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A Correlation Study of Atmospheric Conditions & Incidences of Respiratory Deaths

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A CORRELATION STUDY
OF ATMOSPHERIC CONDITIONS
AND INCIDENCES OF RESPIRATORY DEATHS

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OF ATMOSPHERIC CONDITIONS

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Mortality data from two populations, Bowling Green and Lexington, Kentucky, were correlated with atmospheric conditions for this region. The mortality data included the cause of death by respiratory disease, age, sex and race. The respiratory diseases considered in the study were emphysema, tuberculosis, pneumonia, asthma, influenza, acute and chronic bronchitis. The atmospheric conditions considered to have an effect on health were temperature, barometric pressure, relative humidity and precipitation. Mean temperature, mean barometric pressure, and mean precipitation per month were correlated with the death rate per thousand but proved no significance at the .05 level in either study area. In the null hypotheses low temperatures, high barometric pressure, and dry weather did not show a high significant correlation with death rate. The availability of data and sample size were limiting factors in this study.

CHAPTER ONE

CLIMATIC FACTORS AND HEALTH

Introduction

This study is in an area of interest between two major disciplines - Geography and Medicine. It is a new area called medical geography and has been widely recognized only in the last two decades. The field encompasses those environmental conditions which are causatively related to human health. There are three broad environmental factors that affect man and disease: 1) physical, which includes geographic, geologic, and climatic factors; 2) biological factors; and 3) socio-economic factors (Fox, 1970, 93). Only the climatic factors will be utilized in this study.

Medical geography has been used as an etiological research tool with emphasis on reducing mankind's suffering from diseases (McGlashan, 1972, 5). The geographic distribution of diseases and the nature of their etiology constitute the field of geographic epidemiology or medical geography as defined by Dr. Jacques May in his book, The Ecology of Human Diseases. Geography acts as an indirect determinant of disease; but climatic or meterological conditions play an important role in the incidences of diseases. Prior to the Industrial Revolution, Hippocrates and later Sir Thomas Sydenham believed atmospheric changes (depending on season and year) determined the nature of prevailing epidemics of disease. Atmospheric factors such as solar effects, temperature, precipitation, barometric pressure, and winds influence disease occurrence directly by their interaction with the causative agents and hosts and indirectly influence the biological and socio-economic environment (Fox, 1970, 96).

Mortality rate from many diseases vary with seasons and short term weather changes. Respiratory diseases occur most frequently in the colder months, mainly because there is an increase of people congregating indoors which facilitates transmission or increases susceptibility of the disease. The very young and very old are perhaps the most susceptible to pneumonia and other respiratory diseases because their bodies are physically incapable of fighting off the causative agents (Mills, 1954, 124).

Atmospheric pressure and relative humidity changes bear a relation on irritating respiratory passages. Atmospheric conditions were found to trigger asthma attacks in the study by Landsberg in 1961. There are seasonal patterns for such non-allergenic attacks*. As late summer and early autumn come to an end with warm air followed by sharp cold fronts and decreasing temperatures causing intense storm centers, these attacks become more numerous and severe. Hospital admissions during these periods increased two to three times the usual number. As the weather warmed, the number of patients seeking

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*attacks that are not provoked by allergen or substances that cause an allergy in an individual.

treatment decreased to normal (Landsberg, 1969, 107). Because weather is a contributing factor to infectious respiratory diseases, incidences of these diseases peak in winter and occur less frequently in summer. Cough and sneezing droplets are transmitted through the air, but with a rise in temperature the droplets will evaporate because of lowered humidity (there being no base for the fluid). With a drop in temperature the droplets will remain intact because the humidity has increased. Consequently, in the winter when the relative humidity is higher than in summer the incidence rate is higher. Cough and sneezing droplets will freeze at temperatures below 32°F or 0°C; therefore respiratory diseases are rarely found in polar regions. These diseases survive better in damp, cloudy, and cool climates (Landsberg, 1969, 115-116).

Changes in climate affect people with chronic respiratory ailments such as asthma and emphysema which are both characterized by heavy mucous secretions. The respiratory passages become blocked with the secretion; but they are sometimes relieved by a change in climate to a better quality of air and lower relative humidity. Climatically, deserts or arid areas would be the ideal environment, but there is too much dust present in the air. The leeside of high mountains, especially at moderate elevations, provides climatic conditions favorable for alleviating these ailments (Landsberg, 1969, 134-135).

Purpose and Setting

The study area of this thesis falls within a Humid Subtropical Climate (Cfa) which is characterized by abundant rainfall and hot to cool temperatures. The climate of Kentucky is generally temperate; sunlight, heat, moisture, and winds are all in moderation without prolonged extremes (Griffin, 1968, 231). For this study the author selected Bowling Green in western Kentucky and Lexington in eastern Kentucky. Both cities exhibit a comparable climate as shown on the Overlays 1-2 (Appendix J).

The purpose of this study is to determine if a significant correlation exists between certain atmospheric conditions and incidences of respiratory deaths. The atmospheric conditions being used are barometric pressure, temperature, and wet versus dry seasons. The respiratory diseases are pnemonia, chronic and acute bronchitis, asthma, emphysema, influenza, and tuberculosis. (See Appendix B for definitions.)

Review of Literature

As stated before, medical geography had not really been recognized until the last twenty years. Considerable research has been reported by various medical doctors, epidemiologists, and geographers or environmentalists. Neither discipline claims the knowledge or understanding of the other. The environmentalist cannot pinpoint causative agents for diseases and what causes people to die; whereas the medical doctors cannot really do an effective spatial or correlated study of climatic conditions and diseases. Both disciplines realize these limitations and often work together.

Most recent studies have dealt with the effects of air pollution on health. With the increasing population, industrialization, and modes of transportation, air pollution has become one of society's biggest problems. Medical doctors and epidemiologists have been especially interested in the effects of air pollution on a wide variety of life forms. These studies show that air pollution does in fact have an affect on both the quality and quantity of life.

McCarroll and Bradley (1966) noted that peaks of high mortality were associated with periods of high air pollution. Periods of low wind speed and temperature inversion conditions had to be present in order to increase pollution levels.

In his study, Carroll (1968) found the cause of New Orlean's asthma epidemics to be air borne for two reasons: 1) air pollution never occurred on rainy days and 2) people were affected in a very short time. In New Orleans October was the driest month, but the increased incidence did not seem directly related to this dryness. Even though spring was relatively dry compared to the rest of the year, epidemics during this time were more variable.

Cassell (1968) reconsidered mortality as a useful index of the environmental factors related to health. He noted that the complexity of different variables which act to produce mortality over short time periods make it difficult to assign a cause and effect role to any of them. Interpretation of data played an important role in determining mortality as an index.

Fox, Hall and Elveback (1970) discussed the different environmental factors that affect man and disease. The factors studied were physical, biological and socio-economic. The physical factors were considered to act as a determinant of the other factors. Weather conditions were found to be conducive for related causative agents to survive in order to influence the health status of the residents. One socio-economic factor considered was occupation. If the occupation was not agriculturally related, the climate had little influence directly upon it.

Thompson (1970) studied pollutants, such as particulate matter, carbon monoxide and sulphur dioxide levels and meterological variables like temperature, relative humidity, wind speed, barometric pressure, and solar radiation to determine if they affect health. He found respiratory diseases, especially the common cold, were affected by environmental factors.

Many environmentalists have done research on air pollution and its relationship to health. During certain meterological conditions air pollutants will increase causing air to become heavy with smog, making it more difficult to breathe, especially if toxic forming substances like sulphur dioxide are in the air. When sulphur dioxide is mixed with water, as often occurs in persistent fog, it becomes weak sulphuric acid which is very hazardous to human health and other life forms (Leithe, 1970).

Herber (1965) completed studies on photochemical pollutants and periods of persistent air pollution to determine which caused the most harm to health. He found there was difference between the acute and chronic effects. Edelson and Worshofsky (1966) have done studies in Japan, Los Angeles, Denver, and New Orleans on the effects of air pollution on health. The factors they considered causually related to upper respiratory diseases were socio-economic, population density, aviation location, surrounding terrain, and meterological conditions. They concluded that cities need to know weather conditions and geographical features to combat air pollution and its effects.

Stern (1967) concluded that with a better understanding of meterological air pollution potential of different parts of the nation, man will better anticipate trouble spots in the future, especially if big cities and heavy industry expand to geographical areas of poor ventilation. Landsberg (1970) studied how man has changed the climate and what affects this causes in urban and rural areas. Man and other life forms have to fight for survival in this technologically advanced world.

Paul and Anne Ehrlich (1970 and 1973) found in the southern counties of California that anyone who has chronic respiratory ailments should leave this region of the country as part of their treatment. As population increases, air pollution control agencies have found difficulties in the improvement of air quality because of increased needs and use of transportation, business and industry. The effects of air pollution were thought to be a major cause of excessive mortality rates that have occurred during smog disasters (Ehrlich, 1973, 120).

Leighton (1971) found that since 1940 emissions continue to increase relative to population. Deaths from the common cold, asthma, chronic bronchitis, and emphysema can be correlated with the amount and type of fuel used and the sulphur dioxide level in the air. Detwyler (1971) discussed many various aspects of man's influence on the environment and how the different environmental factors influence man and other life forms. The section of the book that was of concern in this study was atmospheric conditions and man's health.

Detwyler and Marcus (1972) discussed how urbanization has affected the environment. In turn, they also discussed the environment's effects on various life forms. The authors included topics on environmental problems such as pollution causes and effects. Ivany (1972) included several readings in Environment that discussed the environment's problems and influences on man's health.

All the previously cited studies found significant increases in death rates from prolonged exposure to air pollutants. These include disasters where 4000 persons died from sulphur dioxide poisoning in London in 1952 and in Donora, Pennsylvania in 1948 when hundreds were killed from the same problem. Detwyler (1971, 108) points out that the U.S. Weather Bureau established, through statistical evidence, there was a concurrent relationship of high pollution values and certain atmospheric conditions covering wide areas of the nation. Persistent high levels of air pollution were associated with large areas of light winds (at the surface and aloft) and sufficient atmospheric stability (anticyclone) to inhibit vertical motion. Landsberg (1968, 83) cited an example of this condition which occurred in December 1952 in London. When the cold winter season set in, a stagnant air mass and a high pressure or anticyclone system settled over London. An inversion of temperature caused the cold air to hug the ground lowering the dew point; thus a damp fog formed allowing the sulphur dioxide to become mixed with the water droplets forming sulphuric acid. As sulphur dioxide was fed into this acid forming fog, it resulted in a tremendous increase in the death rate.

Ivany (1972, 86) reported that in elderly and people with pre-existing respiratory ailments, deaths increased when a combination of fog, temperature inversion, and stagnant air coupled with large amounts of combustion produced a high level of pollutants. The Ehrlich research (1970, 119-125) found death rates above normal when and where smog occurred. The people most affected were the very young, the very old, and those with respiratory ailments. People with acute and chronic bronchitis, asthma, and emphysema were observed to have been more seriously affected by severe air pollution. Sulphur dioxide irritated respiratory passages causing coughing and choking. The effects of these were found to be major causes of abnormal death tolls that occured during smog disasters.

Edelson and Worshofsky (1966, 26) established that the chances of a man between fifty and seventy years of age dying of respiratory diseases were doubled if he lived in a polluted area. In any year, the death rate in polluted areas is 20 percent higher than the rate in areas exhibiting better quality air. The number of people dying of respiratory deaths doubles every five years. Herber (1965, 40-41) concluded persistent air pollution and long term exposure of people to pollutants result in chronic respiratory illness and premature death. Air pollution affects the health of three out of five Americans to varying degrees.

There have also been many studies on atmospheric conditions and health. As weather conditions have such a tremendous effect on air pollutants, it is difficult to separate the two in a study. Williamson (1973, 48) noted weather patterns were largely responsible for episodes of increased respiratory illnesses. Temperature change puts an unusual stress on the body and nervous system. Warm spells contributed to exhaustion and cold decreased mucous transport; thereby reducing efficiency in removing airborne materials from the lungs. Atmospheric pressure and relative humidity changes irritate respiratory passages especially when air is dry, windy and dusty. Fox (1970, 97) reported that brief peaks of dailty death rates coincided with passage of cold fronts reflecting the inability of sick people to withstand weather induced stress. McCarroll (1966, 1937) noted that in the winter of 1962-1963 New York City had repeated periods of extremely low temperatures. In London the same conditions existed. Observations showed that following these cold waves there were periods of increased mortality occurring approximately eight to nine days after the onset of the cold waves.

Huntington's Mexico City study related climatic conditions with death rates. The death rates were at a low level in

November increasing to a high level in May. He concluded that temperature had nothing to do with fluctuating death rates, because while the death rate increased with cooler weather and was fairly low in January (mean temperature 53°F), the rate kept increasing until May, the warmest month (mean temperature 65°F). April and May were the driest months of the year and also had the highest death rates. When the June rains began the death rates started decreasing. The death rates increased little after the rainy season and declined slightly more under the stimulus of cooler weather, only to increase with the dry warm weather of spring. Huntington (1930) in a study of New York City used the weather conditions on the day of death and also on the days preceding deaths for the period from April 15, 1882 to March 21, 1888. The elements of weather used were mean temperature between successive days immediately preceding death. Some conclusions found were:

> ...any disease with a pronounced seasonal variability must show worse conditions as measured by deaths for those temperatures that prevail during the season of high incidence and better conditions for those that prevail during periods of low incidence.

In other words, pneumonia and influenza, normally being winter diseases, will show a higher temperature optimum than would diarrhea and enteritis which are summer diseases. His findings were as follows:

1) Deaths under five years, except pneumonia and influenza were high during 45°F optimum temperature.

2) Deaths in all ages from all causes were high during 63°F optimum temperatures.

3) Deaths over five years except pneumonia and influenza were high during 67° optimum temperatures.

4) Deaths in all ages from pneumonia and influenza were high during 80° optimum temperature.

Hypotheses to be Tested

This study will assume there are significant factors relating to weather conditions and incidences of respiratory deaths. Multiplicity of complex and variable factors which act to produce mortality over any given period of time makes it exceedingly difficult to assign a specific "cause and effect" relationship to any one of them. Any observed excess of mortality can be subject to numerous interpretations, on the other hand, over long periods of time the same mixture of factors results in a stable pattern of mortality (Cassell, 1968, 1957). The significant findings of the studies reviewed provided a basis upon which the hypotheses can be developed to determine if a signficant correlation exists between weather and mortality.

The following null hypotheses will be tested:

1. During periods of high pressure there is not a significant correlation with death rates.

2. During periods of low temperatures there is not a significant correlation with death rates.

3. During dry periods there is not a significant correlation with deaths.

Taking all the hypotheses into consideration, a general hypothesis is formed:

The variables selected in the hypotheses, one through three will explain higher death rates during certain weather conditions for Bowling Green and Lexington, Kentucky.

Summary

The first chapter dealt with establishing the purpose and setting of this study. A review of literature was given to justify and provide greater insight into the nature of the study. Utilizing the findings from these studies, the formulation of the hypotheses to be tested were set forth.

CHAPTER TWO

RESEARCH DESIGN

Collection of Data

The data for analysis were provided by three sources: the local health departments, weather stations of Bowling Green and Lexington, Kentucky and the U.S. Census. In the selection of data one must know where to search for them and whether or not they are available. The specialization of a study lies in the type of data which an individual most often uses. Many medical and geographical studies come up with inconclusive answers because there may be other factors that have to be considered. Having a meager biological or medical background, this author was limited in finding the cause-effect or etiology or respiratory diseases with weather conditions. This study deals with one causative factor - weather conditions which might hinder people with respiratory ailments.

Some limitations in the data collected should be explained. The data gathered from the U.S. Census of Population for the two study areas were easily accessible. Information of this type can be found in any library or resource center. Some of the population characteristic information for Bowling Green had to be obtained directly from the Vital Statistics Department in Frankfort, Kentucky. Bowling Green is not considered a Standard Metropolitan Statistical Area (SMSA), whereas Lexington is a SMSA. The information needed was a breakdown of population into age, sex, and race. The census provided this information for Lexington, but Bowling Green data sent from Frankfort were not complete for the female sex/race characteristics since the year 1964. These data had been combined with the male sex/race characteristics for the years 1964 through 1970. Consequently, the Lexington data had to be recombined and the study revised to include a race differentiation (white and non-white) rather than separately correlating race and sex statistics. The availability of comprehensive figures was a major problem when dealing with statistical data.

Confidentiality had to be taken into consideration when dealing with statistical data. It was necessary for the author to obtain permission from the county health departments in each study area to receive and use the necessary information. Warren County and Fayette County Health Department officials granted permission; and the data for Bowling Green and Lexington were gathered by researching all the death certificates for the study years 1961 through 1970. The data from death certificates were not always straightforward as there are primary and secondary causes involved in some deaths. The recorded cause of death was sometimes influenced by factors like the special interest or skills of the doctor or his consideration for the surviving relatives. Autopsies were not performed at all deaths, thus limiting the doctor's correct diagnosis of the cause of death.

People living in Bowling Green or Warren County and Lexington or Fayette County were considered in the gathering of the statistical data by place of residence. The place of residence was limited because the length of stay at a particular address could not be determined. The information obtained included the date on which the patient died, when the patient was admitted to a hospital for the respiratory ailment (if available), the patient's race, sex, age, and whether he lived in an urban or rural area. Occupation was also researched, but proved a limiting factor in the study because of an inability to establish how long the deceased worked at the recorded occupation and whether he worked inside or out.

Once the date of admission or date of death was established, it was correlated with meterological data for the date. Meterological data for Bowling Green were gathered from comprehensive records in the Department of Geography and Geology at Western Kentucky University. Meterological data for Lexington were obtained from the records of the Lexington Airport.

The data involved the date on which the patient had died or the date he was admitted to a hospital. The death certificate did not always note whether the patient was in a hospital or under doctor's care at the time of death. If the patient was in a hospital or under doctor's care, it did not note the duration of his stay or care. The meterological data included barmetric pressure, temperature, the relative humidity, if rainfall had occurred, or if sunny and dry conditions prevailed. Data were collected on two separate dates because weather could influence some patients prior to death. The weather in the study areas is known to "change every five minutes." Most of the weather data recorded by the meterologist at Western Kentucky University were at 0600 hours every morning, whereas in Lexington it was recorded every hour each day. The Lexington data were a twenty-hour average for the day, whereas Bowling Green was just one reading or sample for the weather for a particular day. This was a limiting factor in the weather data.

Preparation of Data

The mortality data were classified into race, sex, age, and respiratory disease. The data were converted into age-specific death rates per thousand, which was determined by dividing the number of deaths in each age and race group by the total population in each respective study area. The age-adjusted death rate for each race was computed by dividing the age-race specific death rate per thousand by the proportion of the U.S. 1970 population (in age groups) for each year and respective study area.

The weather data were classified into barometric pressure, temperature, and precipitation (wet or dry). The means of pressure and temperature were computed and the death rate for each month of each year and study area. The precipitation data were set up seasonally on graphs and were compared with the study areas' "wet and dry" seasons. For these particular areas, the "wet and dry" seasons corresponded to the "Tennessee" precipitation pattern in which there is no extremes of wet or dry, but the wettest month is March and driest is October.

Method of Analysis

Pearson's product-moment correlation was used to measure the degree to which the variables vary together or measure the strength of their relationship from 0 to 1.0 positively or negatively. This correlation was used on the total ten year period, rather than on the year to year correlation because of the sample size. The formula used is found in Appendix C. A Student's t-test was applied to test the significance of the correlation in testing the null hypotheses at the .05 significance level. To aid in interpreting the data on a year to year basis, because of the sampling size, Spearman's rank-order correlation was used to measure the independent variable, death rate to the dependent variables, mean temperature per month, mean pressure per month and mean rainfall per month. The formula used is found in Appendix C. To test the significance of the correlation of r_s, Table P in Siegel's Non-Parametric Statistics for Behaviorial Sciences (1956, 284) was used. Tables and graphs were used to further explain the interpretations of the data.

Summary

Chapter Two dealt with the research design for testing the hypotheses. The collection of data and why the author selected certain variables and their limitations were discussed. The preparation of data and the method of analysis were also discussed. Chapter Three will deal with the explanations of the statistical analysis and the null hypotheses' rejection or acceptance.

CHAPTER THREE

STATISTICAL ANALYSIS

<u>During periods of high pressure there is not a significant correlation with death rates.</u>

In testing this hypothesis Table 1 shows the Spearman's rank-order correlation, r_s for each year for Bowling Green. At twelve observations any value above .506 is significant at the .05 level (Siegel, 1956, 284). The calculation for the value of r_s is found in Appendix D. The independent variable (Y) is the death rate for each month. The dependent variables (X_1, X_2, and X_3) are the mean temperature, mean barometric pressure, and mean rainfall per month respectively.

In Bowling Green the mean barometric pressure proved no significant correlation in its relationship with respiratory deaths for any year. The graphs (Figures 2-11) in Appendix F indicate that there are more deaths during high pressure periods rather than during low pressure periods within each year. Since this is a visual comparison and there is no significant correlation between high pressure and respiratory deaths, then the null hypothesis is accepted.

