians, who are more occupationally exposed to x-ray, 1.7 times that of the general white male adult population (113). A few months later, March reported that radiologists experience a nine times greater leukemia death rate than all other physicians (194, 195). Ulrich, using the same data obtained similar results (288).

Gilliam pointed out that what March and Ulrich reported was the ratio of leukemia deaths to all deaths, and since leukemia accounts for a larger proportion of deaths in the middle than in the later years, the difference may be accounted for by the younger age of the radiologists among the physicians (92). In another study, Miller showed radiologists to experience an age adjusted death rate three times greater than other physicians (208).

As excess of leukemia was found among the survivors of atomic bombing (82). Among these survivors, a peak was reached six or seven years after the atomic explosion (117). Lewis found excesses among radiologists of aplastic anemia, leukemia, and multiple myeloma, and attributed this excess to radiation exposure (157). Simpson et al. found significant excesses of leukemia, thyroid adenomas, and carcinomas among 1,502 persons who had received irradiation of the thymus during infancy (254). In Britain, patients treated with x-rays for ankylosing spondylitis showed an excess of leukemia deaths (43). Mothers of cancer children reported twice as many diagnostic radiation exposures of the abdomen during pregnancy as the mothers of the controls (268).

Heath et al. reported on an unusual clustering of 8 cases of childhood leukemia in Nile, Illinois between September, 1957 and August, 1960. Three of the children affected and the siblings of 4 others attended the same high school. The authors emphasized the possible role of an infective agent in the spread of leukemia (109). Some studies demonstrated case aggregation (109, 192, 204, 213), while others indicated random distribution of the disease (75, 85, 175). Walter et al. reported in 1949-51 that a high leukemia death belt existed across the northern parts of the United States (292). Ten years later reports indicated the belt had shifted to the general course of the Mississippi River (238).

Minnesota reported some of the highest death rates for leukemia in the United States (238), however, since 1950 leukemia death rates have remained stable there. St. Paul consistently and significantly experienced higher leukemia mortality than Minneapolis (238).

Cancer of Other Sites

The localization of Burketts lymphoma to humid parts of Africa suggests that this type of cancer is due to an infection spread by insects (22).

In a study of the geographic distribution of Missourians with multiple cancer, Cook _et al_. (39) showed that counties with high incidence rates seem to cluster around the Missouri River. They suggested the possibility that a positive correlation existed between cancer prevalence and some factor in the river water. They also postulated on the increased incidence of skin cancer in certain parts of the state to the increased amount of crop land and the increase in farmers' hours of sun exposure.

Proposed Study

Much evidence has been obtained relating oral cancer to chewing habits; lung cancer to cigarette smoking and air pollution; esophageal cancer to alcoholism; myeloid cancer to ionizing radiation; gastrointestinal cancer to some aspect of the total diet; and cancer of the cervix uteri to some aspect of sexual relation. It is then worthwhile to consider the hypothesis that most cancer is due not to any single causative agent, but to complex multiple factors, each contributing something to the total process.

The purpose of this study is to determine if there is any clustering of certain types of malignancy in specific geographic areas or in any period of time in the seventy-seven counties of Oklahoma for the period 1956-1965. Hopefully, if any significant increases or decreases in malignancy death rates are found, attention would be directed at delineating possible determinants of the variation in cancer rates. Reported variation in mortality rates would be investigated by studying the association of the disease with selected environmental factors, customs or characteristics of the populations having high mortality rates with populations having low mortality rates. Such comparisons may provide clues concerning etiology.

The geographic distribution of Oklahomans with single cancer is unknown. It is hoped that this study will shed some light on the epidemiology of malignant disease in the state of Oklahoma.

The objectives of this study are threefold:

1. To examine the secular and geographic changes in mortality from malignant disease during the years 1956-1965 for Oklahoma's 77 counties.
2. To determine the relationship of changes in mortality in Oklahoma to environmental factors and other variables.
3. To help delineate factors and provide guiding hypotheses for experimental research and preventive programs.

The epidemiology of malignant disease in Oklahoma may be similar to that reported by other studies in different areas of the world. However, studies such as this will determine the true epidemiology of malignant disease for Oklahoma.

CHAPTER II

METHODS AND PROCEDURES

Mortality data were taken from death certificates reported to the office of vital statistics at the State Health Department, Oklahoma City, Oklahoma, and are presently stored on magnetic tapes at the Biostatistics Unit. Death certificates were the ultimate source of information for this study. Information for the period 1956-1965 were punched on I.B.M. cards. Mortality data for out-of-state residents were excluded from the study.

The deaths from malignant disease were sorted into 34 specific sites using the International Classification of Disease Code revised in 1955 (130). Data were analyzed on the following 34 sites:

Code	Specific Site
140-148	Buccal cavity and pharynx
150	Esophagus
151	Stomach
152, 158-159	Small intestine, peritoneum, and G.I. unspecified
153-154	Large intestine and rectum
155-156	Liver
157	Pancreas
160	Nose, nasal cavity, middle ear, and accessary sinuses
161	Larynx

Code	Specific Site
162-163	Bronchus, trachea, and lung
164-165	Mediastinum and secondary thoracic organ
170	Breast
171	Cervix uteri
172-174, 176	Corpus uteri, uterus, and other of female genitalia
175	Ovary, fallopian tube and broad ligament
177	Prostate
178-179	Testis and other of male organs
180	Kidney
181	Bladder and other urinary organs
190	Melanoma of the skin
191	Others of skin
192	Eye
193	Brain and nervous system
194	Thyroid gland
195	Other endocrine glands
196	Bone
197	Connective tissue
198-199	Other unspecified sites
200	Lympho-sarcoma and reticulosarcoma
201	Hodgkin's disease
202, 205-206	Other lymphomas, mycosis fungoides and lymphatic system
203	Multiple myeloma
204	Leukemia, aleukemia, and haematopoetic system
210-239	Benign neoplasm and other of unspecified sites

Data on each site were divided into two five year periods (1956-1960, and 1961-1965) to determine if the disease increases, decreases, or remains unchanged over the ten year period in Oklahoma.

The number of deaths for each sex, race, and the following nine age groups: <5, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75+ for the seventy-seven Oklahoma counties were tabulated and punched on I.B.M. cards so that each county did have at least 4 case cards (white males, white females, non-white males, and non-white females) for each of the 34 specific sites, with each containing the nine age groups.

Deaths were attributed to the county of residence, not the county in which the patient died. All death certificates which listed each of the 34 specific sites of cancer as the underlying cause of death during the years 1956-1965 were analyzed.

Estimation of the Oklahoma population for intercensal years by county and age group was necessary before calculating age-sex-race specific and adjusted death rates. The population census data for 1950 and 1960 were used as the basis to estimate the population for the two mid years of the two five year periods (1958 and 1963). Population data for each sex, race, and age group for the seventy-seven Oklahoma counties were estimated and punched on I.B.M. cards so that each case card had a population card containing the nine age groups to match it.

The estimated populations were used to calculate age-sex-race specific death rates per 100,000 people for the seventy-seven Oklahoma counties. The direct method of adjustment was used, as described by Bradford Hill (121), to tabulate age-sex-race adjusted death rates, based on the population for the state of Oklahoma using the 1960 white male census as the standard population. This procedure is essentially one of providing a weighted average of the age-specific mortality rate in each of the comparison populations. The weights used are the standard populations falling into each group.

The age-sex-race specific and adjusted death rates for the state of Oklahoma and for the 34 specific sites were tabulated for the two five year periods.

The average annual age-adjusted death rates for the Oklahoma white population (the data for Oklahomas non-white population were not tabulated) were tabulated for the ten year period for each of the 34 sites and the seventy-seven counties, and were plotted on Oklahoma county maps. These maps were used to determine the geographic distribution of malignant disease in Oklahoma.

It was difficult to find a statistical method that could be used to analyze the geographic distribution of mortality from malignant disease in order to determine if the disease is randomly distributed or if it forms a pattern of irregular distribution. Therefore, each specific site was taken separately and the seventy-seven Oklahoma counties were divided into four quartiles (upper, second, third, and lower) and shaded. Counties falling in the upper quartile were considered "high" counties, while those falling in the lower quartile were considered "low" counties. Three or more adjacent counties belonging to the same quartile were considered a "cluster".

Another method was used to detect presence or absence of geographic clustering by examining the degree of association between rates for males and females. The presence of geographic clustering due to environmental factors was indicated by the similarity between the male and female death rates. The Kendall (219) method is a nonparametric statistic in which the two variables X and Y were ranked from 1 to n. The Tau gave a measure of the degree of association or correlation between the two sets of ranks. Tau was subjected to tests of significance. The X variable was arranged in natural order; the Y variable was arranged on the corresponding order of rank. The sum (S) of the differences of the number of ranks which are larger to its right and subtract the number of ranks which are smaller to its right. The sum (S) was the total of each one of the ranks. The following formula was used:

$$\text{Tau} = \frac{S}{\frac{1}{2}N\ (N-1)}$$

Another method was used to examine the differences between mortality in urban and in rural areas. The counties in the state were grouped according to the number of people in the major cities of the counties into metropolitan, non-metropolitan and rural counties such as:

1. 30,000 - 325,000 as metropolitan
2. 15,000 - 30,000 as non-metropolitan
3. Less than 15,000 as rural

The 1960 Oklahoma census classifies ten counties as metropolitan, seventeen as non-metropolitan, and fifty counties as rural.

To ascertain if significant differences existed among the three urbanization classes, the male and female average annual age adjusted death rates by county were ranked and tested by the Kruskal-Wallis rank test (219). The test is analogous to a one way analysis of variance. The sum of the ranks in each of the three classes is found. The test determines whether these sums of ranks are disparate and not likely to have come from samples drawn from the same population. The Kruskal-Wallis test is distributed as Chi square with df=k-1. The following formula was used:

$$H = \frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j^2}{n_j} - 3(N+1)$$

Also the mean average adjusted death rates for each of the three urbanization classes were tabulated to determine the direction of urban-rural differences.

Other variables were measured as they affect the specific site of malignant disease. The age specific death rates were looked at in an effort to explain the variation among age adjusted death rates.

It was impossible in such a study to look at environmental factors and their relationship to all the 34 sites of malignant disease. Therefore, the variation or lack of variation as determined by the geographic distribution and clustering of each specific site determined how far the problem was explored.

The following are factors in the human environment, the customs and habits of the people of Oklahoma that were compared to the geographic distribution of malignant disease.

1. The per capita sales of cigarettes were obtained from the Cigarette and Tobacco Division of the Oklahoma Tax Commission. We were able to obtain data on cigarette sales by districts for the period 1960-1961, and 1965-1966 only. The average annual tax-paid per capita sales of cigarettes in Oklahoma were tabulated and plotted on county maps and shaded. Also we were able to obtain tax-paid per capita sales (in number of packs) for Oklahoma, all taxing states, and the national average from 1950-1966.

2. The geologic map of Oklahoma was obtained from the Oklahoma Geologic Survey office of the University of Oklahoma at Norman.

3. Mineral resources map was also obtained from the same office.

4.. Fuels map of Oklahoma was also looked at in an effort to ascertain coal, petroleum, uranium, and other related materials areas.

5. The distribution of Oklahoma counties by elevation was determined from the Oklahoma Highway Department maps.

6. The socioeconomic status in different geographic districts of the state was determined by factors considered as major determinants of socioeconomic status. The following determinants were used: average per capita income, educational level, condition of housing, and number of persons per 100,000 receiving Aid to Deprived Children (ADC).

Data on each of these determinants is available for nine Oklahoma districts and two metropolitan areas. Each district was assigned a rank for each of the four determinants such as one for the districts belonging to the high per capita income, high level of education and housing and low number of children receiving ADC. The number two was assigned to districts belonging to the class above state average, three to the group below state average and four to districts belonging to low classes. The numbers of each district were totaled and grouped accordingly into high socioeconomic state for those districts totaling 4, 6, or 7, and to above state average to those totaling 9, below state average to districts totaling 14 and to very low socioeconomic state to those totaling 16.

7. The cropland distribution by county for Oklahoma was obtained from the State Department of Agriculture including a list of insecticides recommended to be used by the different farmers.

CHAPTER III

RESULTS I. MORTALITY DATA

The methods and procedures as outlined and discussed in the previous chapter were followed and applied to 35,148 deaths from malignant disease occurring in residents of Oklahoma for the ten year period 1956-1965.

A decline in cancer of the stomach among the white males and females, an increase in deaths due to cancer of the respiratory system among both sexes and races, with a dramatic increase in cancer of the lung, trachea, and bronchus among the white males are the most obvious trends among age-adjusted death rates in Oklahoma for the ten year period. Also of interest is a slight increase in cancers of the breast, ovary, fallopian tube, and broad ligament with a definite decrease in trends for cancer of the cervix uteri, corpus uteri, uterus, and others of the female genitalia. Cancers of the kidney, bladder and other urinary system organs are increasing slightly for both whites and nonwhites. As for cancer deaths of the haematopoetic system, lymphosarcomas, reticulosarcomas, multiple myeloma, and leukemias, all groups have experienced a slight increase from one five year period to another (Tables 2-35).

Among cancer deaths for all groups, lung cancer was the leading cause of death during the time period studied, followed by cancers of the large intestine and rectum, breast, stomach, prostate, unspecified sites, leukemia, pancreas, liver, and cancer of the cervix uteri (Table 1).

Lung cancer continues to be the leading cause of cancer death among the white Oklahoma males, followed by cancers of the prostate, large intestine and rectum, stomach, leukemia, pancreas, unspecified sites, liver, bladder and other urinary organs, and cancer of the buccal cavity and pharynx (Table 1).

Among cancer deaths, the nonwhite male leading cause of death was cancer of the prostate gland, followed by cancer of the respiratory system, stomach, large intestine and rectum, liver, unspecified sites, benign neoplasms, leukemia, esophagus, and the small intestine (Table 1).

As for Oklahoma females, more whites die of breast cancer than from any other cancer site. The large intestine and rectum is second, followed by unspecified sites, cervix uteri, ovary, fallopian tube, broad ligament, stomach, lung, leukemia, and cancer of the pancreas. The nonwhite female leading cause of death for the ten year period is cancer of the cervix, followed by breast cancer, cancer of the large intestine and rectum, corpus uteri, uterus, and others of female genitalia, stomach, unspecified sites, liver, ovary, pancreas, and lung cancer (Table 1).

The nonwhite average annual age-adjusted mortality is difficult to interpret due to the fact that a small number of cases and a small susceptible population spread over many counties of the state show unusually high rates; also, many counties do not have any nonwhite population. Therefore, the average annual mortality for the nonwhites by county will not be reported here, and only data for the nonwhite population for the state is shown on tables. The geographic distribution by

TABLE 1

CANCER DEATHS BY SPECIFIC SITE, OKLAHOMA (1956-1965)
NUMBERS IN PARENTHESIS INDICATE ORDER OF RANK

Code	White Male	White Female	Non-White Male	Non-White Female	Total
140-148	492 (10)	186 (17)	37 (11)	12 (19)	727 (16)
150	246 (15)	82 (24)	56 (9)	6 (24)	390 (20)
151	1318 (4)	825 (7)	165 (3)	118 (5)	2426 (4)
152,158-9	152 (22)	160 (18)	44 (10)	12 (19)	368 (21)
153-154	1782 (3)	2101 (2)	129 (4)	188 (3)	4200 (2)
155-156	683 (8)	667 (11)	116 (5)	92 (7)	1558 (9)
157	1037 (6)	698 (10)	85 (7)	65 (9)	1885 (8)
160	54 (27)	35 (29)	4 (25)	5 (26)	98 (32)
161	195 (18)	27 (30)	18 (18)	1 (29)	241 (26)
162-163	4014 (1)	735 (8)	223 (2)	61 (10)	5033 (1)
164-165	113 (24)	49 (28)	1 (28)	7 (23)	170 (27)
170	14 (31)	2362 (1)	1 (28)	194 (2)	2570 (3)
171	--	909 (4)	--	201 (1)	1110 (10)
172-4,176	--	834 (6)	--	139 (4)	973 (11)
175	--	864 (5)	--	79 (8)	943 (12)
177	2035 (2)	--	281 (1)	--	2316 (5)
178-179	122 (23)	--	7 (22)	--	129 (29)
180	387 (13)	209 (16)	34 (13)	15 (17)	645 (17)
181	545 (9)	272 (14)	37 (11)	27 (13)	881 (13)
190	188 (20)	154 (20)	5 (24)	0 (31)	347 (25)
191	273 (14)	155 (19)	9 (21)	7 (22)	444 (19)
192	29 (30)	23 (31)	0 (31)	0 (31)	52 (34)
193	471 (11)	319 (12)	27 (14)	18 (16)	835 (14)
194	38 (29)	62 (25)	1 (28)	4 (27)	105 (31)
195	41 (28)	19 (32)	4 (25)	1 (29)	65 (33)
196	195 (18)	135 (22)	18 (18)	15 (17)	363 (23)
197	73 (25)	52 (26)	3 (27)	3 (28)	131 (28)
198-199	884 (7)	975 (3)	86 (6)	111 (6)	2056 (6)
200	421 (12)	317 (13)	27 (14)	19 (15)	784 (15)
201	222 (17)	118 (23)	14 (20)	9 (21)	363 (24)
202,205-6	59 (26)	48 (27)	6 (23)	6 (24)	119 (30)
203	182 (21)	140 (21)	21 (16)	22 (14)	365 (22)
204,207	1057 (5)	717 (9)	75 (8)	47 (12)	1896 (7)
210-239	223 (16)	268 (15)	19 (17)	49 (11)	559 (18)
Totals	17,545	14,517	1,553	1,533	35,148

county for those specific sites where the data are too small and difficult to interpret is also excluded.

Among the specific sites within the digestive system, cancer of the buccal cavity and pharynx (ISC 140-148) indicate a stable age-specific and age-adjusted death rate for all age, sex, and racial groups and for the two five year periods (Table 2). The white male average annual age-adjusted death rates for the-seventy-seven Oklahoma counties show an irregular distribution, with eight of the upper quartile counties being located in the northeast geographic area of the state. Other high counties seem to cluster in different geographic areas of the state such as the three-county area of Murray, Johnston, and Coal in the south central, and Logan, Kingfisher, and Canadian counties in the central parts of the state. Most of the lower quartile counties occur in the western parts of the state (Fig. 1).

The white female average annual adjusted death rates show a random distribution with several of the upper quartile counties located in the east central geographic area, whereas low quartile counties are located in the western third of the state (Fig. 2). The mortality for both groups of males appears to be three times higher than their female counterpart (Table 2).

An increase from cancer of the esophagus (ISC 150) is reported among the nonwhite population over the two five year periods; the males experienced excessive mortality over the females for the same time period (Table 3). Cancer of the esophagus appears to be more prevalent in the white males (Fig. 3) in counties located in the central, western, and southwestern areas, and a high cluster area appears for the eastern

TABLE 2

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF BUCCAL CAVITY AND PHARYNX (140-148)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.0	0.9	0.0	0.0
5-14	0.0	0.4	0.5	0.0
15-24	0.0	0.0	0.0	1.4
25-34	0.7	0.8	0.7	0.8
35-44	7.6	3.1	2.1	2.2
45-54	23.5	28.3	4.8	6.1
55-64	62.2	61.9	13.0	8.3
65-74	110.0	100.2	25.3	42.2
75+	213.6	183.0	82.9	94.5
AADR*	24.2	22.6	6.8	8.1

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	3.5	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	7.6	0.0
35-44	0.0	10.1	0.0	0.0
45-54	19.9	50.0	0.0	0.0
55-64	85.0	33.9	0.0	20.1
65-74	82.3	94.9	15.7	14.7
75+	90.9	80.0	119.1	74.2
AADR*	18.6	19.8	6.2	5.4

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

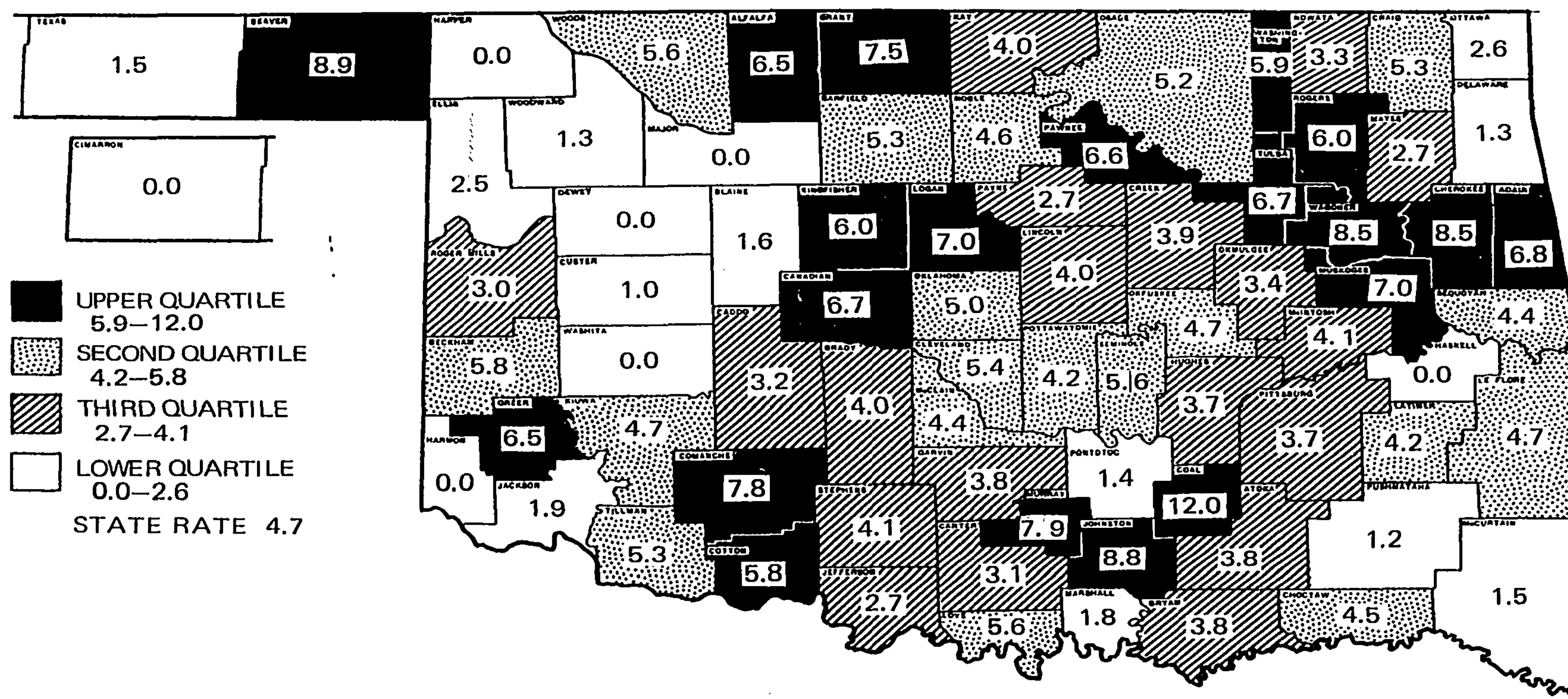


Figure 1. Cancer of Buccal Cavity and Pharynx (140–148), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

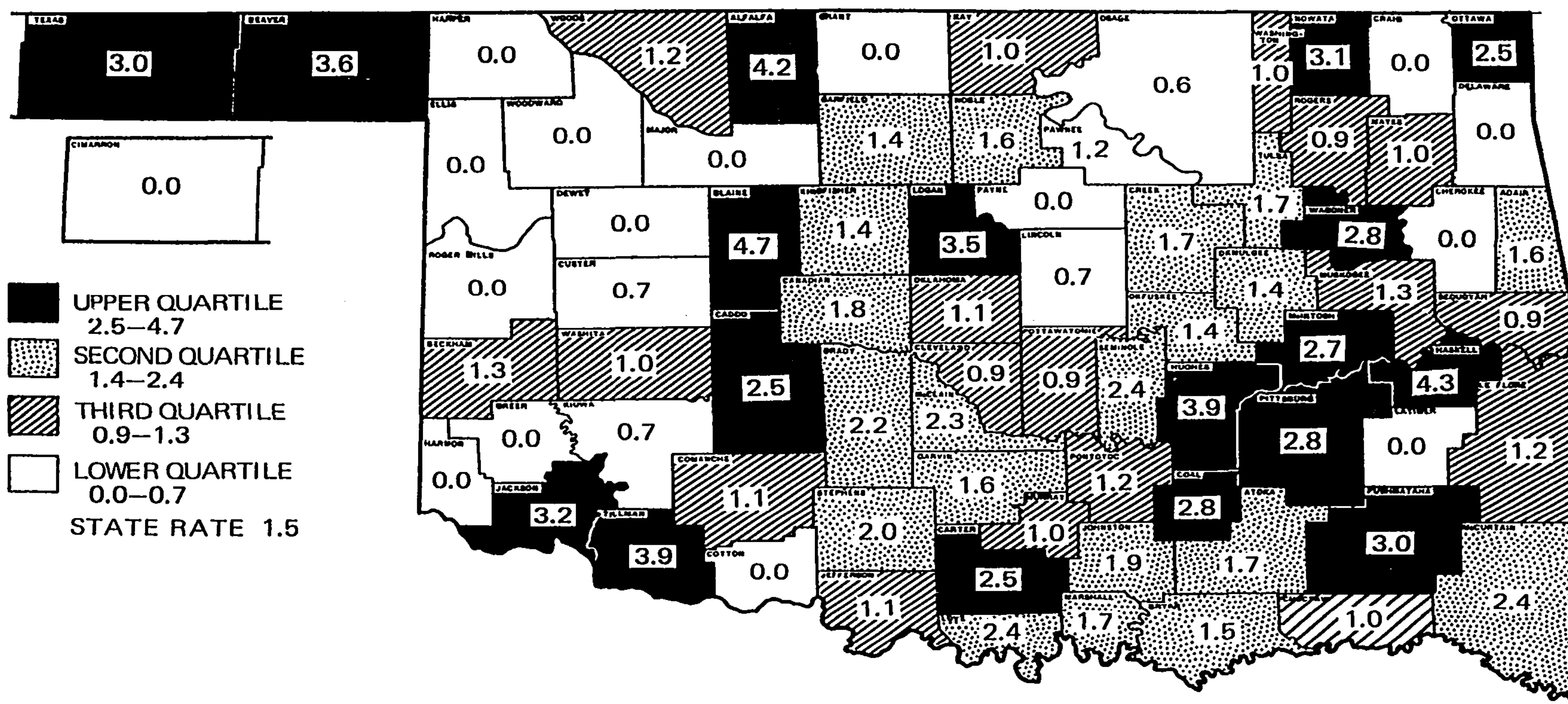


Figure 2. Cancer of Buccal Cavity and Pharynx (140–148), White Females.

TABLE 3

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE ESOPHAGUS (150)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.8	0.0	0.0
35-44	2.2	1.5	0.7	0.7
45-54	10.9	10.5	1.6	1.5
55-64	37.5	32.5	6.0	11.0
65-74	51.9	57.2	20.0	16.8
75+	99.8	92.7	34.5	27.0
AADR*	11.9	11.5	3.3	3.3

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	20.3	0.0	16.7
45-54	39.9	20.0	17.5	0.0
55-64	97.2	181.3	0.0	20.1
65-74	115.2	142.4	0.0	14.7
75+	90.9	133.3	0.0	0.0
AADR*	24.2	35.4	2.0	4.8

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

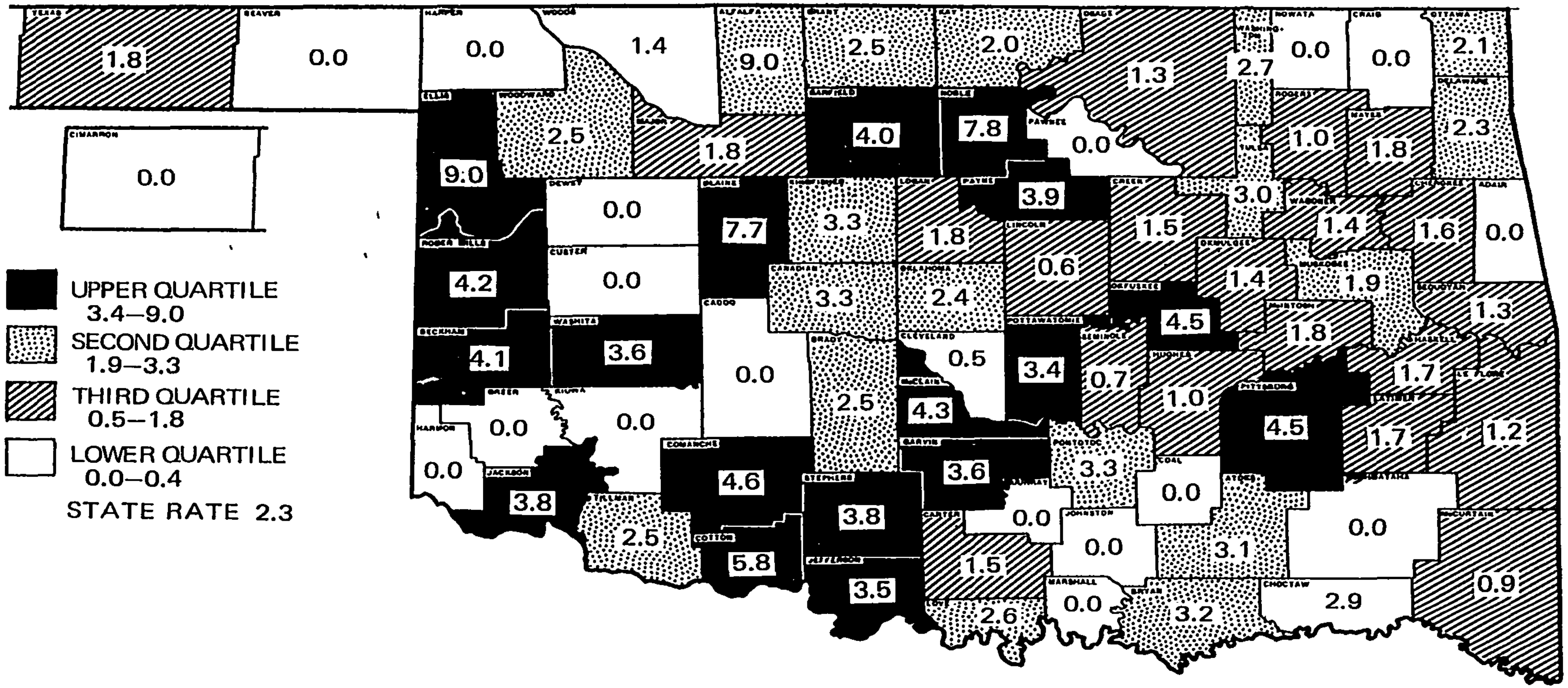


Figure 3. Cancer of the Esophagus (150), White Males.

counties bordering Arkansas for the white females (Fig. 4).

Stomach cancer (ISC 151) mortality among white males and females shows a definite decline for all age-specific and age-adjusted death rates over the two five year periods in Oklahoma. No such trends are indicated for the nonwhites (Table 4). The males experienced higher age-adjusted mortality than the females. Counties in the western parts of the state show the highest death rates for the white males (Fig. 5), while a regular distribution is indicated for the white females.

Relatively few deaths occurred among Oklahomans from cancer of the small intestine (ISC 152), peritonium and others of the digestive system (ISC 158-9). They show an irregular time trend, increasing for some age groups, while decreasing for others. The only consistent increase occurred among the nonwhite males (Table 5).

As for cancer of the large intestine and rectum (ISC 153-154), the rates show no changes with time. The white Oklahoma males and females experienced similar mortality from this disease while adjusted rates for the nonwhite females are slightly elevated over their male counterpart (Table 6). Oklahoma white males residing in the northwest counties from Beaver to Mclain experienced high rates from the disease, as did white males residing in the counties of Washington, Tulsa, Wagoner, Okmulgee, and Okfuskee in the Northeast (Fig. 7). A northern and western distribution of high death rates is indicated for the females (Fig. 8).

Liver malignancies are difficult to interpret because the liver is an organ to which cancers of other sites frequently metastasize. Oklahoma data shows an almost stable rate for white males and nonwhite females, a slight decline among the white females and a significant increase

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

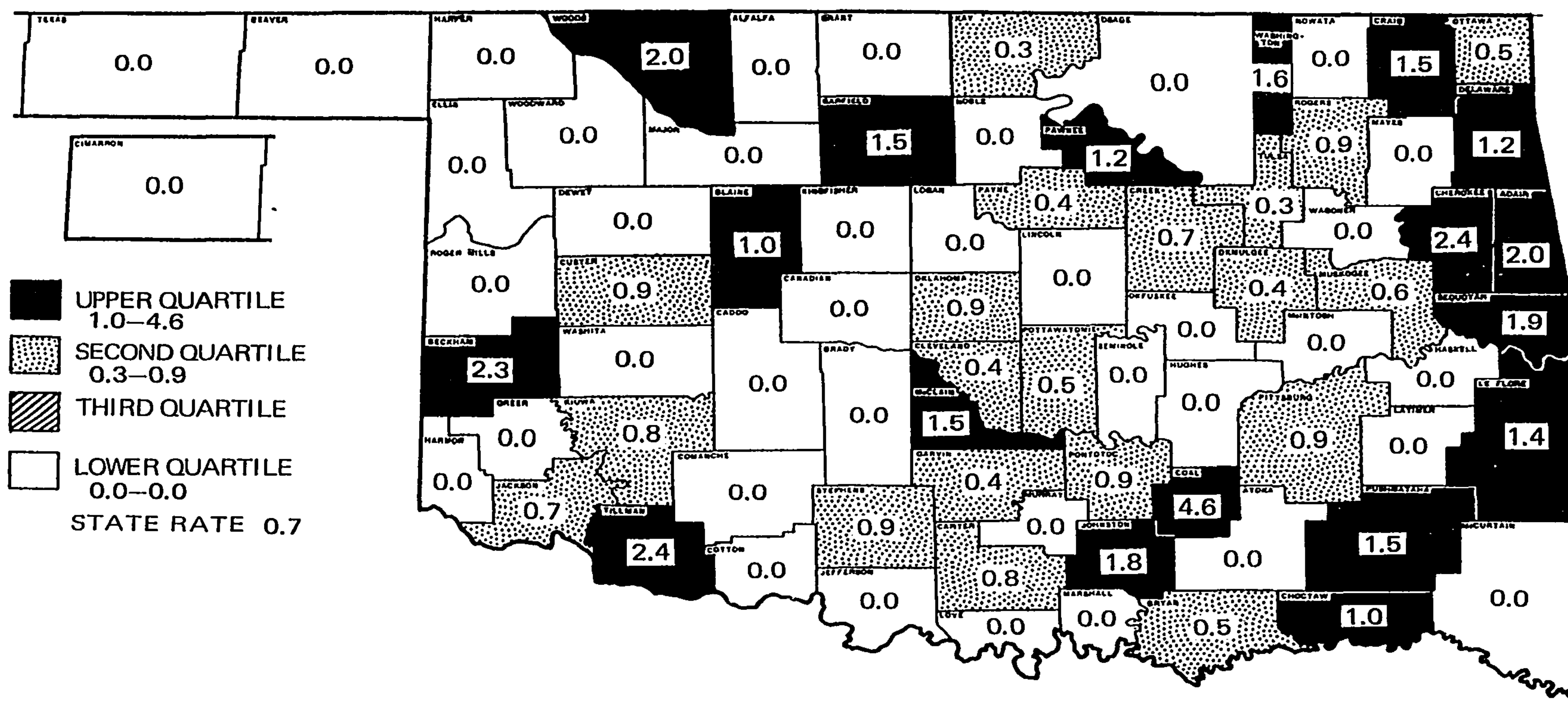


Figure 4. Cancer of the Esophagus (150), White Females.

TABLE 4

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF STOMACH (151)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.9	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.6	0.0	0.0	0.7
25-34	2.3	1.6	3.7	1.6
35-44	10.6	8.5	10.9	8.2
45-54	45.4	36.4	31.4	30.5
55-64	149.2	114.8	50.1	47.1
65-74	401.9	259.2	169.5	132.5
75+	724.0	579.1	444.8	366.7
AADR*	72.6	53.5	37.1	30.9

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	12.8	0.0	0.0	0.0
25-34	9.2	9.8	0.0	7.9
35-44	19.1	10.1	8.0	16.7
45-54	49.9	100.0	43.9	67.7
55-64	243.1	203.9	90.7	120.7
65-74	312.7	474.8	314.8	295.1
75+	909.0	666.6	655.3	445.5
AADR*	86.3	87.3	58.3	57.0

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

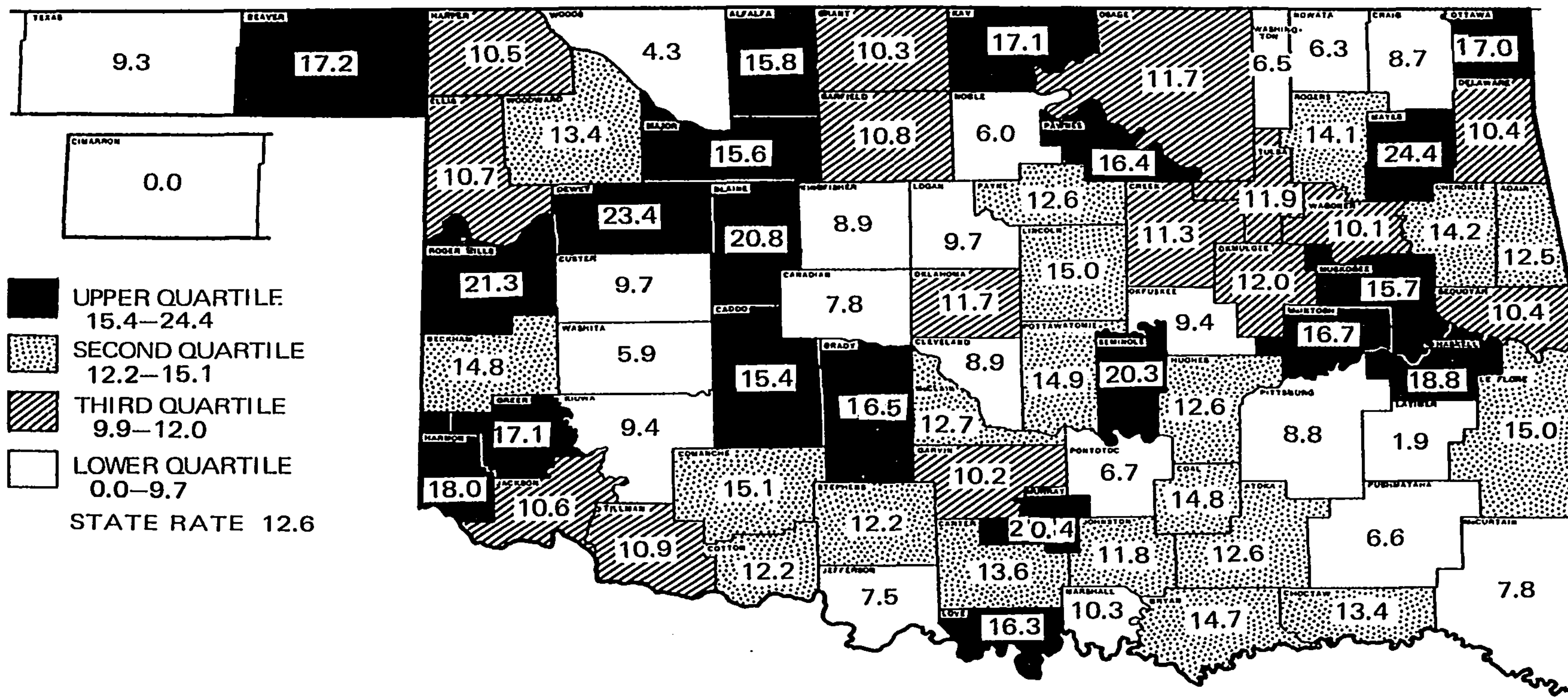


Figure 5. Cancer of the Stomach (151), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

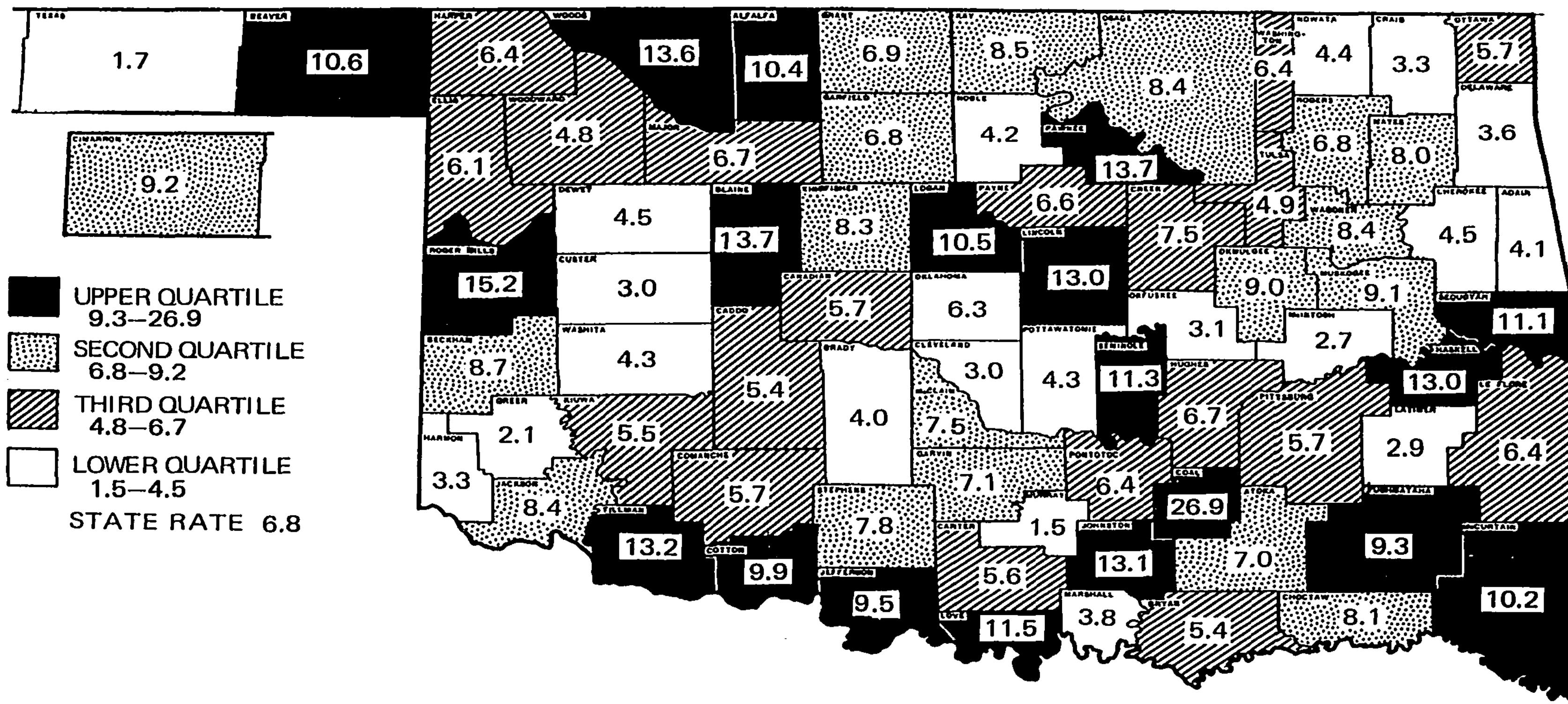


Figure 6. Cancer of the Stomach (151), White Females.

TABLE 5

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE SMALL INTESTINE PERITONIUM AND OTHERS OF DIGESTIVE SYSTEM (152, 158-9)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.6	0.0	0.0	0.0
25-34	1.5	0.8	0.0	2.4
35-44	4.5	3.9	0.7	1.4
45-54	3.3	3.2	1.6	4.5
55-64	18.2	12.1	11.0	17.5
65-74	48.9	20.0	35.3	31.3
75+	61.0	80.2	50.7	94.5
AADR*	8.2	6.2	4.7	8.0

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	9.5	0.0	0.0	0.0
45-54	19.9	20.0	8.7	8.4
55-64	36.4	56.6	11.3	40.2
65-74	115.2	126.6	0.0	14.7
75+	151.5	293.3	59.5	49.5
AADR*	19.7	26.2	4.1	7.3

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 6

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE LARGE INTESTINE AND RECTUM (153-154)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	1.9	2.6	2.7	0.7
25-34	11.5	10.0	10.4	4.9
35-44	13.6	24.9	24.1	24.6
45-54	58.9	51.8	89.4	68.7
55-64	182.5	174.8	173.4	188.6
65-74	435.6	383.8	329.7	370.2
75+	909.9	852.4	940.3	903.4
AADR*	87.8	82.2	86.0	85.4

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	6.4	0.0	6.3	0.0
25-34	27.8	9.8	7.6	7.9
35-44	19.1	61.1	64.0	16.7
45-54	39.9	60.0	52.7	76.2
55-64	145.8	147.3	192.8	201.1
65-74	246.9	332.3	362.0	368.9
75+	818.1	453.3	893.6	1113.8
AADR*	70.0	67.0	89.1	94.2

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

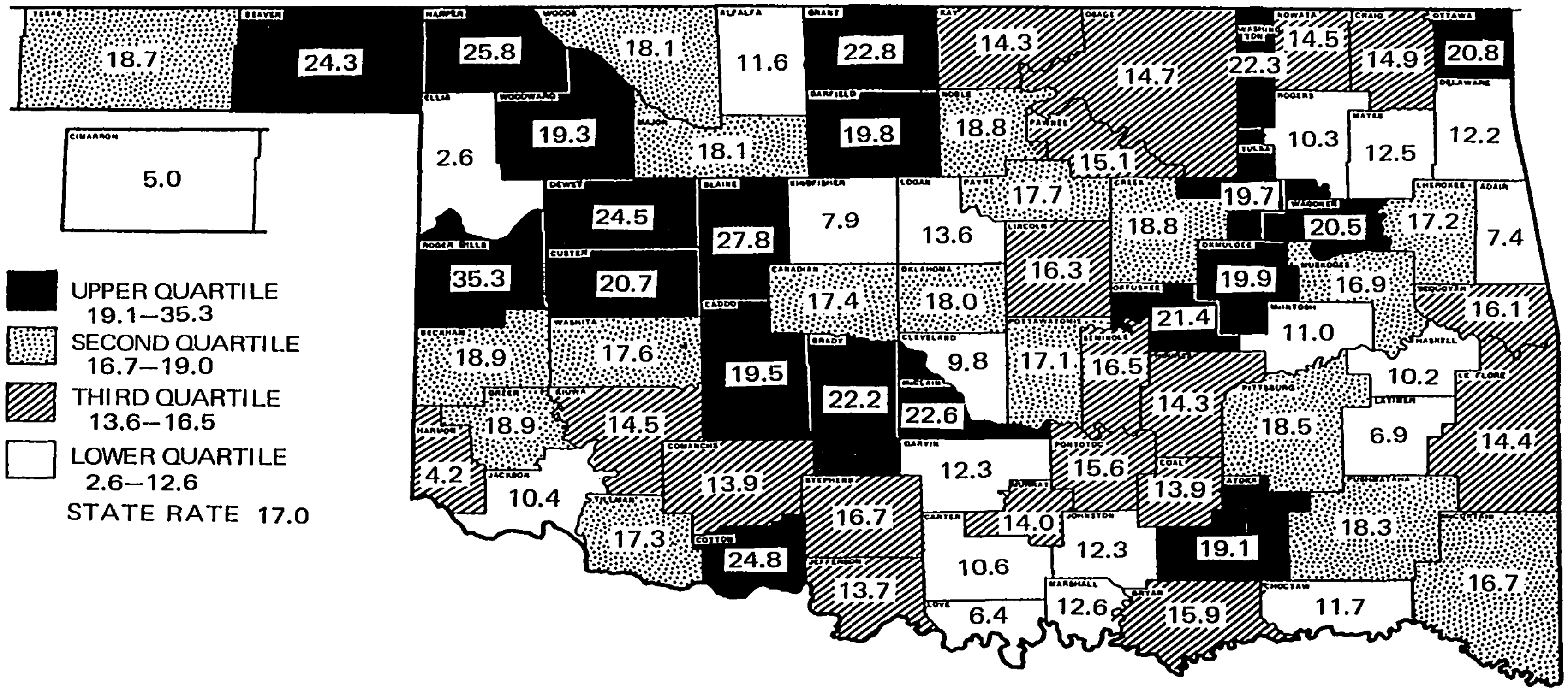


Figure 7. Cancer of the Large Intestine and Rectum (153–154), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

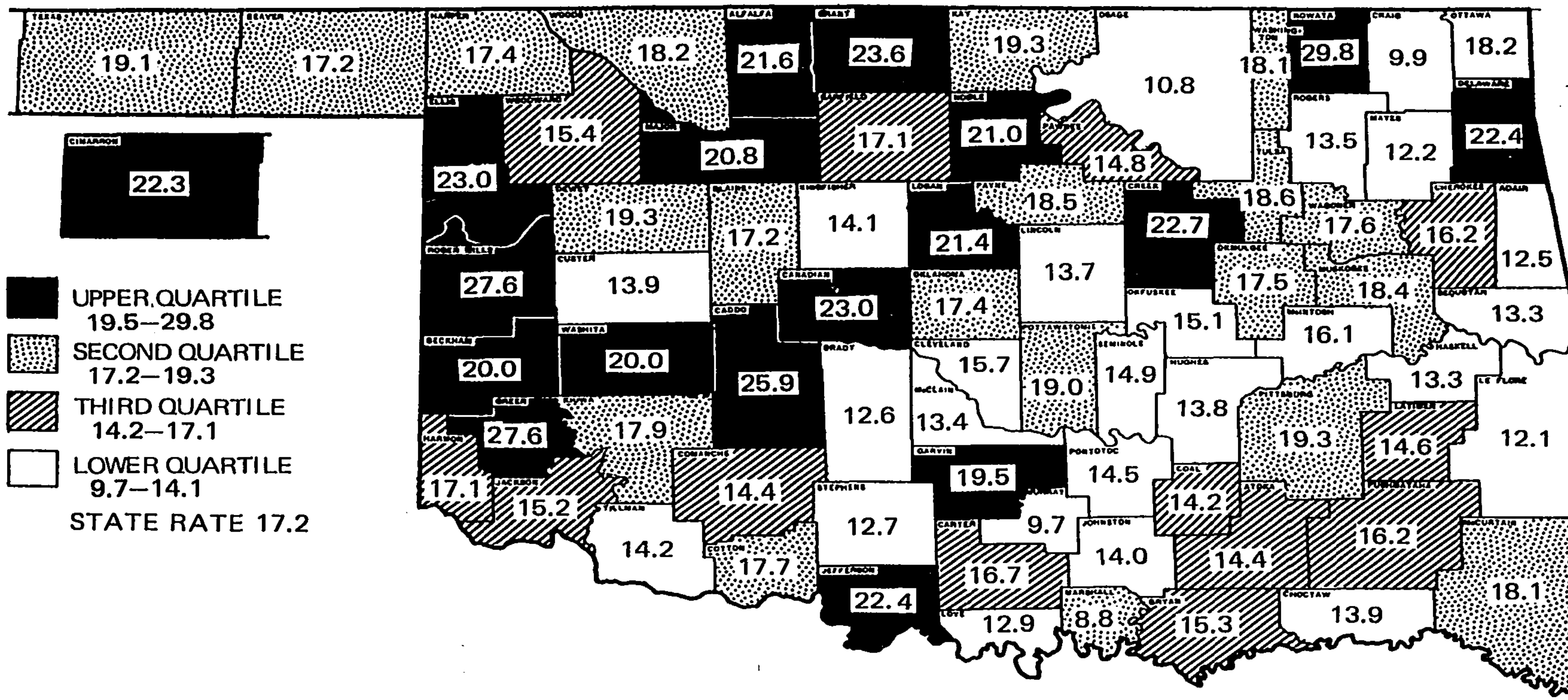


Figure 8. Cancer of the Large Intestine and Rectum (153–154), White Females.

for the nonwhite males (Table 7). The white male average deaths show a high death rate area located in the northeastern counties (Fig. 9), while mortality for the white female shows the highest death rate area to be in the eastern counties (Fig. 10).

Cancer of the pancreas (ISC 157) mortality shows no change with time among the white population of Oklahoma, but a slight increase for the nonwhites. Males experience higher adjusted mortality than do females (Table 8). The geographic distribution of high death rates among the white males favors the southwestern counties (Fig. 11), while the white female rates show a high cluster area for the western and south central counties (Fig. 12).

Cancers of the nose, cavities, and sinuses (ISC 160) show a slight increase for all age groups (Table 9). The rate for cancer of the larynx (ISC 161) remained stable among the white males and increased among the nonwhite males (Table 10). As for other cancer of the respiratory system, one of the most marked changes has been the increase in mortality from trachea, bronchus and lung cancers (ISC 162-3) for white males and females. It is interesting to note that a peak is reached at age 65-74 for male age specific rates after which a decline is reported. The white male adjusted rates exceed those of the white females by six times. Among the nonwhites a fourfold increase is observed for the males (Table 11). The geographic distribution of high age adjusted mortality favors in an obvious way the northeastern counties for the white males (Fig. 13) and the east central counties for the white females (Fig. 14). Cancer of the mediastinum and thoracic cavities (ISC 164-165) also indicate a slight increase with time. The males experienced higher age-

TABLE 7

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE LIVER (155-156)

Oklahoma: 1956-61, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.9	0.0	0.9	0.0
5-14	0.0	0.0	0.0	0.0
15-24	1.9	0.0	0.0	0.7
25-34	1.5	2.5	2.2	0.0
35-44	6.0	3.9	10.9	2.9
45-54	29.4	29.1	27.3	14.5
55-64	78.4	71.1	59.1	47.1
65-74	143.6	171.8	154.8	125.4
75+	307.9	305.8	318.0	235.5
AADR*	32.2	32.7	31.7	23.0

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	9.8	7.6	7.9
35-44	0.0	30.5	24.0	16.7
45-54	39.9	120.0	52.7	25.4
55-64	170.1	226.6	102.1	100.5
65-74	131.6	427.3	173.1	309.9
75+	181.8	533.3	327.6	346.5
AADR*	35.2	86.4	42.3	47.6

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

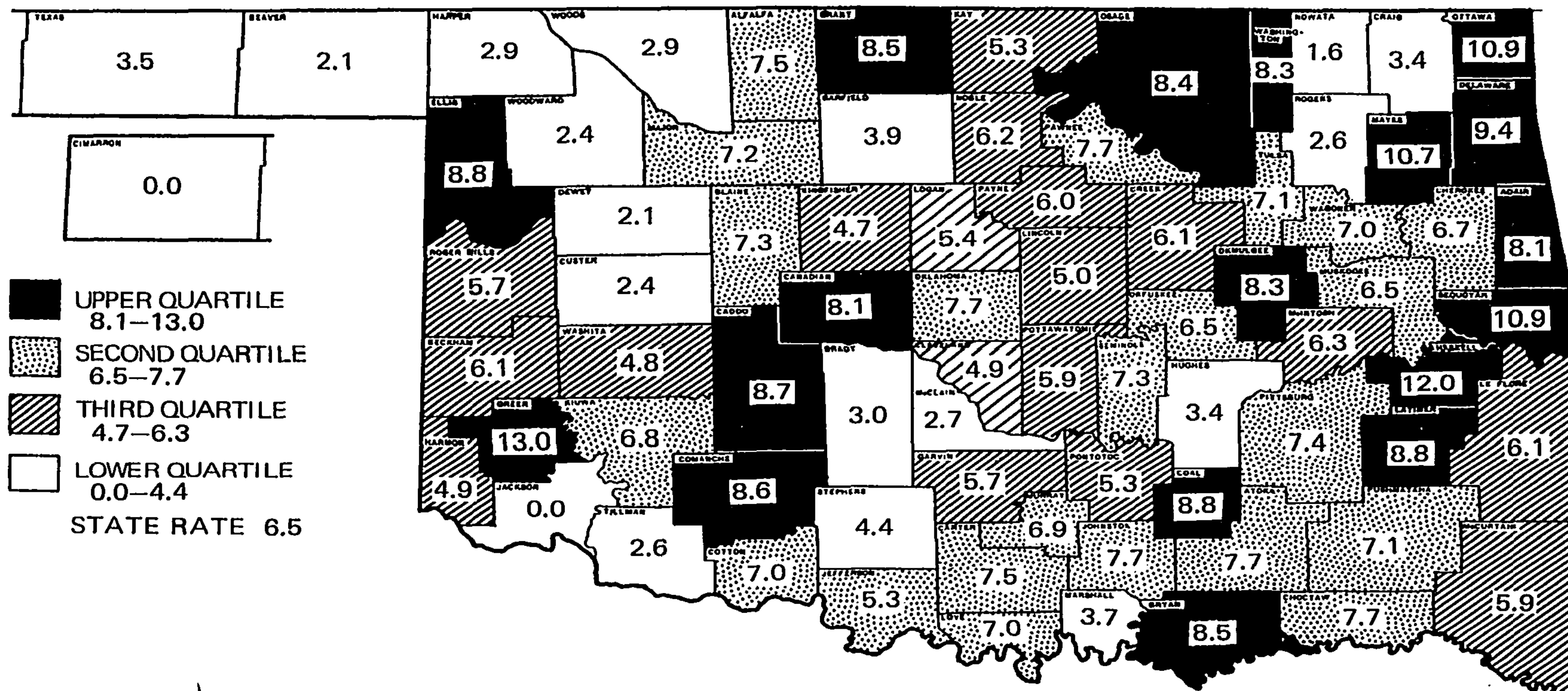


Figure 9. Cancer of the Liver (155–156), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

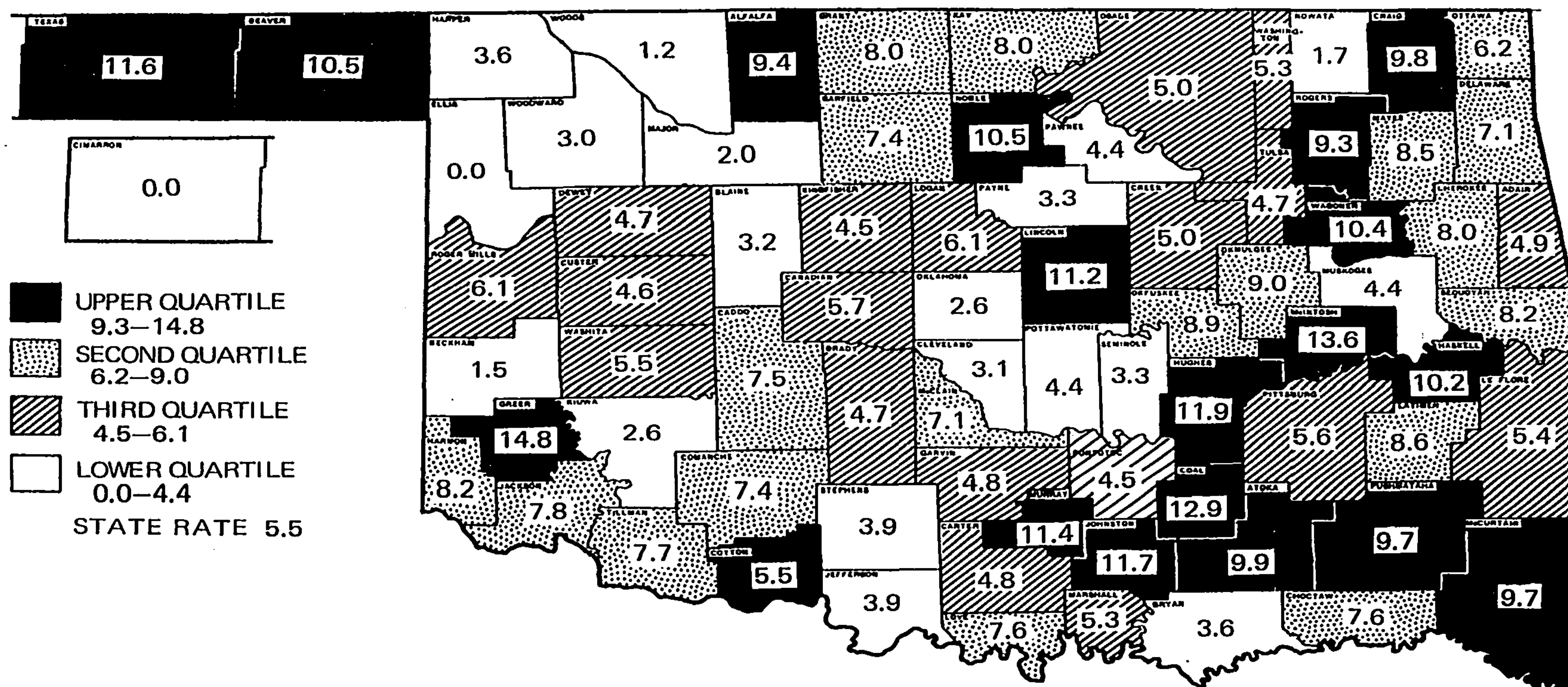


Figure 10. Cancer of the Liver (155–156), White Females.