Table 2 shows the Spearman's correlation for Lexington. During the years 1968 and 1969, the correlation between barometric pressure and the death rate proved to be highly signifi-

TABLE 1.

Spearman's Correlation for Bowling Green

Year	r_s value for mean temperature/month correlated with mean death rate/month	r_s value for mean pressure/month correlated with mean death rate/month
1961	.55*	.44 ns
1962	.15 ns	.23 ns
1963	-.29 ns	.23 ns
1964	-.68*	.14 ns
1965	-.32 ns	.40 ns
1966	-.62*	.35 ns
1967	-.70*	.31 ns
1968	-.46 ns	.36 ns
1969	-.64*	.33 ns
1970	-.55*	.19 ns

*significant at .05 level; ns- not significant
Source: Calculated by author.

TABLE 2.

Spearman's Correlation for Lexington

Year	r_s value for mean temperature/month correlated with mean death rate/month	r_s value for mean pressure/month correlated with mean death rate/month
1961	-.26 ns	-.06 ns
1962	-.18 ns	-.06 ns
1963	-.53*	-.22 ns
1964	-.48 ns	.14 ns
1965	-.20 ns	-.02 ns
1966	-.55*	.12 ns
1967	-.40 ns	.10 ns
1968	-.17 ns	.94*
1969	-.59*	.92*
1970	.03 ns	.01 ns

*significant at .05 level; ns - not significant
Source: Calculated by author.

cant at .94 and .92 respectively. No other year showed significant correlation. As in the case of Bowling Green, the graphs (Figure 2-11) in Appendix F indicate that there is a higher incidence of deaths during periods of high pressure. Since this is a visual comparison and the correlation test showed only two years out of ten as significant, the null hypothesis is accepted.

For the total ten year period as seen in Table 3 only in Bowling Green did barometric pressure have a signigicant correlation with the death rate. Lexington data proved no significant correlation at the .05 level. In Appendix F, Figure 12 showes a relationship between barometric pressure and death rate for both study areas. The Bowling Green correlation was not that significant, therefore, the null hypothesis is accepted.

TABLE 3.

Pearson's Product-moment Correlation on the Total Ten Year Period

	Lexington	Bowling Green
Temperature	Death rate/1000	Death rate/1000
Group 1 - Low	.0387	.0593
Group 2 - High	.0264	.0617
T-value	-3.07*	3.35*
Pressure		
Group 1 - Low	.0306	.0515
Group 2 - High	.0357	.0934
T-value	-.92 ns	-2.86*

*significant at .05 level; ns - not significant
Source: Calculated by author.

<u>During periods of low temperatures there is no significant correlation with death rates</u>.

Table 1 shows mean temperature and death rate in the Spearman's correlation for Bowling Green. The years 1961, 1964, 1966, 1967, 1969, and 1970 showed significant correlations at .55, -.68, -.62, -.70, .64, and -.55 respectively. The negative sign indicates that high temperature seems to have a relationship with the death rate and only the year 1961 indicates a low temperature correlation with death rate. All other years were of no significant correlation at the .05 level. Therefore the null hypothesis is accepted for Bowling Green.

For Lexington, Table 2 shows the mean temperature and death rate correlation just as in Table 1 for Bowling Green. The years 1963, 1966, and 1969 showed significant correlations at -.53, -.55 and -.59 respectively. The negative sign again showed a high temperature correlation with death rate. None of the years demonstrated a low temperature correlation. The remaining years showed no signficant correlation at the .05 leve; therefore, the null hypothesis is accepted.

Figures 13-23 in Appendix G graphically demonstrated the relationship of low and high temperatures to death rates for Bowling Green and Lexington. As in the barometric pressure graphs, the graphs indicate a relationship, but the Spearman's correlation showed no significant correlation beteeen low temperature and death rate, thus the null hypothesis is accepted for Bowling Green and Lexington.

<u>During dry periods there is not a significant correlation with deaths</u>.

For the third hypothesis a Spearman's rank-order correlation was calculated with Y as the death rate and X_3 as precipitation. In Bowling Green the mean precipitation per month proved to be only significant at the .05 level (.60, .51, and .54) for the years 1963, 1968, and 1969 respectively as shown in Table 4. None of the remaining years showed no significant correlation at the .05 level. The graphs (Figures 24-34) in Appendix H indicate no increase in deaths during either wet or dry periods of a particular year. On Figure 34 (Total Ten Year graph) there is an increase in deaths during the dry months, August and September and then decreases in October. The deaths decrease during the wet months, March, rising in April and decreasing again in May.

For Lexington the mean precipitation per month proved no significant correlation with dealt for any year or the total ten years as shown in Table 4. The graphs (Figures 24-34) in Appendix H, as in Bowling Green's case, showed no real increase during either wet ot dry months of any particular year. On Figure 34 the deaths decrease in March which is a wet month and increase in September and October which are dry months. The graphs show no marked difference in death rates with precipitation patterns and the correlation test proved not significant; so the author accepted the null hypothesis.

<u>The General Hypothesis</u>

The variables of barometric pressure, temperature and precipitation selected for the hypotheses proved to show no

TABLE 4.

Mean Precipitation/Month Correlated
with Mean Death Rate/Month

Year	Bowling Green	Lexington
1961	.12 ns	.44 ns
1962	-.23 ns	-.34 ns
1963	.60*	.12 ns
1964	.47 ns	.24 ns
1965	.36 ns	-.11 ns
1966	-.04 ns	.006ns
1967	.40 ns	-.25 ns
1968	-.51*	-.34 ns
1969	.54*	.07 ns
1970	-.23 ns	-.21 ns
Total ten years	.37 ns	-.03 ns

*significant at .05 level; ns - not significant
Source: Calculated by author.

significant relationship to deaths. All null hypotheses were accepted. None of the variables explained the higher death rates. Looking at all the variables together on seasonal graphs (Figures 35-44) in Appendix I, the incidence of deaths in both study areas does not appear to be higher in any particular season of any year. On the graphs the weather conditions describing the seasons are as follows:

1. cd - cool, dry
2. ch - cool, humid
3. md - mild, dry
4. mh - mild, humid
5. wd - warm, dry
6. wh- warm, humid
7. hd- hot, dry
8. hh- hot, humid
9. cdd - cold, dry
10. cdh - cold, humid

Each variable was averaged per month to determine the atmosperic condition for the season. The interaction of the weather elements formed a certain atmospheric condition. For example, on a day of 72° temperature, 30.21 barometric pressure, 60% relative humidity, five mile per hour winds and no rain would indicate a warm, dry day. The variables were not used to establish a cause-effect relationship, but to indicate whether or not certain weather conditions correlated with higher incidences of respiratory deaths.

Summary

Chapter Three dealt with the analysis and interpretation of data in testing the null hypotheses. All showed no significant correlation at the .05 level, thus all null hypotheses were accepted. Chapter Four will deal with a summary and conclusions drawn from this study.

CHAPTER FOUR

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine if a significant correlation existed between weather conditions and reported respiratory deaths. The study areas were Bowling Green and Lexington, Kentucky. The study included the years 1961 through 1970. A review of literature relating meterological conditions, especially air pollution, and health was cited and aided in formulating the null hypotheses to be tested.

The independent variable statistics on death were collected from the vital statistics of the local health departments in Bowling Green and Lexington, Kentucky. The dependent variables temperature, barometric pressure, and precipitation were collected from the weather stations of each study areas. Three null hypotheses were formed:

1. During periods of high pressure there is not a significant correlation with death rate.

2. During periods of low temperatures there is not a significant correlation with death rate.

3. During dry periods there is not a significant correlation with death rate.

A general hypothesis was formed taking into consideration the other three hypotheses. It is as follows:

The variables selected in hypotheses one through three will explain higher death rates during certain weather conditions for Bowling Green and Lexington, Kentucky.

The Spearman's rank-order correlation was used to test the hypotheses at the .05 significance level for each year. The Pearson's product-moment correlation was utilized for the total ten year period. A t-test was calculated to show if there was a significant correlation at the .05 level. Graphs and tables were made to help further explain the calculations and correlations. In the analysis the null hypotheses were accepted, because there proved to be no significant correlation at the .05 level between weather conditions and incidences of respiratory deaths.

Limitations

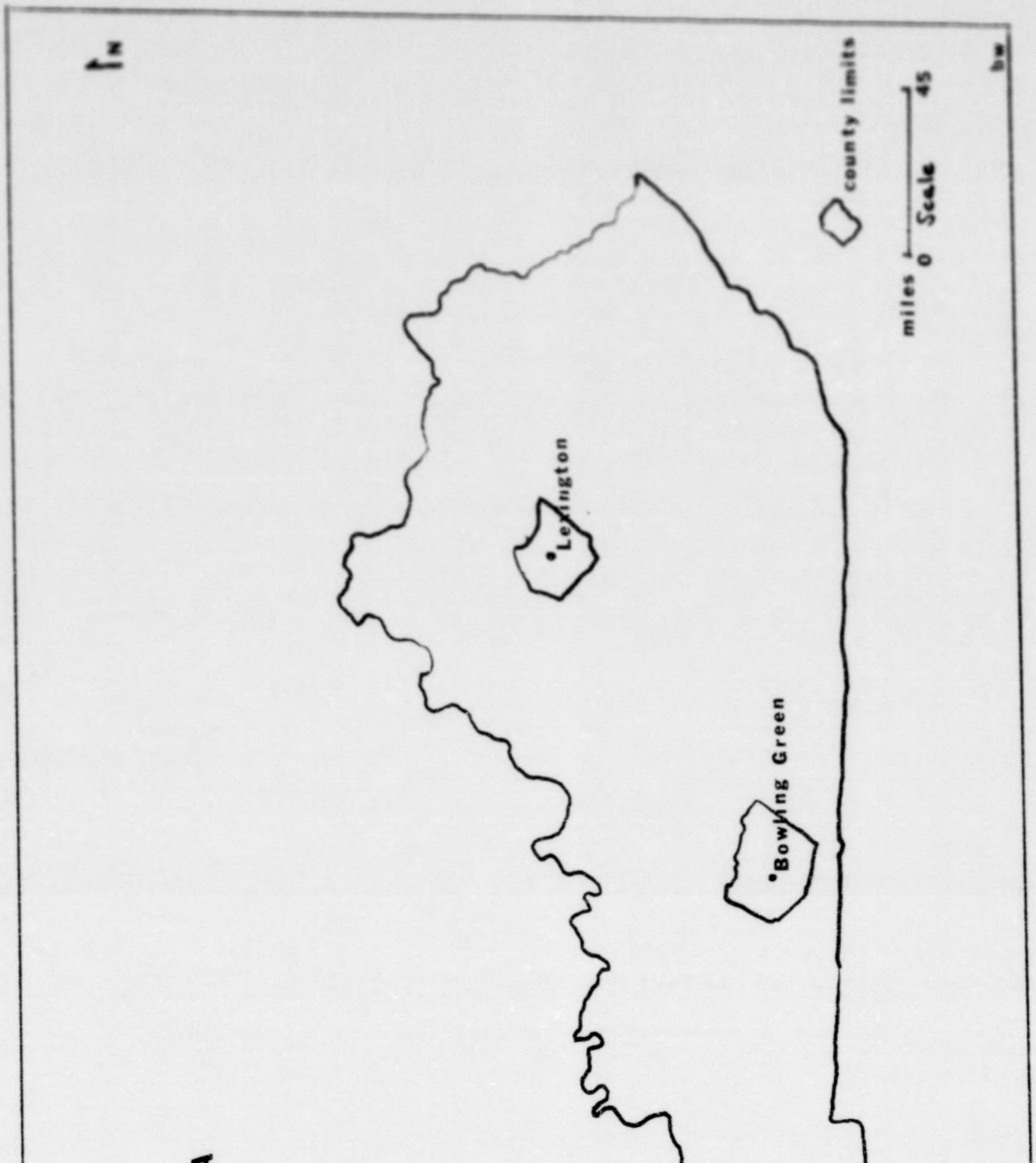
When using Pearson's product-moment correlation the sample size of a study should be in weekly increments rather than monthly to make the sample size large enough for significant results. Because this study utilized the statistics on a monthly basis, the sample size was too small for Pearson's product-moment correlation; thus Spearman's rank-order correlation was used. With all null hypotheses accepted, this indicated that the sample size was too small. A more significant study might have resulted if the statistics were weekly increments rather monthly.

The data from the death certificates were not always straightforward as there were primary and secondary causes involved in some deaths. Also if the patient smoked or lived and worked under poor health conditions, this could have affected him so that certain weather conditions only hampered his health. It was difficult to establish when the patient was affected by certain weather conditions prior to death because all death certificates did not note whether the patient was in a hospital or under doctor's care at home at the time of death. A patient with a respiratory ailment exposed to adverse weather conditions and then treated at an air conditioned hospital might improve his health. But upon moving back to his home, he could die from being exposed to different weather conditions. So it was difficult to establish what kind of weather conditions really affected the deceased prior to death.

From studies previously cited in Chapter One significant correlations were demonstrated between weather conditions and health. Their sample sizes were either on a weekly or daily basis for certain periods, like Huntington's study of New York City which covered a period from April 15, 1882 to March 21, 1888 and utilized daily statistical data.

Areas of Further Research

Air pollution and its affect on health has been studied by numerous people. Air pollution is so affected by weather conditions that this study could be expanded to include that factor. Several elements of weather conditions have to be extremely unfavorable to cause poor health conditions for people suffering with respiratory ailments. A comparison of two different climatic types, such as a Cfa and Csa, might show significant correlations between weather conditions and incidences of respiratory deaths for two different climatic areas. Socio-economic data could be used to include the physical conditions of the individual's work and living area. Many factors affect health in varying degrees, consequently, studies in geographic epidemiology could be expanded upon by geographers or environmentalists working with medical doctors.


STUDY AREA
N
Lexington
Bowling Green
county limits
miles 0 45
Scale
bw

APPENDIX B- DEFINITIONS

Asthma is a chronic disorder of the bronchial tree (tubes which carry air from the trachea to the lungs). The tubes contract and one can no longer exhale, but can inhale. This causes an oxygen shortage and an excess of carbon dioxide. It is characterized by wheezing and coughing (Erhlich, 1970, 121).

Bronchitis is an inflammation of the bronchial tree muscles surrounding the tubes. The tubes constrict and mucous accumulates and can suffocate. There are two kinds:

Acute bronchitis which is a short lasting disease caused by one or more irritants such as a virus, fumes from chemical agents and dust.

Chronic bronchitis is a long lasting disease that will develop from acute bronchitis if not treated (Williamson, 1973, 41) (Erhlich, 1970, 121).

Emphysema is a condition of the lung where thinning and destruction of the alvelor walls results in enlargement of the air sacs. This causes the heart to become overworked (Williamson, 1973, 42).

Influenza is an acute and contagious, infectious disease that is caused by any of several viruses and characterized by inflammation of the respiratory tract.

Pneumonia is a disease of the lungs in which tissue becomes inflamed, hardened and watery.

Tuberculosis is an infectious disease caused by the tubercle bacillus and characterized by the formulation of tubercles in various tissues of the body; especially in the lungs.

APPENDIX C

FORMULAS

Pearsons Product-Moment Correlation:

$$r^2 = \frac{\Sigma xy - \frac{\Sigma xy}{N}}{\sqrt{x^2 - \frac{(\Sigma x)^2}{N}}\sqrt{y^2 - \frac{(\Sigma y)^2}{N}}}$$

or

$$r^2 = \frac{\text{Total variance - residual variance}}{\text{total variance}}$$

Spearman's rank-order correlation:

$$r_s = \frac{6\Sigma d^2}{n^3-n}$$

APPENDIX D

Spearman's rank-order correlation for Bowling Green

1961	Y	X_1	d	d^2	Y	X_2	d	d^2
January	5	1	4	16	5	1	4	16
February	1	3	-2	4	1	3	-2	4
March	11	5	6	36	11	9	2	4
April	8	6	2	4	8	6	2	4
May	12	8	4	16	12	10	2	4
June	6	9	-3	9	6	12	-6	36
July	10	12	-2	4	10	7	3	9
August	7	11	-4	16	7	8	-1	1
September	9	10	-1	1	9	4	5	25
October	3	7	-4	16	3	2	1	1
November	2	4	-2	4	2	5	-3	9
December	4	2	2	4	4	11	-7	49
			0	130			0	162
r_s				.55*				.44ns
1962								
January	5	11	-6	36	5	4	1	1
February	2	10	-8	64	2	11	-9	81
March	4	9	-5	25	4	6	-2	4
April	6	7	-1	1	6	3	3	9
May	9	4	5	25	9	7	2	4
June	10	3	7	49	10	2	8	64
July	7	2	5	25	7	5	2	4
August	8	1	7	49	8	8	0	0
September	3	5	-2	4	3	9	-6	36
October	11	6	5	25	11	12	-2	4
November	12	8	4	16	12	10	2	4
December	1	12	-11	121	1	1	0	0
			0	330			0	221
r_s				.15ns				.23ns
1963								
January	3	12	-9	81	3	6	-3	9
February	1	10	-9	81	1	2	-1	1
March	2	8	-6	36	2	8	-6	36
April	4	7	-3	9	4	10	-6	36
May	5	5	0	0	5	2	3	9
June	10	3	7	49	10	6	4	16
July	11	1	10	100	11	5	6	36
August	12	2	10	100	12	7	5	25
September	6	4	2	4	6	9	-3	9
October	5	6	-1	1	5	4	1	1
November	7	9	-2	4	7	1	6	36
December	8	11	-3	9	8	3	5	25
			0	490			0	222
r_s				-.29ns				.23ns

*significant at the .05 level; ns - not significant

Source: Calculated by the author.

Appendix D continued

1964	Y	X_1	d	d^2	Y	X_2	d	d^2
January	1	11	-10	100	1	8	-7	49
February	11	12	-2	4	11	12	-1	1
March	6	9	-3	9	6	5	1	1
April	4	6	-2	4	4	11	-7	49
May	5	5	0	0	5	2	3	9
June	10	3	7	49	10	6	4	16
July	12	1	11	121	12	10	2	4
August	3	2	1	1	3	7	-4	16
September	7	4	3	9	7	3	4	16
October	8	7	1	1	8	4	4	16
November	9	8	1	1	9	1	8	64
December	2	10	-8	81	2	9	-7	49
			0	380			0	246
r_s				-.68*				.14ns
1965								
January	2	12	-10	100	2	2	0	0
February	3	11	-8	64	3	4	-1	1
March	1	10	-9	81	1	3	-2	4
April	10	6	4	16	10	6	4	16
May	4	5	-1	1	4	5	-1	1
June	9	3	6	36	9	8	1	1
July	12	1	11	121	12	9	3	9
August	5	2	3	9	5	10	-5	25
September	11	4	7	49	11	7	4	16
October	6	7	-1	1	6	12	-6	36
November	7	8	-1	1	7	11	-4	16
December	8	9	-1	1	8	1	7	49
			0	480			0	174
r_s				-.32ns				.40 ns
1966								
January	12	12	0	0	12	10	2	4
February	4	10	-6	36	4	7	-3	9
March	5	8	-3	9	5	3	2	4
April	9	6	3	9	9	1	8	64
May	10	5	5	25	10	6	4	16
June	6	3	3	9	6	2	4	16
July	11	1	10	100	11	11	0	0
August	7	2	5	25	7	8	-1	1
September	8	4	4	16	8	12	-4	16
October	1	7	-6	36	1	5	-4	16
November	2	9	-7	49	2	4	-2	4
December	3	11	-8	81	3	9	-6	36
			0	396			0	186
r_s				-.62*				.35ns

* significant at .05 level; ns - not significant
Source: Calculated by author.

Appendix D continued.

1967	Y	X_1	d	d^2	Y	X_2	d	d^2
January	1	11	-10	100	1	2	-1	1
February	9	12	-3	9	9	1	8	64
March	3	8	-5	25	3	3	0	0
April	12	6	6	36	12	12	0	0
May	4	5	-1	1	4	11	-7	49
June	5	2	3	9	5	6	-1	1
July	10	1	9	81	10	7	3	9
August	11	3	8	64	11	4	7	49
September	7	4	3	9	7	10	-3	9
October	2	7	-5	25	2	5	-3	9
November	6	9	-3	9	6	9	-3	9
December	8	10	-2	4	8	8	0	0
			0	372			0	200
r_s			-.70*				.31ns	
1968								
January	2	12	-10	100	2	1	1	1
February	7	11	-4	16	7	6	1	1
March	3	9	-6	36	3	2	1	1
April	12	7	5	25	12	10	2	4
May	8	5	3	9	8	8	0	0
June	6	3	3	9	6	9	-3	9
July	11	2	9	81	11	11	0	0
August	9	1	8	64	9	3	6	36
September	5	4	1	1	5	4	1	1
October	10	6	4	16	10	7	3	9
November	1	8	-7	49	1	12	-11	121
December	4	10	-6	36	4	5	-1	1
			0	442			0	184
r_s			-.46ns				.36 ns	
1969								
January	5	11	-6	36	5	1	4	16
February	9	10	-1	1	9	11	-2	4
March	6	9	-3	9	6	8	-2	4
April	10	6	4	16	10	6	4	16
May	4	5	-1	1	4	5	-1	1
June	12	3	9	81	12	12	0	0
July	7	1	6	36	7	7	0	0
August	8	2	6	36	8	10	-2	4
September	3	4	-1	1	3	3	0	0
October	11	7	-4	16	11	2	9	81
November	2	8	-6	36	2	4	-2	4
December	1	12	-11	121	1	9	-8	64
			0	390			0	194
r_s			-.64*				.33 ns	

*significant at .05 level; ns - not significant
Source: Calculated by author.