TABLE 8

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE PANCREAS (157)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.6	0.0	0.0	0.0
25-34	4.6	1.6	0.7	0.8
35-44	11.4	7.8	7.3	2.9
45-54	39.5	39.7	17.7	19.8
55-64	140.7	133.1	64.1	63.8
65-74	256.7	247.7	156.1	139.9
75+	413.3	388.6	248.9	303.0
AADR*	50.9	47.9	27.9	28.5

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	7.6	0.0
35-44	9.5	0.0	8.0	16.7
45-54	59.8	30.0	26.3	16.9
55-64	121.5	124.6	102.1	110.6
65-74	197.5	379.8	141.6	132.6
75+	90.9	400.0	178.7	297.0
AADR*	35.2	53.8	29.8	33.4

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

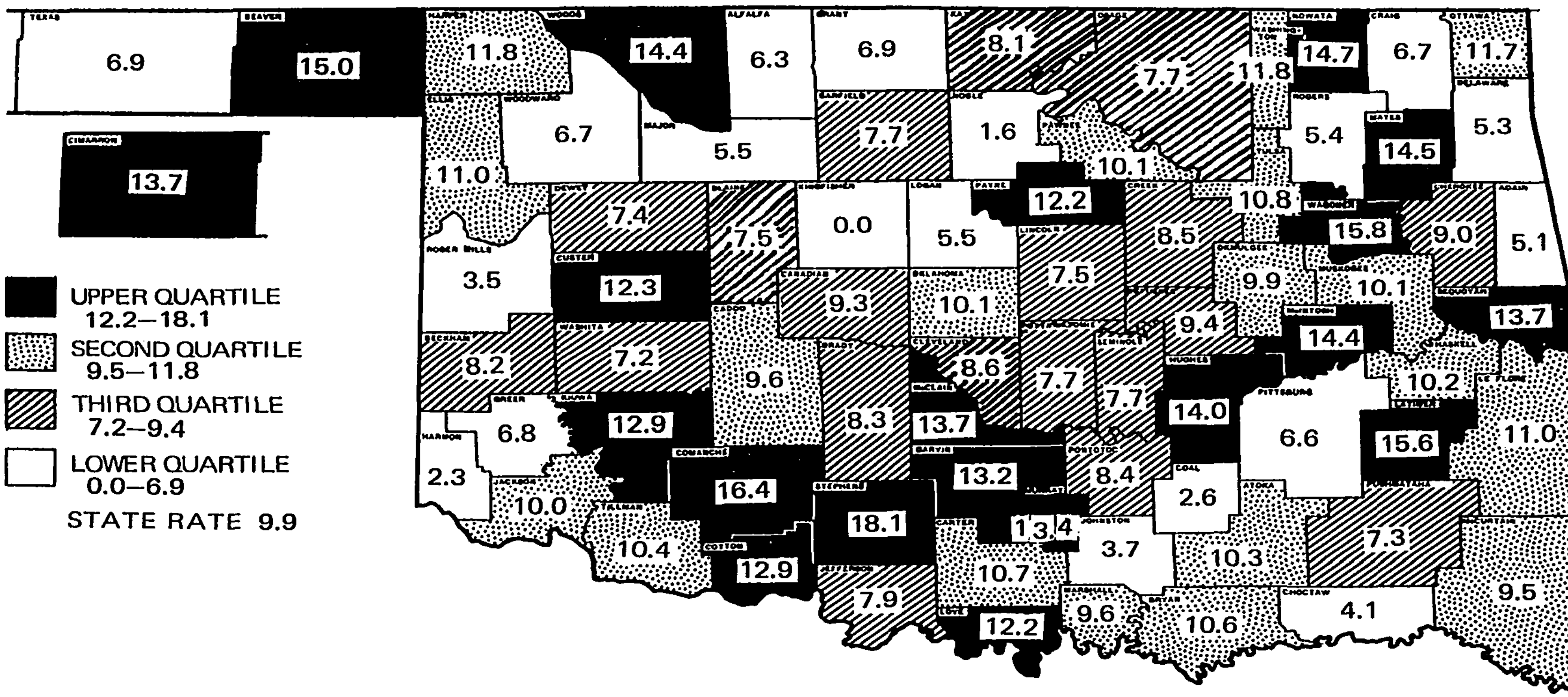


Figure 11. Cancer of the Pancreas (157), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

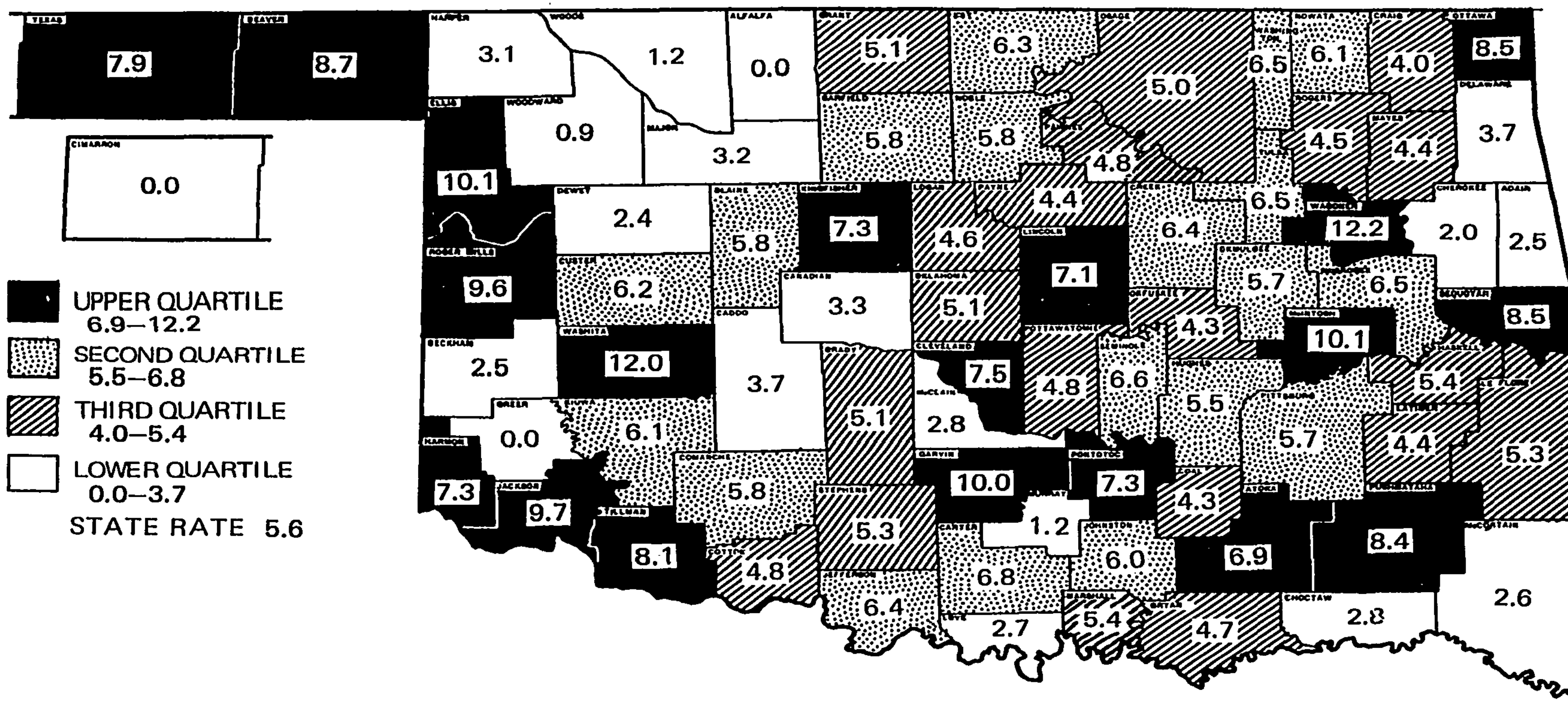


Figure 12. Cancer of the Pancreas (157), White Females.

TABLE 9

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF NOSE, CAVITIES AND SINUSES (160)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.4	0.0	0.0
15-24	0.0	0.0	0.0	1.4
25-34	0.0	0.0	0.0	0.0
35-44	0.7	0.7	0.0	0.7
45-54	3.3	4.0	0.8	1.5
55-64	3.2	6.0	3.0	1.8
65-74	4.5	22.9	6.6	4.8
75+	13.8	22.5	13.8	17.3
AADR*	1.5	3.4	1.2	1.5

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	0.0	0.0	0.0
45-54	0.0	0.0	0.0	8.4
55-64	12.1	11.3	0.0	20.1
65-74	0.0	15.8	0.0	14.7
75+	0.0	26.6	0.0	0.0
AADR*	1.1	3.0	0.0	3.7

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 10

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE LARYNX (161)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	0.0	0.0	0.0
45-54	14.3	7.2	1.6	0.7
55-64	30.0	37.6	3.0	0.9
64-74	44.3	50.1	2.6	6.0
75+	58.2	47.6	23.0	5.7
AADR*	9.3	9.2	1.4	0.7

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	0.0	0.0	0.0
45-54	9.9	30.0	0.0	0.0
55-64	0.0	45.3	0.0	0.0
65-74	49.3	47.4	15.7	0.0
75+	60.6	53.3	0.0	0.0
AADR*	6.5	12.6	1.0	0.0

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 11

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE LUNG, BRONCHUS AND TRACHEA (162-163)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.9	0.9	0.0
5-14	0.0	0.0	0.5	0.0
15-24	2.6	0.0	0.6	0.7
25-34	8.4	13.4	2.9	2.4
35-44	54.0	57.7	11.7	13.4
45-54	238.1	278.0	33.0	53.4
55-64	617.5	747.9	64.1	90.6
65-74	833.0	1117.1	110.8	130.2
75+	674.1	832.4	216.6	254.8
AADR*	170.2	211.6	26.7	34.1

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	6.4	0.0	0.0
25-34	9.2	19.7	7.6	0.0
35-44	76.6	81.5	0.0	16.7
45-54	179.6	200.1	52.7	16.9
55-64	388.9	441.9	102.1	90.5
65-74	427.9	617.2	110.1	132.8
75+	424.2	373.3	208.5	222.7
AADR*	109.9	130.3	30.9	28.9

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

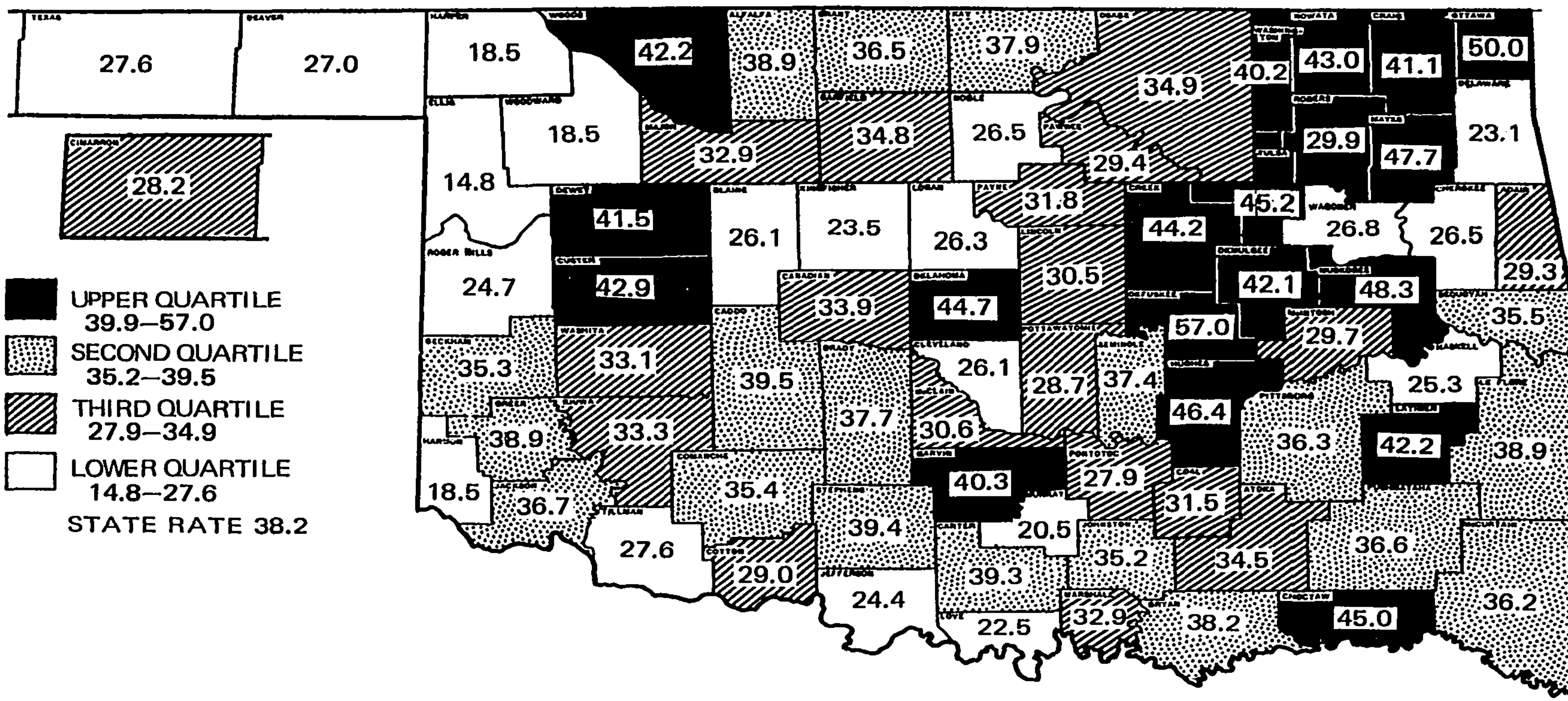


Figure 13. Cancer of the Lung, Bronchus and Trachea (162–163), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

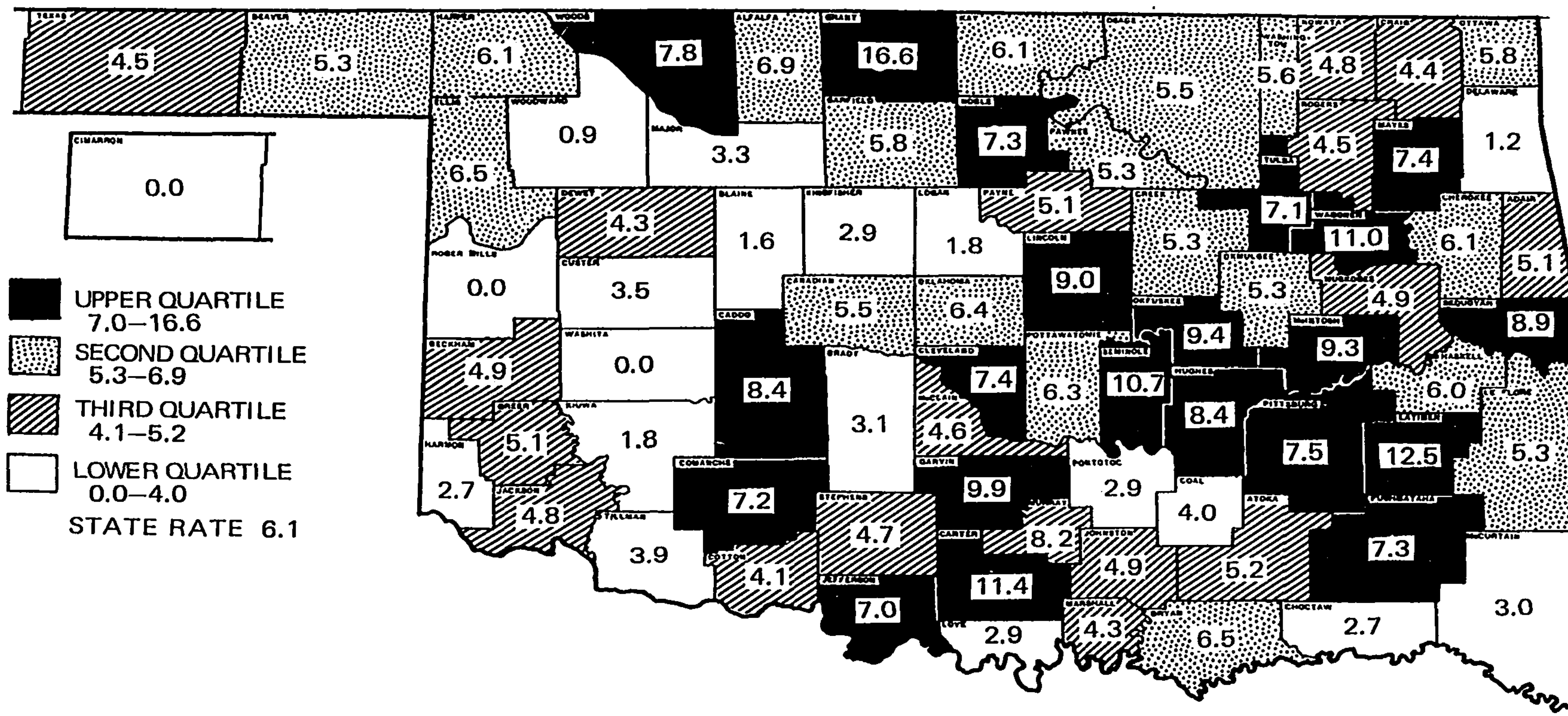


Figure 14. Cancer of the Lung, Bronchus and Trachea (162–163), White Females.

adjusted mortality than their female counterparts (Table 12).

Cancer of the breast (ISC 170) age-adjusted death rates remained stable during the ten year period studied for the white females with a slight increase among the nonwhite females. Few Oklahoma males died from breast cancer (Table 13). The disease shows the highest death rates to be located in the northwestern and northeastern counties; otherwise the geographic distribution appears to be random (Fig. 15).

The age-sex-race specific and adjusted death rates for cancer of the cervix uteri (ISC 171) among the Oklahoma females shows a decreasing trend, with the nonwhites experiencing much higher rates than the white females (Table 14). The geographic distribution of adjusted mortality by county for cancer of the cervix uteri favors in an obvious way the eastern counties of the state for white females (Fig. 16).

Deaths in Oklahoma for cancer of the corpus uteri, uterus and others of female organs (ISC 172-174, 176) have decreased for the white female and all age groups for the nonwhite females except for the age group 35-44 and 75 and over where an increase is indicated. Nonwhite females experienced higher rates than whites (Table 15).

Cancer of the ovary, fallopian tube, and broad ligament (ISC 175) mortality remained stable for the Oklahoma white females, but decreased among the nonwhites. It is of interest to report that the rates for both whites and nonwhites were similar (Table 16). The geographic distribution shows a high cluster area in the east central and northwestern counties (Fig. 17).

The age-sex-race specific and adjusted death rates for cancer of the prostate gland (ISC 177) shows an increasing trend for the nonwhite

TABLE 12

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE MEDIASTINUM AND THORACIC CAVITIES (164-165)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.9	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.6	0.0	0.0
25-34	0.7	1.6	0.0	0.0
35-44	3.0	2.3	0.0	0.7
45-54	2.5	7.2	1.6	1.5
55-64	13.9	22.3	0.0	4.6
65-74	12.2	31.5	2.6	19.2
75+	16.6	47.6	18.4	23.1
AADR*	3.4	7.1	1.1	2.7

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	0.0	0.0	8.3
45-54	0.0	0.0	0.0	8.4
55-64	0.0	0.0	0.0	0.0
65-74	0.0	15.8	0.0	29.5
75+	0.0	0.0	29.7	49.5
AADR*	0.0	1.0	1.0	5.7

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 13

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE BREAST (170)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.7	0.0
25-34	0.0	0.0	18.6	17.4
35-44	0.0	0.0	86.4	83.0
45-54	0.8	0.8	234.5	197.0
55-64	1.1	1.0	266.7	274.7
65-74	3.1	1.4	329.8	343.7
75+	11.0	7.5	431.7	492.2
AADR*	0.8	0.6	101.5	100.4

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	6.3	0.0
25-34	0.0	0.0	46.1	15.8
35-44	0.0	0.0	96.1	126.0
45-54	0.0	0.0	237.2	110.1
55-64	0.0	0.0	226.9	301.8
65-74	0.0	0.0	157.4	324.7
75+	0.0	26.7	327.7	618.8
AADR*	0.0	1.0	88.7	101.3

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

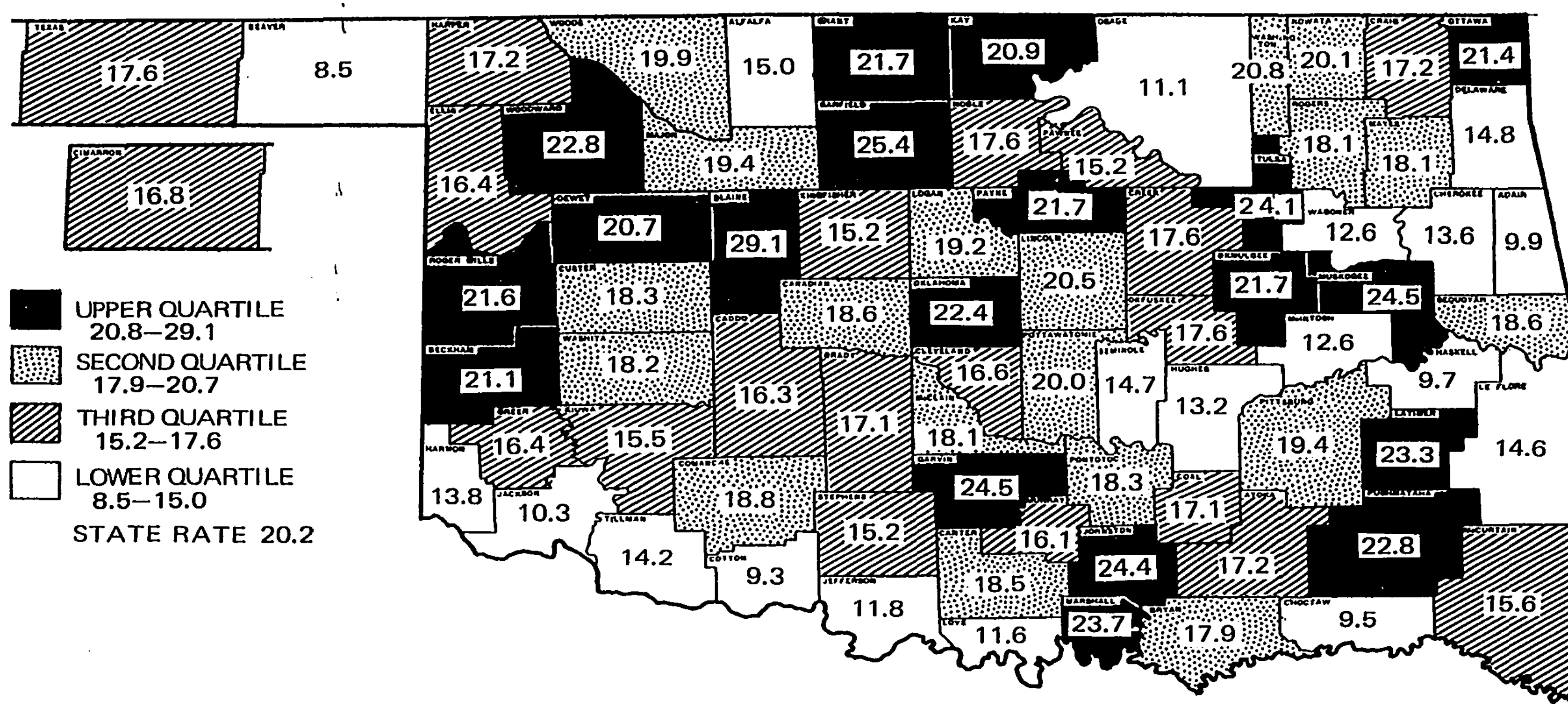


Figure 15. Cancer of the Breast (170), White Females.

TABLE 14

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE CERVIX UTERI (171)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Female		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	2.7	0.0	0.0	0.0
25-34	17.8	14.8	46.1	63.3
35-44	58.5	37.3	80.0	117.4
45-54	86.2	67.9	202.0	160.9
55-64	118.3	86.9	385.7	211.2
64-74	122.8	103.7	377.7	177.0
75+	161.3	148.6	565.9	222.7
AADR*	44.4	34.3	119.0	79.7

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

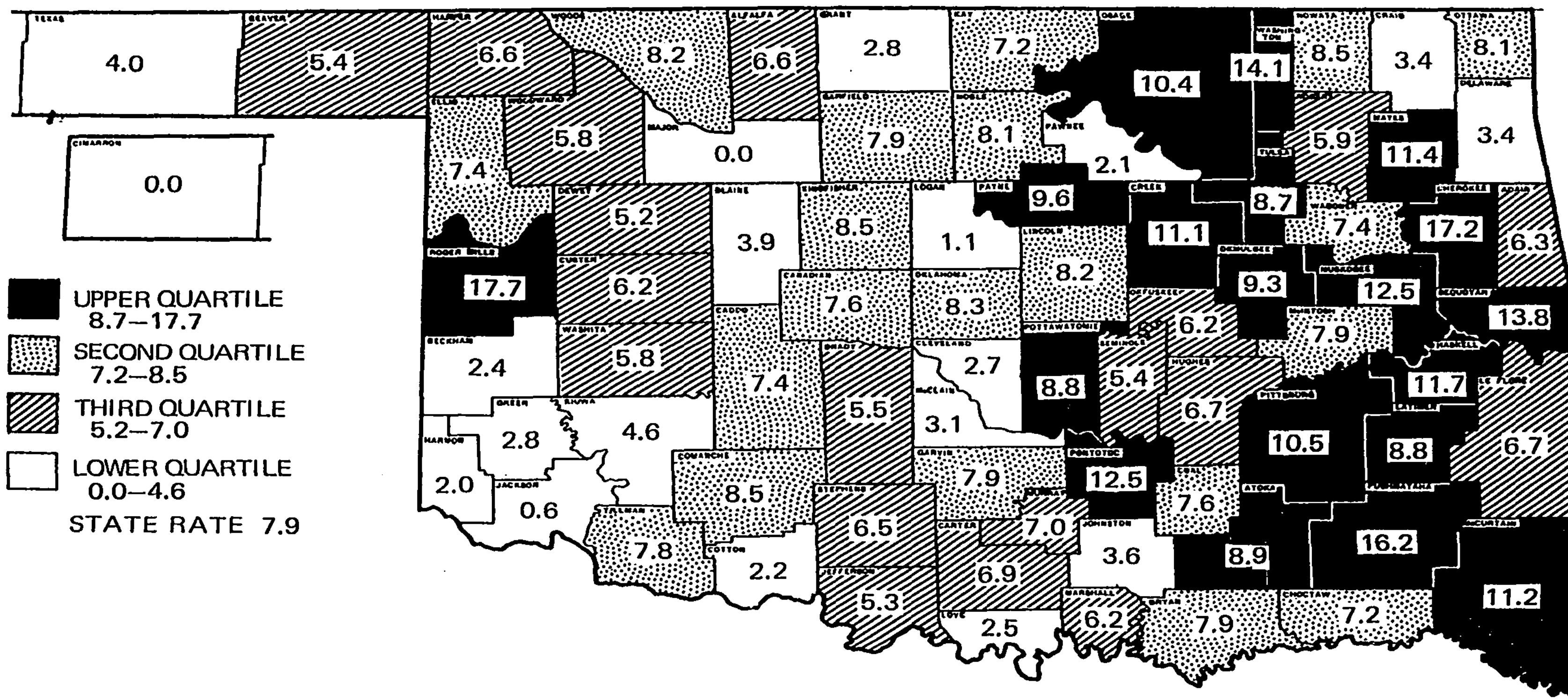


Figure 16. Cancer of the Cervix Uteri (171), White Females.

TABLE 15

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CORPUS UTERI, UTERUS AND OTHERS OF FEMALE ORGAN (172-174, 176)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Female 1956-60	White Female 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.7	6.3	0.0
25-34	3.7	3.3	15.3	0.0
35-44	18.3	9.7	24.0	41.9
45-54	40.2	22.1	131.7	67.7
55-64	108.3	75.8	294.9	150.8
65-74	177.5	145.9	346.2	221.3
75+	308.8	249.0	238.3	445.5
AADR*	39.8	29.6	78.9	57.2

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 16

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE OVARY, FALLOPIAN TUBE AND BROAD LIGAMENT (175)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Female		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	1.5	0.9	0.0	0.0
15-24	4.0	2.1	0.0	19.4
25-34	5.2	4.1	15.3	0.0
35-44	24.1	22.4	32.0	16.7
45-54	82.9	64.8	61.4	33.8
55-64	107.2	121.1	158.8	160.9
65-74	126.8	139.9	173.1	118.0
75+	131.3	156.3	89.3	123.7
AADR*	36.8	37.0	41.8	35.6

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

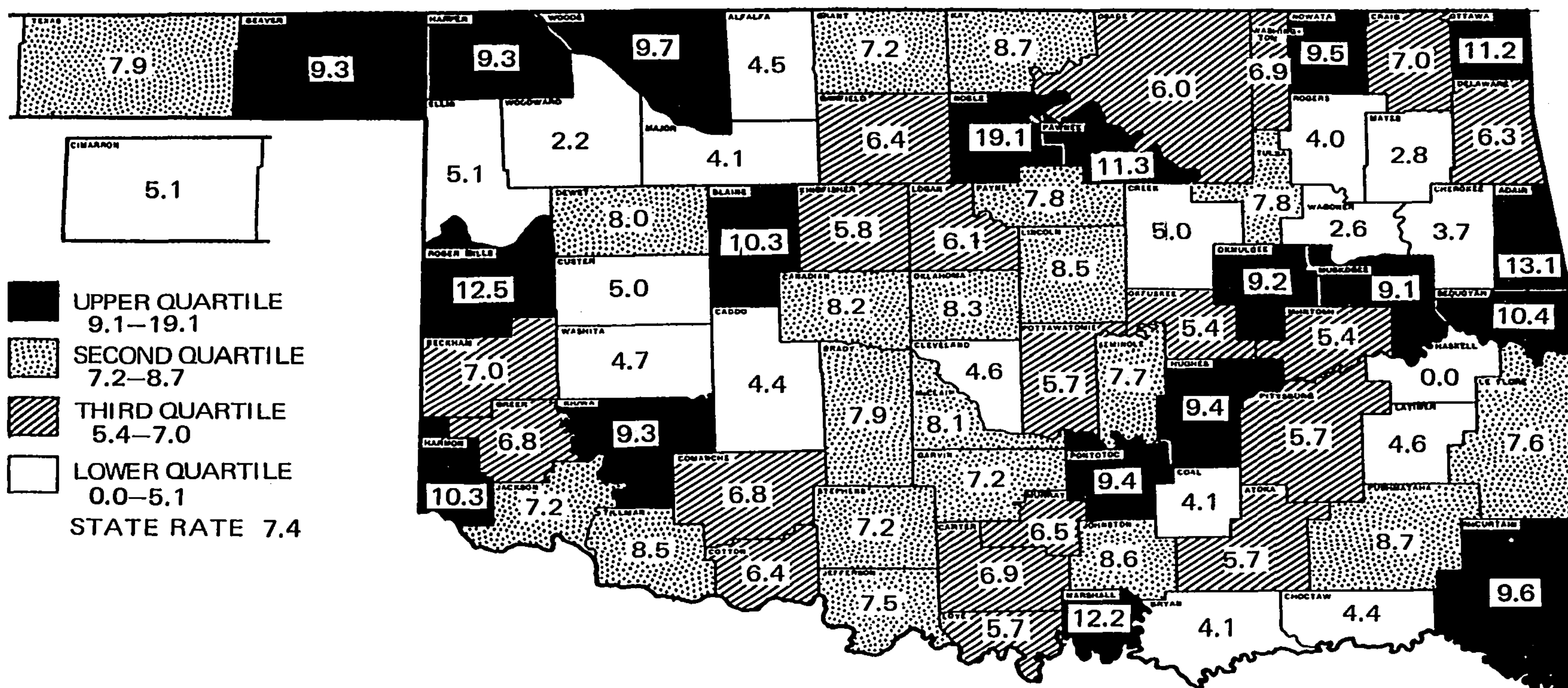


Figure 17. Cancer of the Ovary, Fallopian Tube and Broad Ligament (175), White Females.

Oklahoma males, but a stable trend for the white males. Higher rates are reported for the nonwhite over the white males (Table 17). The geographic distribution by county of residence indicates a high cluster area in the northwestern and east central counties for the white males and shows a low cluster area for the west central and eastern counties of the state (Fig. 18). Rates for cancer of the testis and others of male organs (ISC 178-9) shows a stable trend, with the whites experiencing higher rates than the nonwhites (Table 18).

As for cancer of the kidney (ISC 180), the age-sex-race specific and adjusted death rates show a slight but consistent increase over the two five year periods for the white and nonwhite males except for the age group 35-44, and 55-64 among the nonwhite males and the less than five years of age among the white males. Rates for the Oklahoma white female show a slight increase while those of the nonwhite female show a slight decrease (Table 19). The white male geographic distribution of cancer of the kidney appears to be random (Fig. 19), while two high rate areas are indicated for the white females; one in the east central and another in the west central (Fig. 20).

Bladder cancer (ISC 181) mortality shows trends similar to those of cancer of the kidney (ISC 180), a slight increase in adjusted mortality for all four groups, with the male rates being higher than the female rates (Table 20). The white male geographic distribution of age-adjusted mortality shows the disease to be more prevalent in the north central counties of the state (Fig. 21), while for the white females, a random distribution is reported with one high rate area located in the south central counties (Fig. 22).

TABLE 17

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE PROSTATE (177)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		Non-White Male	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.9	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.7	0.0	0.0	0.0
45-54	10.0	17.8	9.9	30.0
55-64	76.2	93.4	218.7	237.9
65-74	496.7	474.0	888.8	680.5
75+	1603.5	1501.8	1636.3	2240.0
AADR*	98.1	95.4	137.5	149.9

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

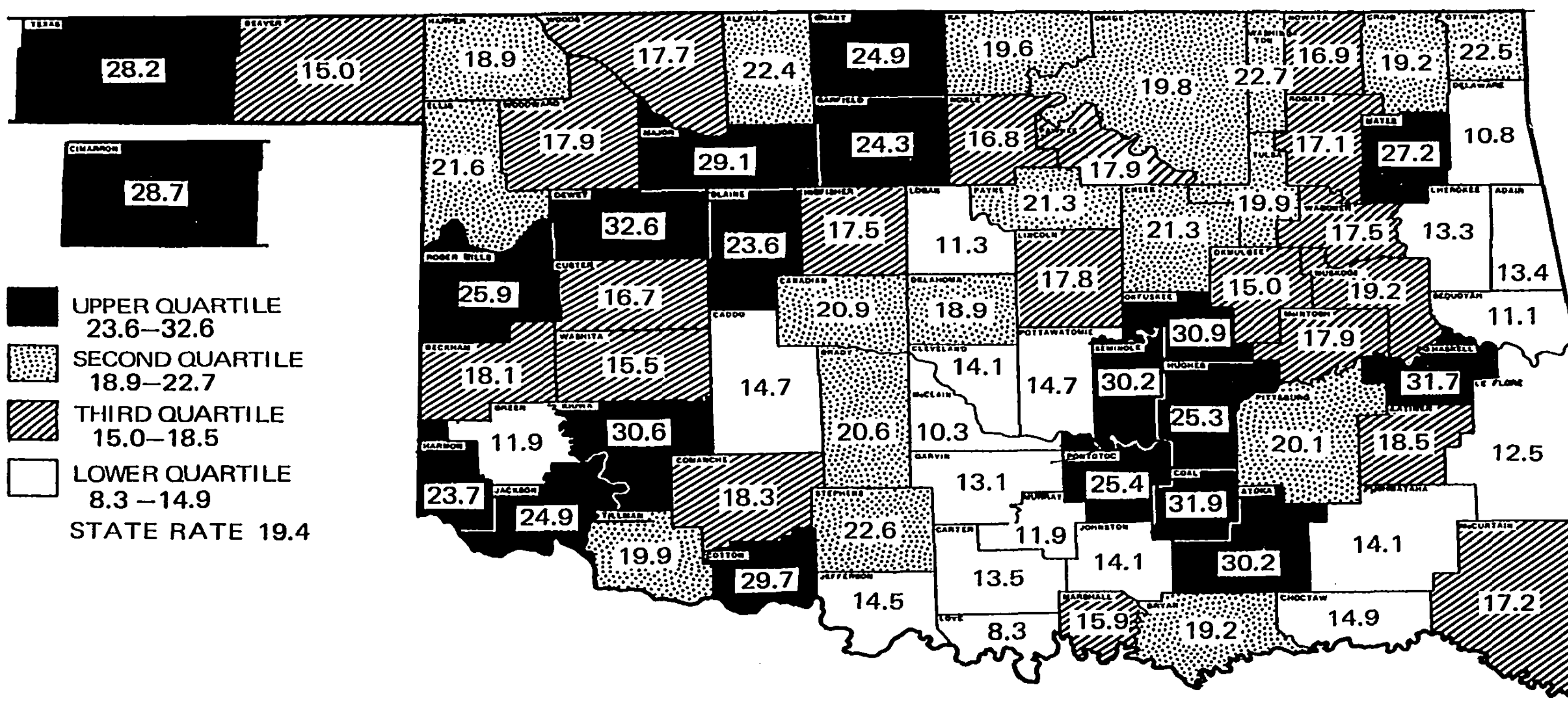


Figure 18. Cancer of the Prostate (177), White Males.

TABLE 18

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE TESTIS AND OTHERS OF MALE ORGAN (178-179)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		Non-White Male	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.9	0.0	0.0
5-14	0.4	0.4	0.0	0.0
15-24	3.9	5.9	0.0	0.0
25-34	10.0	7.5	9.2	0.0
35-44	5.3	7.0	0.0	0.0
45-54	4.2	5.6	9.9	0.0
55-64	8.5	5.0	0.0	0.0
65-74	10.6	14.3	0.0	31.6
75+	33.2	30.0	30.3	53.3
AADR*	5.6	5.9	3.3	3.9

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 19

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE KIDNEY (180)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	6.4	3.7	1.9	2.9
5-14	0.0	0.9	1.0	0.0
15-24	0.0	0.0	0.0	0.7
25-34	0.7	1.6	0.7	0.0
35-44	7.6	8.5	5.1	3.7
45-54	17.6	22.6	4.8	10.6
55-64	53.7	63.0	13.0	21.2
65-74	82.5	87.3	40.0	30.1
75+	83.0	105.3	66.8	92.6
AADR*	16.9	19.6	7.8	9.3

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	19.1	0.0	0.0	0.0
45-54	19.9	40.0	0.0	0.0
55-64	85.0	56.6	22.6	30.1
65-74	32.9	63.3	47.2	29.5
75+	90.9	133.3	59.5	49.5
AADR*	17.8	18.7	7.2	6.4

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

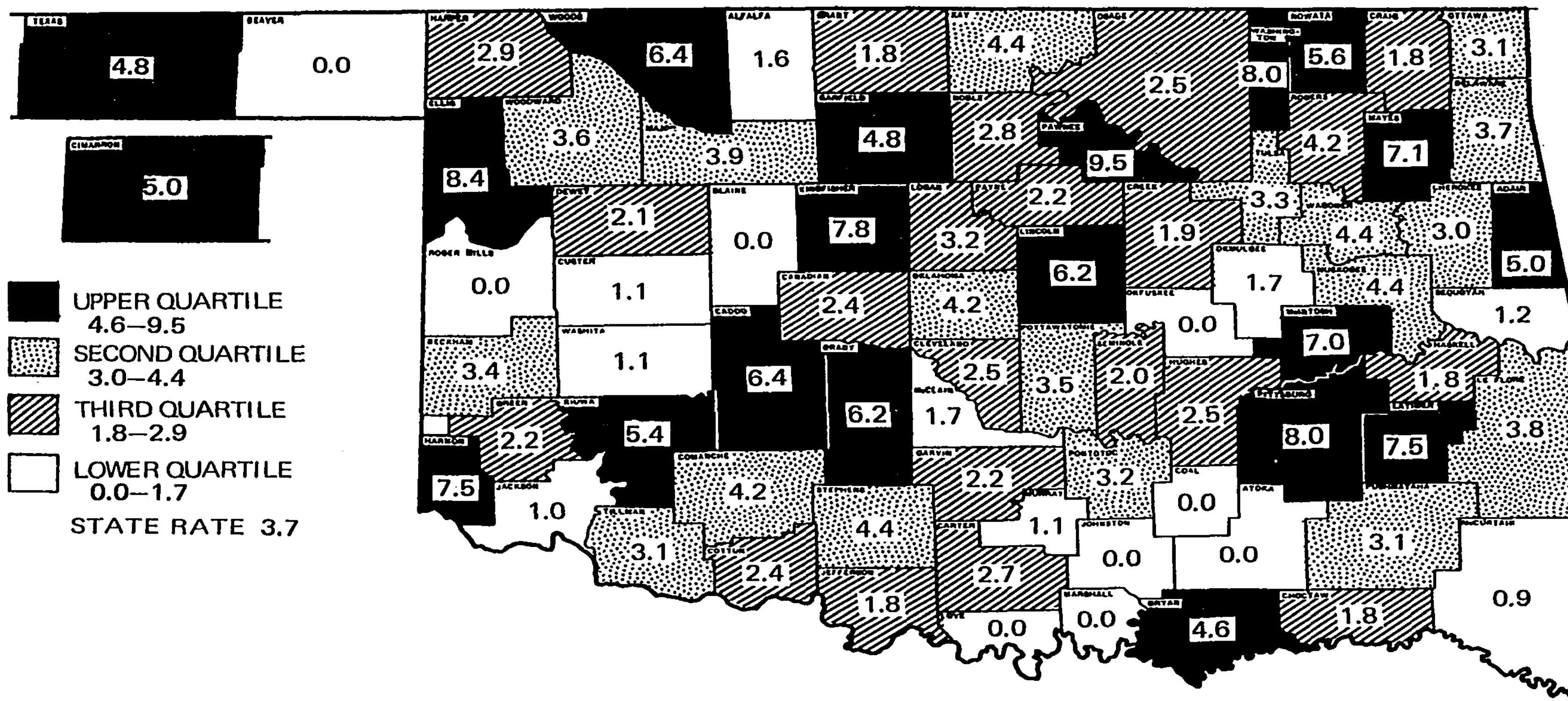


Figure 19. Cancer of the Kidney (180), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

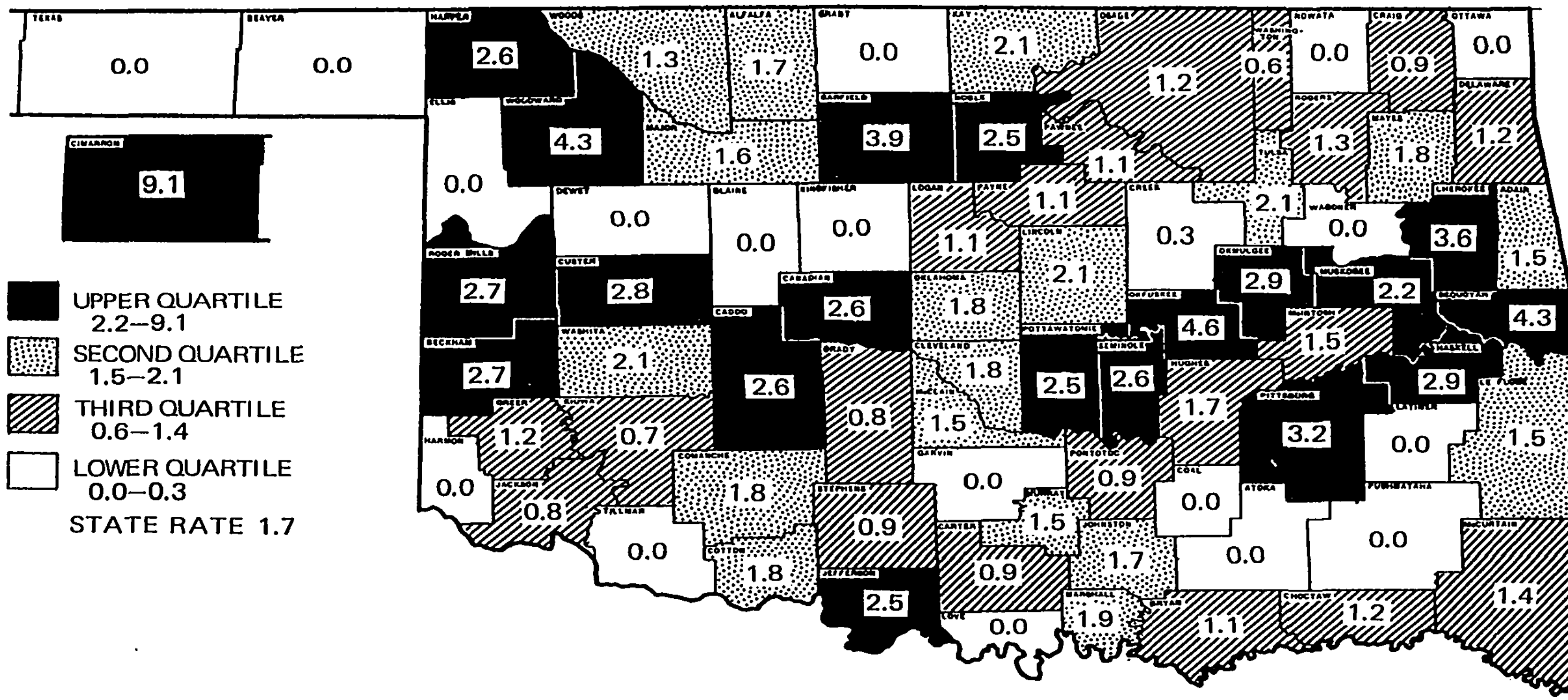


Figure 20. Cancer of the Kidney (180), White Females.

TABLE 20

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE BLADDER (181)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.9	0.0	0.0	0.1
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.7	0.0
35-44	0.7	1.5	1.4	2.2
45-54	14.3	12.1	5.6	7.6
55-64	49.4	69.1	17.0	24.9
65-74	132.9	147.5	46.7	43.4
75+	255.2	283.3	140.5	140.9
AADR*	24.1	27.6	10.5	11.3

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	10.1	0.0	0.0
45-54	19.9	10.0	0.0	8.4
55-64	60.7	90.6	45.3	20.1
65-74	49.3	110.7	78.7	118.0
75+	90.9	186.6	29.7	148.5
AADR*	14.3	24.5	10.2	15.7

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

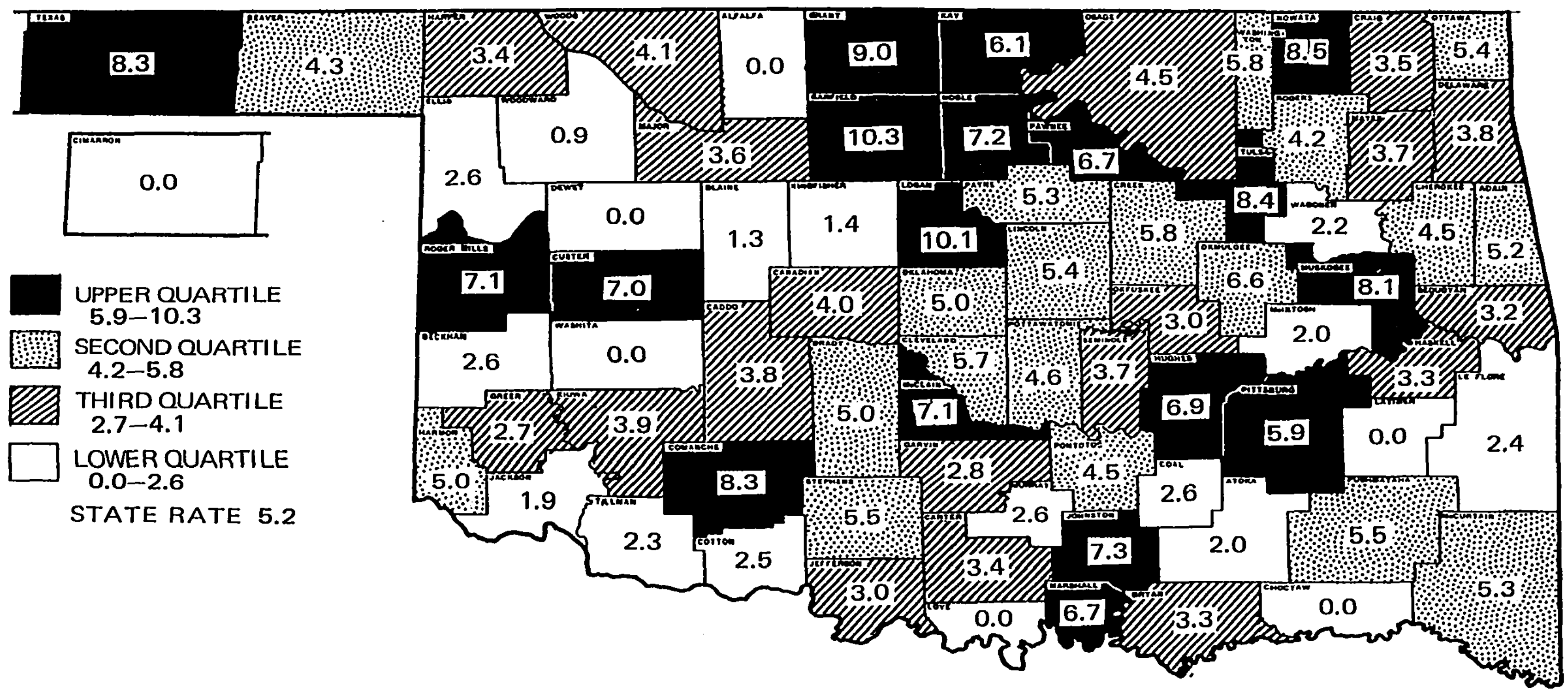


Figure 21. Cancer of the Bladder (181), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

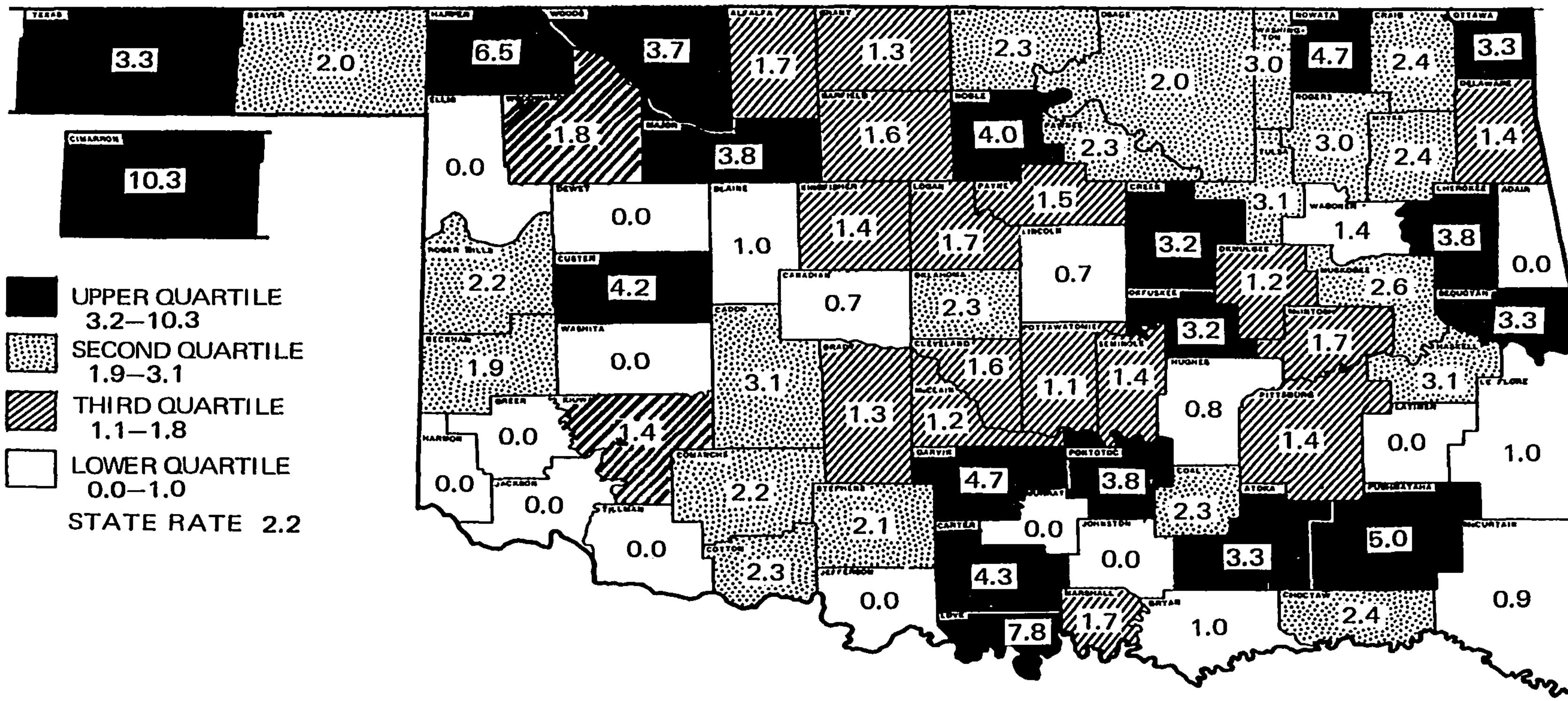


Figure 22. Cancer of the Bladder (181), White Females.

Mortality from cancer of the skin (ISC 190) shows a stable trend with slightly elevated male death rates over females, and whites over nonwhites (Table 21).

As for other cancers of the skin (ISC 191), a slight decrease is noticed among all groups for the two five year periods. The white males continue to experience a higher adjusted mortality than their female and nonwhite counterparts (Table 22). For the white male geographic distribution, several high mortality areas are indicated (Fig. 25). As for the white females, two cluster areas, one in the east central and another in the northwestern counties are noted (Fig. 26).

Too few deaths were reported for cancer of the eye (ISC 192) among Oklahomans to warrant interpretation (Table 23, Figs. 27, 28).

Mortality from cancer of the brain and nervous system (ISC 193) have remained stable over the two five year periods for the white population and the nonwhite males. An increase is reported for the nonwhite females. In general males experienced higher mortality than did females, and whites experienced a higher death rate than did nonwhites (Table 24). The white male geographic distribution favors the northwestern and southeastern counties of the state (Fig. 29), while that of the white females favors the southwestern and south central counties (Fig. 30).

The age-adjusted death rates for cancer of the thyroid gland (ISC 194) are too small to indicate definite trends. The data shows a slightly higher female adjusted mortality than males (Table 25). The geographic distribution shows highest mortality of the disease to be occurring across many counties from the Northeast to the Southwest (Fig. 31). Similar observations are noted for the white female data (Fig. 32). Cancer of the other endocrine glands shows slightly higher adjusted mortality

TABLE 21

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE SKIN (190)

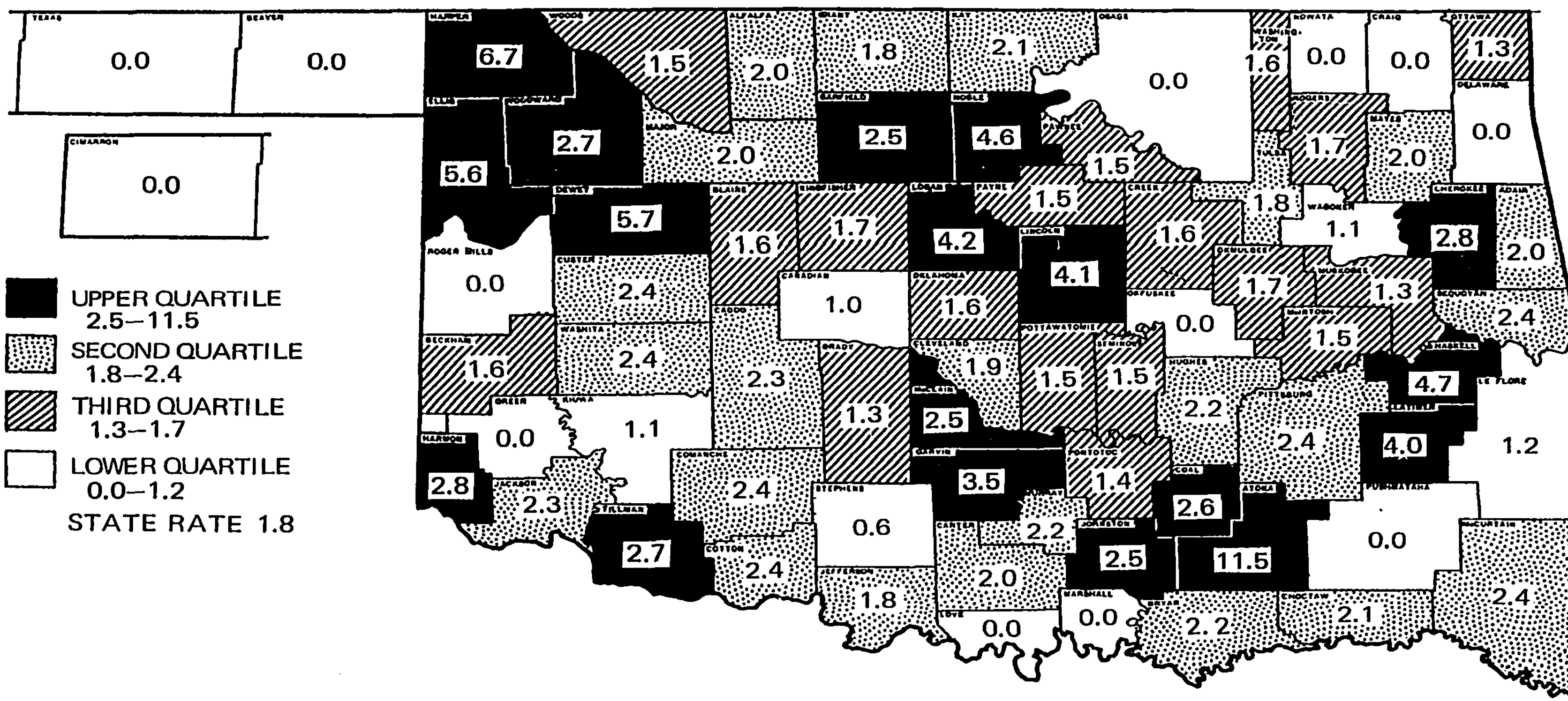
Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.9	0.0	0.0	0.0
5-14	0.4	0.4	0.0	0.4
15-24	1.3	0.6	0.0	0.7
25-34	2.3	5.0	3.7	9.0
35-44	10.6	14.8	10.9	2.9
45-54	18.5	15.3	16.1	8.3
55-64	18.2	20.3	13.0	16.6
65-74	16.7	30.0	6.6	19.2
75+	38.8	40.1	32.2	36.6
AADR*	8.2	9.6	6.4	6.6

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	0.0	0.0	0.0
45-54	9.9	0.0	0.0	0.0
55-64	0.0	0.0	0.0	0.0
65-74	32.9	0.0	0.0	0.0
75+	30.3	26.6	0.0	0.0
AADR*	4.3	0.9	0.0	0.0

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population



UPPER QUARTILE 2.5–11.5
SECOND QUARTILE 1.8–2.4
THIRD QUARTILE 1.3–1.7
LOWER QUARTILE 0.0–1.2
STATE RATE 1.8

Figure 23. Cancer of the Skin (190), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

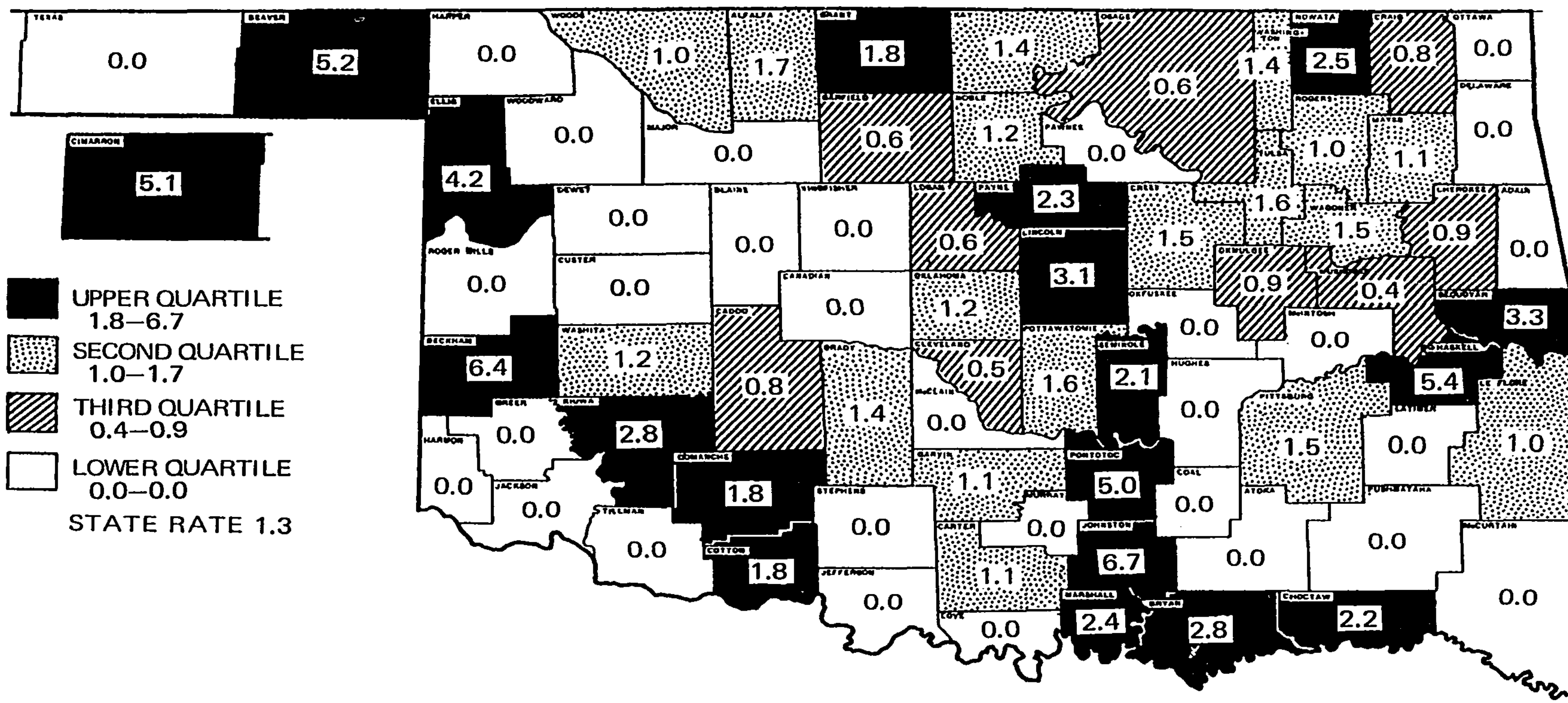


Figure 24. Cancer of the Skin (190), White Females.