Appendix D continued

1970	Y	X_1	d	d^2	Y	X_2	d	d^2
January	3	12	-9	81	3	7	-4	16
February	4	11	-7	49	4	2	2	4
March	1	9	-8	64	1	12	-11	121
April	11	6	5	25	11	8	3	9
May	9	5	4	16	9	4	5	25
June	10	4	6	36	10	6	4	16
July	2	2	0	0	2	10	-8	64
August	7	1	6	36	1	11	-10	100
September	12	3	9	81	12	1	11	121
October	8	7	2	4	8	3	5	25
November	5	8	-3	9	5	9	-4	16
December	6	10	-4	16	6	5	1	1
			0	417			0	518
r_s			-.55*				-.19ns	

*significant at .05 level; ns - not significant
Source: calculated by author

1961	Y	X_3	d	d^2	1962	Y	X_3	d	d^2
January	8	1	-7	49		2	8	-6	36
February	1	7	-6	36		1	12	-11	121
March	12	9	3	9		12	9	3	9
April	9	10	-1	1		4	3	1	1
May	6	8	-2	4		3	7	-4	16
June	10	12	-2	4		8	5	3	9
July	5	6	-1	1		9	4	5	25
August	11	2	9	81		10	1	9	81
September	3	3	0	0		5	11	-6	36
October	7	4	3	9		11	10	1	1
November	2	5	-3	9		6	2	4	16
December	4	11	-7	49		7	6	1	1
			0	252				0	352
r_s			.12 ns					-.23 ns	

1963	Y	X_3	d	d^2	1964	Y	X_3	d	d^2
January	2	3	-1	1		7	6	1	1
February	1	6	-5	25		1	4	-3	9
March	11	12	-1	1		12	12	0	0
April	3	4	-1	1		5	7	-2	4
May	4	9	-5	25		2	3	-1	1
June	8	8	0	0		8	2	6	36
July	9	11	-2	4		9	5	4	16

Appendix D continued

1963 continued	Y	X_3	d	d^2	1964	Y	X_3	d	d^2
August	12	10	2	4		4	10	-6	36
September	5	2	3	9		3	8	-5	25
October	6	1	5	25		6	1	5	25
November	10	7	3	9		10	9	1	1
December	7	5	2	4		11	11	0	0
			0	116				0	154
r_s			.60*						.47 ns
1965					**1966**				
January	12	10	2	4		3	11	-8	64
February	1	9	-8	64		2	7	-5	25
March	11	12	-1	1		12	1	11	121
April	10	7	3	9		9	12	-3	9
May	2	8	-6	36		4	3	1	1
June	9	5	4	16		10	2	8	64
July	6	11	-5	25		7	8	-1	1
August	3	1	2	4		6	5	1	1
September	7	6	1	1		1	4	-3	9
October	5	3	2	4		5	6	-1	1
November	8	4	4	16		8	9	-1	1
December	4	2	2	4		11	10	1	1
			0	184				0	298
r_s			.36 ns					-.04 ns	
1967					**1968**				
January	3	2	1	1		12	2	10	100
February	4	3	1	1		4	1	3	9
March	12	8	4	16		1	11	-10	100
April	6	5	1	1		3	10	-7	49
May	7	9	-2	4		6	12	-6	36
June	9	11	-2	4		9	5	4	16
July	2	12	-10	100		5	7	-2	4
August	11	7	4	16		10	3	7	49
September	1	4	-3	9		11	4	7	49
October	5	1	4	16		2	6	-4	16
November	8	6	2	4		7	9	-2	4
December	10	10	0	0		8	8	0	0
			0	172				0	432
r_s			.40 ns					-.51*	

*significant at .05 level; ns - not significant
Source: calculated by author

Appendix D continued

1969	Y	X_3	d	d^2	1970	Y	X_3	d	d^2
January	11	9	2	4		1	1	0	0
February	5	5	0	0		2	9	-7	49
March	6	4	2	4		3	10	-7	49
April	12	11	1	1		7	12	-5	25
May	4	6	-2	4		10	2	8	64
June	8	12	-4	16		9	5	4	16
July	1	7	-6	36		11	3	8	64
August	3	2	1	1		5	6	-1	1
September	9	1	8	64		4	7	-3	9
October	2	3	-1	1		6	8	-2	4
November	7	8	-1	1		12	4	8	64
December	10	10	0	0		8	11	-3	9
			0	132				0	354
r_s			.54*						-.23 ns

Total Ten years

	Y	X_3	d	d^2
January	2	4	-2	4
February	1	5	-4	16
March	10	12	-2	4
April	5	11	-6	36
May	7	9	-2	4
June	12	10	2	4
July	6	8	-2	4
August	8	3	5	25
September	3	2	1	1
October	9	1	8	64
November	4	6	-2	4
December	11	7	4	16
			0	182
r_s			.37 ns	

*significant at .05 level; ns - not significant
Source: caluculated by author

APPENDIX E

Spearman's rank-order correlation for Lexington

1961	Y	X_1	d	d^2	Y	X_2	d	d^2
January	1	12	-11	121	1	2	-1	1
February	2	10	-8	64	1	7	-5	25
March	3	8	-5	25	3	12	-9	81
April	4	7	-3	9	4	11	-7	49
May	10	5	5	25	10	8	2	4
June	6	4	2	4	6	10	-4	16
July	11	1	10	100	11	9	2	4
August	12	2	10	100	12	5	7	49
September	9	3	6	36	9	3	6	36
October	5	6	-1	1	5	4	1	1
November	7	9	-2	4	7	1	6	36
December	8	11	-3	9	8	6	2	4
			0	498			0	306
r_s			-.26 ns				-.06 ns	
1962								
January	1	12	-11	121	1	2	1	1
February	3	10	-7	49	3	12	-9	81
March	2	9	-7	49	2	11	-9	81
April	5	7	-2	4	5	5	0	0
May	9	4	5	25	9	8	1	1
June	7	3	4	16	7	9	-2	4
July	6	2	4	16	6	3	3	9
August	10	1	9	81	10	10	0	0
September	8	5	3	9	8	6	2	4
October	11	6	5	25	11	1	10	100
November	12	8	4	16	12	7	5	25
December	4	11	-7	49	4	4	0	0
			0	339			0	306
r_s			-.18ns				-.06 ns	
1963								
January	3	11	-8	64	3	8	-5	25
February	1	10	-9	81	1	4	3	9
March	2	8	-6	36	2	11	-9	81
April	7	7	0	0	7	10	-3	9
May	8	5	3	9	8	3	5	25
June	10	3	7	49	10	9	1	1
July	5	1	4	16	5	12	-7	49
August	11	2	9	81	11	5	6	36
September	6	4	2	4	6	6	0	0
October	12	6	6	36	12	2	10	100
November	9	9	0	0	9	7	2	4
December	4	12	-8	64	4	1	3	9
			0	440			0	351
r_s			-.538*				-.227 ns	

*significant at .05 level; ns - not significant
Source: Calculated by author.

Appendix E continued.

1964	Y	X_1	d	d^2	Y	X_2	d	d^2
January	2	11	-9	81	2	5	-3	9
February	1	12	-11	121	1	10	-9	81
March	10	9	1	1	10	12	-2	4
April	12	6	6	36	12	11	1	1
May	5	5	0	0	5	5	0	0
June	4	3	1	1	4	9	-5	25
July	8	1	7	49	8	8	0	0
August	11	2	9	81	11	2	9	81
September	9	4	5	25	9	3	6	36
October	3	7	-4	16	3	1	2	4
November	6	8	-2	4	6	4	2	4
December	7	10	-3	9	7	6	1	1
			0	424			0	246
r_s			-.48 ns				.14 ns	

1965	Y	X_1	d	d^2	Y	X_2	d	d^2
January	5	12	-7	49	5	12	-7	49
February	1	11	-10	100	1	9	-8	64
March	10	10	0	0	10	1	9	81
April	4	6	-2	4	4	5	1	1
May	3	4	1	1	3	6	-3	9
June	9	3	6	36	9	8	1	1
July	6	2	4	16	6	7	-1	1
August	11	1	10	100	11	10	1	1
September	7	5	2	4	7	2	5	25
October	2	7	-5	25	2	4	-2	4
November	8	8	0	0	8	3	5	25
December	12	9	3	9	12	11	1	1
			0	344			0	262
r_s			-.202 ns				-.02 ns	

1966	Y	X_1	d	d^2	Y	X_2	d	d^2
January	2	12	-10	100	2	1	1	1
February	1	11	-10	100	1	8	-7	49
March	7	9	-2	4	7	3	4	16
April	6	7	-1	1	6	11	-5	25
May	9	5	4	16	9	4	5	25
June	3	3	0	0	3	6	-3	9
July	8	1	7	49	8	9	-1	1
August	12	2	10	100	12	12	0	0
September	10	4	6	36	10	7	3	9
October	4	6	-2	4	4	10	-6	36
November	11	8	3	9	11	2	9	81
December	5	10	-5	25	5	5	0	0
			0	444			0	252
r_s			-.55*				.12 ns	

* significant at .05 level; ns - not significant
Source: Calculated by author.

Appendix E continued.

1967	Y	X_1	d	d^2	Y	X_2	d	d^2
January	6	11	-5	25	6	2	4	16
February	3	12	-9	81	3	5	-2	4
March	1	8	-7	49	1	3	-2	4
April	12	6	6	36	12	6	6	36
May	7	5	2	4	7	12	-5	25
June	4	2	2	4	4	10	-6	36
July	8	1	7	49	8	9	-1	1
August	9	3	6	36	9	11	-2	4
September	11	4	7	49	11	7	4	16
October	5	7	-1	4	5	4	1	1
November	10	9	1	1	10	1	9	81
December	2	10	-8	64	2	8	-6	36
			0	402			0	260
r_s			-.40 ns				.10 ns	
1968								
January	4	11	-7	49	4	1	3	9
February	8	12	-4	16	8	8	0	0
March	2	9	-7	49	2	4	-2	4
April	11	7	4	16	11	11	0	0
May	5	5	0	0	5	10	-5	25
June	9	3	6	36	9	9	0	0
July	7	1	6	36	7	2	5	25
August	3	2	1	1	3	3	0	0
September	10	4	6	36	10	6	4	16
October	6	6	0	0	6	7	-1	1
November	12	8	4	16	12	12	0	0
December	1	10	-9	81	1	5	-4	16
			0	336			0	96
r_s			-.17 ns				.94*	
1969								
January	1	12	-11	121	1	4	-3	9
February	4	10	-6	36	4	1	3	9
March	5	9	-4	16	5	9	-4	16
April	11	7	4	16	11	11	0	0
May	10	5	5	25	10	5	5	25
June	12	3	9	81	12	10	2	4
July	6	1	5	25	6	8	-2	4
August	8	2	6	36	8	2	6	36
September	7	4	3	9	7	3	4	16
October	3	6	-3	9	3	7	-4	16
November	9	8	1	1	9	12	-3	9
December	2	11	-9	81	2	6	-4	16
			0	456			0	123
r_s			-.59*				.92*	

*significant at .05 level; ns - not significant
Source: Calculated by author.

Appendix E continued

1970	Y	X_1	d	d^2	Y	X_2	d	d^2
January	4	12	-8	64	4	3	1	1
February	1	11	-10	100	1	6	-5	25
March	5	9	-4	16	5	10	-5	25
April	3	7	-4	16	3	11	-8	64
May	8	5	3	9	8	7	1	1
June	9	4	5	25	9	5	4	16
July	7	2	5	25	7	4	3	9
August	12	1	11	121	12	9	3	9
September	11	3	8	64	11	12	-1	1
October	6	6	0	0	6	2	4	16
November	2	8	-6	36	2	8	-6	36
December	10	10	0	0	10	1	9	81
			0	296			0	284
r_s				-.03 ns				.01 ns

*significant at .05 level; ns - not significant
Source: calculated by author

1961	Y	X_3	d	d^2	1962 Y	X_3	d	d^2
January	5	2	3	9	8	7	1	1
February	1	7	-6	36	1	12	-11	121
March	9	11	-2	4	9	10	-1	1
April	7	10	-3	9	5	2	3	9
May	10	12	-2	4	4	11	-7	49
June	8	8	0	0	2	9	-7	49
July	6	9	-3	9	6	6	0	0
August	12	4	8	64	10	4	6	36
September	3	3	0	0	11	1	10	100
October	2	1	1	1	12	8	4	16
November	4	5	-1	1	7	5	2	4
December	11	6	5	25	3	3	0	0
			0	162			0	386
r_s				.44 ns				-.34 ns

*significant at .05 level; ns - not significant
Source: caluculated by author

Appendix E continued

1963	Y	X_3	d	d^2	1964	Y	X	d	d^2
January	1	5	-4	16		6	2	4	16
February	2	6	-4	16		1	3	-2	4
March	11	11	0	0		12	12	0	0
April	5	7	-2	4		4	6	-2	4
May	7	9	-2	4		5	4	1	1
June	9	8	1	1		2	8	-6	36
July	3	12	-9	81		10	9	1	1
August	12	10	2	4		11	5	6	36
September	10	2	8	64		3	10	-7	49
October	8	1	7	49		9	1	8	64
November	6	4	2	4		7	7	0	0
December	4	3	1	1		8	11	-3	9
			0	252				0	220
r_s			.12 ns					.24 ns	

1965	Y	X_3	d	d^2	1966	Y	X	d	d^2
January	5	6	-1	1		10	5	5	25
February	2	7	-5	25		1	4	-3	9
March	11	12	-1	1		11	1	10	100
April	6	8	-2	4		9	12	-3	9
May	1	2	-1	1		2	10	-8	64
June	4	9	-5	25		7	3	4	16
July	3	11	-8	64		4	11	-7	49
August	12	4	8	64		12	9	3	9
September	7	10	-3	9		8	7	1	1
October	8	5	3	9		3	2	1	1
November	9	3	6	36		5	6	-1	1
December	10	1	9	81		6	8	-2	4
			0	320				0	288
r_s			-.11 ns					-.006 ns	

1967	Y	X_3	d	d^2	1968	Y	X	d	d^2
January	7	1	6	36		4	2	2	4
February	3	2	1	1		10	1	9	81
March	10	11	-1	1		3	11	-8	64
April	8	7	1	1		9	8	1	1
May	1	12	-11	121		1	12	-11	121
June	9	4	5	25		8	4	4	16
July	5	10	-5	25		2	9	-7	49
August	11	6	5	25		12	10	2	4
September	12	5	7	49		11	6	5	25
October	6	3	3	9		7	3	4	16
November	2	9	-7	49		5	7	-2	4
December	4	8	-4	16		6	5	1	1
			0	358				0	386
r_s			-.25 ns					-.34 ns	

Appendix E Continued

1969	Y	X_3	d	d^2	1970	Y	X_3	d	d^2
January	3	11	-8	64		8	1	7	49
February	10	4	6	36		12	8	4	16
March	1	3	-2	4		1	10	-9	81
April	12	6	6	36		9	12	-3	9
May	5	7	-2	4		5	6	-1	1
June	6	9	-3	9		10	7	3	9
July	2	10	-8	64		3	5	-2	4
August	11	12	-1	1		11	3	8	64
September	7	1	6	36		6	9	-3	9
October	4	2	2	4		4	4	0	0
November	8	5	3	9		7	2	5	25
December	9	8	1	1		2	11	-9	81
			0	268				0	348
r_s			.07 ns					-.21 ns	

<u>Total Ten years</u>

Total Ten years	Y	X_3	d	d^2
January	4	2	2	4
February	1	3	-2	4
March	11	12	-1	1
April	6	9	-3	9
May	2	11	-9	81
June	7	8	-1	1
July	3	10	-7	49
August	12	7	5	25
September	10	4	6	36
October	9	1	8	64
November	5	5	0	0
December	8	6	2	4
			0	278
r_s			.03 ns	

*significant at .05 level; ns - not significant
Source: calculated by author

Monthly Distribution of Respiratory Deaths

by Barometric Pressure

Figure 2.

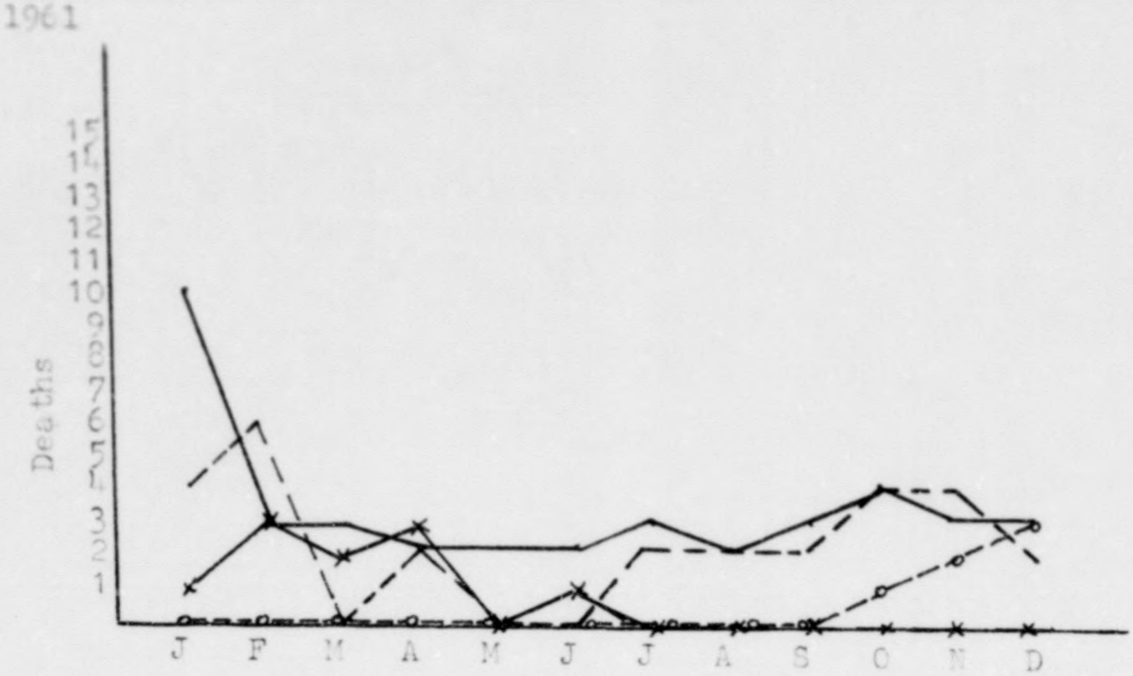
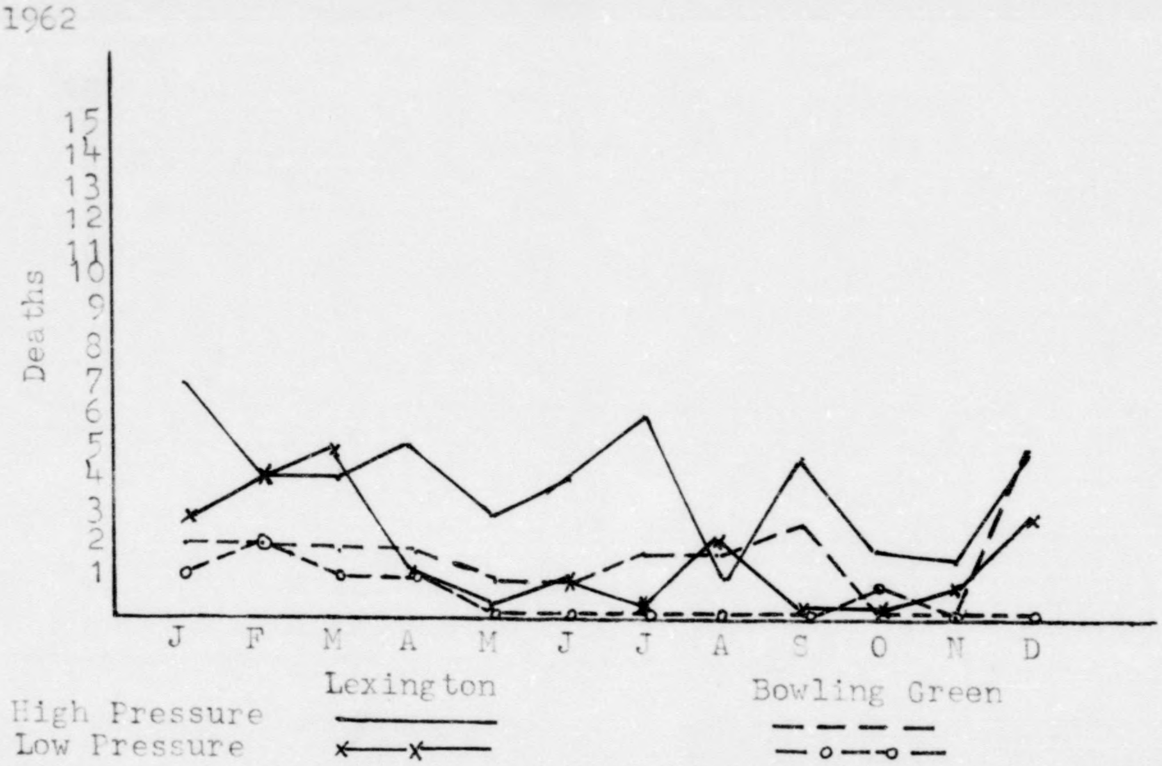


Figure 3.