TABLE 22

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF OTHERS OF SKIN (191)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.8	0.0	1.6
35-44	2.2	0.7	1.4	2.2
45-54	8.4	5.6	3.2	2.2
55-64	27.9	26.4	11.0	6.4
65-74	45.8	42.9	24.0	16.8
75+	210.8	157.9	112.9	81.0
AADR*	14.3	11.7	7.1	5.3

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.5	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	7.6	0.0
35-44	9.5	0.0	0.0	0.0
45-54	9.9	0.0	8.7	8.4
55-64	12.1	11.3	0.0	10.0
65-74	16.4	0.0	0.0	0.0
75+	90.9	0.0	59.5	24.7
AADR*	7.7	1.7	4.0	2.7

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

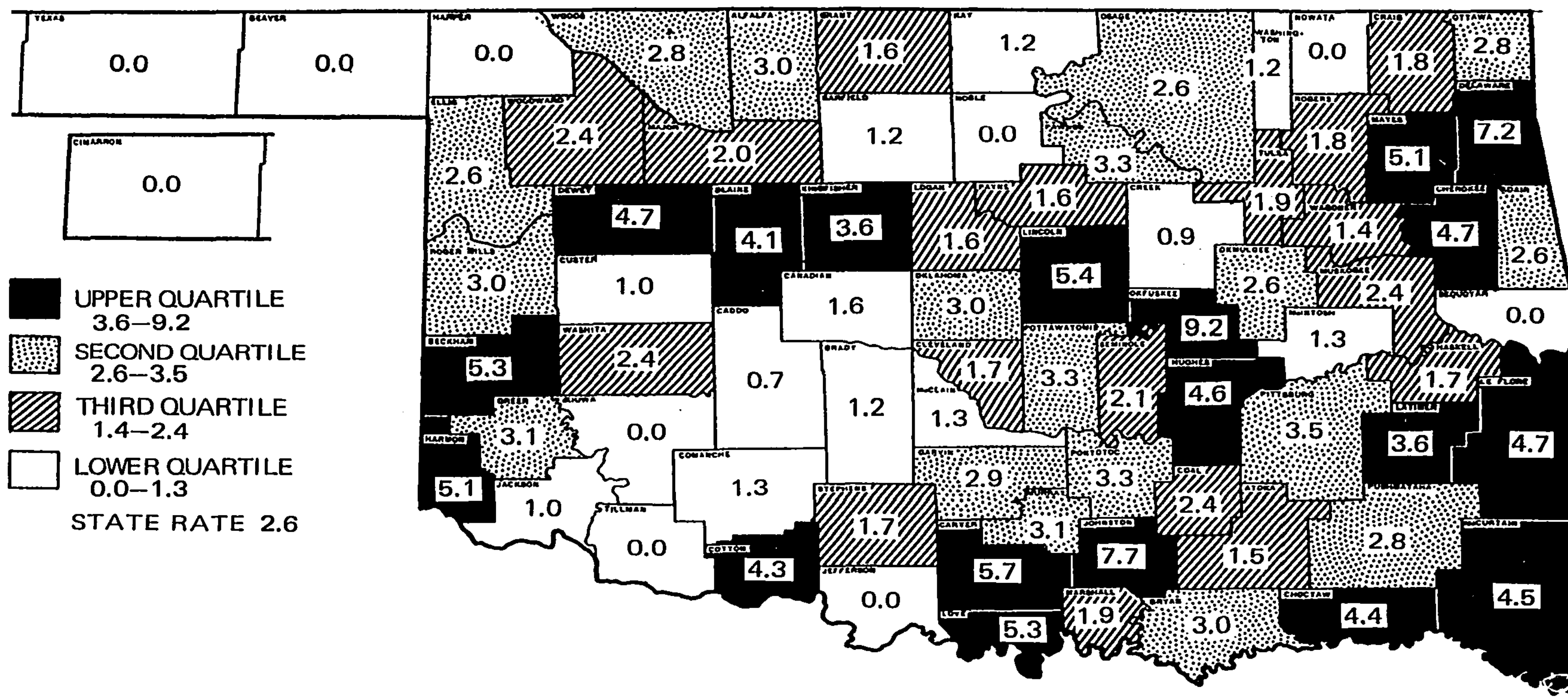


Figure 25. Cancer of Others of Skin (191), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

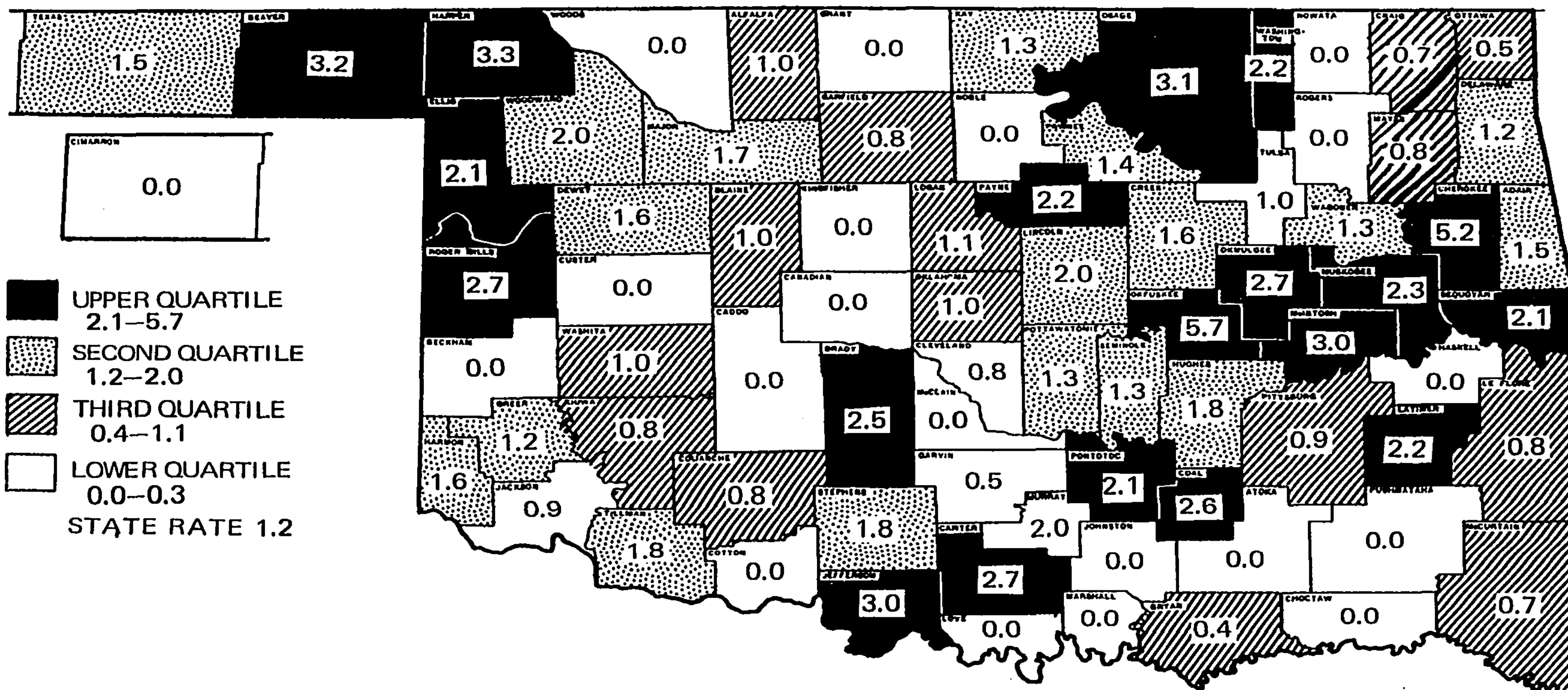


Figure 26. Cancer of Others of Skin (191), White Females.

TABLE 23

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE EYE (192)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.9	0.0	0.0	1.9
5-14	0.4	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	0.0	0.7	0.7
45-54	0.0	1.6	0.0	1.5
55-64	3.2	2.0	2.0	3.6
65-74	9.1	7.1	2.6	2.4
75+	13.8	10.0	9.2	5.7
AADR*	1.5	1.1	0.7	1.1

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

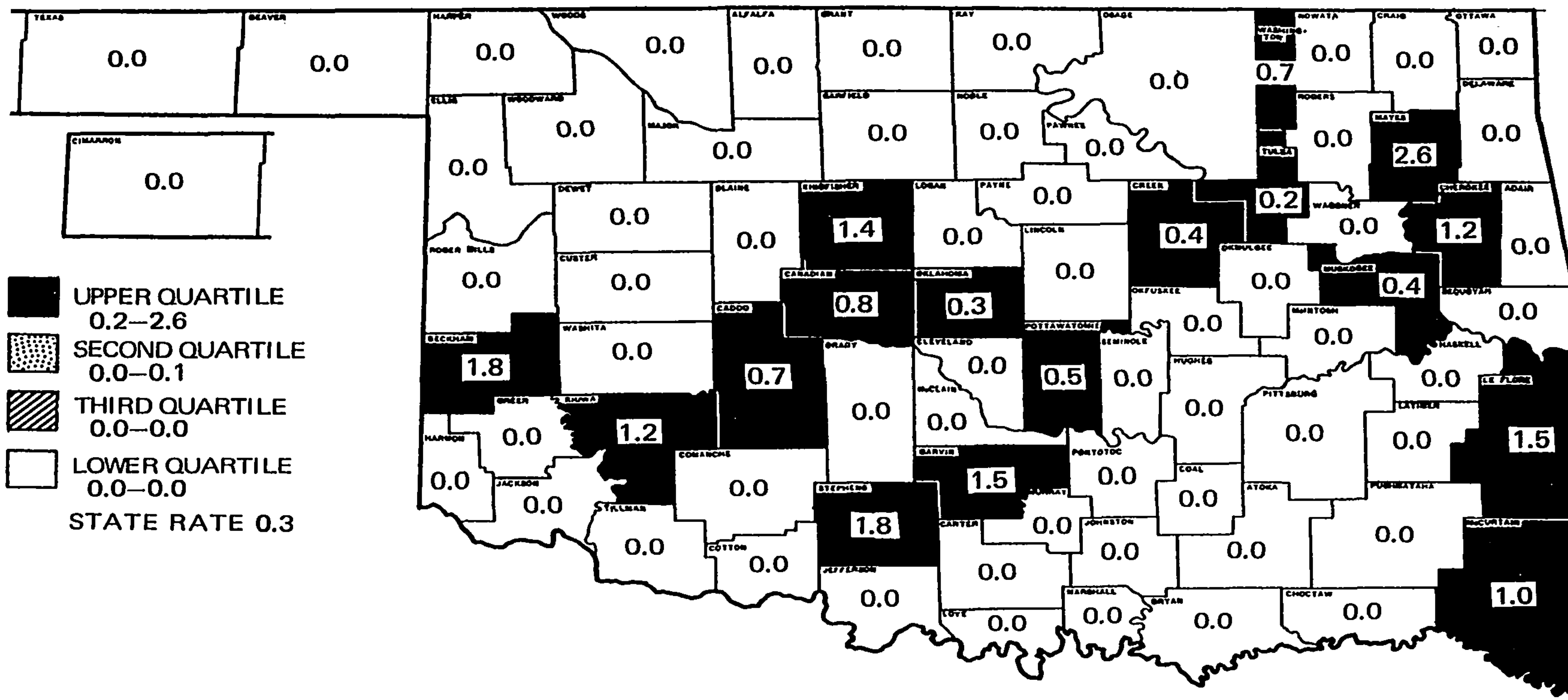


Figure 27. Cancer of the Eye (192), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

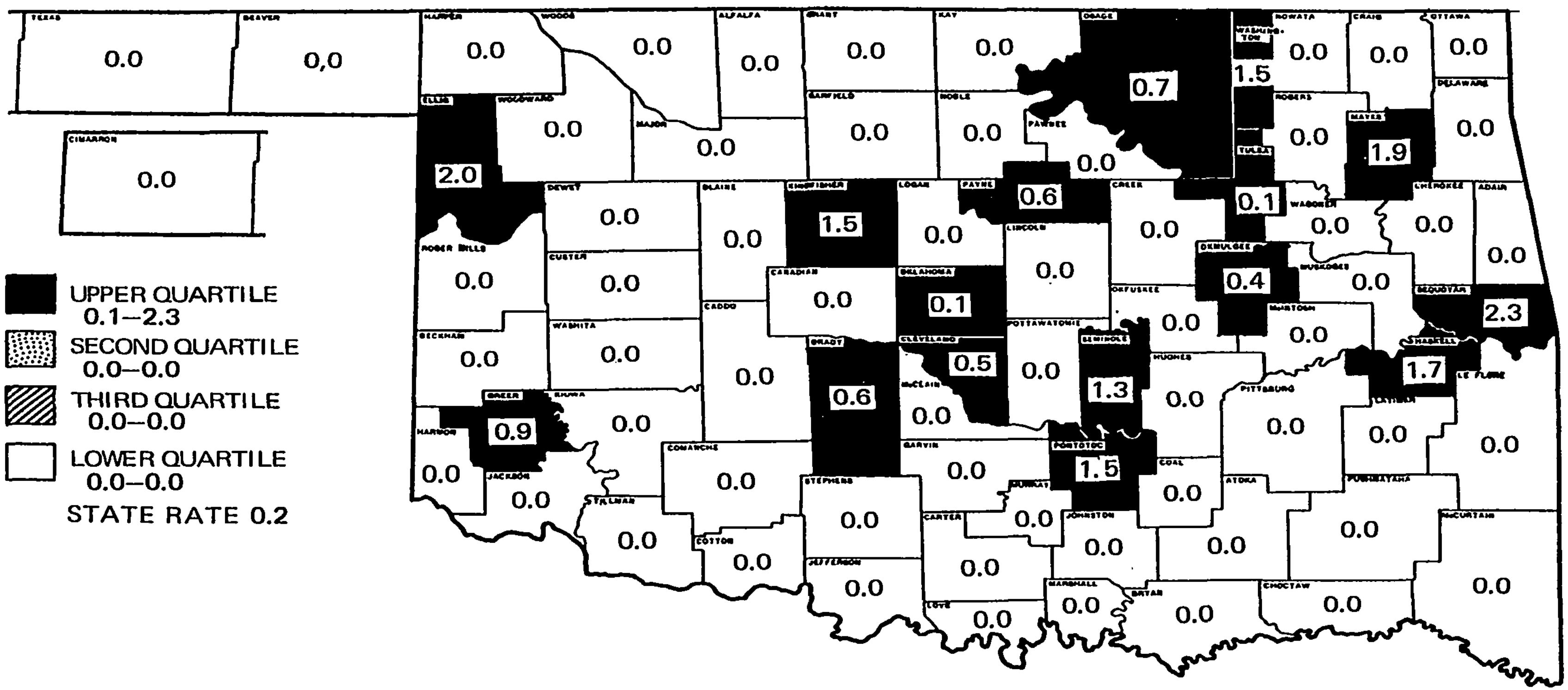


Figure 28. Cancer of the Eye (192), White Females.

TABLE 24

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE BRAIN AND OTHERS OF NERVOUS SYSTEM (193)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	10.1	11.2	10.5	5.8
5-14	8.9	3.7	8.3	5.3
15-24	3.9	5.2	2.7	3.5
25-34	14.6	14.2	8.9	7.4
35-44	26.6	31.9	10.9	19.4
45-54	42.9	34.8	26.5	23.6
55-64	61.2	74.1	42.1	29.5
65-74	47.3	42.9	33.3	37.3
75+	13.8	12.5	6.9	11.5
AADR*	22.5	22.3	14.8	13.7

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	7.8	10.6	3.9	7.1
15-24	19.2	6.4	6.3	6.4
25-34	9.2	9.8	15.3	0.0
35-44	9.5	10.1	0.0	16.7
45-54	19.9	50.0	8.7	42.3
55-64	36.4	22.6	11.3	0.0
65-74	0.0	15.8	0.0	14.7
75+	30.3	0.0	0.0	24.7
AADR*	13.3	14.3	5.5	11.1

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

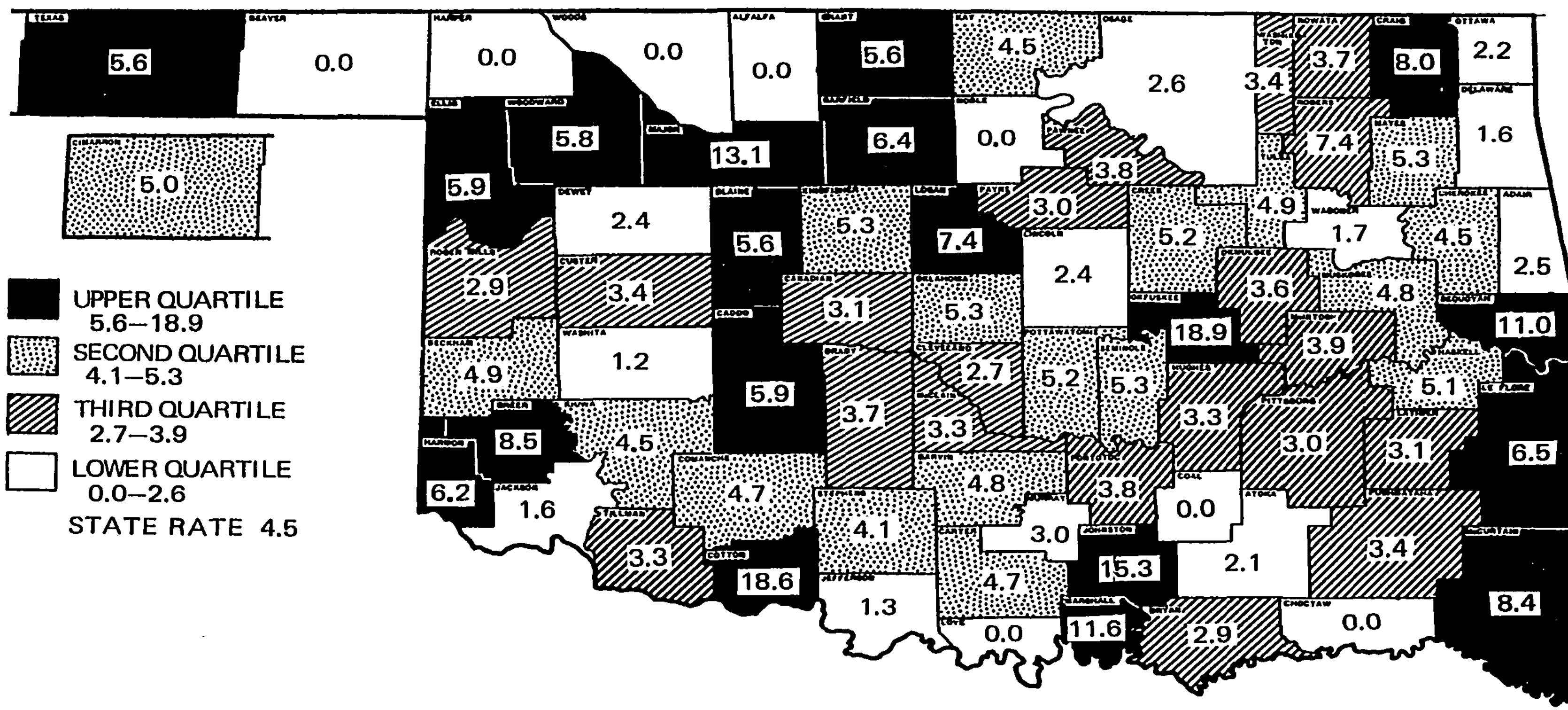


Figure 29. Cancer of the Brain and Others of Nervous System (193), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

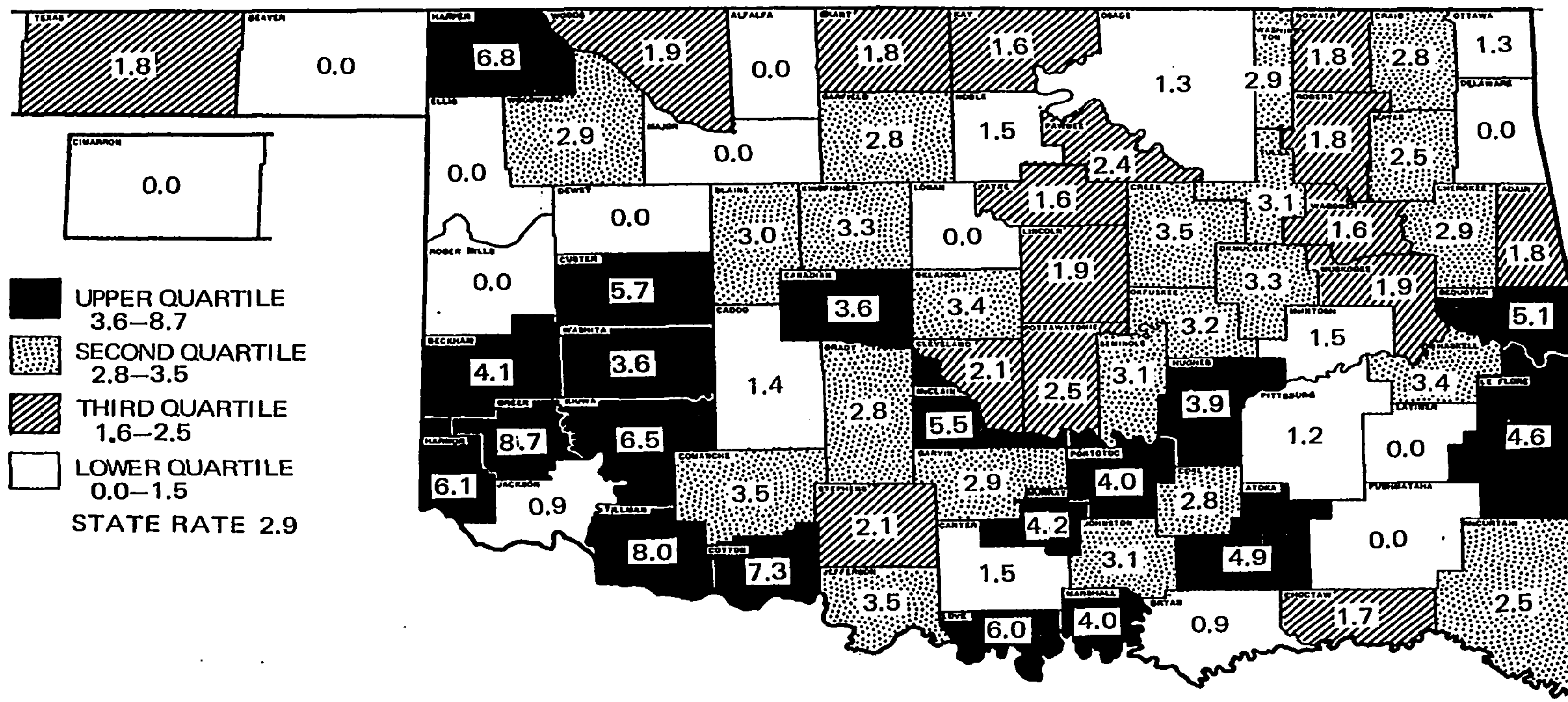


Figure 30. Cancer of the Brain and Others of Nervous System (193), White Females.

TABLE 25

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE THYROID GLAND (194)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.6	0.0	0.0
25-34	0.7	0.0	0.0	0.0
35-44	0.0	0.7	0.7	0.7
45-54	2.5	2.4	3.2	3.0
55-64	4.2	6.0	6.0	3.6
65-74	3.0	10.0	14.6	9.6
75+	19.4	7.5	29.9	19.3
AADR*	1.6	1.9	3.0	2.0

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5		0.0	0.0	0.0
5-14		0.0	0.0	0.0
15-24		0.0	0.0	0.0
25-34		0.0	0.0	0.0
35-44		0.0	0.0	0.0
45-54		0.0	0.0	0.0
55-64		11.3	11.3	0.0
65-74		0.0	31.4	0.0
75+		0.0	0.0	24.7
AADR*		1.0	3.0	0.8

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

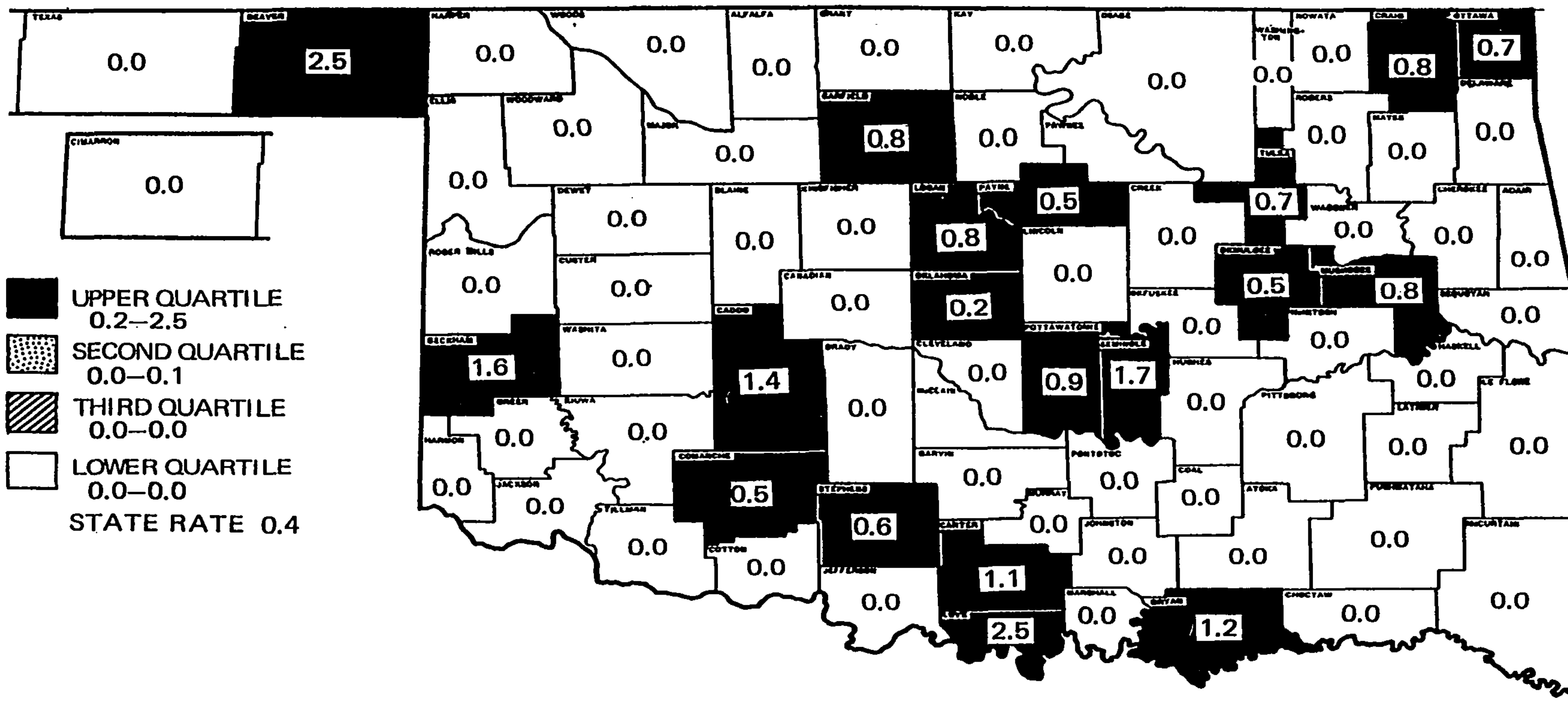


Figure 31. Cancer of the Thyroid Gland (194), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

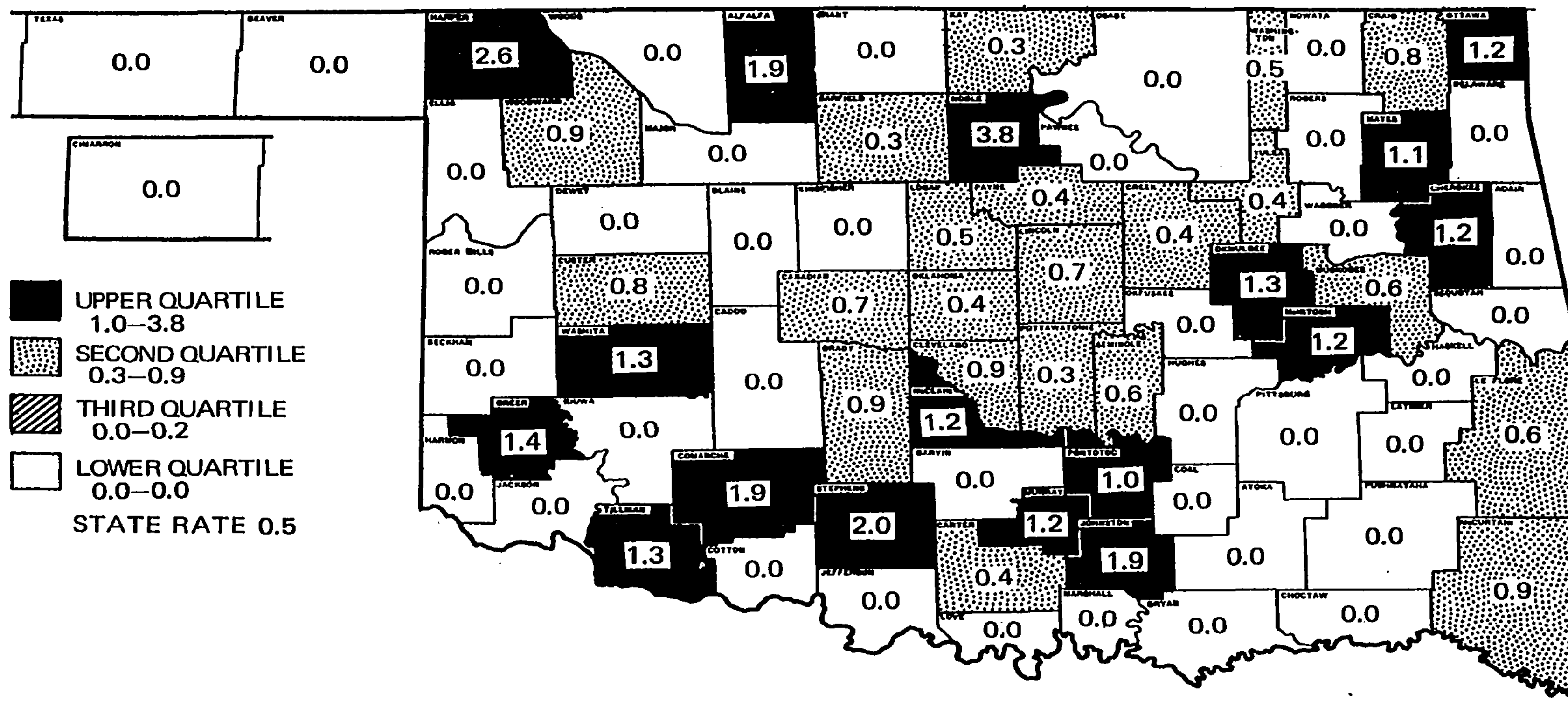


Figure 32. Cancer of the Thyroid Gland (194), White Females.

for males than for females (Table 26).

Oklahoma males experience a higher adjusted mortality for cancer of the bone (ISC 196) than do the females. The disease shows a stable trend over the two five year periods for all groups studied (Table 27). Very few deaths have occurred during the ten year period for cancer of the connective tissue (ISC 197).

Cancer of unspecified sites and that of lymph nodes (ISC 198-199) shows a stable age-adjusted mortality for all groups with time, with little variation between males and females or whites and nonwhites (Table 29).

The age-adjusted mortality experienced by Oklahomans during the ten year period studied for lympho-sarcomas and reticulum sarcomas (ISC 200) show a stable trend with time for all groups except the nonwhite females, where the disease appears to be decreasing. Males in general experience higher mortality than do females and the disease is slightly elevated among the whites over the nonwhites (Table 30). The average annual age-adjusted death rate for the ten year period studied shows a high cluster area in the central and southeastern counties of the state for the white males (Fig. 33) and a central distribution of the high rate counties for the white females (Fig. 34).