Appendix F continued

Monthly Distribution of Respiratory Deaths

by Barometric Pressure

Figure 4

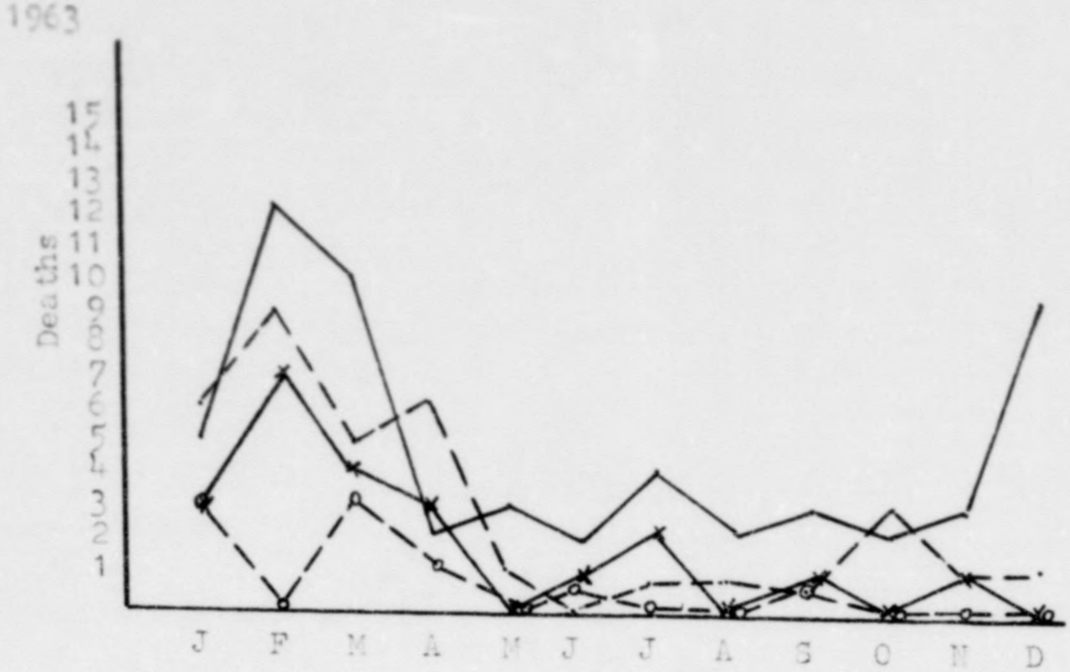
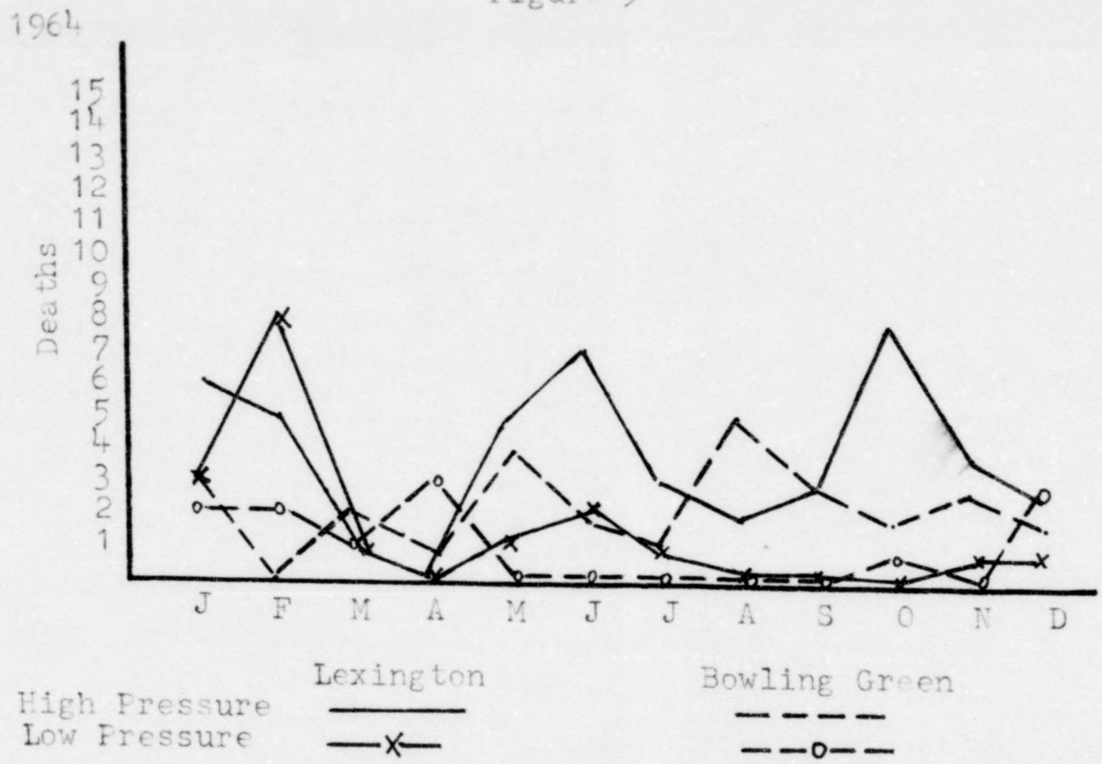


Figure 5



Monthly Distribution of Respiratory Deaths

by Barometric Pressure

Figure 6

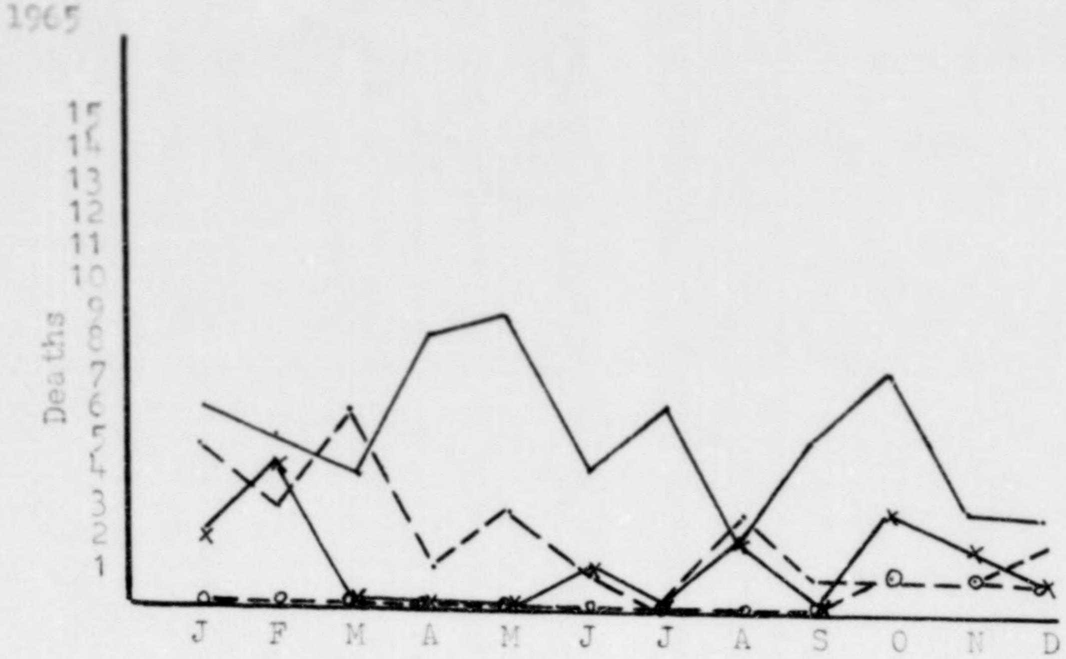
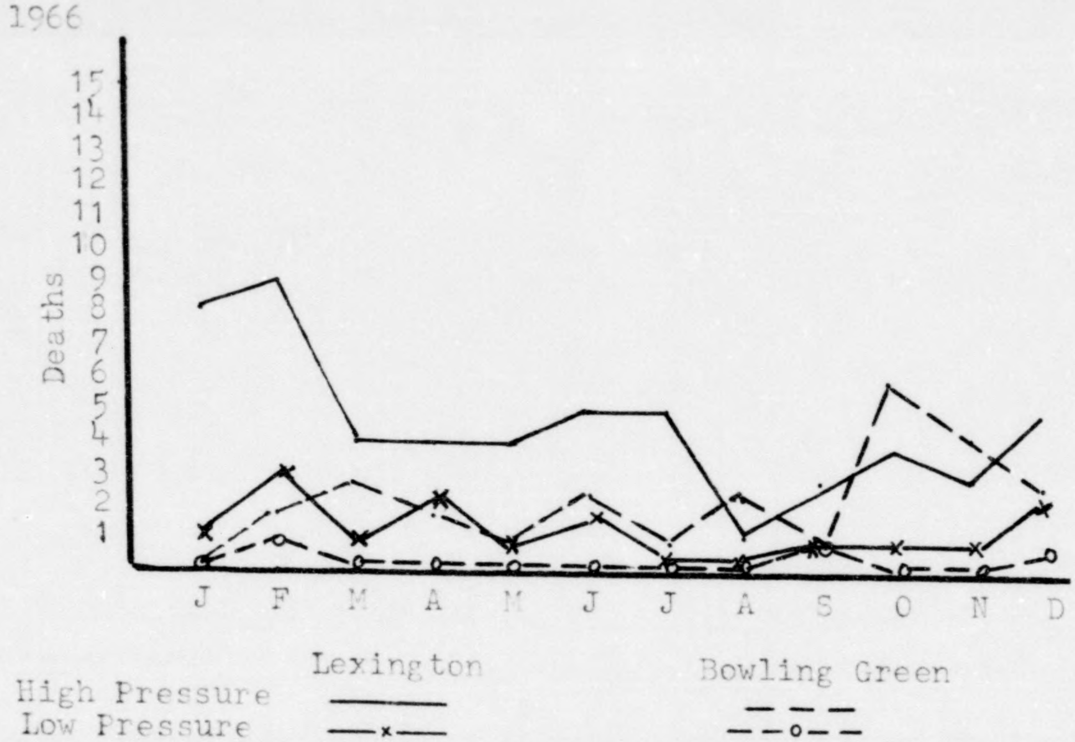


Figure 7



Appendix F continued

Monthly Distribution of Respiratory Deaths

by Barometric Pressure

Figure 8

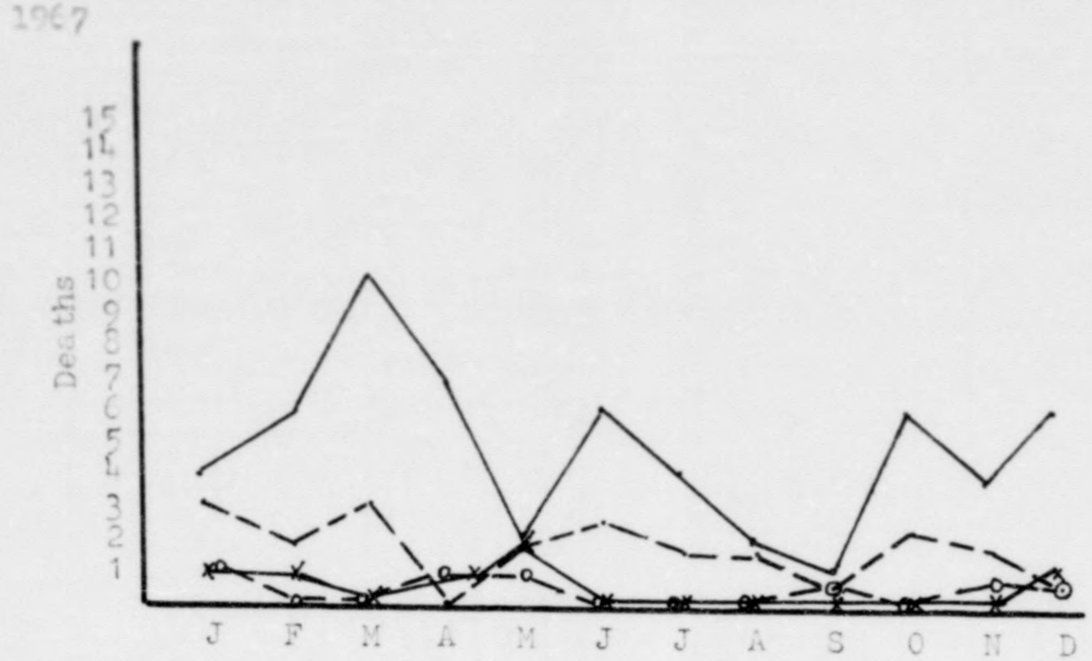
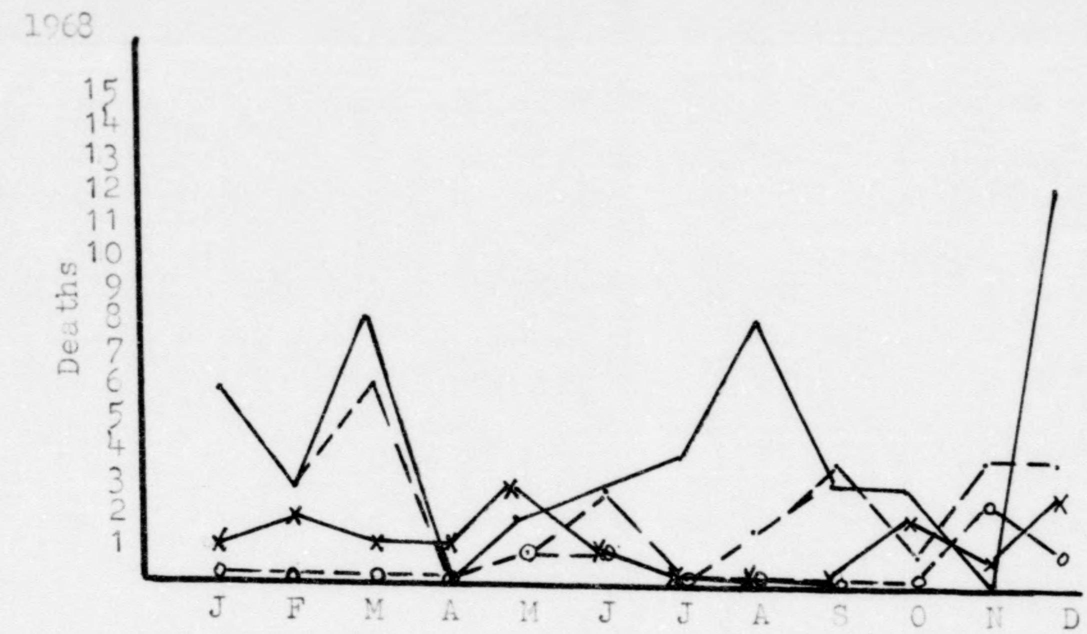


Figure 9



	Lexington	Bowling Green
High Pressure	———————	— — — —
Low Pressure	—x—	—o—o—

Appendix F continued

Monthly Distribution of Respiratory Deaths

by Barometric Pressure

Figure 10

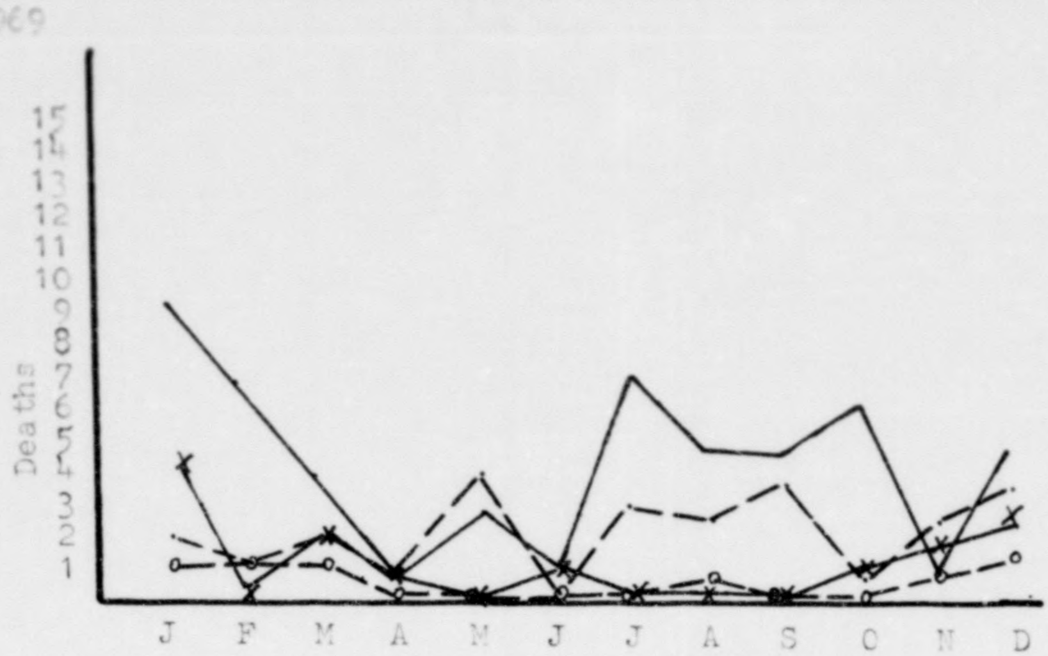
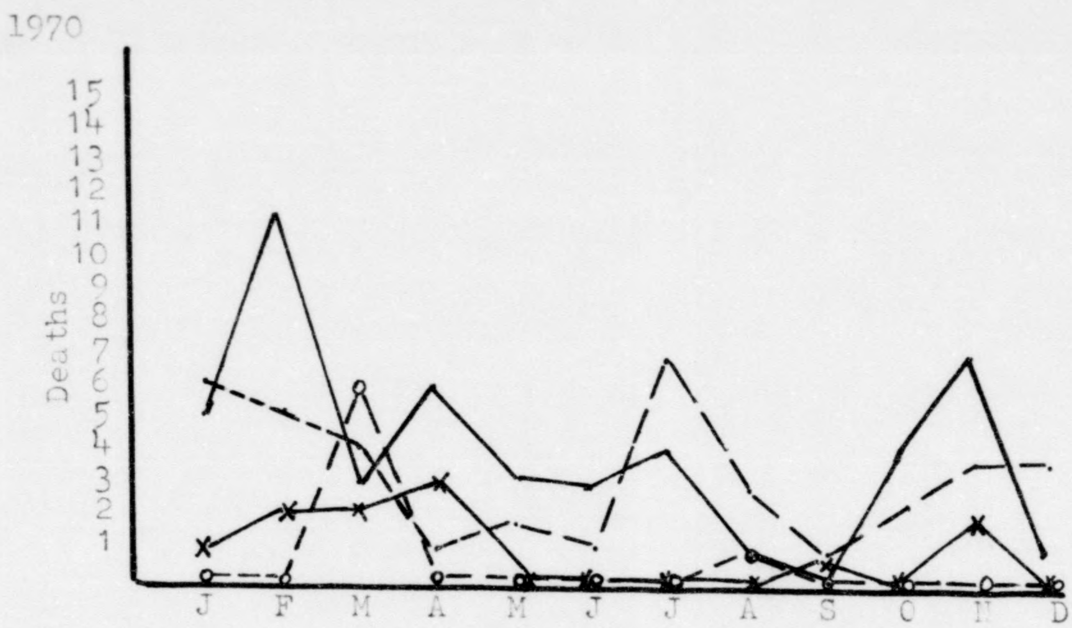


Figure 11



	Lexington	Bowling Green
High Pressure	————	— — —
Low Pressure	—x—	—o—o—

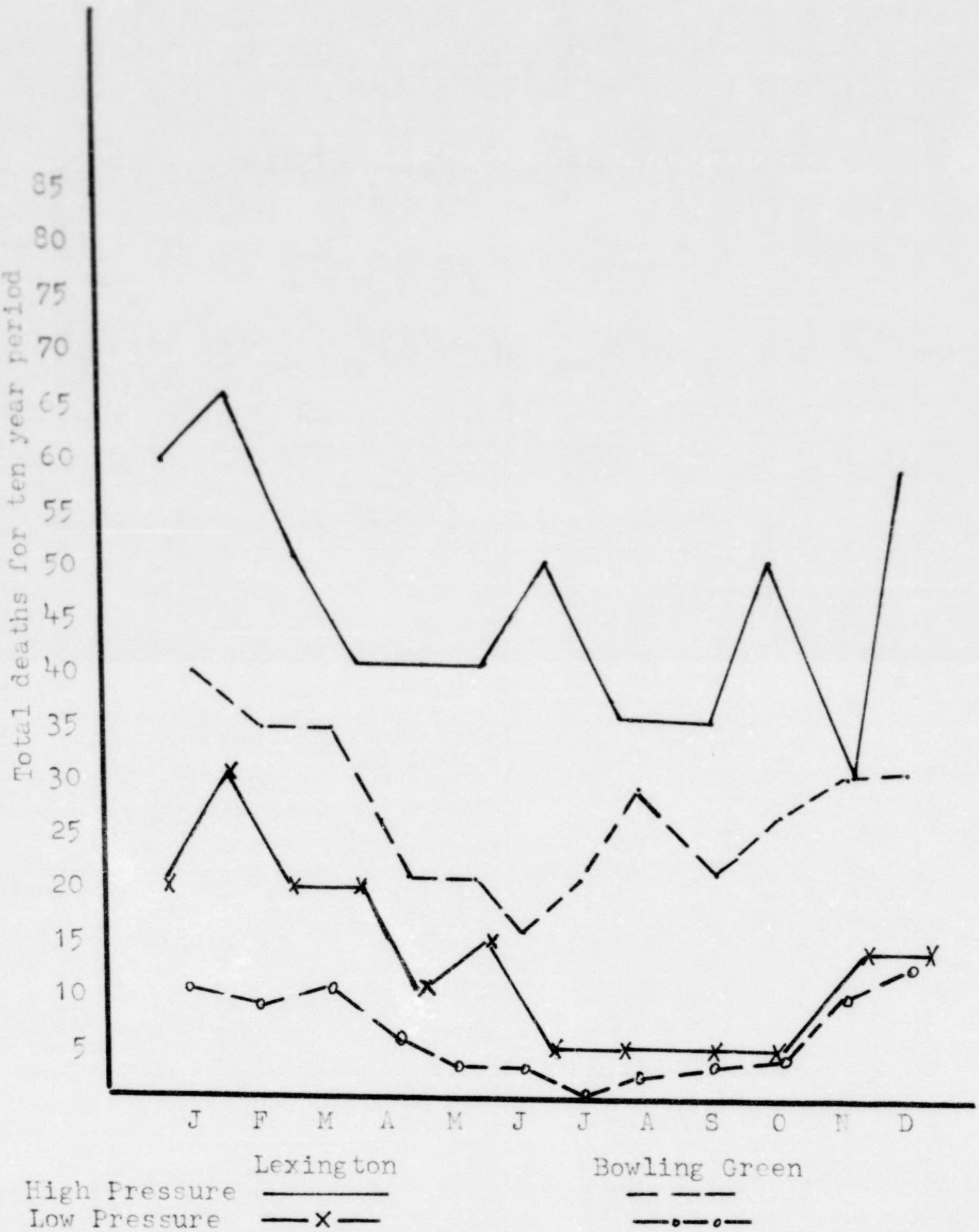
Appendix F continued

Monthly Distribution of Respiratory Deaths

by Barometric Pressure

Total

Figure 12



Monthly Distribution of Respiratory Deaths

by Temperature

Figure 13

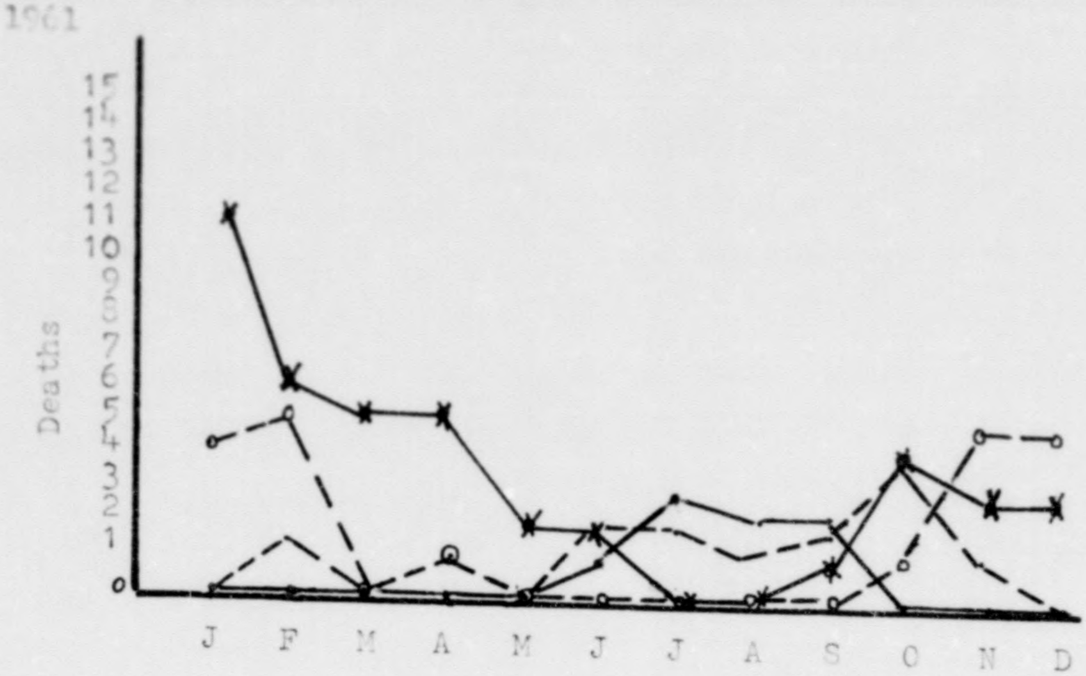
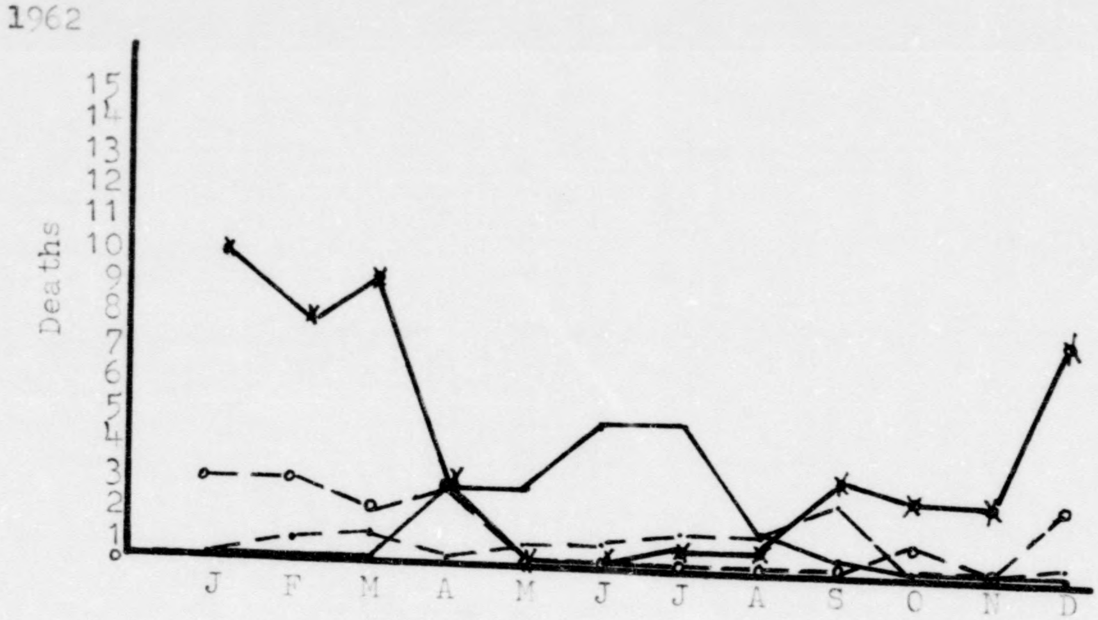


Figure 14



	Lexington	Bowling Green
High Temperature	———	— — —
Low Temperature	—x—	—o—o—

Monthly Distribution of Respiratory Deaths

by Temperature

Figure 15

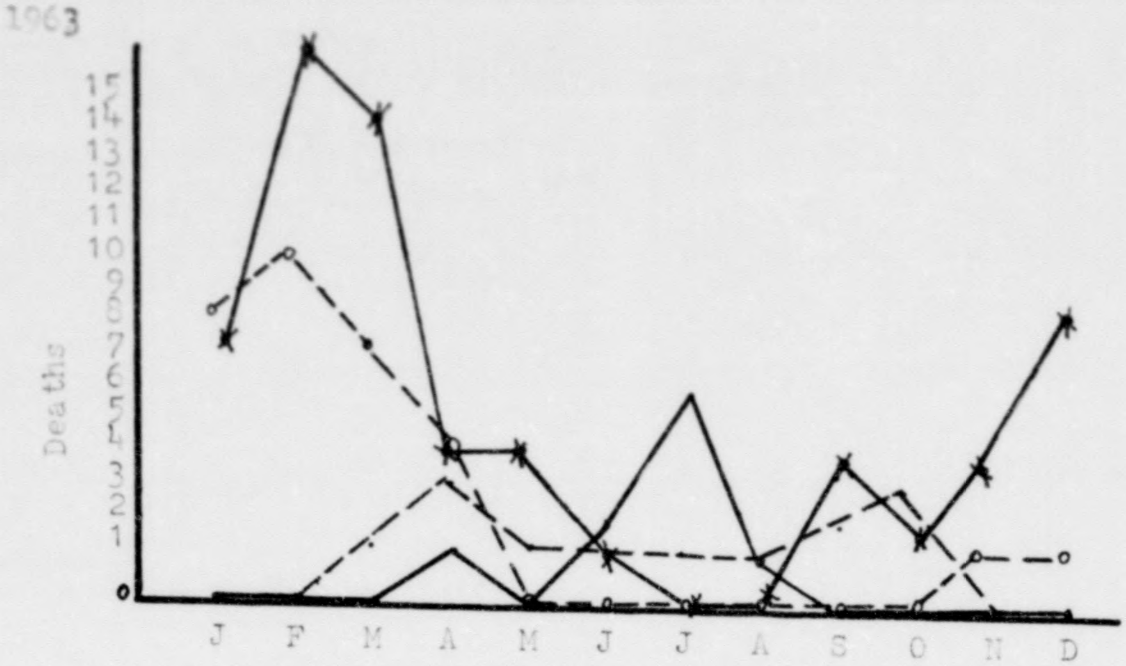
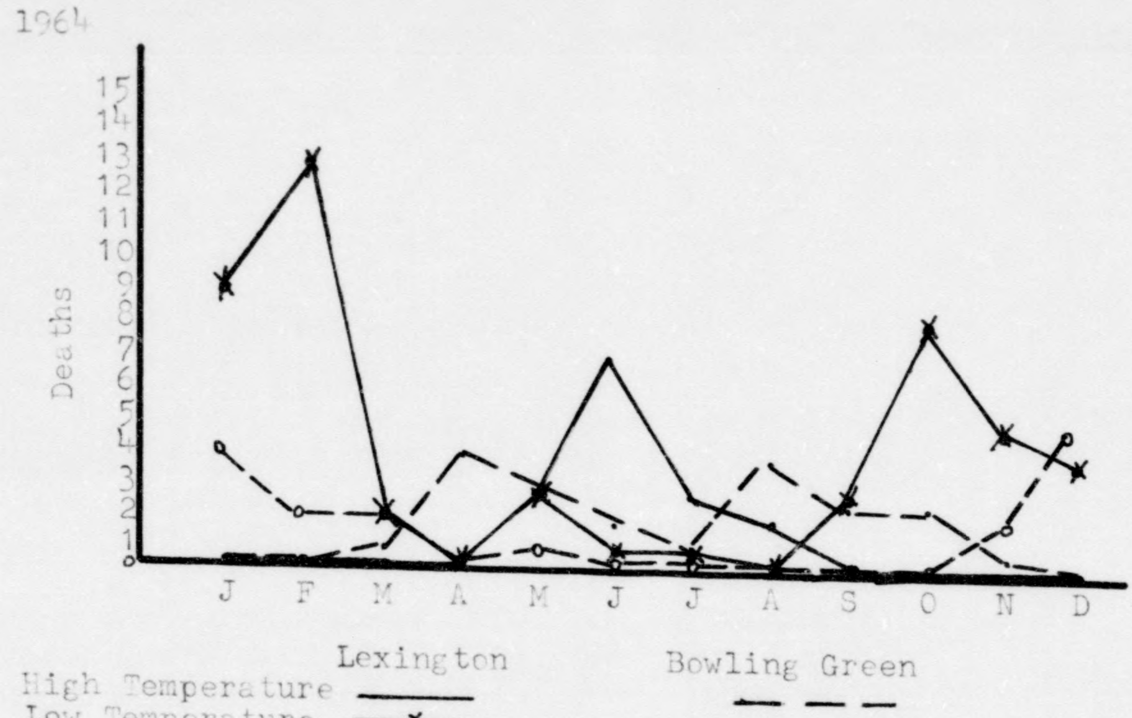


Figure 16



Monthly Distribution of Respiratory Deaths

by Temperature

Figure 17

1965

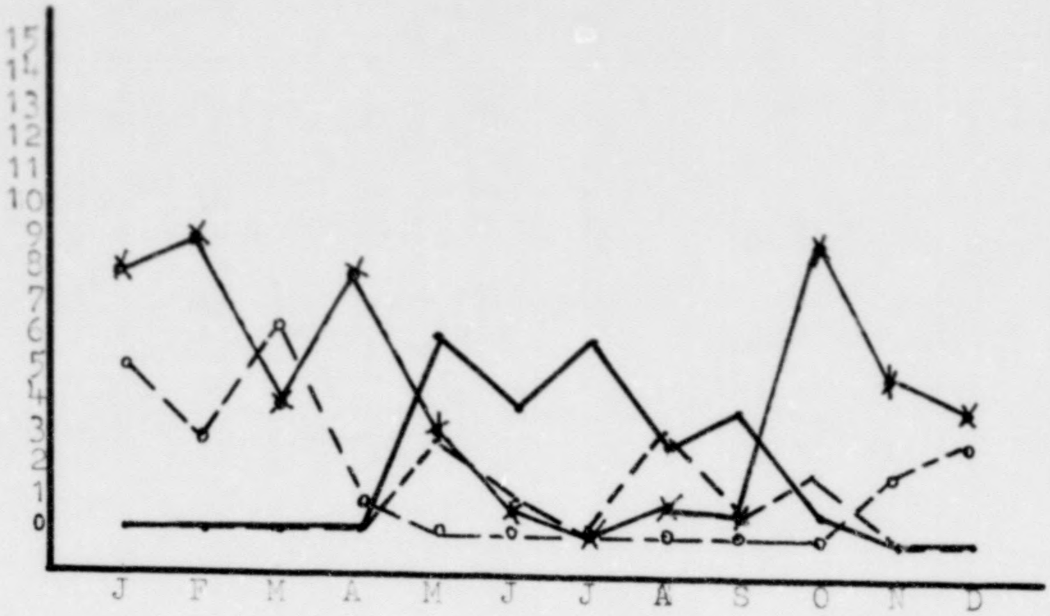
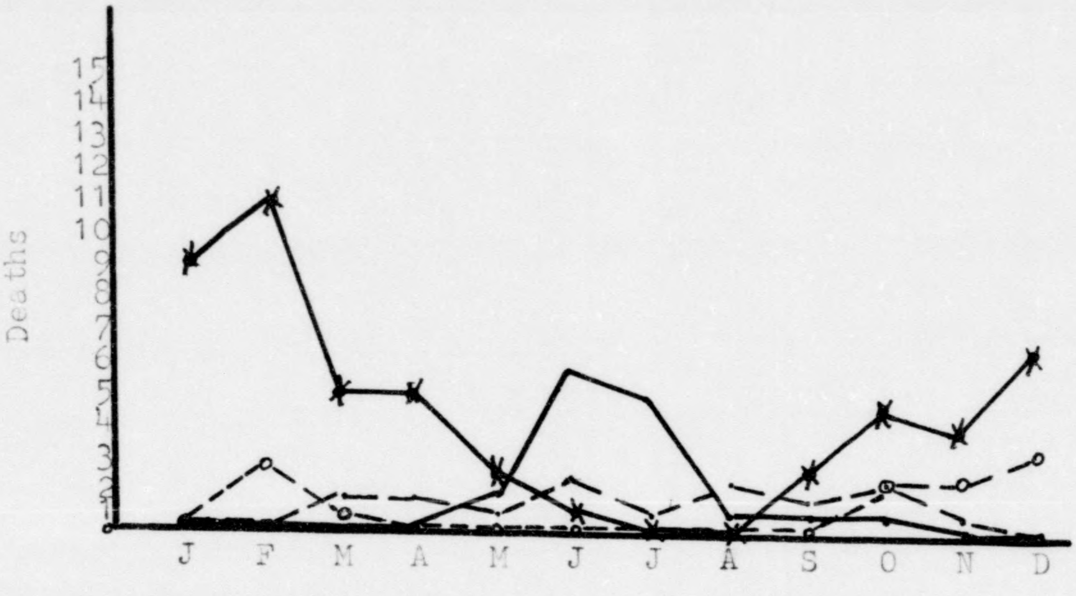