Hodgkins disease (ISC 201) occurs with greater frequency among males than among females, and among whites than the nonwhites. The disease has remained stable over the two five year periods studied with a slight increase among the nonwhite females (Table 31). The average annual adjusted death rates by county show a high death rate area for Tulsa and three other counties bordering it on the South, and for several counties extending from the southeastern to the south central area of the

TABLE 26

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF OTHER ENDOCRINE GLANDS (195)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.9	0.9	0.0	0.0
5-14	0.4	0.4	0.5	0.0
15-24	0.0	0.6	0.6	0.7
25-34	0.7	0.0	0.7	0.0
35-44	0.7	0.0	1.4	0.0
45-54	6.7	3.2	0.8	1.5
55-64	5.3	5.0	0.0	1.8
65-74	7.6	5.7	0.0	4.8
75+	0.0	7.5	2.3	3.8
AADR*	2.0	1.7	0.6	0.9

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	6.6	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	9.8	0.0	0.0
35-44	0.0	0.0	0.0	0.0
45-54	9.9	0.0	0.0	0.0
55-64	0.0	0.0	0.0	10.0
65-74	0.0	15.8	0.0	0.0
75+	0.0	0.0	0.0	0.0
AADR*	1.8	2.1	0.0	0.9

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 27

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF THE BONE (196)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.9	0.9	0.9	0.0
5-14	1.4	2.3	3.6	3.4
15-24	5.2	4.6	6.1	1.4
25-34	1.5	1.6	1.4	0.0
35-44	4.5	1.5	2.1	5.2
45-54	13.4	7.2	4.8	4.5
55-64	22.5	31.5	13.0	8.3
65-74	25.9	28.6	9.3	25.3
75+	72.1	45.1	41.4	32.8
AADR*	9.7	8.7	5.9	5.6

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	3.9	0.0
15-24	19.2	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	9.5	0.0	0.0	16.7
45-54	0.0	10.0	17.5	16.9
55-64	0.0	22.6	11.3	10.0
65-74	49.3	63.3	31.4	14.7
75+	60.6	53.3	59.5	24.7
AADR*	9.3	9.2	8.0	6.8

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 28

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF CONNECTIVE TISSUE (197)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.9	0.0	0.9	1.9
5-14	0.9	0.9	0.0	1.4
15-24	0.6	0.6	0.6	0.7
25-34	1.5	0.8	0.0	1.6
35-44	1.5	4.6	1.4	0.0
45-54	1.6	8.1	1.6	3.0
55-64	5.3	7.1	5.0	3.6
65-74	10.6	14.3	10.6	6.0
75+	22.1	15.0	6.9	17.3
AADR*	2.8	3.9	1.9	2.4

	Non-White Male		Non-White Female	
Age	1956-50	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	7.9
35-44	9.5	0.0	0.0	0.0
45-54	0.0	0.0	8.7	0.0
55-64	12.1	0.0	0.0	0.0
65-74	0.0	15.8	0.0	0.0
75+	0.0	0.0	29.7	0.0
AADR*	2.2	1.0	2.0	0.9

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 29

AGE-SEX-RACE SPECIFIC DEATH RATES FOR CANCER OF UNSPECIFIED SITES (198-199)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	1.8	1.8	1.9	0.0
5-14	0.4	1.4	1.0	2.4
15-24	1.9	2.6	1.3	0.0
25-34	3.0	5.0	5.9	3.3
35-44	7.6	14.0	10.9	14.9
45-54	33.6	35.6	47.5	39.6
55-64	110.6	100.6	92.2	96.1
65-74	163.5	183.3	180.2	162.8
75+	460.5	358.5	341.1	368.6
AADR*	43.0	41.2	40.5	39.9

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	3.9	0.0
15-24	6.4	0.0	6.3	0.0
25-34	0.0	0.0	7.6	0.0
35-44	9.5	30.5	24.0	75.5
45-54	39.9	70.0	70.2	0.0
55-64	109.3	169.9	136.1	150.8
65-74	263.3	126.6	251.8	206.6
75+	424.2	213.3	417.0	396.0
AADR*	49.0	43.3	57.4	50.8

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

TABLE 30

AGE-SEX-RACE SPECIFIC DEATH RATES FOR LYMPHOSARCOMA AND RETICULOSARCOMA (200)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	3.7	3.7	1.9	0.0
5-14	4.9	3.3	2.5	1.4
15-24	5.8	7.2	1.3	4.9
25-34	4.6	6.7	4.4	3.3
35-44	11.4	12.4	2.1	4.4
45-54	21.0	17.8	16.1	17.5
55-64	47.2	43.7	19.0	45.3
65-74	77.9	105.9	58.7	61.5
75+	97.1	92.7	87.5	67.5
AADR*	19.4	20.6	12.2	14.5

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	3.5	0.0	0.0
15-24	0.0	0.0	18.9	0.0
25-34	9.2	19.7	15.3	0.0
35-44	19.1	10.1	8.0	8.3
45-54	19.9	0.0	17.5	0.0
55-64	36.4	22.6	45.3	10.0
65-74	49.3	79.1	15.7	14.7
75+	60.6	80.0	29.7	24.7
AADR*	14.4	14.3	13.8	3.7

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

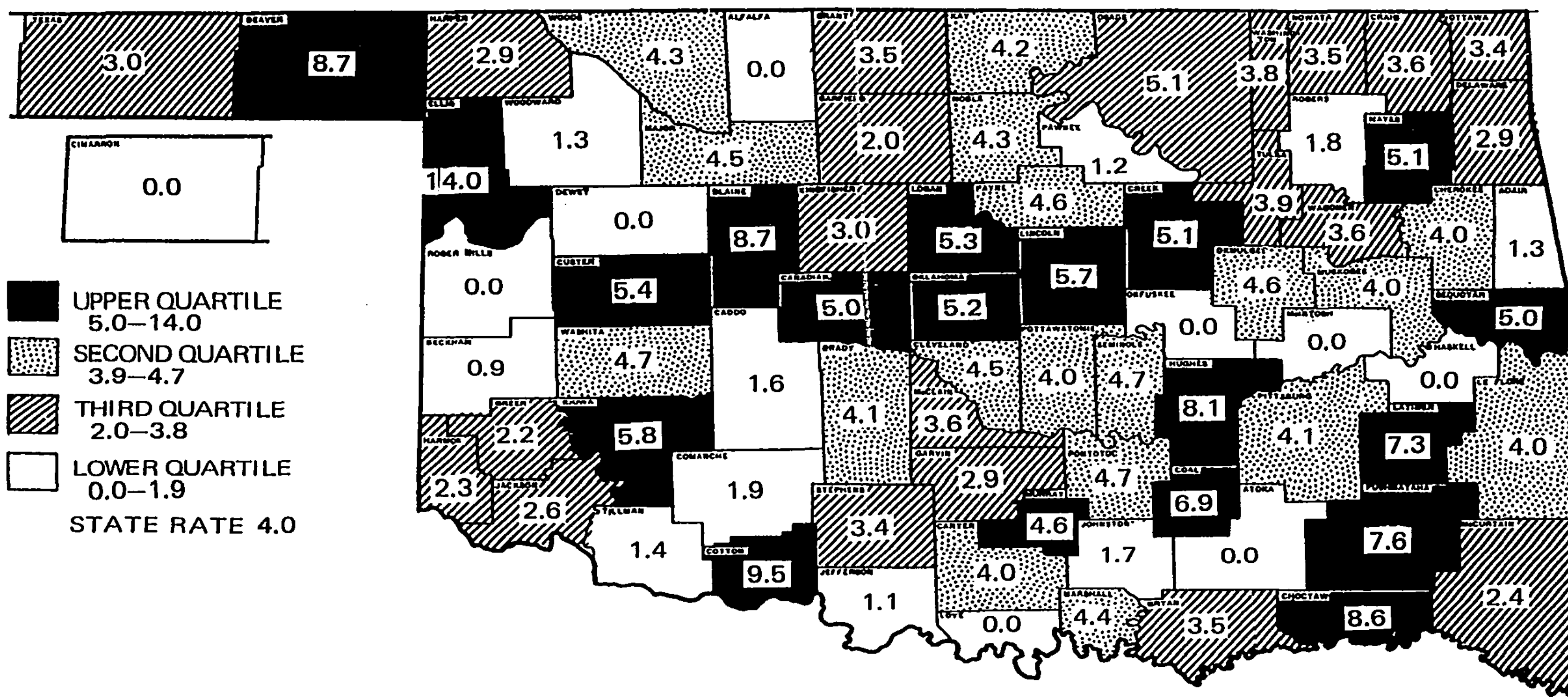


Figure 33. Lymphosarcoma and Reticulosarcoma (200), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

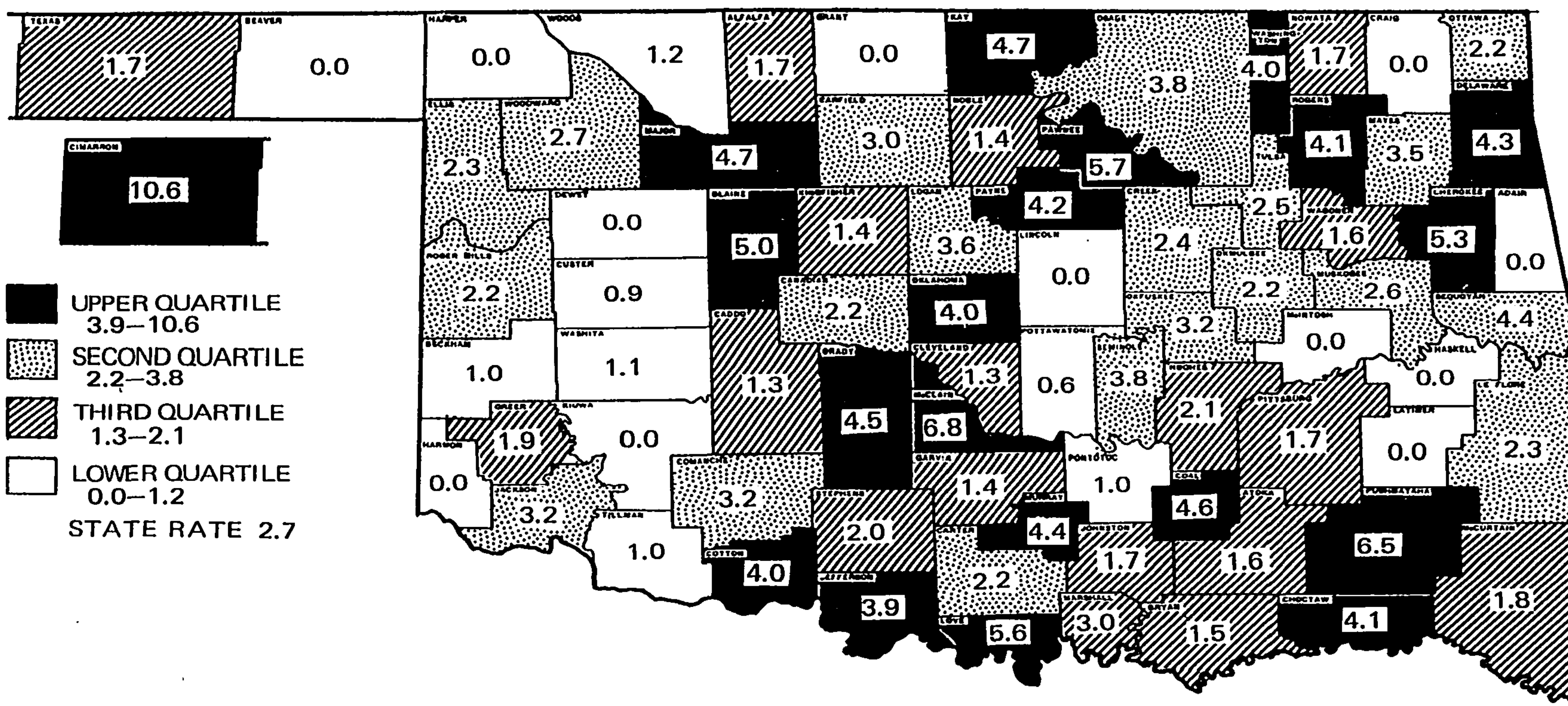


Figure 34. Lymphosarcoma and Reticulosarcoma (200), White Females.

TABLE 31

AGE-SEX-RACE SPECIFIC DEATH RATES FOR HODGKINS DISEASE (201)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.9	0.0	0.0	0.0
5-14	0.9	0.4	1.5	0.0
15-24	5.2	3.3	0.0	6.3
25-34	10.0	9.2	3.7	4.1
35-44	13.6	9.3	6.5	5.2
45-54	14.3	11.3	4.0	5.3
55-64	25.7	24.3	11.0	10.1
65-74	35.1	34.3	18.5	13.2
75+	27.7	37.6	27.6	17.3
AADR*	11.2	9.9	5.2	5.0

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	6.4	0.0	0.0
25-34	9.2	0.0	7.6	0.0
35-44	9.5	10.1	0.0	0.0
45-54	9.9	10.0	8.7	0.0
55-64	36.4	22.6	11.3	20.1
65-74	16.4	15.8	0.0	29.5
75+	0.0	26.6	0.0	24.7
AADR*	7.8	7.4	2.9	4.6

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

state for the white males (Fig. 35). The white female geographic distribution of mortality favors the northeastern counties and north central area of the state (Fig. 36). As for mycosis fungoides and others of lymphatic system (ISC 202, 205), very few Oklahomans die from this disease. The rates have stablized for all groups except for the nonwhite males were an increase is apparent (Table 33). The white male geographic distribution of high counties favors the northwestern and central areas of the state (Fig. 37), while the white females show a southwestern and southeastern pattern (Fig. 38).

Age-adjusted mortality for Multiple Myeloma (ISC 203) for all groups shows an increasing trend over the two five year periods. Nonwhite mortality is slightly higher than white mortality (Table 33). The disease seems to be more prevalent in the western counties of the state for the white males (Fig. 39) while a random distribution is indicated for the white females (Fig. 40).

Deaths from leukemia and aleukemia have shown a stable trend for the white population with an increase for the nonwhite males, and a decrease for the nonwhite females. Males in general have experienced a much higher adjusted rate than have females (Table 34). The geographic distribution of white male mortality shows a four-county high rate area in the Northeast and another four-county area in the West central. Otherwise high counties show no definite pattern of clustering (Fig. 41). The white female geographic distribution of high counties favors the southeastern to south central counties of the state. Other high counties are indicated for the northeastern and northwestern portions of the state (Fig. 42).

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

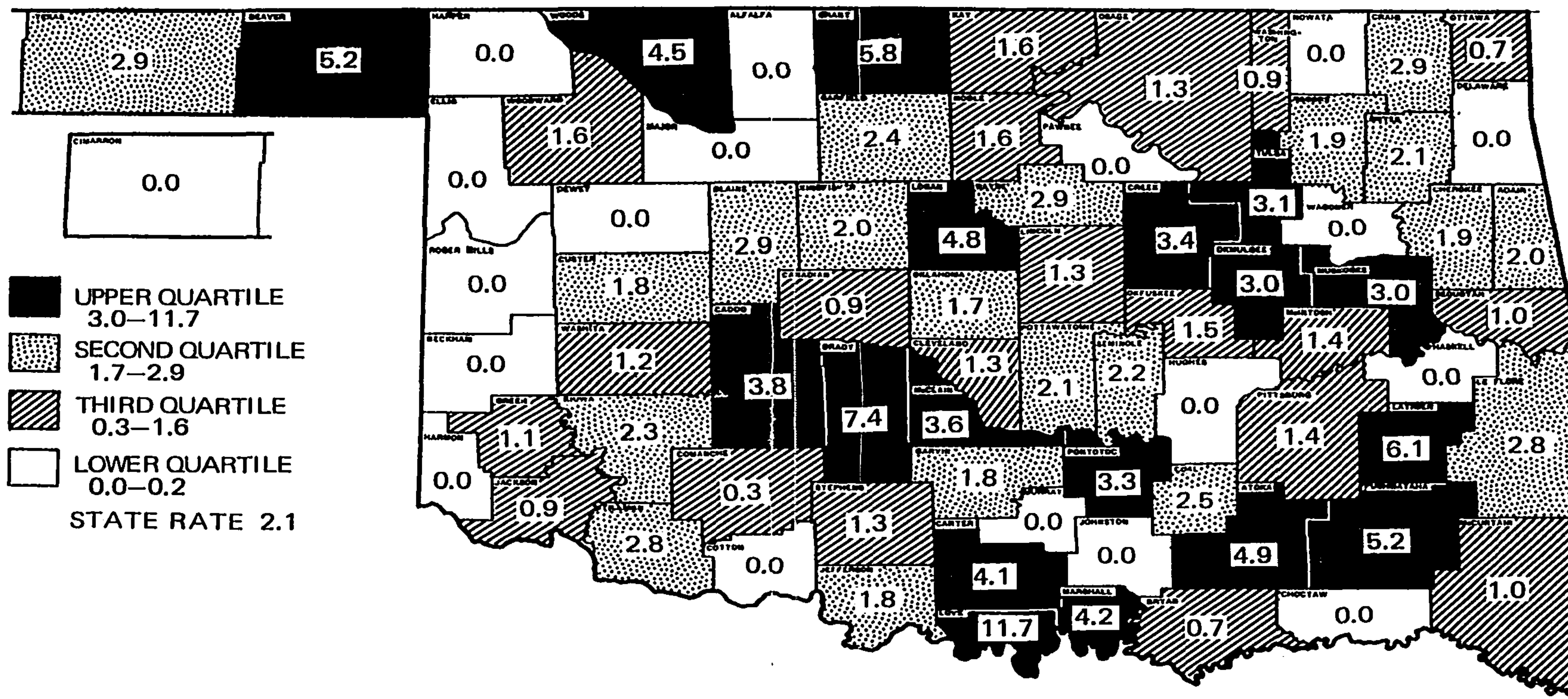


Figure 35. Hodgkins Disease (201), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

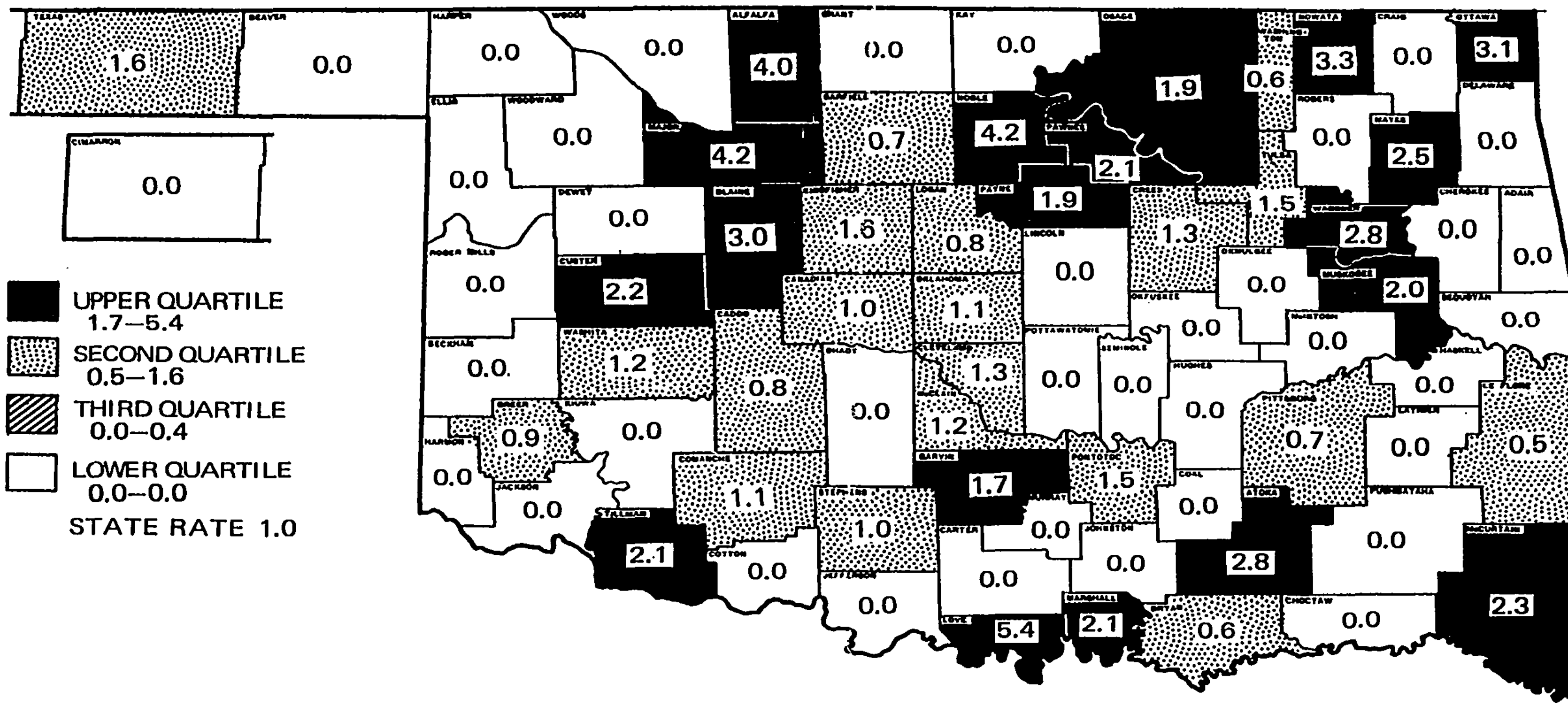


Figure 36. Hodgkins Disease (201), White Females.

TABLE 32

AGE-SEX-RACE SPECIFIC DEATH RATES FOR OTHERS LYMPHOMA (202, 205)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	4.6	0.0	0.9	0.9
5-14	0.4	0.4	0.0	0.0
15-24	0.0	0.0	0.6	0.7
25-34	0.7	0.8	0.0	0.0
35-44	3.0	0.0	0.7	1.4
45-54	2.5	2.4	1.6	3.0
55-64	7.5	8.1	6.0	6.4
65-74	6.1	15.7	5.3	8.4
75+	8.3	17.5	11.5	11.5
AADR*	2.6	2.8	1.7	2.2

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	6.3	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	0.0	0.0	0.0
45-54	9.9	0.0	0.0	0.0
55-64	0.0	22.6	11.3	20.1
65-74	16.4	15.8	0.0	14.7
75+	0.0	26.6	29.7	0.0
AADR*	2.2	4.0	3.0	2.7

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

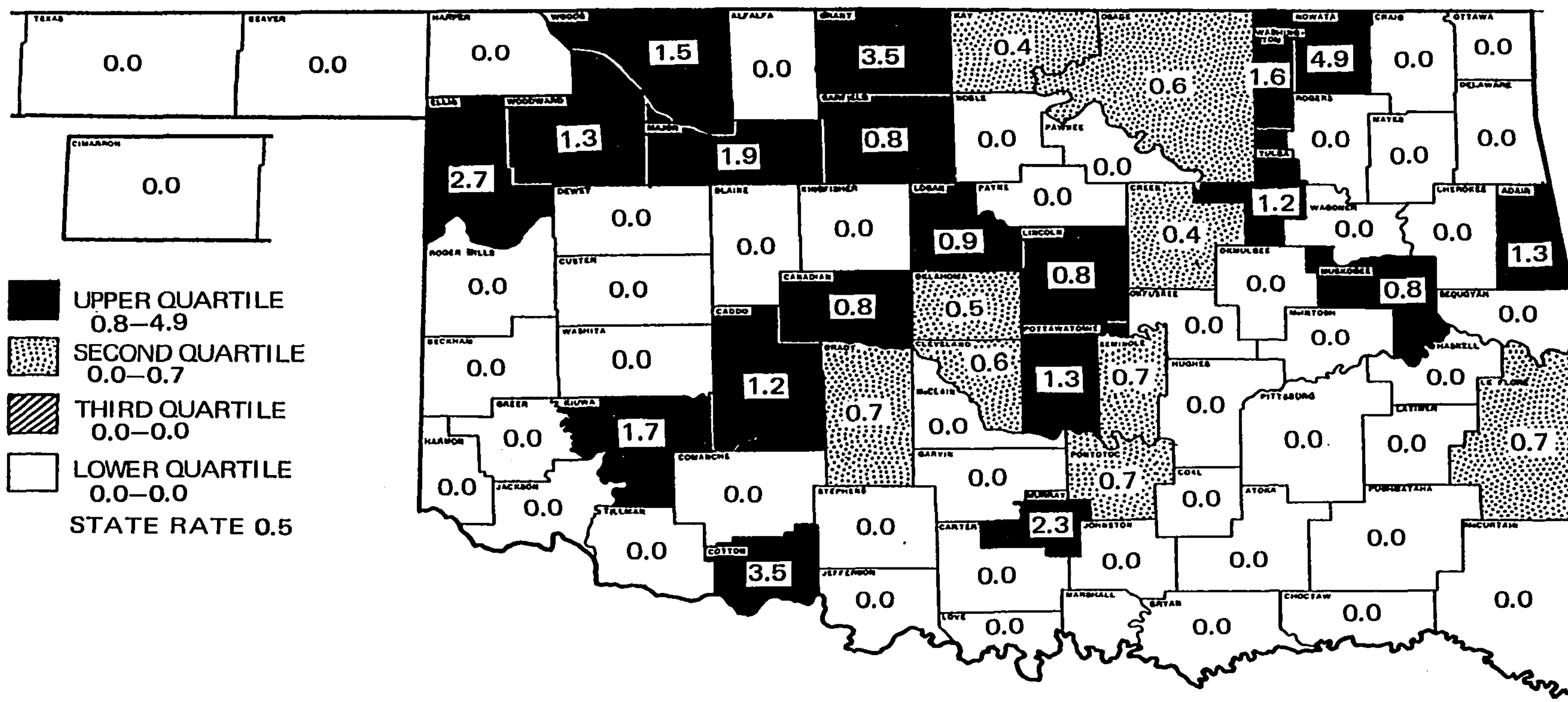


Figure 37. Lymphoma (202, 205), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

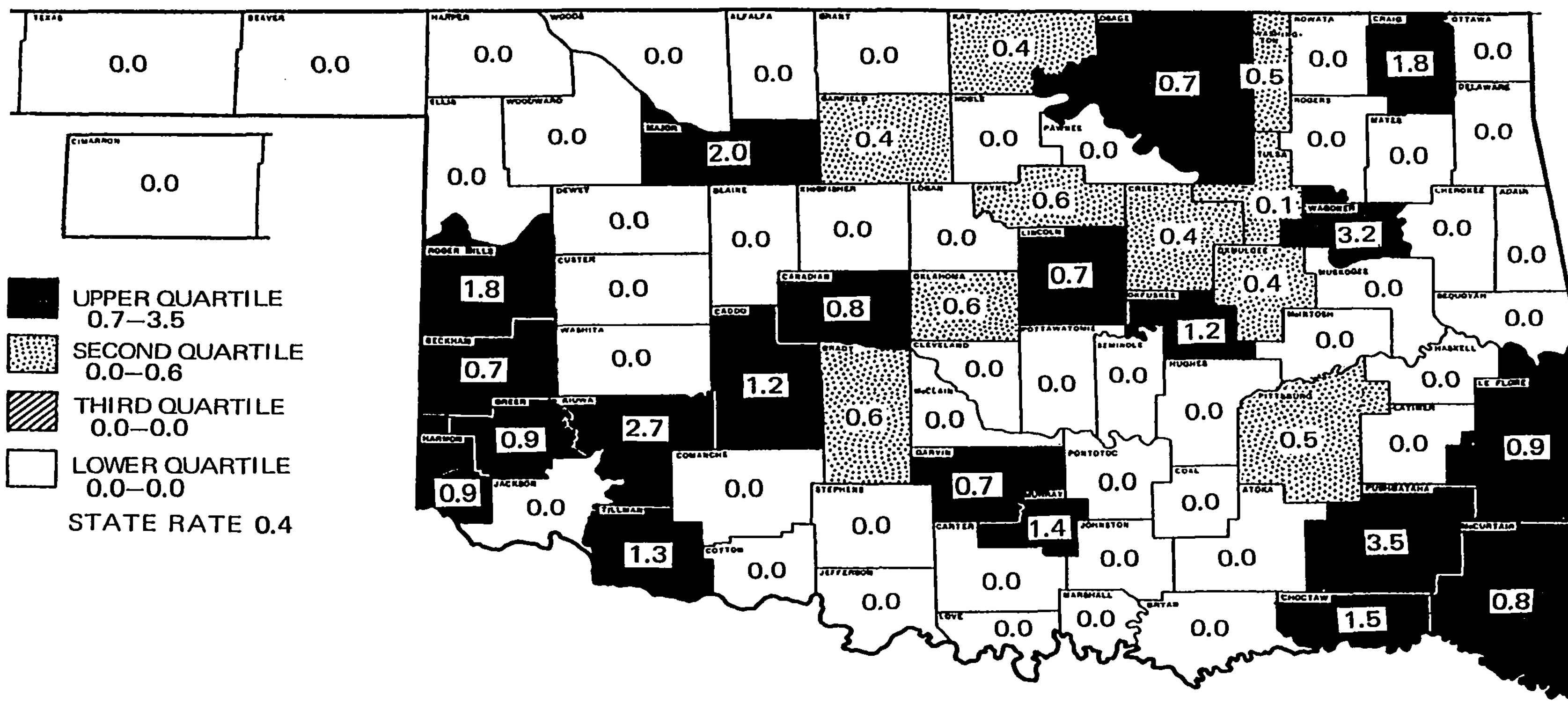


Figure 38. Lymphoma (202, 205), White Females.

TABLE 33

AGE-SEX-RACE SPECIFIC DEATH RATES FOR MULTIPLE MYELOMA (203)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.6	0.7
35-44	0.7	3.9	2.9	1.4
45-54	6.7	17.8	3.2	6.1
55-64	32.2	31.5	19.0	17.5
65-74	30.5	42.9	29.3	31.3
75+	38.8	50.1	29.9	42.4
AADR*	7.1	10.1	5.5	6.0

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	0.0	0.0	0.0	0.0
5-14	0.0	0.0	0.0	0.0
15-24	0.0	0.0	0.0	0.0
25-34	0.0	0.0	0.0	0.0
35-44	0.0	0.0	0.0	8.3
45-54	0.0	20.0	17.5	0.0
55-64	60.7	56.6	11.3	40.2
65-74	49.3	31.6	62.9	103.3
75+	30.3	80.0	29.7	49.5
AADR*	9.8	12.4	8.1	13.1

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

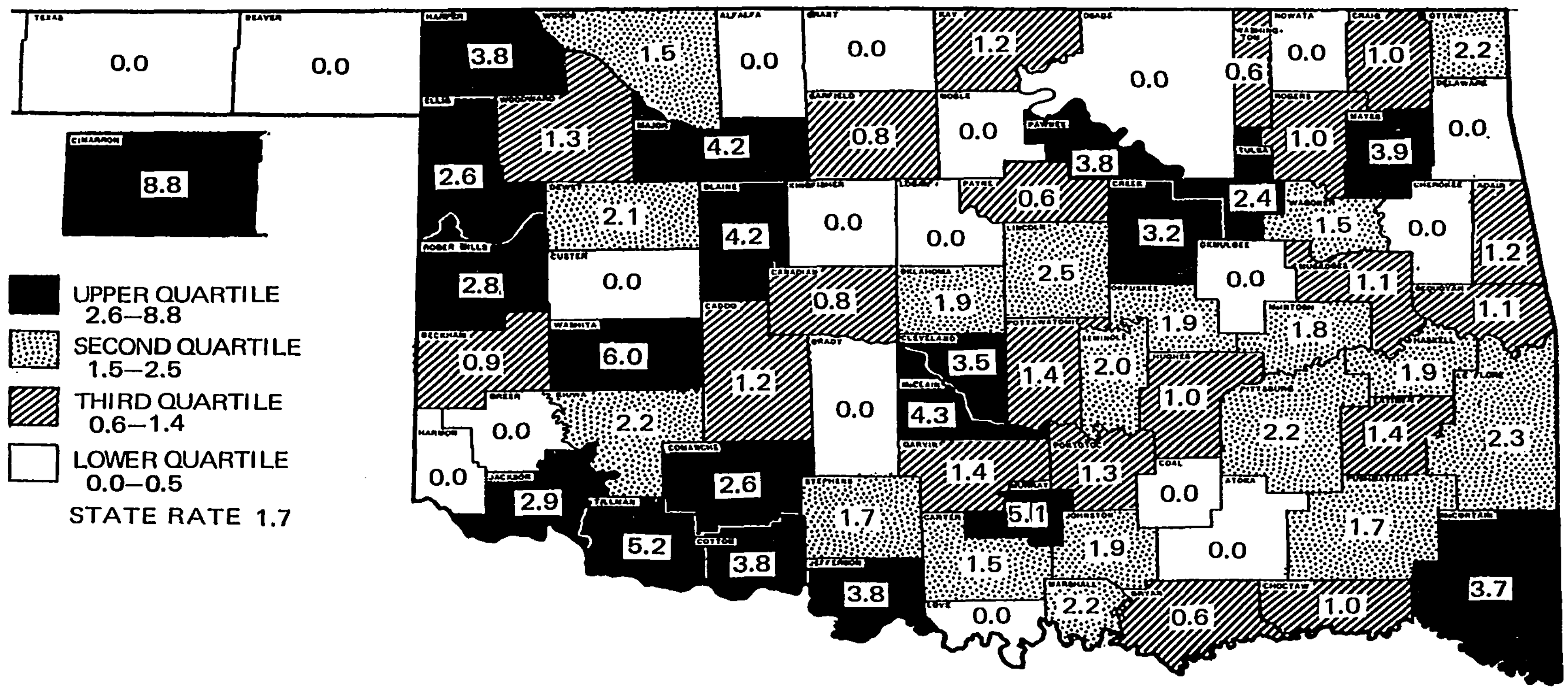


Figure 39. Multiple Myeloma (203), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

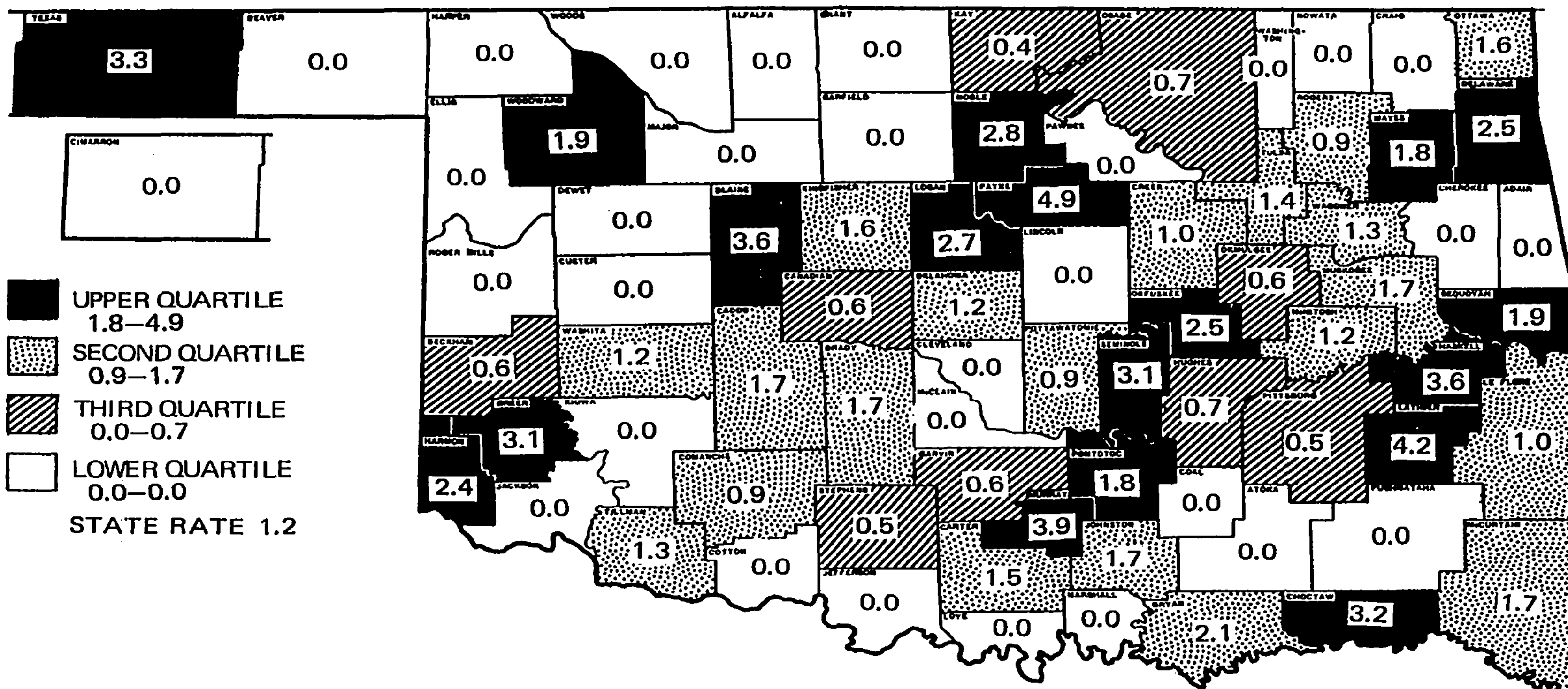


Figure 40. Multiple Myeloma (203), White Females.