Figure 18

1966



Appendix G continued

Monthly Distribution of Respiratory Deaths

by Temperature

Figure 19

1967

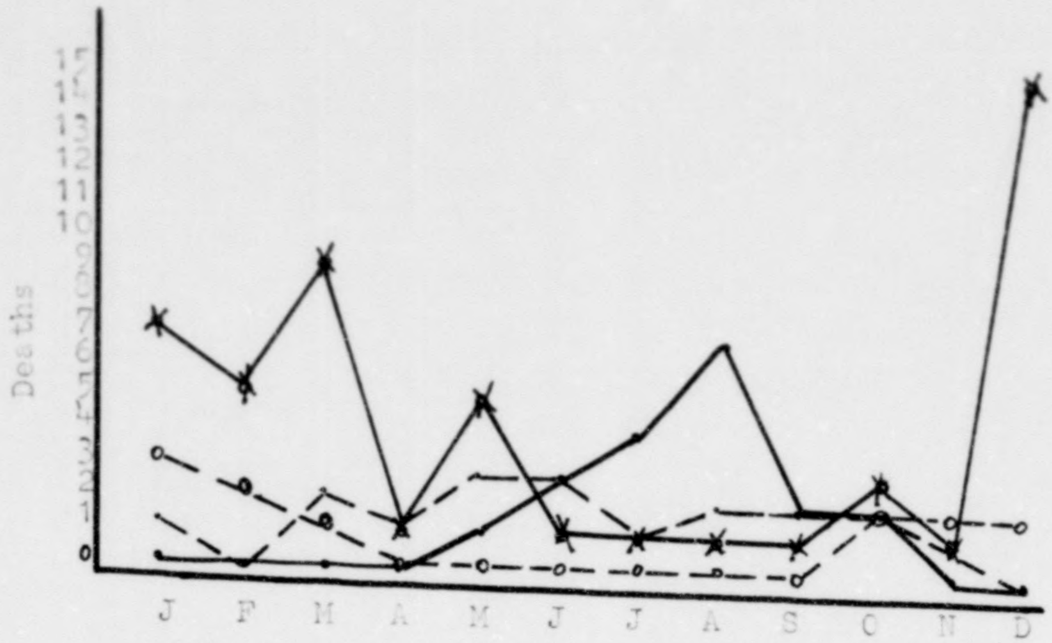


Figure 20

1968

	Lexington	Bowling Green
High Temperature	———	— — —
Low Temperature	—x—	—o—o—

Appendix G continued

Monthly Distribution of Respiratory Deaths

by Temperature

Figure 21

1969

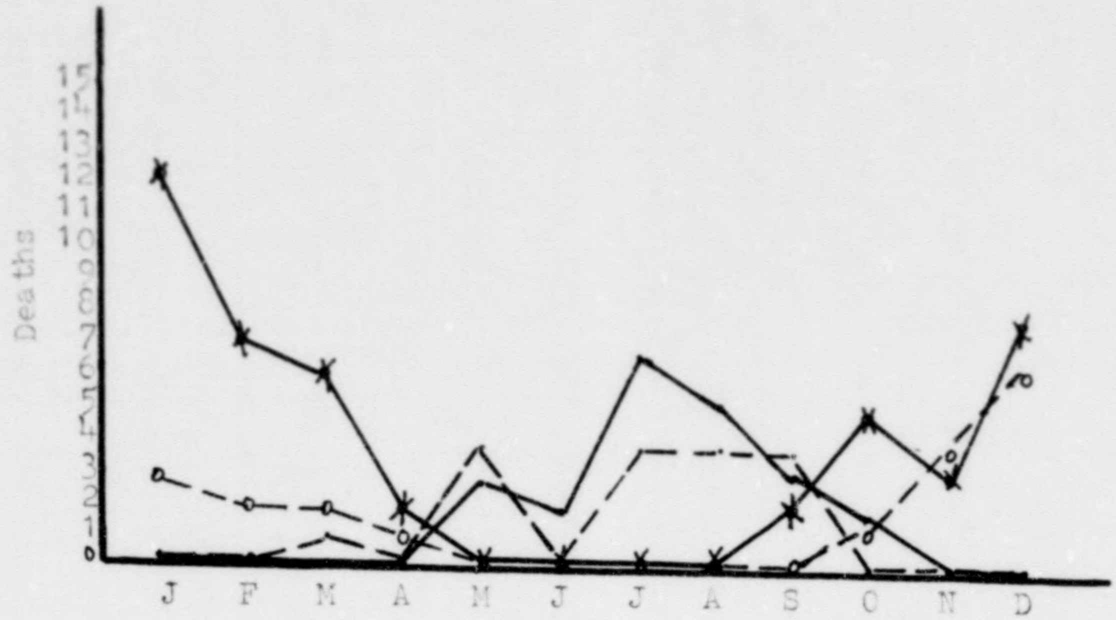
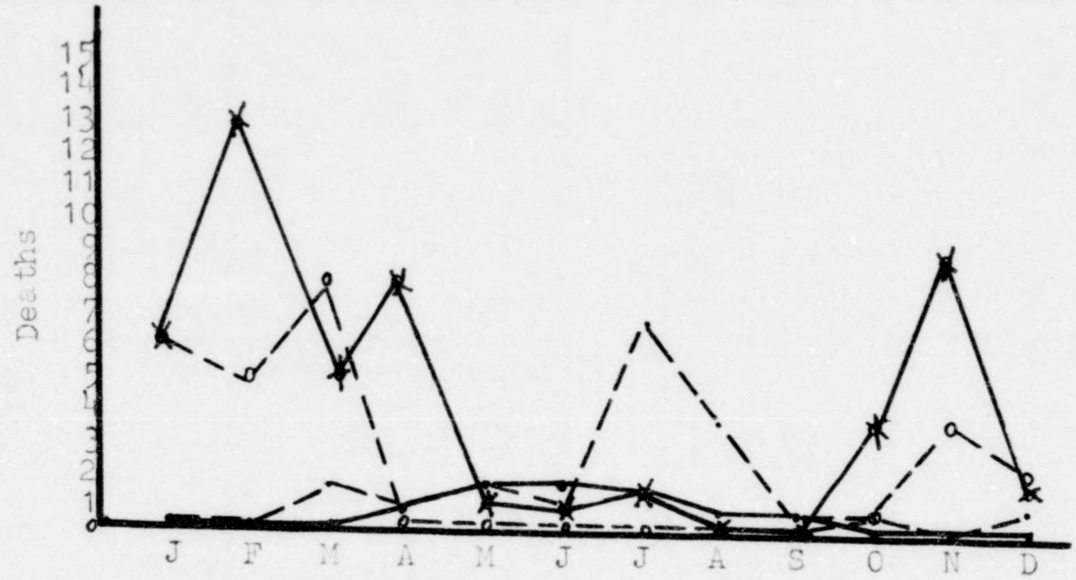


Figure 22

1970



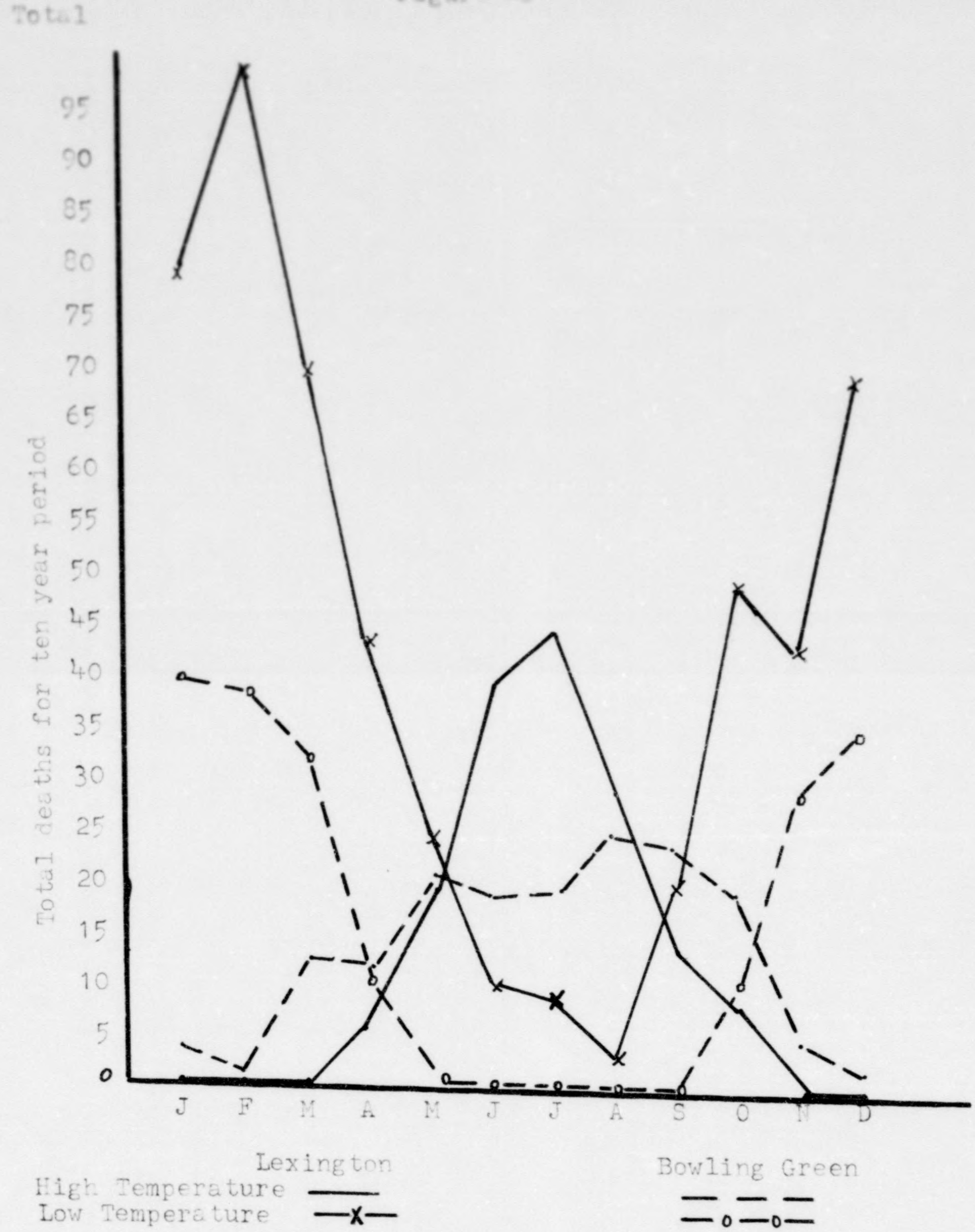
	Lexington	Bowling Green
High Temperature	———	— — —
Low Temperature	—x—	—o—o—

Appendix C continued

Monthly Distribution of Respiratory Deaths

by Temperature

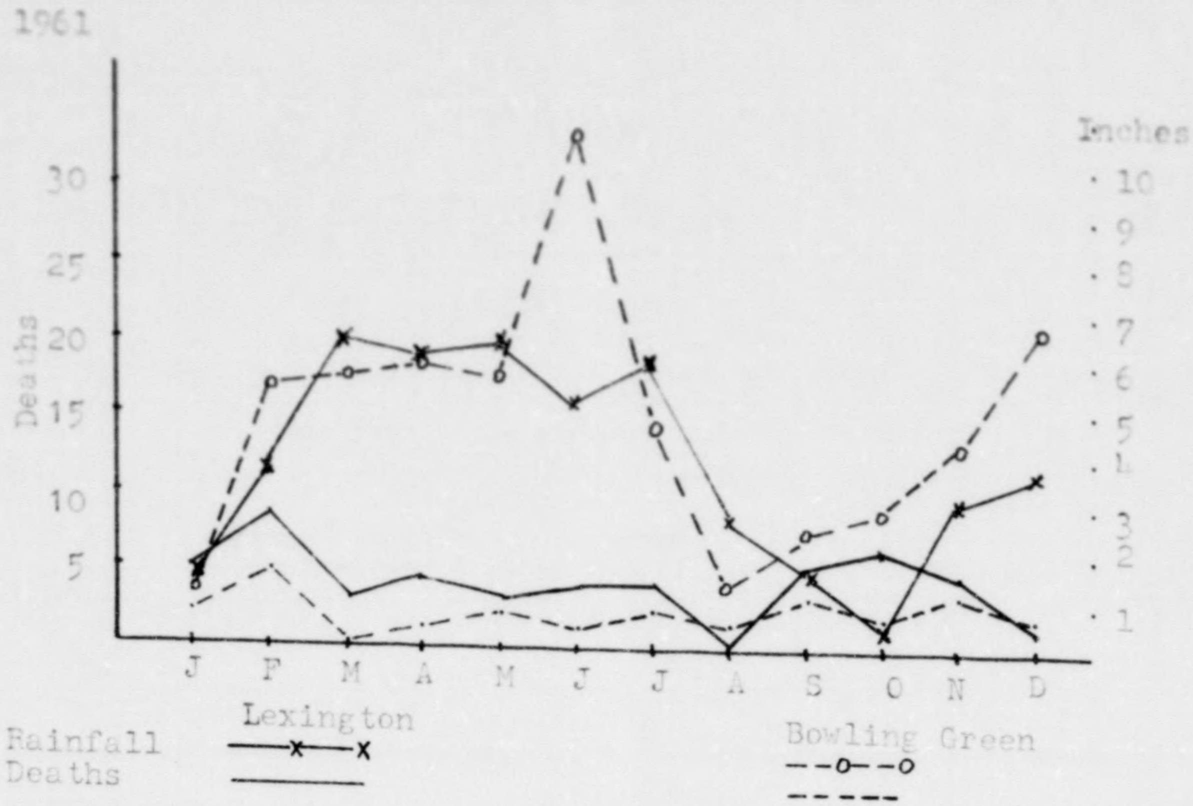
Figure 23



Monthly Distribution of Respiratory Deaths

by Precipitation

Figure 24



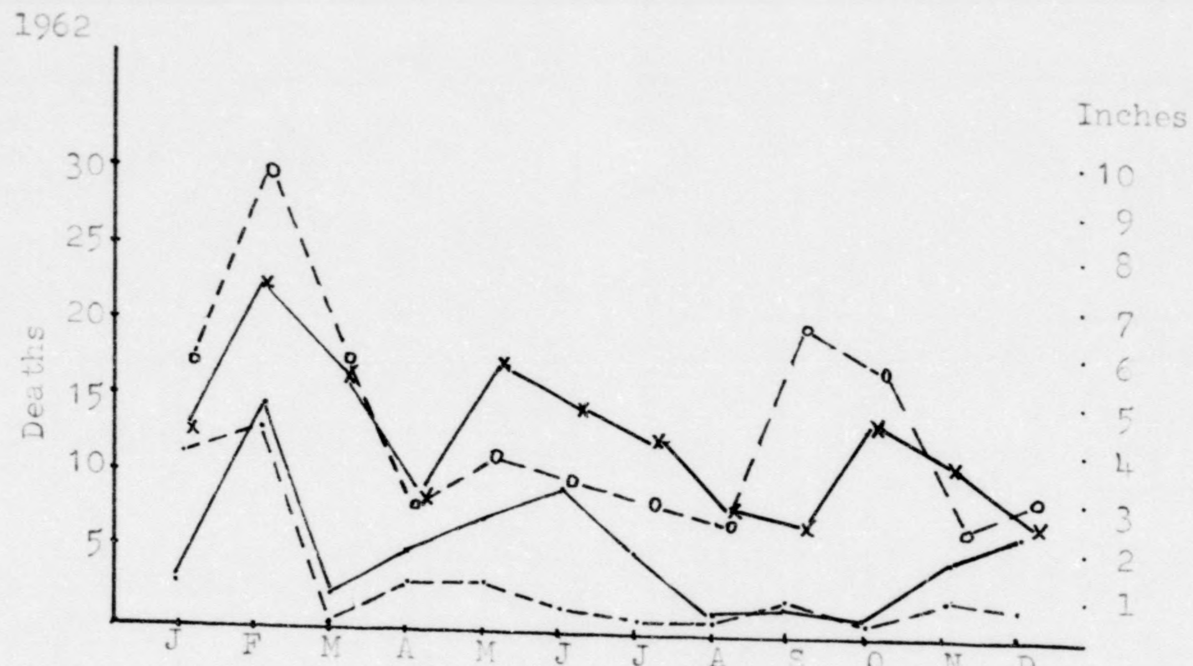


Figure 25

Monthly Distribution of Respiratory Deaths

by Precipitation

Figure 26

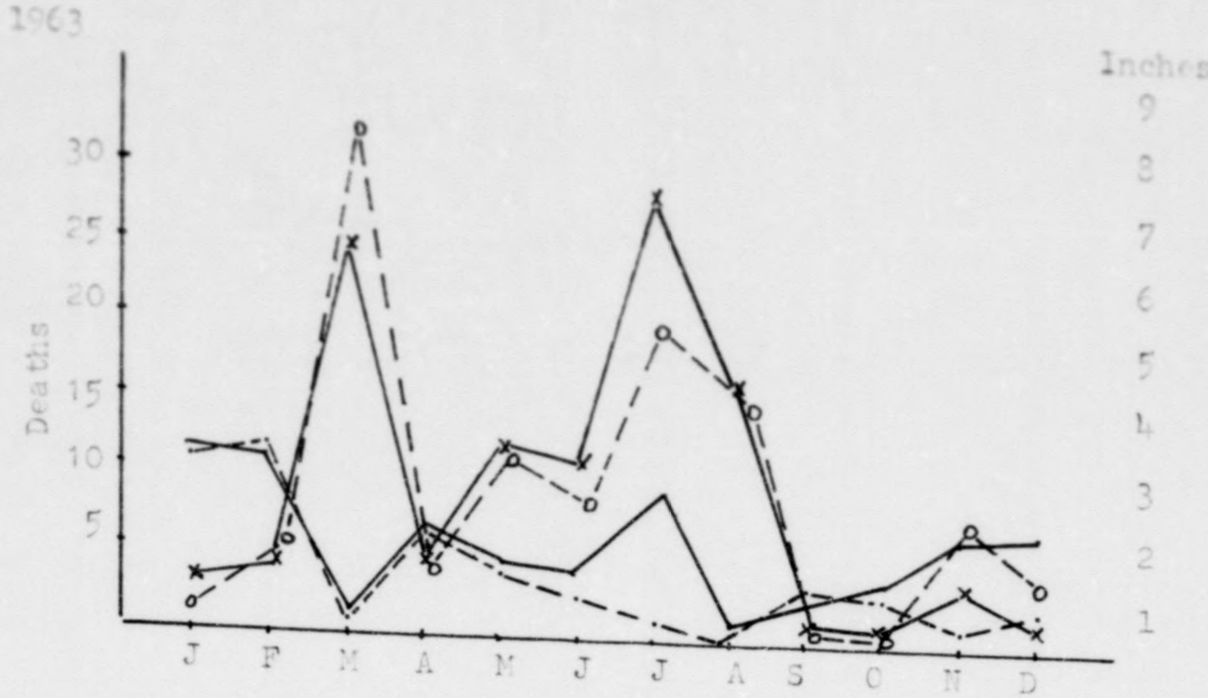
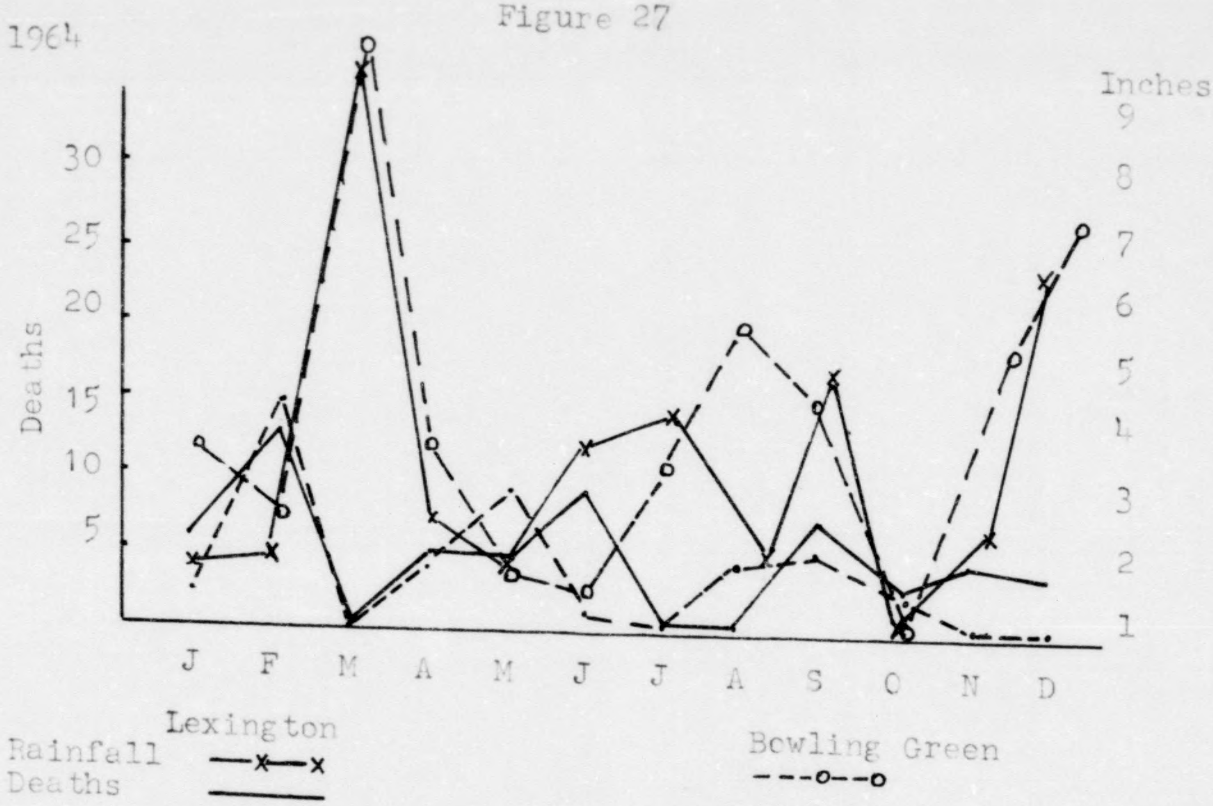


Figure 27



Monthly Distribution of Respiratory Deaths
by Precipitation

Figure 28

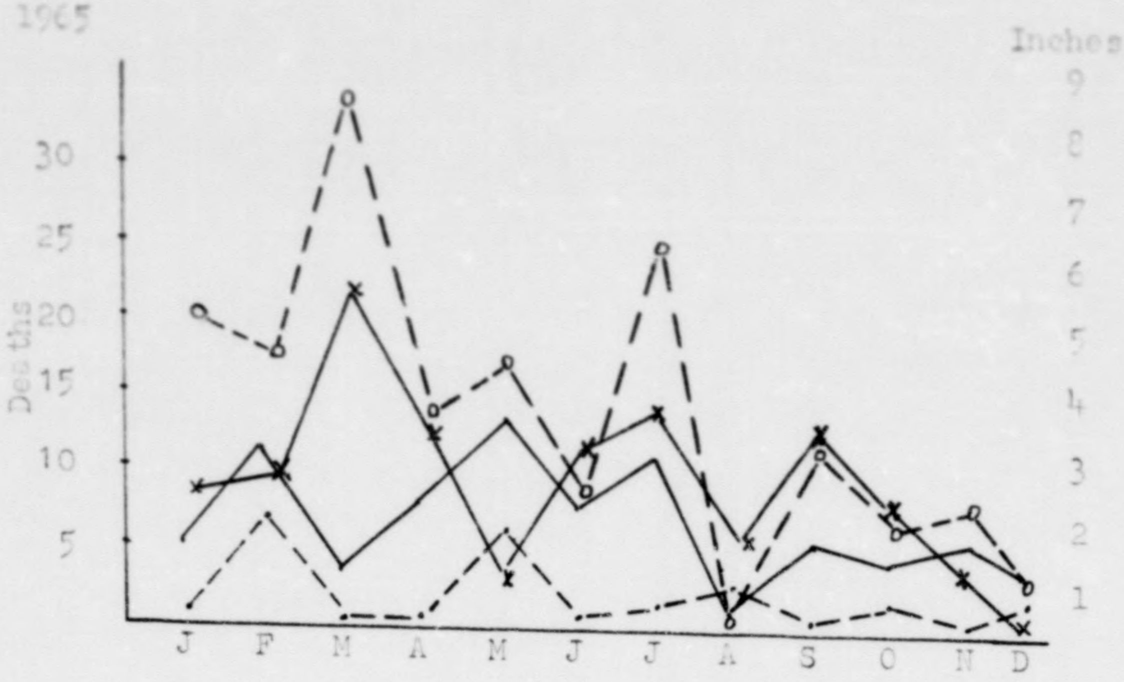
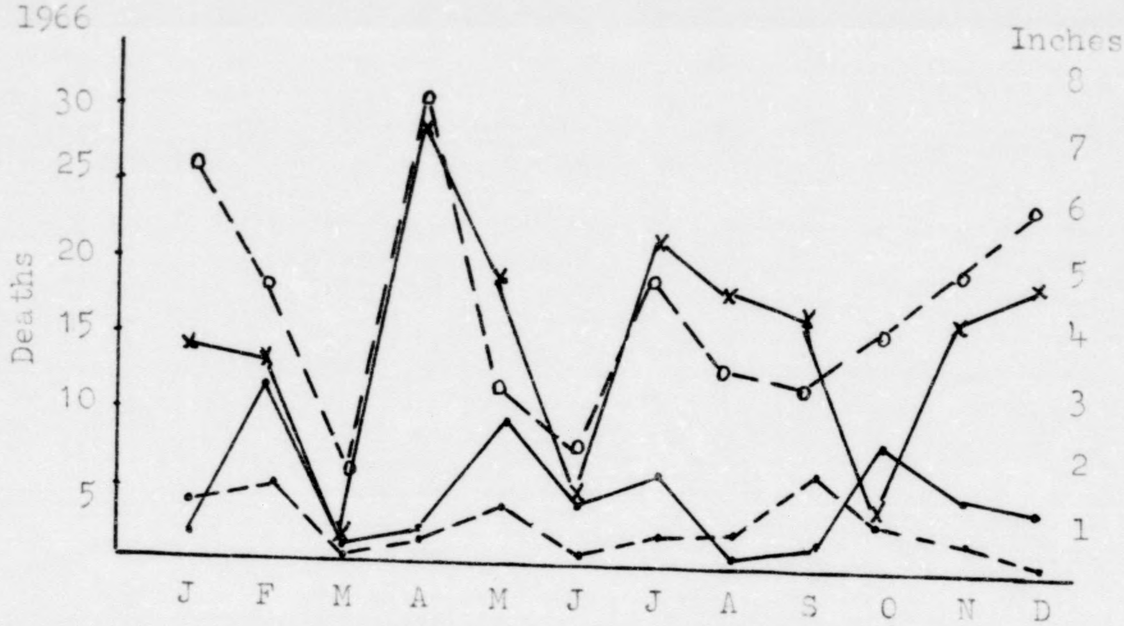


Figure 29



Lexington
Rainfall —x—x
Deaths ———

Bowling Green
--o--o

Appendix H continued

Monthly Distribution of Respiratory Deaths

by Precipitation

Figure 30

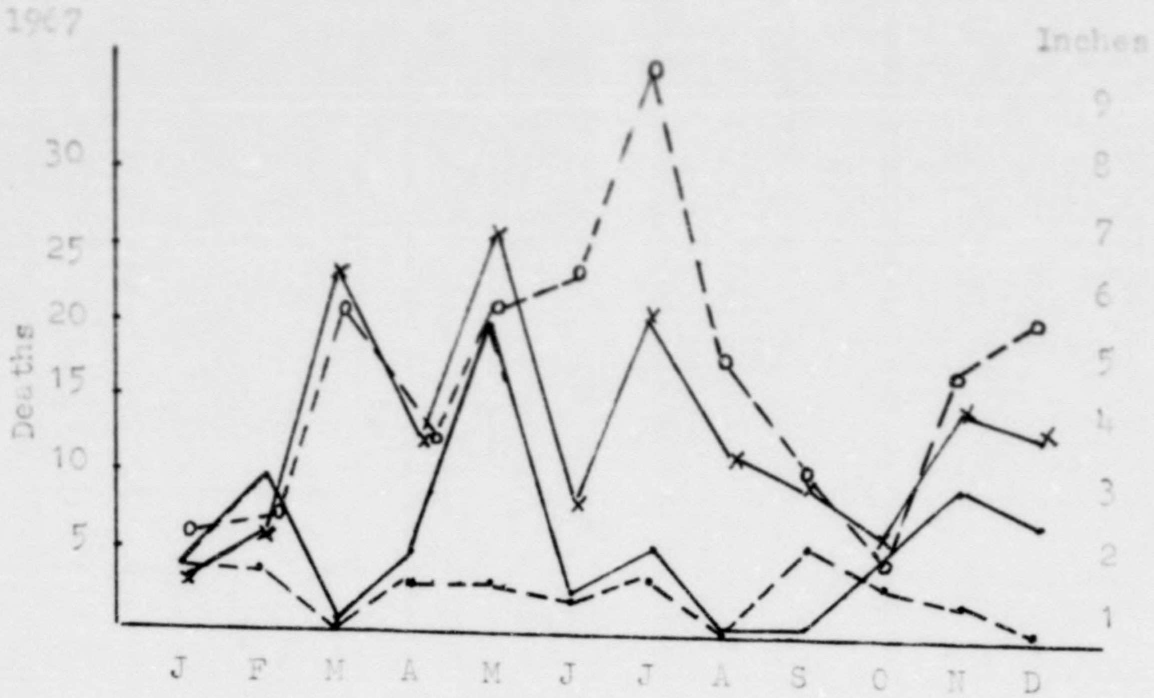
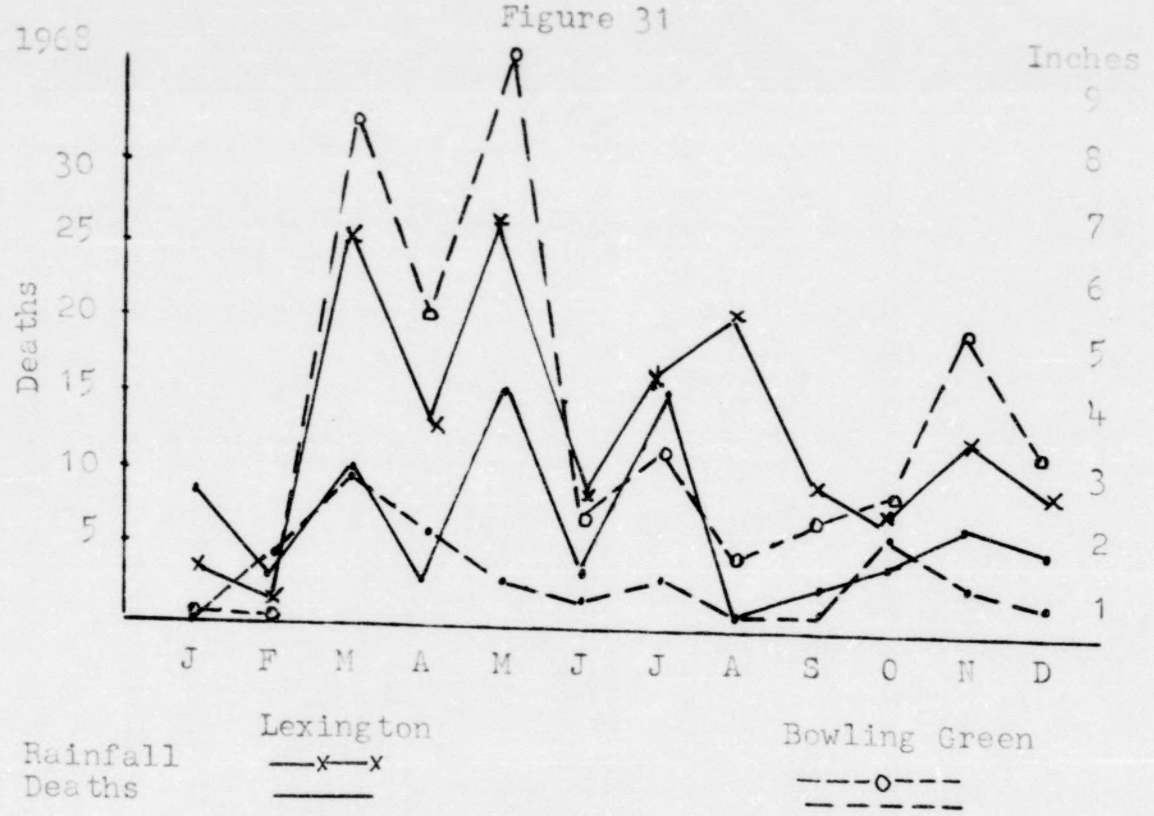


Figure 31



Monthly Distribution of Respiratory Deaths

by Precipitation

Figure 32

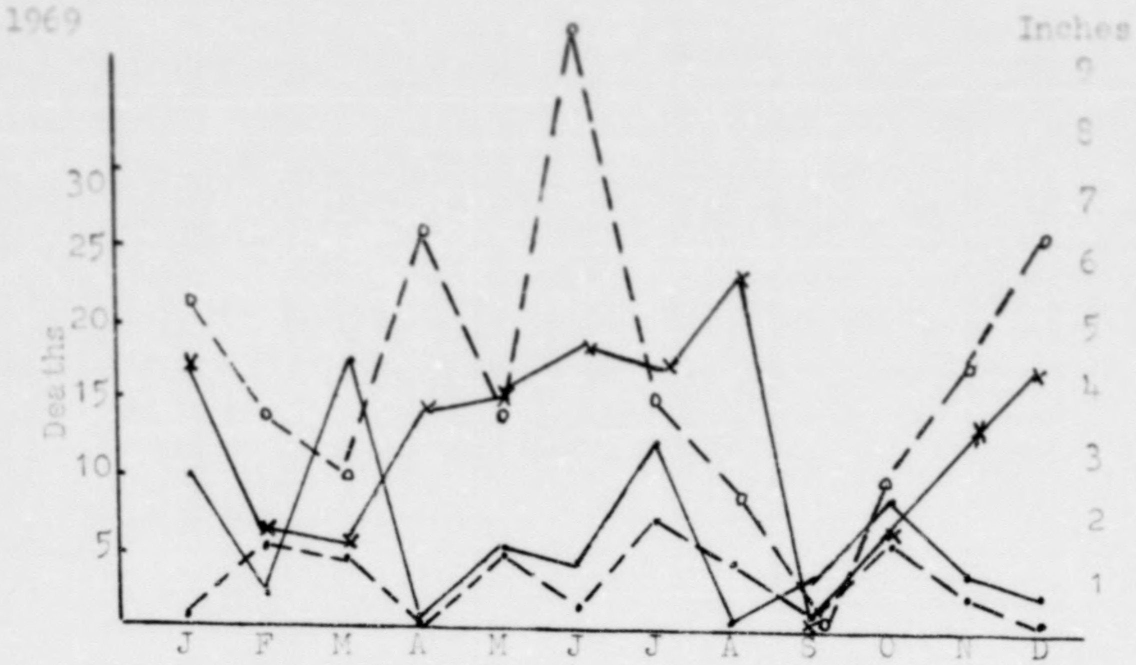
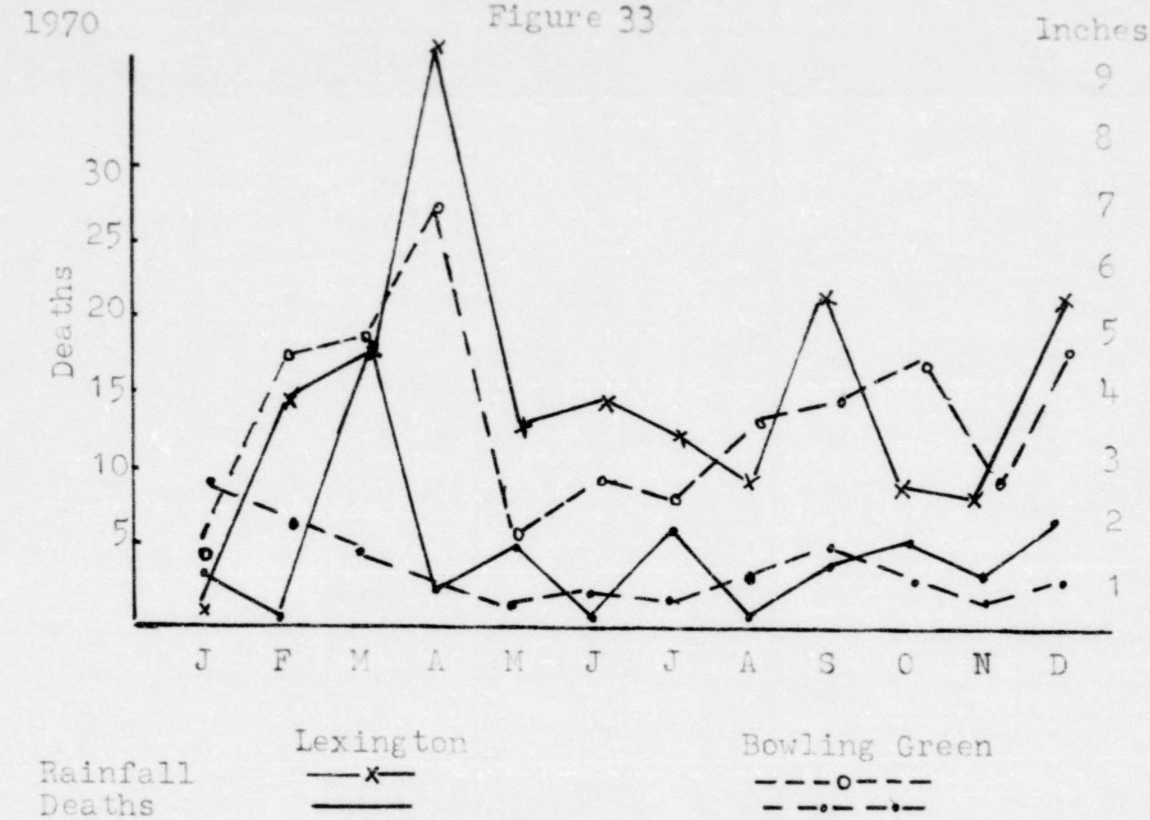