TABLE 34

AGE-SEX-RACE SPECIFIC DEATH RATES FOR LEUKEMIA AND ALEUKEMIA (204)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

Age	White Male 1956-60	White Male 1961-65	White Female 1956-60	White Female 1961-65
<5	36.1	29.9	29.7	17.4
5-14	17.4	19.8	12.4	9.8
15-24	8.4	9.9	10.1	7.7
25-34	14.6	5.8	5.9	7.4
35-44	20.5	15.6	12.4	12.7
45-54	31.9	45.3	26.5	17.5
55-64	76.2	86.3	69.1	63.8
65-74	230.7	184.7	106.8	107.3
75+	316.2	411.1	163.6	218.1
AADR*	49.6	50.9	31.4	29.9

Age	Non-White Male 1956-60	Non-White Male 1961-65	Non-White Female 1956-60	Non-White Female 1961-65
<5	26.4	12.0	6.6	0.0
5-14	19.6	17.7	7.9	10.7
15-24	0.0	12.8	25.2	0.0
25-34	18.5	9.8	7.6	7.9
35-44	28.7	30.5	32.0	0.0
45-54	19.9	20.0	43.9	16.9
55-64	60.7	90.6	34.0	30.1
65-74	98.7	142.4	62.9	88.5
75+	151.5	293.3	89.3	123.7
AADR*	32.0	41.9	26.3	17.9

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

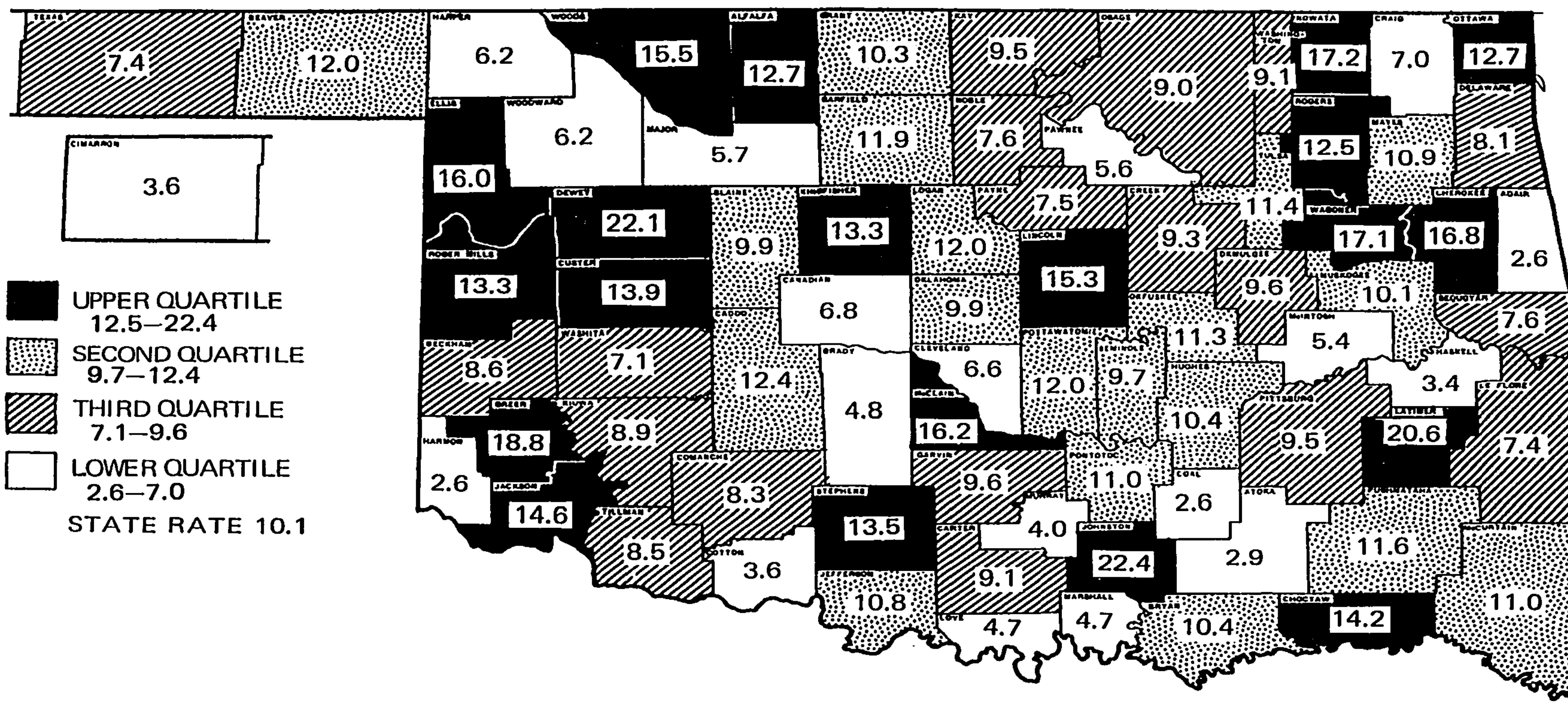


Figure 41. Leukemia and Aleukemia (204), White Males.

Average Annual Age Adjusted Death Rate
Oklahoma, 1956–65
Rates Per 100,000 Population

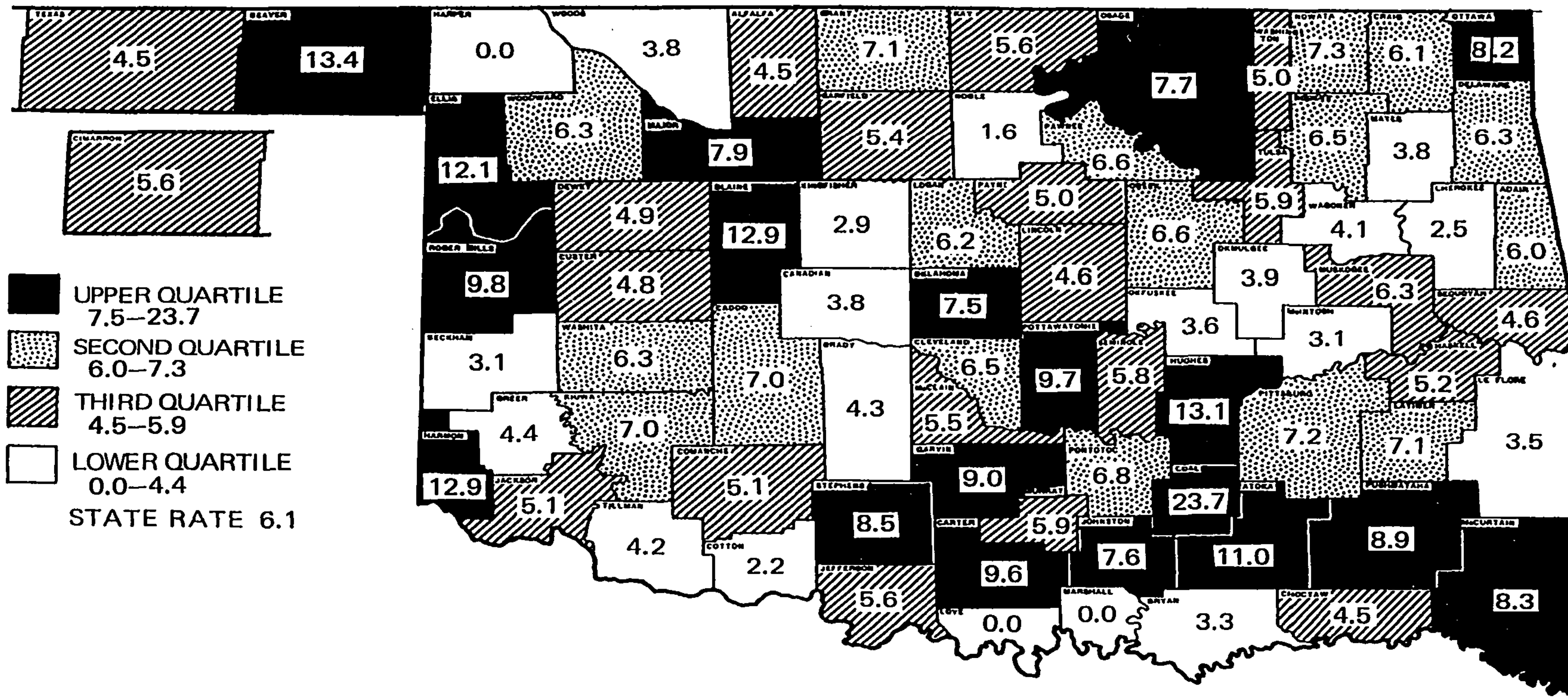


Figure 42. Leukemia and Aleukemia (204), White Females.

Deaths for Oklahomans from benign neoplasm (ISC 210-239) occur among all age groups (Table 35) as does leukemia (Table 34), cancer of the kidney, nervous system, brain, bone, connective tissue and others of the Haematopoetic system. No significant changes have occurred over the two five year periods except for a decline in age-adjusted death rates among the nonwhite Oklahoma females (Table 35).

TABLE 35

AGE-SEX-RACE SPECIFIC DEATH RATES FOR BENIGN NEOPLASM (210-239)

Oklahoma: 1956-60, 1961-65
Rates Per 100,000 Population

	White Male		White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	5.5	4.6	4.8	1.9
5-14	2.9	3.7	2.5	2.4
15-24	2.6	3.9	3.3	3.5
25-34	3.0	0.8	4.4	8.2
35 44	5.3	3.1	12.4	8.9
45-54	20.1	13.7	12.8	12.9
55-64	24.7	31.5	32.0	22.1
65-74	19.8	30.0	25.3	19.2
75+	44.3	67.6	73.7	77.2
AADR*	10.0	11.1	12.2	10.8

	Non-White Male		Non-White Female	
Age	1956-60	1961-65	1956-60	1961-65
<5	13.2	0.0	6.6	0.0
5-14	3.9	3.5	3.9	3.5
15-24	12.8	6.4	12.6	6.4
25-34	0.0	9.8	53.8	7.9
35-44	0.0	10.1	56.0	0.0
45-54	0.0	10.0	52.7	33.8
55-64	24.3	22.6	56.7	30.1
65-74	32.9	0.0	47.2	59.0
75+	60.6	26.6	59.5	24.7
AADR*	10.5	8.2	33.2	13.9

* AGE ADJUSTED DEATH RATE Based on the 1960 State White Males as the Standard Population.

CHAPTER IV

RESULTS II. ENVIRONMENTAL AND OTHER VARIABLES

Once geographic differences in cancer mortality have been described it is necessary to report on those factors in the human environment and or the habits of the people of Oklahoma that tend to vary from one region to another such as climate, geology, occupation, socioeconomic conditions, background radiation, diet, culture, personal habits and genetic constitution.

Not all of the above variables are available to us; however, we shall report on the data that are available. It is logical then to describe the patterns of mortality according to the different areas so that we may be able to provide some clues concerning the complex etiology of cancer.

Cigarette sales in Oklahoma have continued to increase from 93.5 packs per capita in 1950 to peak sales of 118.9 in 1961 and declined to 115.9 in 1966. The data show that Oklahomans buy fewer cigarettes than the national average (Table 36). The geographic distribution of cigarette sales by districts in Oklahoma shows the district including Tulsa and Creek counties to have the highest average annual tax-paid per capita sales, followed by the Oklahoma and Canadian county district. The next four districts with substantially high sales are located in the southern districts extending from areas in the West to the eastern

TABLE 36

TAX-PAID PER CAPITA SALES OF CIGARETTES (IN NUMBER OF PACKS)

Year	Oklahoma	All Taxing States, Median[a]	National Average[b]
1950	93.5	106.8	119.5
1951	89.3	111.7	121.7
1952	93.0	112.4	125.1
1953	97.2	114.1	126.8
1954	96.2	109.5	119.0
1955	94.4	105.4	116.1
1956	97.0	104.5	117.3
1957	96.7	105.1	119.9
1958	99.5	104.4	121.9
1959	106.8	113.7	127.2
1960	112.9	113.6	132.3
1961	118.9	120.3	133.2
1962	112.4	119.9	133.4
1963	113.4	120.8	135.4
1964	111.5	115.7	131.3
1965	115.6	120.5	135.1
1966	115.9	120.2	133.1

[a]Data for Individual States are based on the total number of packages taxed.

[b]Figures prior to 1960 are based on federal dollar collection, from 1960 on figures shown are based upon "Tax-paid removals".

Population figures used are Census Bureau estimates as of July 1, of perspective fiscal year.

portions of the state. It is of interest to report that the northeastern district reported the lowest per capita sales of cigarettes in Oklahoma for the period studied (Fig. 43).

The geologic map of Oklahoma (Fig. 44) indicates several geological characteristics in different areas of the state. The tertiary area includes the counties of the panhandle, Ellis county, and parts of Woodward and Roger-Mills counties. The quaternary area is spread over many counties of the state. The lower Cretaceous area predominates in the southeastern border counties. The Permian areas extend over an area covering the western two-thirds of the state excluding the tertiary and the quaternary areas. The Pennsylvanian region is located in the eastern third of the state except for portions of the area classed as Mississippian.

The mineral map of Oklahoma (Fig. 45) shows the northwestern counties of the state to be located in an area underlain by salt. This same area extends south to include all the western border counties. The principal limestone and dolomite area covers the northeast geographic area of the state. Also of interest is that the chat distribution point and the only zinc lead mine areas are located in Ottawa county north of Miami. Other zinc smelter areas are located in Washington, Kay, and Okmulgee counties.

The fuels map of Oklahoma (Fig. 46) is of interest because it shows the major resources and production areas. For instance, the area of minable coal and coal mines extends from Craig, Nowata, Rogers, Tulsa, and Wagoner counties in the Northeast to Okmulgee, Muskogee, McIntosh, Sequoyah, Leflore, Haskil, Latimer, Pittsburg and Coal in the East Central.

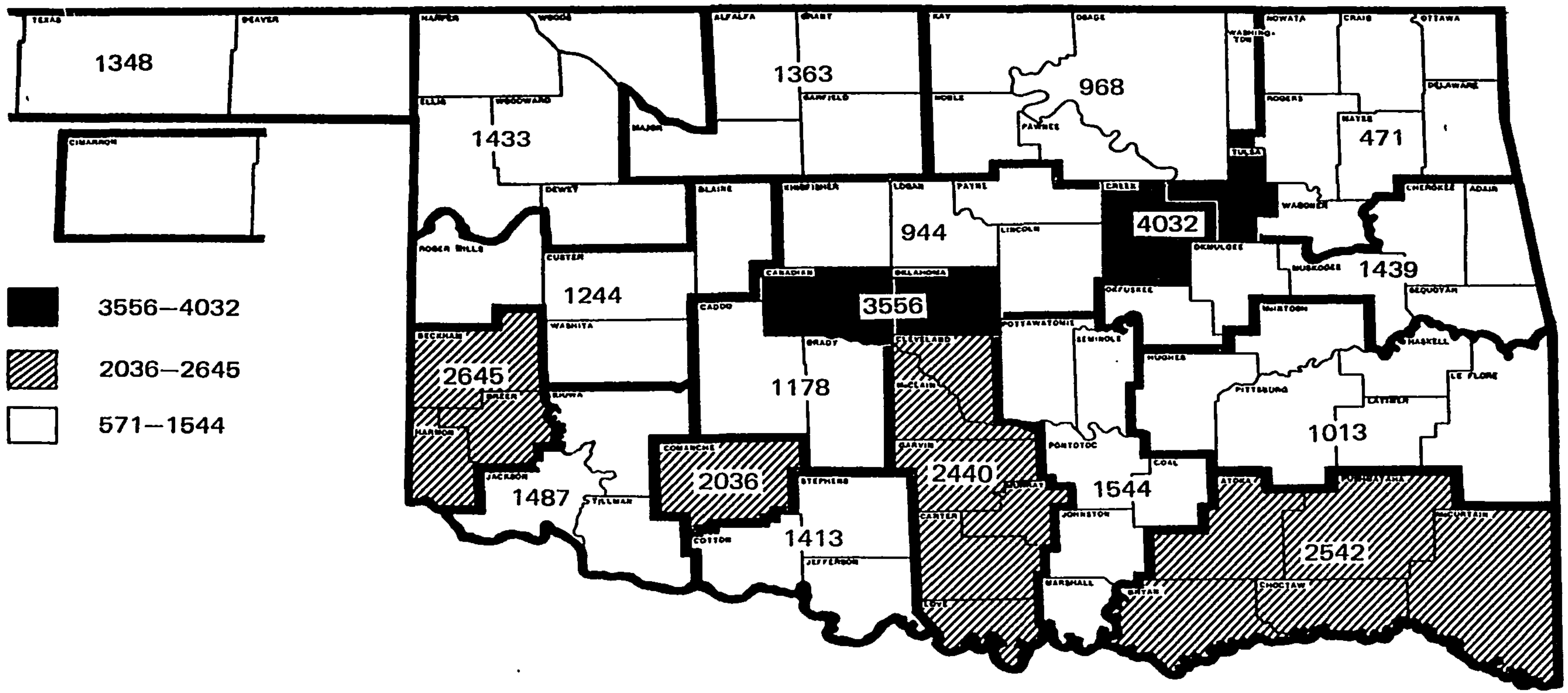


Figure 43. Average Annual Tax–Paid Per Capita Sales of Cigarettes in Oklahoma 1960–1961, 1965– 1966 as of July 1. Population Figures Used are 1960 Census Bureau Figures and 1965 State Health Department Estimates

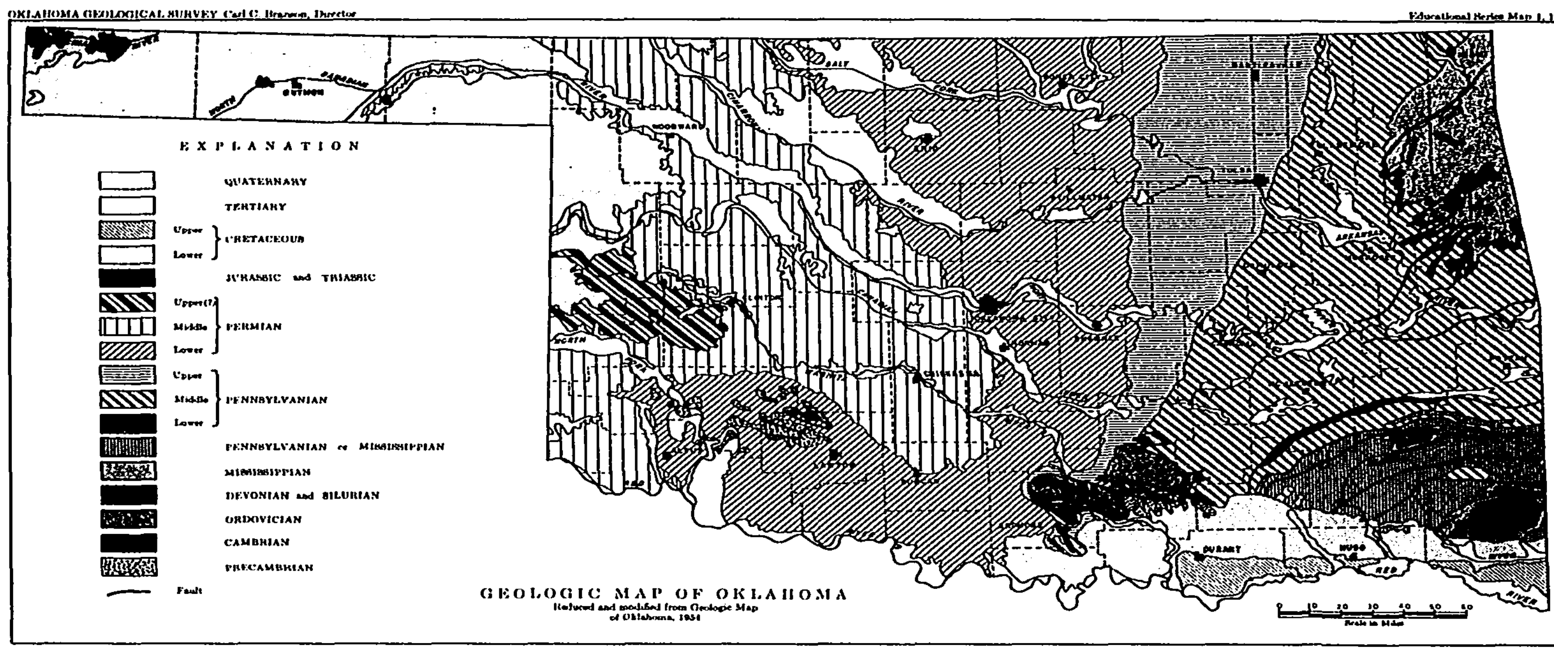

OKLAHOMA GEOLOGICAL SURVEY Carl C. Branson, Director
Educational Series Map 1, 1957
EXPLANATION
QUATERNARY
TERTIARY
Upper
Lower
CRETACEOUS
JURASSIC and TRIASSIC
Upper(?)
Middle
Lower
PERMIAN
Upper
Middle
Lower
PENNSYLVANIAN
PENNSYLVANIAN or MISSISSIPPIAN
MISSISSIPPIAN
DEVONIAN and SILURIAN
ORDOVICIAN
CAMBRIAN
PRECAMBRIAN
Fault
GEOLOGIC MAP OF OKLAHOMA
Reduced and modified from Geologic Map of Oklahoma, 1954
Scale in Miles

Figure 44

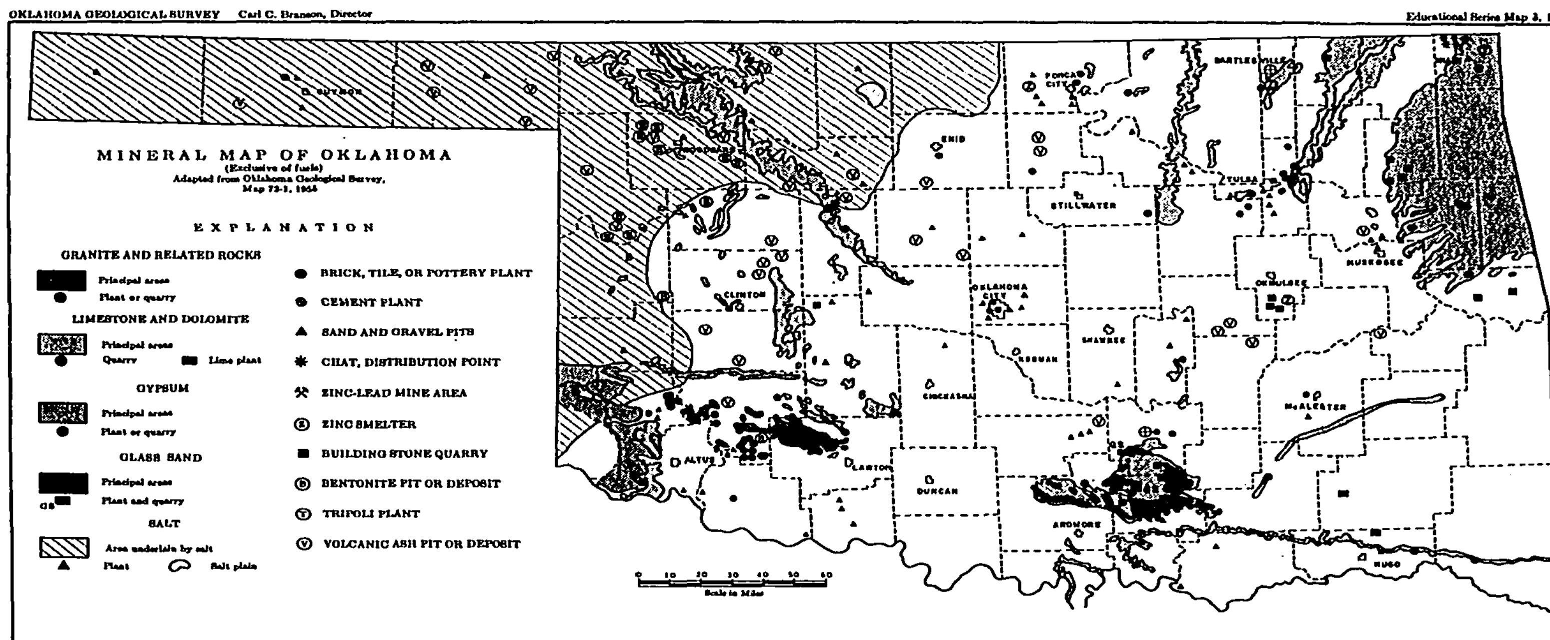
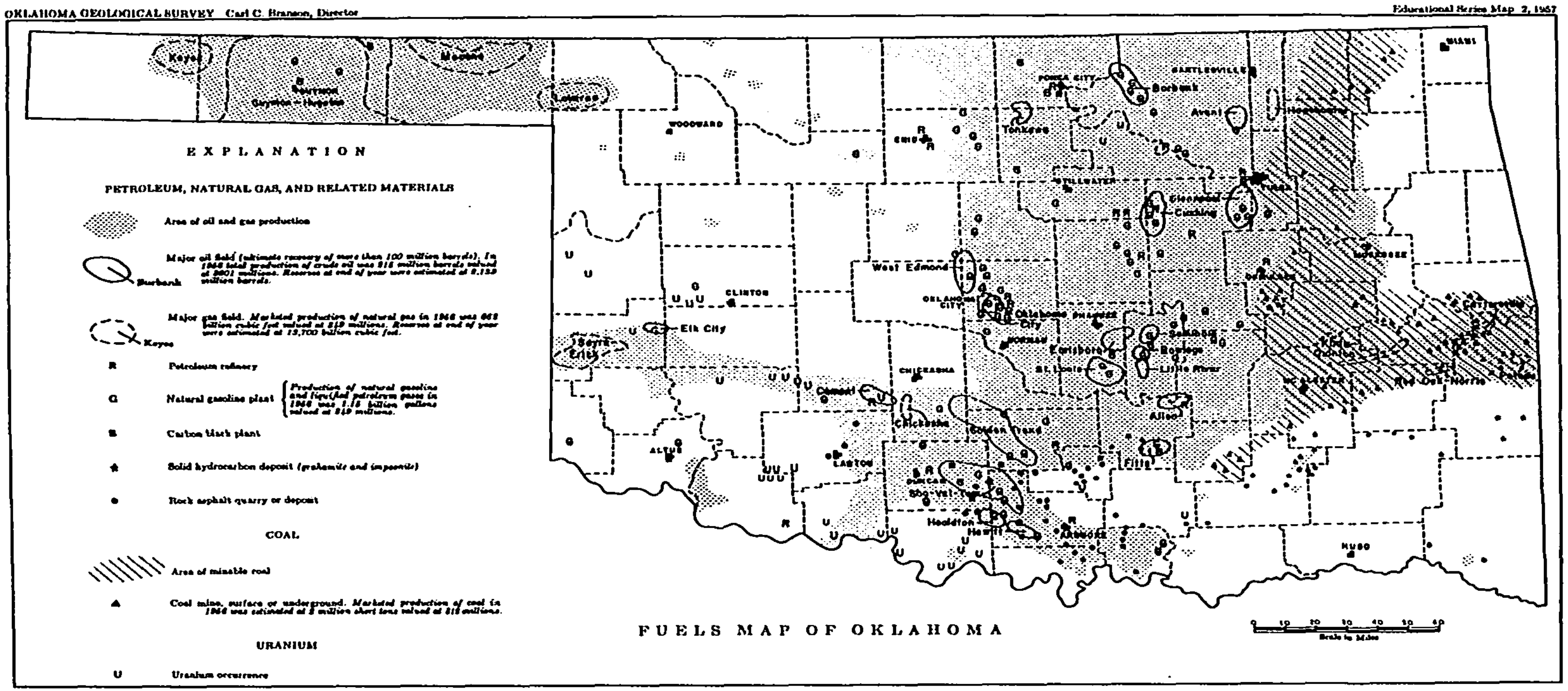

OKLAHOMA GEOLOGICAL SURVEY Carl C. Branson, Director
Educational Series Map 3, 1957
MINERAL MAP OF OKLAHOMA
(Exclusive of fuels)
Adapted from Oklahoma Geological Survey, Map 72-1, 1954
EXPLANATION
GRANITE AND RELATED ROCKS
Principal areas
Plant or quarry
LIMESTONE AND DOLOMITE
Principal areas
Quarry
Lime plant
GYPSUM
Principal areas
Plant or quarry
GLASS SAND
Principal areas
GS
Plant and quarry
SALT
Area underlain by salt
Plant
Salt plain
BRICK, TILE, OR POTTERY PLANT
CEMENT PLANT
SAND AND GRAVEL PITS
CHAT, DISTRIBUTION POINT
ZINC-LEAD MINE AREA
ZINC SMELTER
BUILDING STONE QUARRY
BENTONITE PIT OR DEPOSIT
TRIPOLI PLANT
VOLCANIC ASH PIT OR DEPOSIT
GUYMON
PONCA CITY
BARTLESVILLE
ENID
STILLWATER
TULSA
MUSKOGEE
CLINTON
OKLAHOMA CITY
OKMULGEE
SHAWNEE
NORMAN
CHICKASHA
McALESTER
ALTUS
LAWTON
DUNCAN
ARDMORE
HUGO
0 10 20 30 40 50 60
Scale in Miles

Figure 45



OKLAHOMA GEOLOGICAL SURVEY Carl C. Branson, Director
Educational Series Map 2, 1967
EXPLANATION
PETROLEUM, NATURAL GAS, AND RELATED MATERIALS
Area of oil and gas production
Burbank
Keyes
Petroleum refinery
Natural gasoline plant
Carbon black plant
Rock asphalt quarry or deposit
COAL
Area of minable coal
URANIUM
Uranium occurrence
FUELS MAP OF OKLAHOMA
West Edmond
Oklahoma City
Elk City
Sayre
Cement
Chickasha
Golden Trend
Sho-Vel-Tum
Healdton
Hewitt
Tonkawa
Glenpool
Cushing
Seminole
St. Louis
Little River
Allen
Fitts
Avant
Red Oak-Norris

Figure 46

The map also shows Oklahoma to have twenty-one petroleum refineries located in the central counties extending from the northern counties to the southern counties. The same area seems to have numerous natural gasoline plants; two carbon black plants are in operation - one in Texas county and another in Kay county.

Solid hydrocarbon deposits are located in the four-county area of Atoka, Pittsburg, Pushmataha and Leflore, while the rock asphalt quarry or deposits are present mainly in Pontotoc, Murray, Stephen, Carter, Love, and Marshall. Uranium is reported to occur in the southwestern counties of the state.

The elevation of Oklahoma counties favors the western areas of the state extending from the highest elevation in the panhandle to the lowest in the eastern counties of the state (Fig. 47).

The urban-rural distribution of Oklahoma residents by county (Fig. 48) shows the metropolitan counties to be located in the Northeast (Tulsa, Washington, and Muskogee counties), the North Central (Kay and Garfield), the Central (Oklahoma, Cleveland, and Pottawatama counties), and the South Central (Comanche and Carter counties). The rural counties favor the western third of the state including the panhandle area.

No urban-rural adjusted mortality differences were reported for cancer of the stomach, prostate and leukemia among the white males, cancer of the ovary among the white females, or cancer of the large intestine and rectum among both males and females. Among the white females, rural counties reported higher mortality for cancer of the stomach. The reverse was true among the white females for cancers of the breast, cervix uteri and leukemia (Table 37).

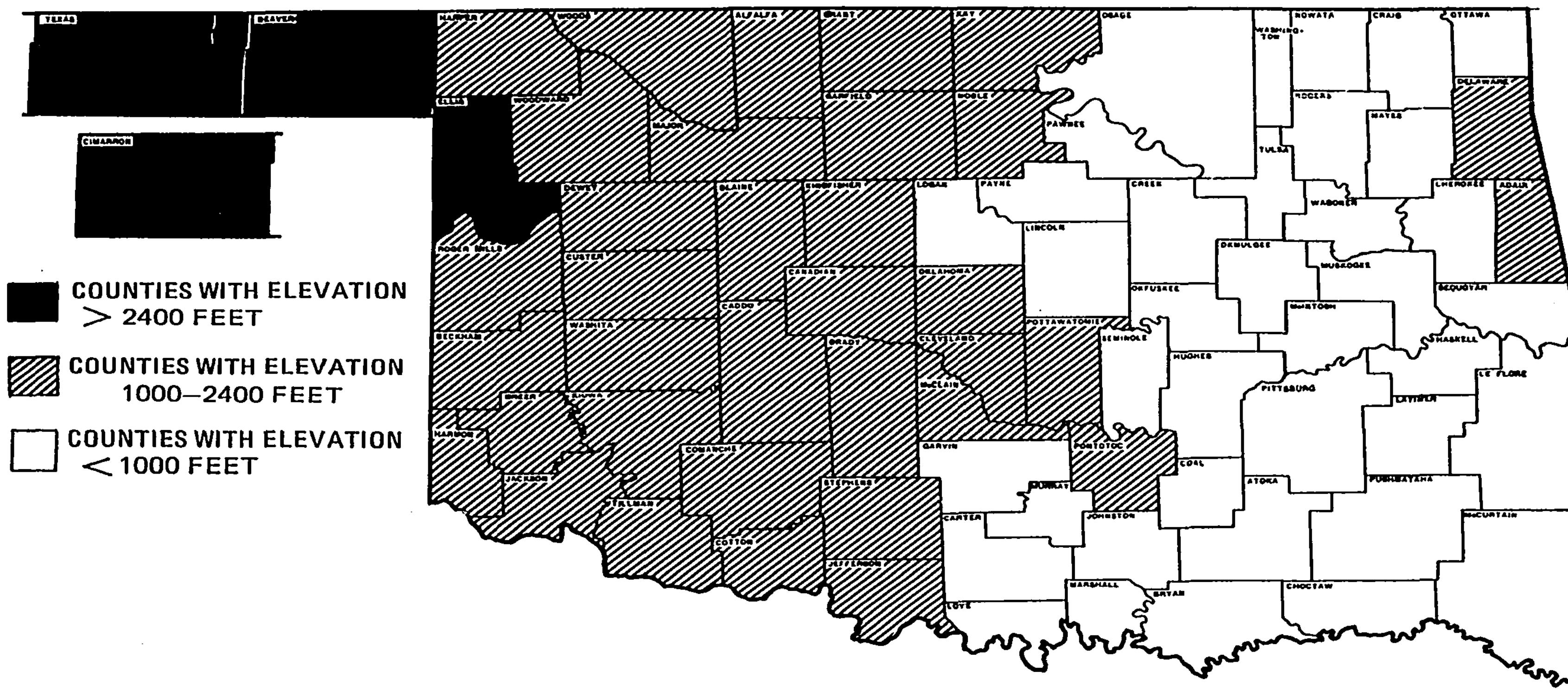


Figure 47. Elevation Map of Oklahoma.

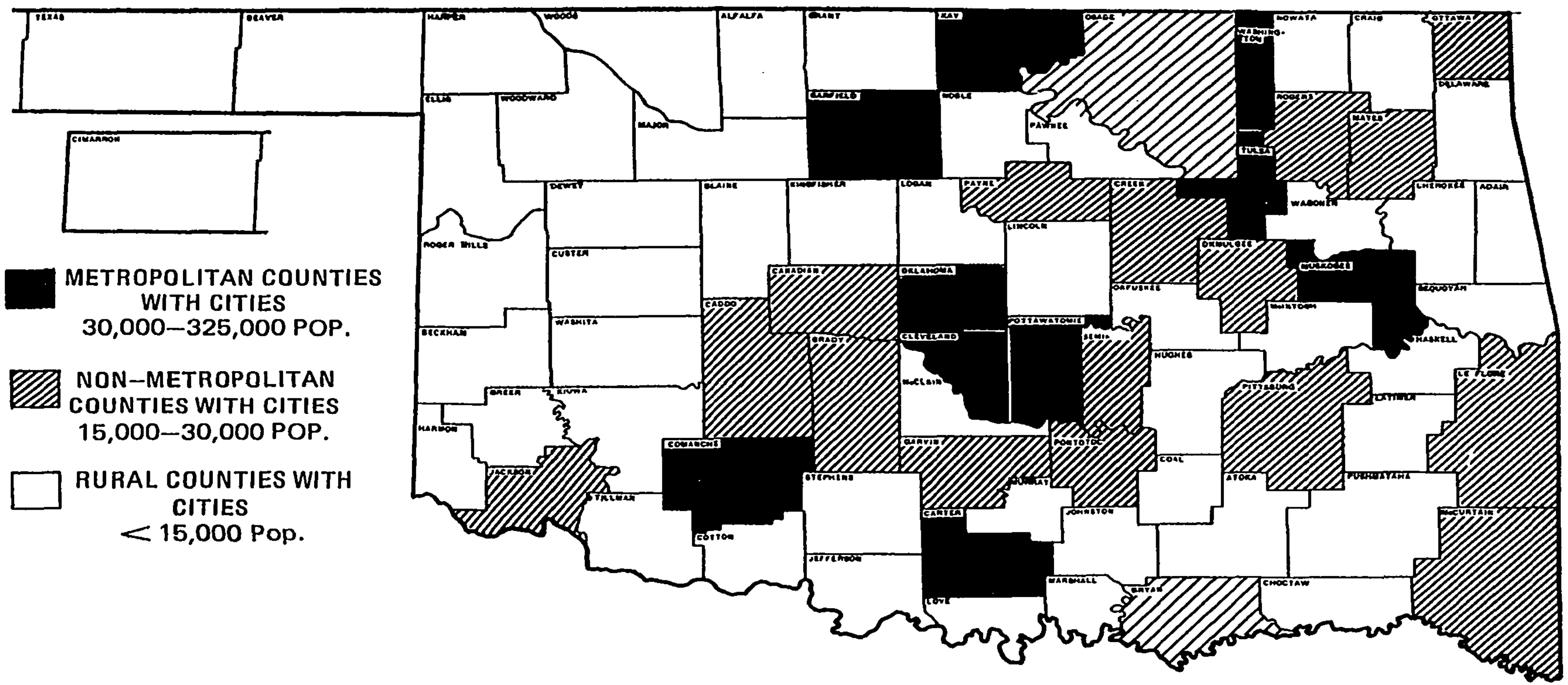


Figure 48. Urban–Rural Distribution of Oklahoma Counties (1960).

Cancers of the pancreas, lung, trachea bronchus, kidney and bladder occurred more frequently among the metropolitan population than among the rural population of Oklahoma (Table 37).

A high socioeconomic status is indicated for Tulsa and Oklahoma counties and for the northern and northwestern districts of Oklahoma. The eastern and southeastern districts are reported to have low socioeconomic status (Fig. 49).

The Kendall rank correlation coefficient for white males and females by cancer site is between -0.00329 for cancer of the esophagus to 0.20641 for cancers of the lung, trachea, bronchus and leukemia (Table 38).

Most of Oklahoma's cropland is located in the western counties including the panhandle area (Fig. 50). Azinphosmethyl, Carbophenthion, Demeton, Methyl-parathion and Parathion are among the many toxic insecticides used by the Oklahoma farmers (Table 39).

TABLE 37

MEAN AVERAGE ANNUAL AGE ADJUSTED DEATH RATES BY SEX OF WHITE POPULATION AND DEGREE OF URBANIZATION FOR OKLAHOMA COUNTIES, 1956-65

Cancer Site		Degree of Urbanization			Kruskal-Wallis Test
		Metro-politan	Nonmetro-politan	Rural	Chi-Square Values
	Sex	Mean	Mean	Mean	
Stomach	Male	12.8	13.3	12.0	5.77
	Female	6.1	7.1	7.8	6.92*
Large Intestine and Rectum	Male	16.3	16.1	16.4	5.67
	Female	17.5	17.0	17.4	5.92
Liver	Male	6.6	6.9	5.4	7.78*
	Female	5.2	6.0	5.2	10.10**
Pancreas	Male	10.2	9.7	8.7	6.35*
	Female	6.2	5.5	5.3	7.60*
Lung, Trachea and Bronchus	Male	34.6	38.6	31.8	16.17***
	Female	6.2	6.0	5.1	11.28**
Breast	Female	21.2	17.5	16.9	15.17***
Cervix	Female	8.6	9.0	6.2	17.59***
Ovary	Female	7.1	6.9	7.0	5.79
Prostate	Male	18.5	19.9	19.9	5.74
Kidney	Male	4.2	3.7	3.1	9.08*
	Female	2.0	1.5	1.6	8.09*
Bladder	Male	6.6	4.8	4.0	15.24***
	Female	2.4	2.1	2.2	6.36*
Leukemia	Male	9.8	9.7	10.3	5.42
	Female	6.7	5.9	6.0	6.43*

Chi-Square Values

***$p < 0.001$

**$p < 0.01$

*$p < 0.05$

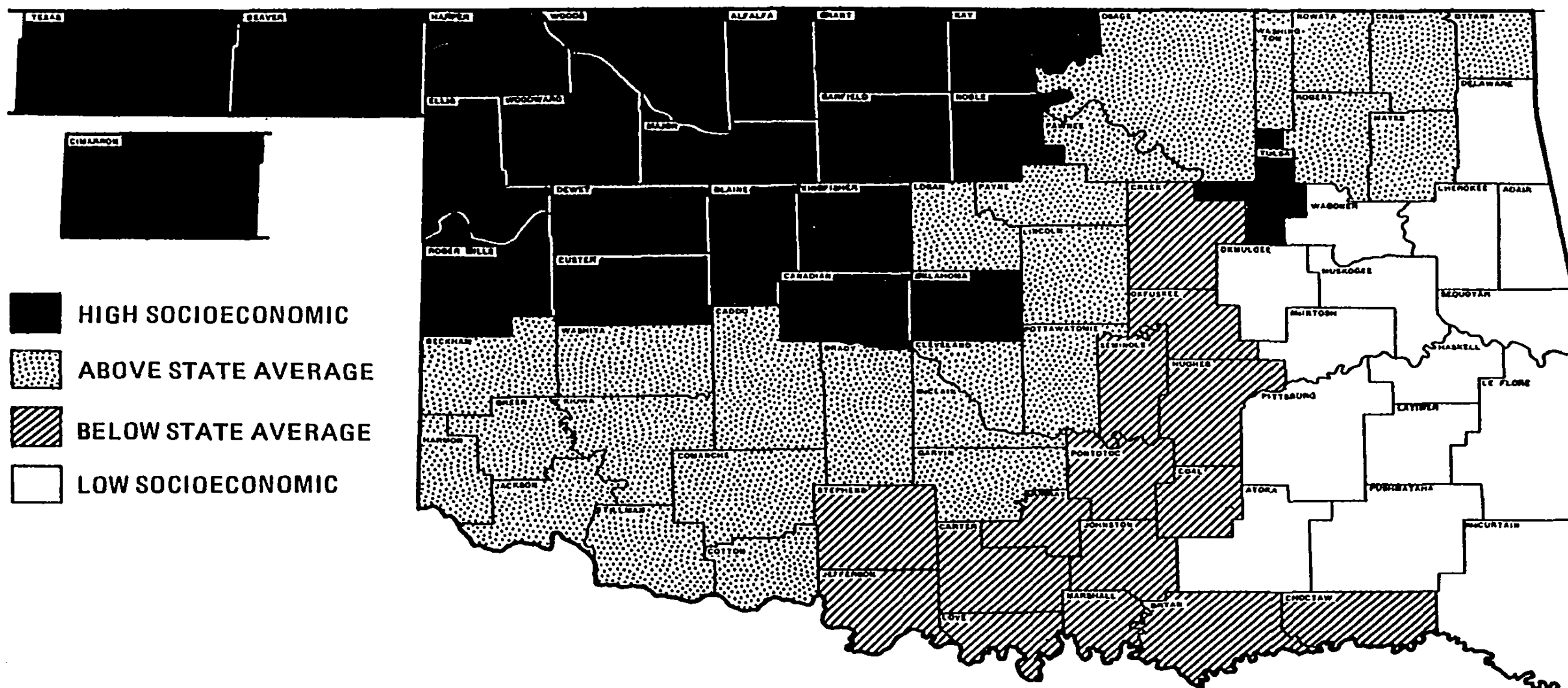


Figure 49. Socioeconomic Distribution of Oklahoma Counties (1950)

TABLE 38

CORRELATION BY COUNTY OF AVERAGE ANNUAL AGE ADJUSTED DEATH RATES FOR OKLAHOMA WHITE MALES AND FEMALES (1956-1965)

Cancer Site	Kendall Rank Coef.	Z
Buccal Cavity	0.06833	0.879
Esophagus	-0.00329	-0.042
Stomach	0.10493	1.350
Large Intestine & Rectum	0.16372	2.106
Liver	0.13096	1.685
Pancreas	0.08211	1.056
Lung, Bronchus & Trachea	0.20641	2.656
Kidney	0.04460	-0.574
Bladder	0.09154	1.178
Skin	0.01343	0.172
Eye	0.19186	2.469
Brain and Nervous Tissue	0.17080	2.198
Thyroid Gland	0.10821	1.392
Hodgkins Disease	0.07908	1.017
Lympho & Reticulo Sarcomas	0.11418	1.469
Others, Lymphoma	0.01309	0.168
Multiple Myeloma	-0.06192	0.796
Leukemia	0.20641	2.656

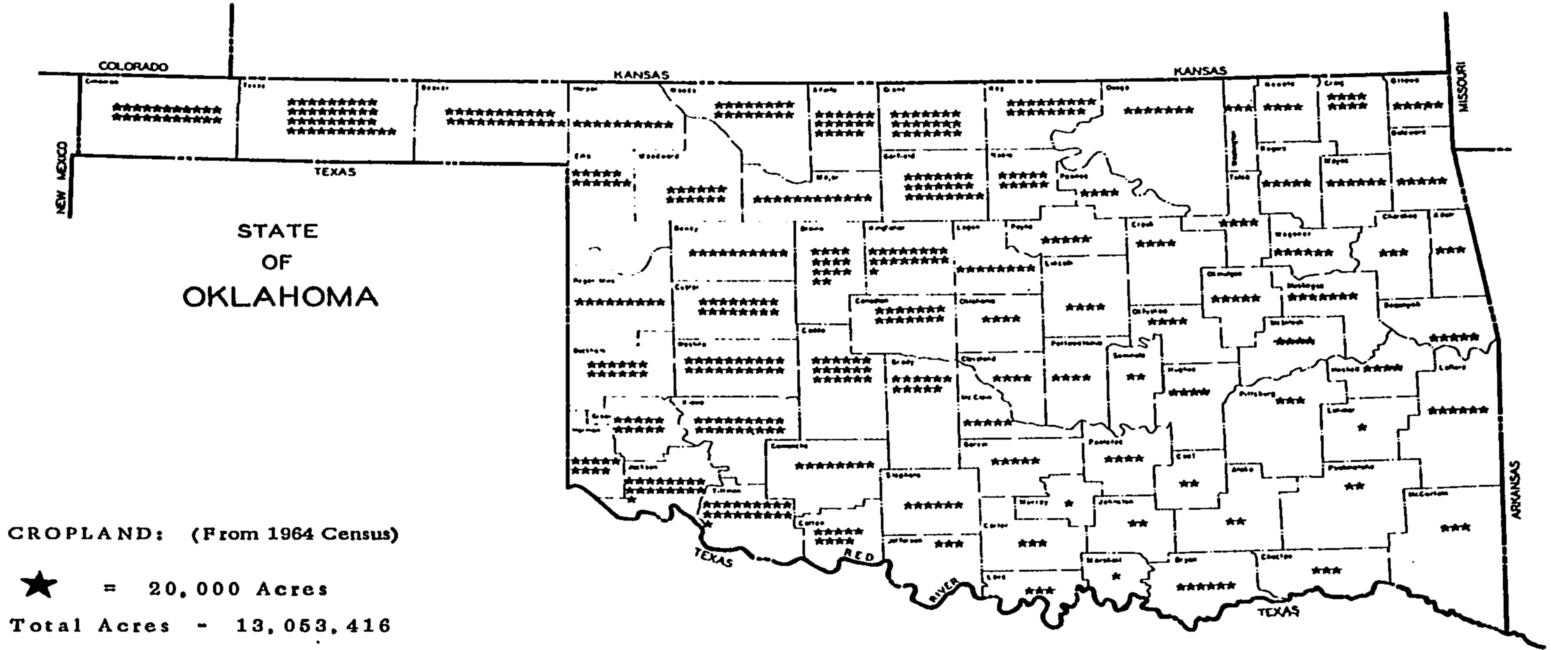

COLORADO
KANSAS
KANSAS
NEW MEXICO
TEXAS
MISSOURI
ARKANSAS
STATE
OF
OKLAHOMA
TEXAS
RED
RIVER
TEXAS
CROPLAND: (From 1964 Census)
★ = 20,000 Acres
Total Acres - 13,053,416

Figure 50

TABLE 39

INSECTICIDES USED TO CONTROL INSECTS AFFECTING CROPS IN OKLAHOMA[b]

Aldrin	Heptachlor
Azinphosmethyl[a]	Malathion
Carbaryl	Methoxychlor
Carbophenothion[a]	Methyl Parathion[a]
Chlordane	Mevinphos
Demeton[a]	Parathion[a]
Diazinon	Phorate
D D T	Toxaphene
Endrin	Trichlorforn

[b]Suggested by the Department of Agriculture.

[a]Known to be toxic to humans.

CHAPTER V

DISCUSSION

Secular Trends

The secular trends of adjusted mortality from malignant disease in Oklahoma for the two five year periods studied are consistent with the trends reported for the rest of the United States (262).

In considering secular changes in age-adjusted mortality from malignant disease in Oklahoma several reasons will have to be considered as affecting these changes. The change may be due to improvement in dianosis, survival experience of patients, the aging of the population, changes in classification of the cause of death, or a true change in the incidence of the disease (158, 159). The changes reported for any specific site are the net results of the above factors (158).

The most probable reason for changes in secular trends are those due to improvement in diagnosis, however, this may be very difficult to assess (158, 159). Improvement in diagnosis may have influenced slight changes in any specific site, the fact is that other factors are responsible for dramatic changes. It is of interest to note that the practices of classifying the cause of death on the death certificate in Oklahoma have not changed during the ten year period studied.

Decreases in mortality from cancer of the stomach have been suggested to be due to previous misdiagnosis, especially of cancers of other sites of the digestive system such as that of the pancreas and the esophagus. The adjusted mortality for cancers of the digestive system other than stomach have not reported any dramatic increases to account for the large decreases from gastric cancer in Oklahoma during the two five year periods.

Lilienfeld suggested that improvement in diagnosis are most marked for the aged (158, 159). The decline in age-specific mortality for cancer of stomach among the white population occurred for all age groups, but were more pronounced for the aged. It is then reasonable to conclude that part of the decline in adjusted mortality is due to improvement in diagnosis and partly due to actual decrease in the incidence of the disease.

The nonwhite population of Oklahoma reported marked increases for some age groups and decreases for others. This lack of consistency in age-specific death rates for gastric cancer among the nonwhites is difficult to interpret and improvement in diagnosis cannot be ruled out as the main reason for this inconsistency in secular trends.

Several epidemiologists have speculated that dietary habits may account for the decrease in gastric cancer mortality. It is difficult to assess such change within the framework of this study.

As for cancer of the lung, trachea, and bronchus, the dramatic increase in the disease is probably due to new factors introduced into the human environment. The increase in mortality is reported for every age group among the white population and for most age groups among the nonwhites. To say that the increase is due to improvement in diagnosis we would have to assume gross misdiagnoses in the past on the part of Oklahoma physicians.

The mean incubation period for cancer varies from one site to another and is in the order of forty years for cancer of the lung (4, 158, 159). Therefore, we must look at factors introduced into the human environment shortly after the turn of the century. The report of the Surgeon General on Smoking (258) indicate a dramatic increase in per capita consumption of cigarettes for the United States that began since the turn of the century. The per capita sales of cigarettes and probably consumption in Oklahoma have increased during the last sixteen years. No data are available previous to 1950 for Oklahoma, but since the trends in cigarette sales since 1950 are consistent with the national trends, it is then reasonable to assume that the increase reported for Oklahoma since 1950 has begun since the turn of the century and has influenced the rising trends of lung cancer mortality in Oklahoma.

No data is available to measure the increase in air pollution for Oklahoma, however, about 78 percent of the Oklahoma counties have lost in population counts between the last two censuses. At the same time the ten metropolitan Oklahoma counties have gained in population. The shift in the population of Oklahoma from the rural counties to the metropolitan counties, where the degree of air pollution is greater, may have contributed to the rising trends in cancers of the lung, trachea, and bronchus.

It is interesting to note here that the Kruskal-Wallis test to test urban-rural difference for lung cancer, is highly significant ($p < .001$) for the male population and significant for the female population. Lung, trachea, and bronchus cancer was less prevalent in the rural counties.

The same may be said of the slight increase in deaths from leukemia. This increase may be partly due to improvement in diagnosis and partly to increased exposure to ionizing radiation or some other environmental factor. It would have been interesting to look at background radiation data, had it been available, and to see in what manner it influences the mortality from leukemia in Oklahoma.

The reported decrease in mortality from cancer of the cervix uteri in Oklahoma may be accounted for by the increased recognition and treatment of precancerous lesions that prevent the eventual development of death from this malignant disease.

It is improbable to assume that genetic factors are responsible for changes in secular trends, since the genetic constitution of the Oklahoma population could not have changed in such a short period of time.

Sex Differences

In the United States, mortality from cancer of the buccal cavity, esophagus, pharynx, larynx, lung, bronchus, and trachea is higher in males than females (158). In addition to these sites, the Oklahoma male experienced higher mortality from cancer of the stomach, pancreas, mediastinum and thoracic cavities, kidney, bladder, skin, and brain and nervous tissue.

Cancer of the liver, small intestine, large intestine and rectum are almost equally distributed between males and females in Oklahoma as in other parts of the United States (158), and only cancer of the thyroid gland occurred with excessive frequency among the Oklahoma females.

In attempting to explain these sex differences it was suggested by Lilienfeld that either males are more predisposed to cancers, or that males are more exposed to environmental carcinongens (159). He also noted that cancer sites most frequently occurring among males are those in the upper end of the respiratory and digestive tracts which are under heavy exposure to external factors. We should also mention that certain human habits and occupations render the males more exposed to some carcinongens than the females. For instance there are more smokers among the males than the females (258). Most occupations where the risk of lung cancer mortality is increased are predominantly male occupations such as mining.

Racial Differences

The nonwhite population of Oklahoma reported marked increases over the white population in mortality from cancer of the esophagus, and small intestine among the males, cancer of the stomach among both males and females and cancer of the liver among the females.

Both whites and nonwhites reported similar adjusted mortality from cancer of the breast, ovary, kidney, bladder, bone and lymph nodes.

The nonwhites experienced fewer deaths from cancer of the lung trachea and bronchus, leukemia, skin and brain and nervous system.

Large increases for the nonwhites were noted for cancers of the cervix uteri, uterus and others of female organs, and prostate gland.

It is difficult to interpret these age adjusted differences as the nonwhite population of Oklahoma is not homogeneous and constitutes two different racial groups. The negro population predominates in the metropolitan counties and the Indian population resides mostly in the rural counties. It is reasonable to assume that the availability of medical care for the two racial groups is not the same nor is it similar to the white population. In dealing with racial groups several factors will have to be considered here, one of which is the genetic constitution of the populations, others are diet and personal habits, socioeconomic and hygienic standards, sexual habits and fertility. Since the nonwhite susceptible population of Oklahoma is so small and is not homogeneous and few deaths may give a very high rate, we shall refrain from making any conclusions from these data.

Socioeconomic Distribution

The distribution of cancer mortality by socioeconomic districts is very difficult to interpret for Oklahoma because the adjusted death rates were tabulated by county and not by districts. There appears to be overlapping of high rate counties from one socioeconomic district to another. There is also an interaction of socioeconomic status with occupation and human habits such as smoking (159).

In Oklahoma, cancer of the large intestine and rectum for both males and females appear to be more prevalent in areas described as high socioeconomic. The same is true for cancer of the stomach among the Oklahoma males.

Among the white population deaths from cancer of the lung, trachea and bronchus appear to be less prevalent in the high socioeconomic areas of the state.

Breast cancer, and cancers of the prostate and ovary appear to be more prevalent in the upper socioeconomic districts. The opposite is true for the Oklahoma female dying from cancer of the cervix uteri. A pattern of change with social class is indicated for cancers of the breast and cervix uteri and not for any other site. Differences in adjusted mortality by social class may be influenced by differences in living habits, fertility pattern and marital practices. Several studies emphasized that the poor hygiene among the low socioeconomic groups might account for the increase observed in cancer of the cervix (89, 261, 271, 283).

Geographic Differences

The industrial environment is very important to consider in explaining geographic differences in mortality as workers are exposed to cancer producing substances in certain occupations. The association between excessive risk of lung cancer and exposure radioactive ore mining, nickel refining, chromate, asbestos, gas or tar is definitely established (158, 159). Certainly the geologic map of Oklahoma indicate definite variation in geology that may have some influence on the etiology of malignant disease.

The mineral map of Oklahoma shows the northwestern counties of the state are located in an area underlain by salt. This same area has the highest elevation of any other area of the state and is the area where the croplands are most prevalent. The geographic mortality by county for cancers of the gastrointestinal tract shows the disease to be more prevalent in this area also. It is difficult to say whether it is the elevation, the salty soil or the diet of the people of this area that is different from any other geographic area. Reports from Costa Rica, Chile, Japan, and Switzerland, all mountainous countries, indicate a very high mortality from gastric cancer. People of upper socioeconomic status engaged in farming are likely to eat more protein diets. An association between gastric cancer and low protein intake is evident for Japan, Chile and Switzerland (274).

The northeastern geographic area of the state is characterized by limestone and dolomite topography. Cancer of the respiratory system and buccal cavity is more prevalent in these areas. The only zinc lead mine area and chat distribution points are located in this area in Ottawa county north of Miami. Ottawa county experienced the second highest age adjusted death rate (50.0/100,000) for cancer of the lung, trachea and bronchus. Other zinc smelter areas are located in Washington and Okmulgee counties where the prevalence of respiratory malignancies is high.

The fuel map of Oklahoma shows the area of minable coal and coal mines to extend from Craig, Nowata, Roger, and Tulsa counties in the Northeast, all belonging to the area of highest lung cancer prevalence to Okmulgee, Muskogee, McIntosh, Sequoyah, Leflore, Haskell, Latimer, Pittsburg, and Coal counties in the east central. Most of these counties have experienced lung cancer mortality of the highest or second highest quartiles.

The central area of the state extending from the northern counties to the southern most counties have located in them more than nineteen petroleum refineries and numerous natural gasoline plants. It is also of interest to mention here that most of Oklahoma metropolitan and nonmetropolitan counties are located in this belt. It is difficult to assess the pollution of the air from these and other industries, as no data are available, but we can say the urban environment contributes something to the complex etiology of some cancers. The urban-rural differences (Table 37) for cancers of the lung, trachea, and bronchus are highly significant ($p < 0.001$). Also urban-rural differences for breast, bladder, liver, pancreas, kidney, and female leukemia and cervix are significant. The diseases seem to increase with urbanization for all the above sites. Whether these differences are true differences because of factors in the human environment or due to availability of medical care and improvement in diagnosis is difficult to say here.

The living habits are most difficult to evaluate. For instance, the lowest per capita sales of cigarettes districts are areas highest in mortality from cancer of the buccal cavity and respiratory system, cancer sites where the association between cigarette smoke and cancer has been established. Several questions will have to be raised here. One concerns the sales of cigarettes. Is the low sale of cigarettes in an area an indication of low consumption or is it an artifact? Do people in the different districts buy their cigarettes from Oklahoma or cross over to the bordering states? Does the fact that the metropolitan counties of Tulsa and Oklahoma have the highest sales, an indicator of higher consumption or just sales to people residing in neighboring counties? The data on cigarette sales covers a very short period of time and may not be in any way near the true picture of tobacco sales twenty, thirty, or forty years ago. It is of interest to note that counties with high sales of cigarettes, excluding the Tulsa-Oklahoma City areas, are located in the southern most counties bordering Texas. Either cross over from Texas to Oklahoma or lack of cross over may account for the high average of sales. The lowest per capita sales district is located in the northeast bordering Kansas, Missouri, and Arkansas.

Since the etiology of lung cancer is still a controversial topic we could only speculate about the decline in age specific death rates after age group 65-74. This trend is not true for other forms of cancer. Assuming that factors such as the habit of smoking or occupational exposure to carcinogens are formed at an early age, say 18-25, and the onset of the disease is 20-40 years later, then the decline after age group 65-74 can be explained. The cohort approach to lung cancer mortality does not show such a decline in age specific death rates (158).

In conclusion we can say that many factors may be responsible for the excessive risk in mortality from malignant disease in any geographic area and no one factor must always be present for the disease to occur in high frequency.

CHAPTER VI

SUMMARY

Mortality from cancer (ISC 140-239) occurring to 35,148 Oklahoma residents during 1956-1965 were analyzed. Age-sex-race specific and adjusted death rates for 34 specific sites were tabulated for 1956-1960 and 1961-1965. An average annual age-adjusted death rate for white males and females was plotted on county maps. Data on the human environment and personal habits were analyzed. An attempt was made to relate secular changes and geographic differences in cancer mortality to factors in the human environment.

The secular trends in malignant disease for Oklahoma are consistent with those reported in the rest of the United States. A definite decline in gastric cancer, attributed partly to improvement in diagnosis, and cancer of the cervix uteri, attributed to increased recognition and treatment of precancerous lesions, and a dramatic increase in cancer of the respiratory system influenced by an increased exposure to air pollution and to increase in cigarette consumption are the most obvious among age-adjusted mortality for Oklahoma during 1956-1965.

The geographic distribution of adjusted mortality shows cancer of the respiratory system and buccal cavity to be more prevalent in the northeastern counties, an area characterized by limestone and dolomite topography where zinc, lead and coal mining predominates, cancer of the cervix uteri in the eastern third of the state, a very low socioeconomic area where hygienic practices are very low, and cancer of the gastro-intestinal tract, prostate, and breast in the northwestern counties, a rural area of high elevation, underlain by salt, inhabited by people of high socioeconomic status whose dietary habits and fertility pattern may be different.

Among cancer deaths for all groups and for the white males, lung cancer was the leading cause of death and among the white females, cancer of the breast. As for the nonwhites, cancer of the prostate was the leading cause of death among the males and cancer of the cervix uteri among the females.

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