Figure 33



Appendix H continued

Monthly Distribution of Respiratory Deaths

by Precipitation

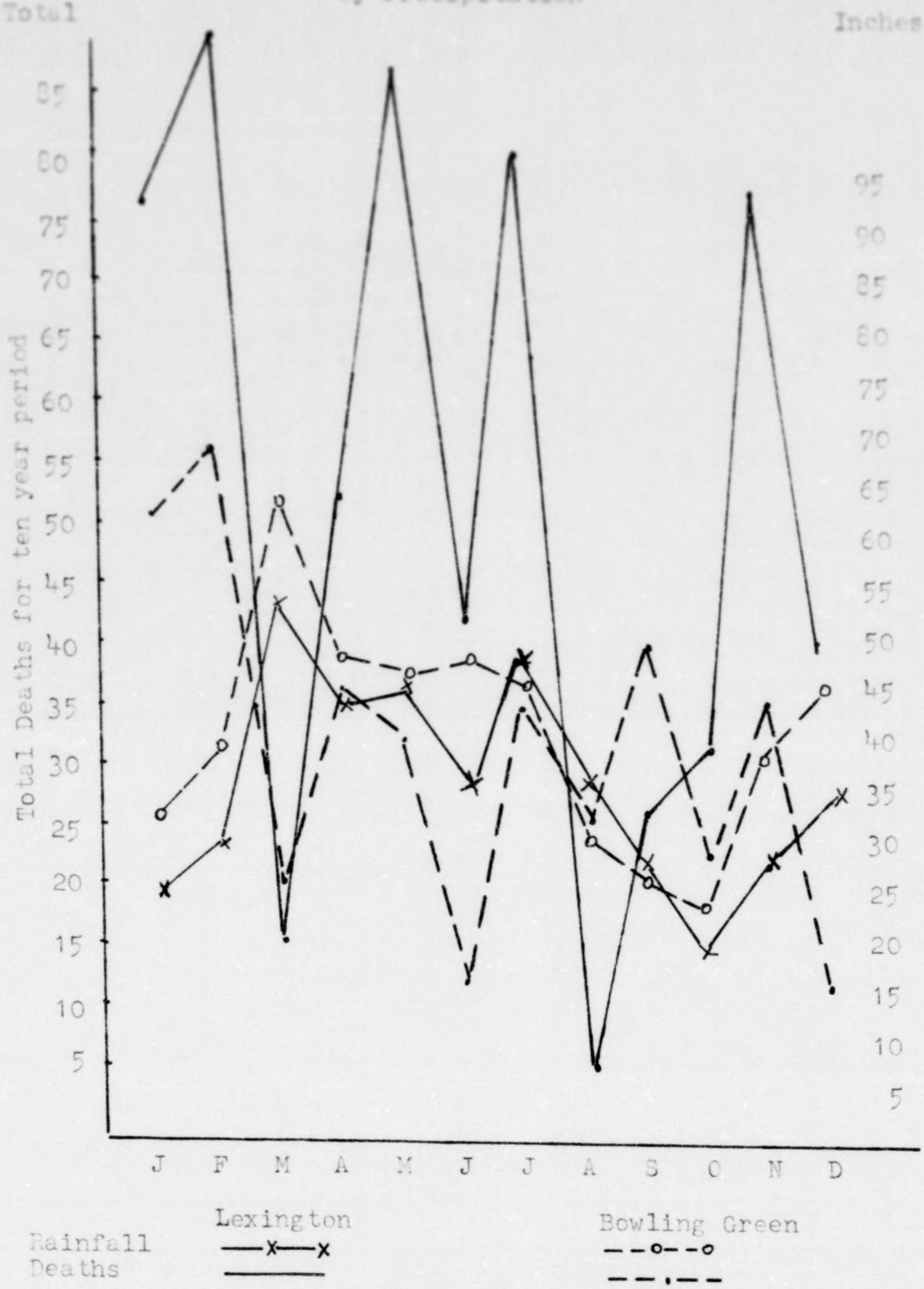


Figure 34

Seasonal Distribution of Respiratory Deaths

Figure 35

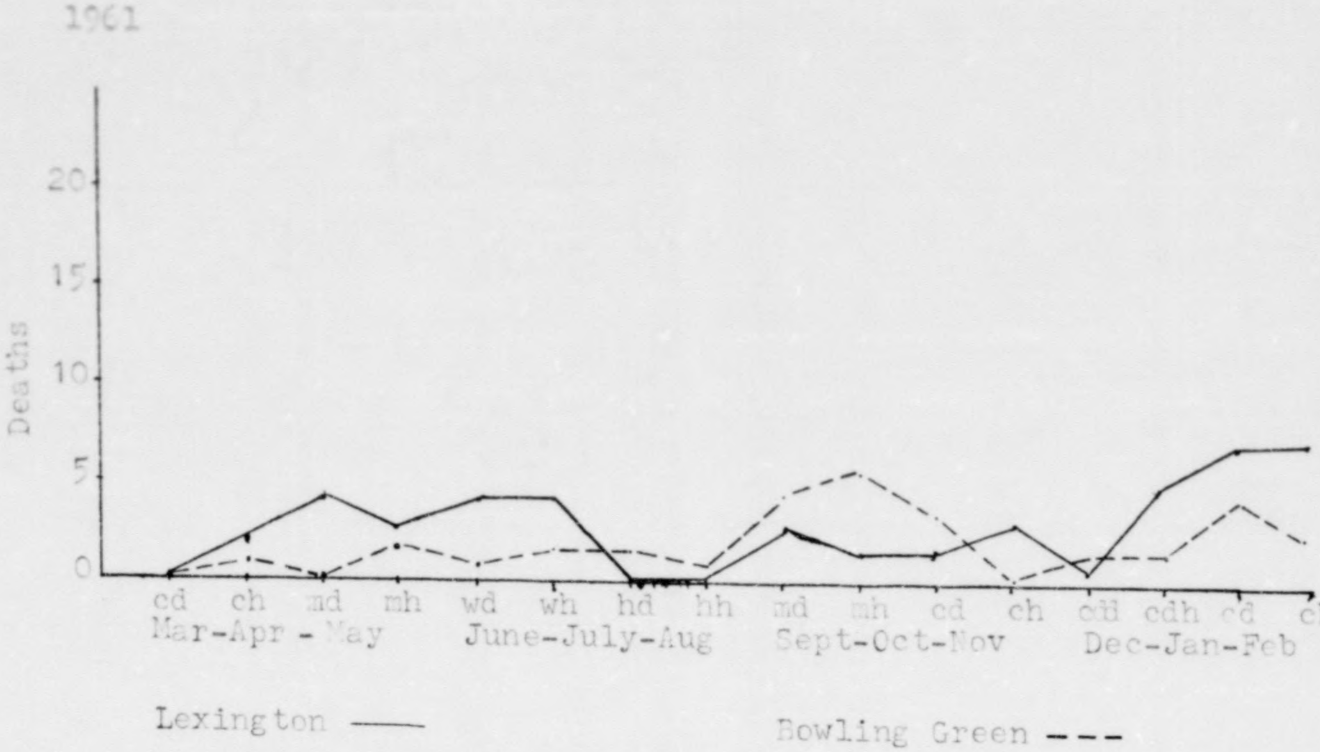
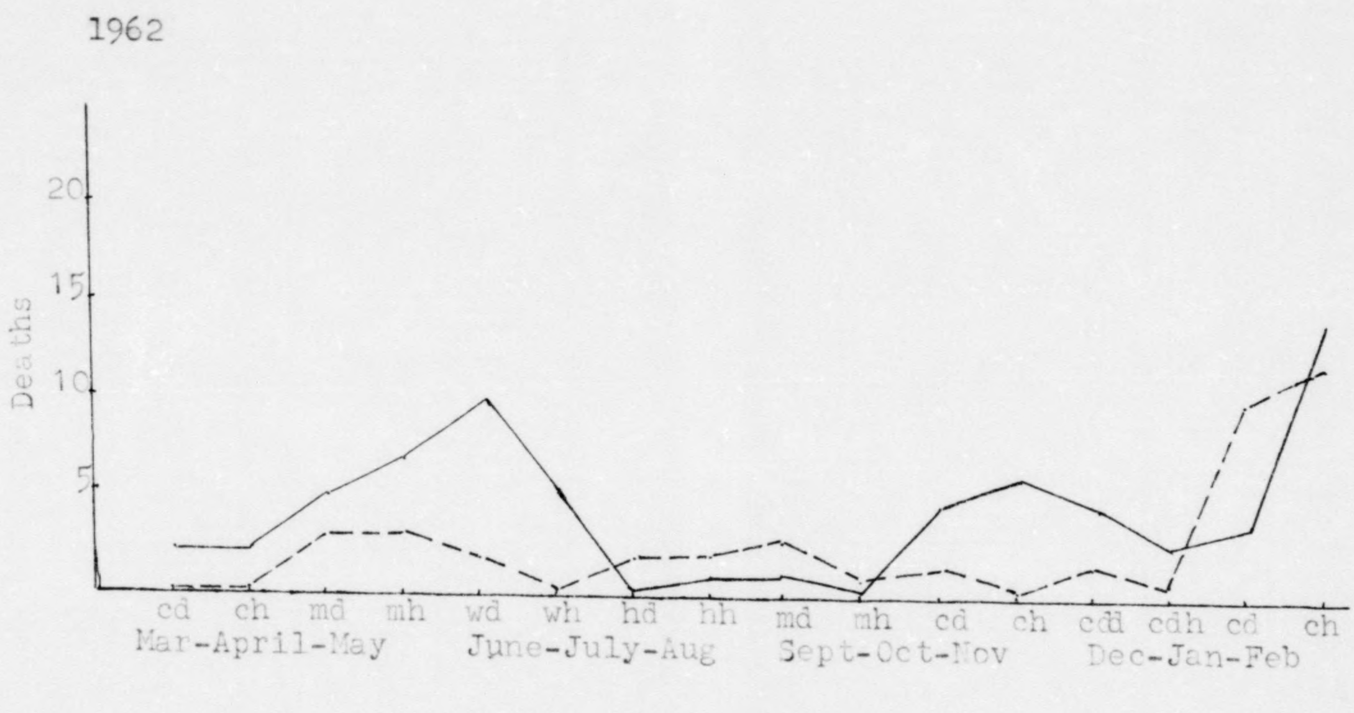


Figure 36



Appendix I continued

Seasonal Distribution of Respiratory Deaths

Figure 37

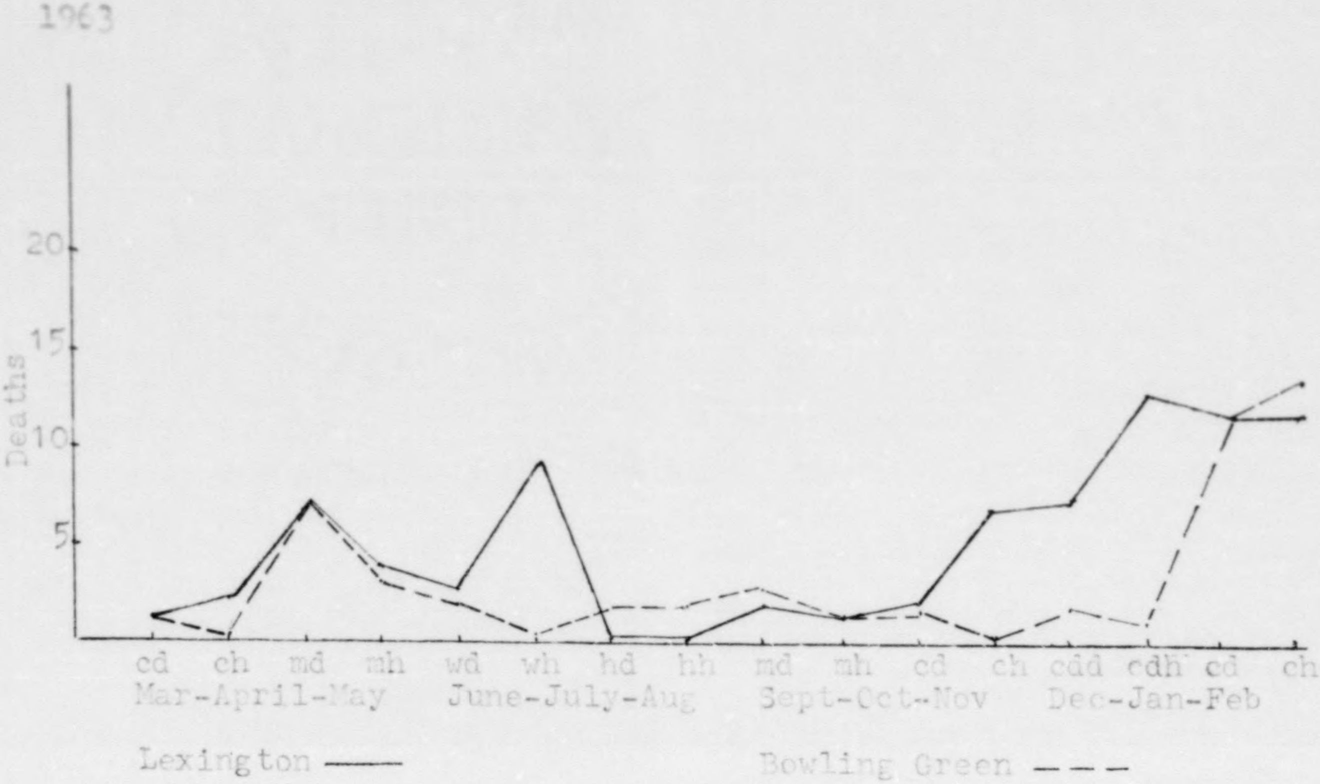
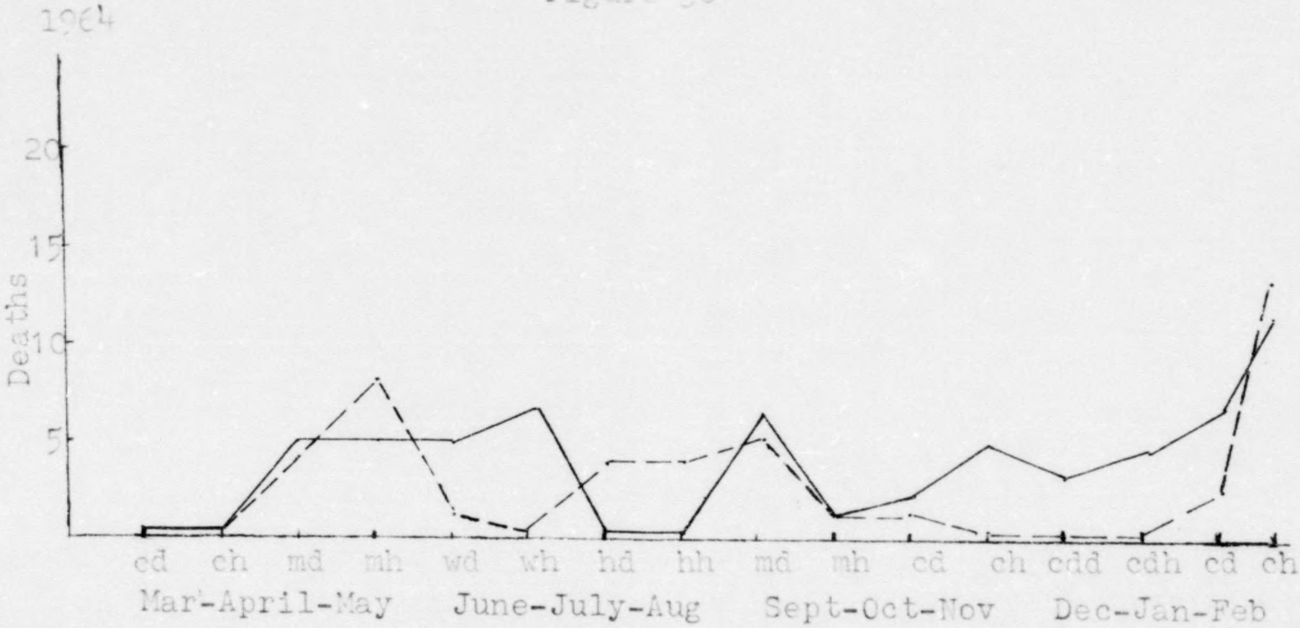
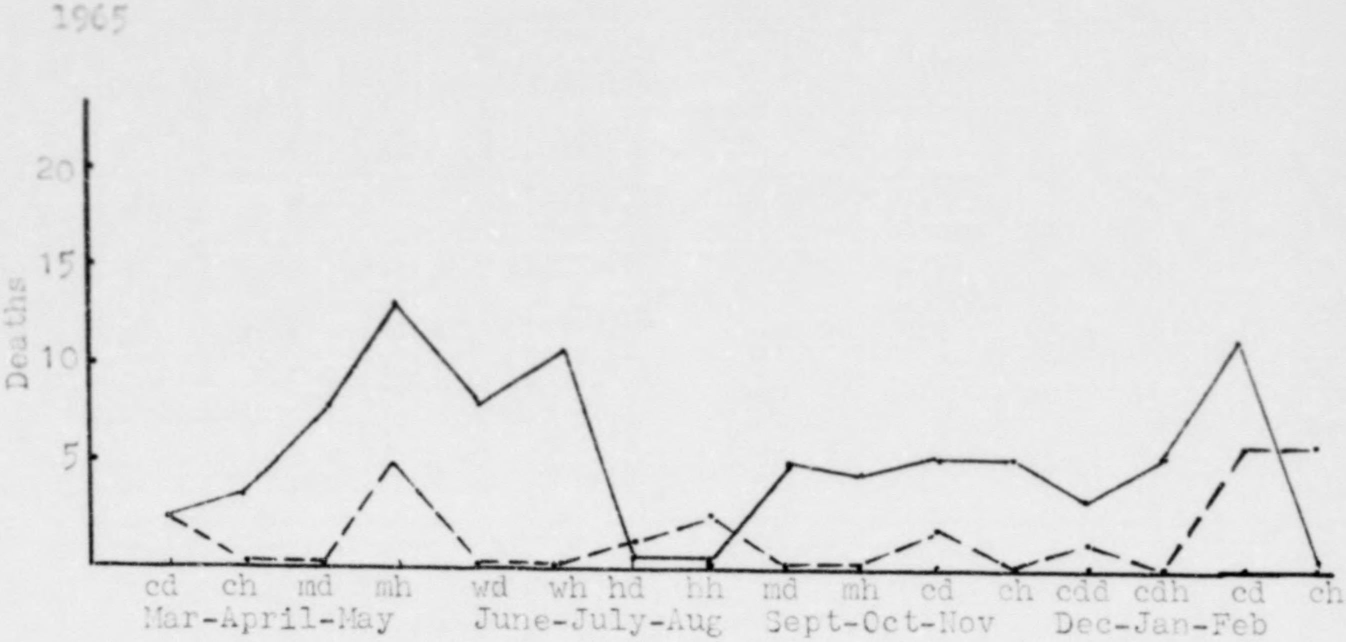


Figure 38



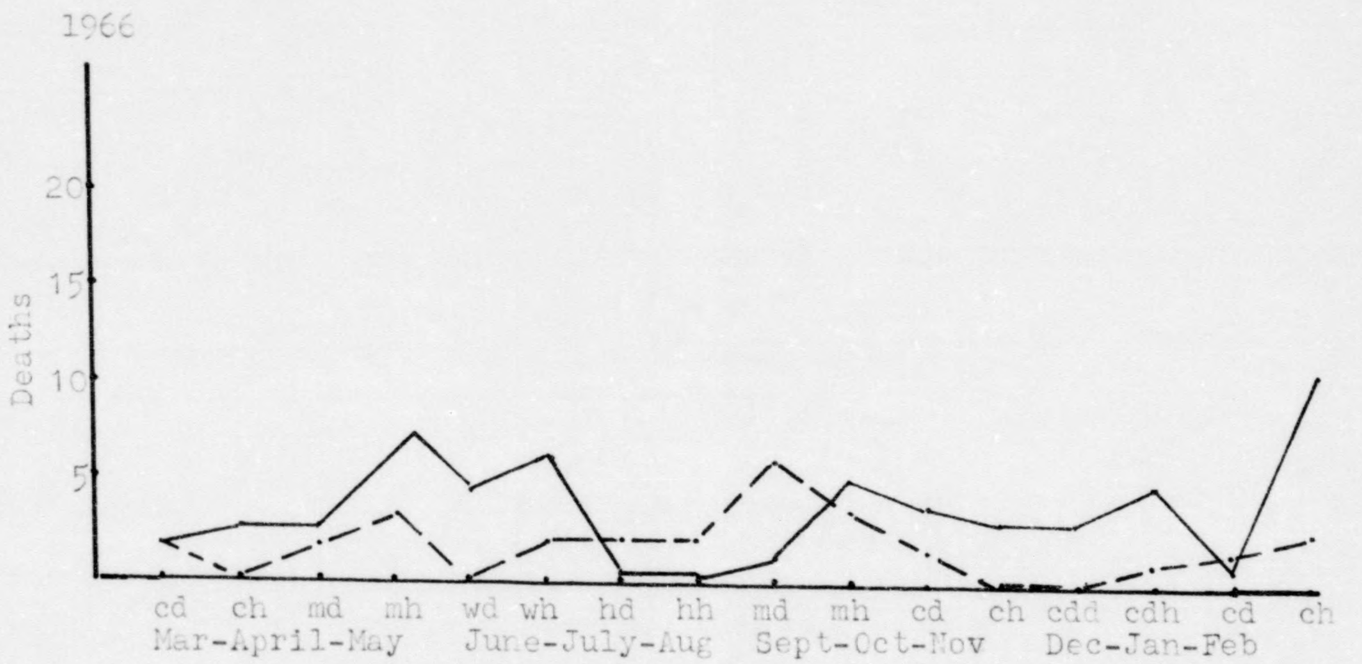
Seasonal Distribution of Respiratory Deaths

Figure 39



Lexington ——— Bowling Green - - -

Figure 40



Seasonal Distribution of Respiratory Deaths

Figure 41

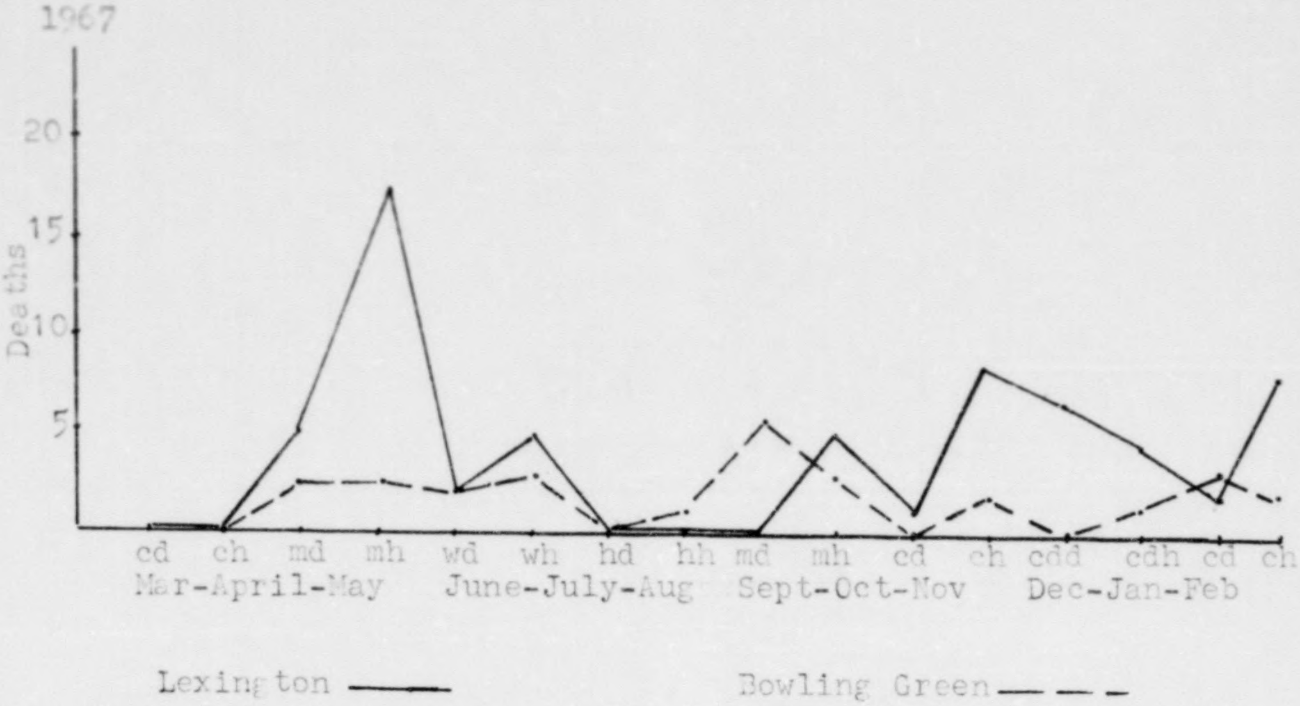
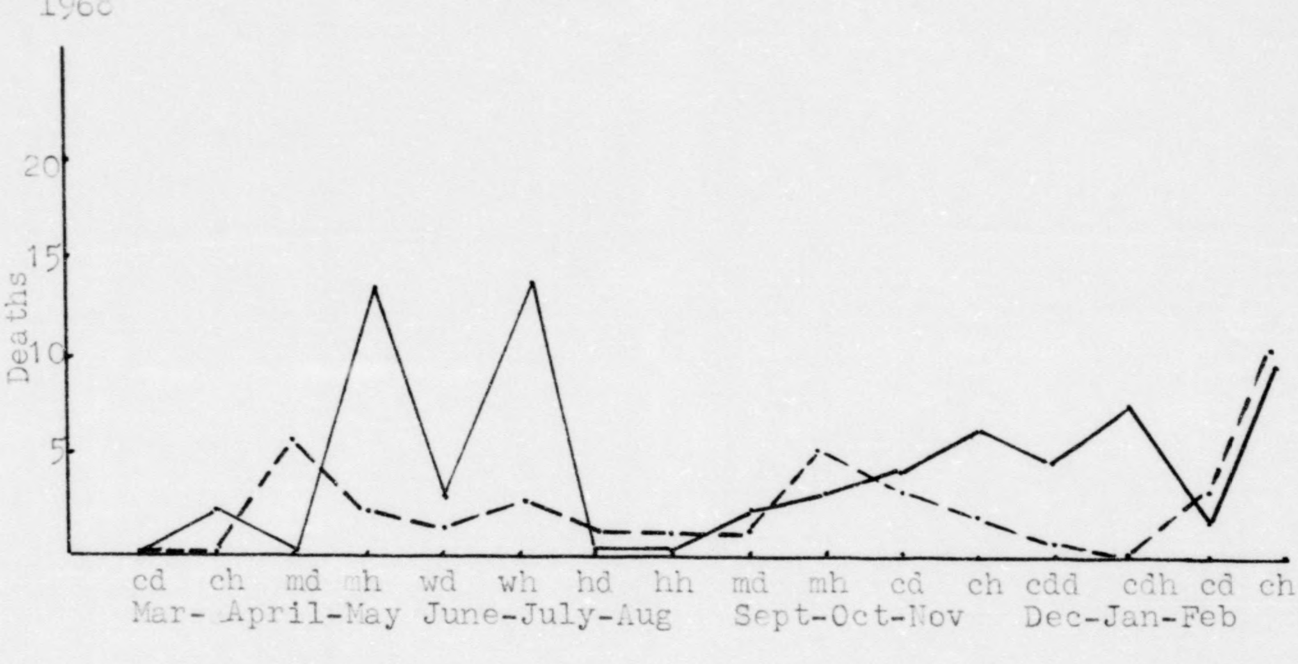


Figure 42



Seasonal Distribution of Respiratory Deaths

Figure 43

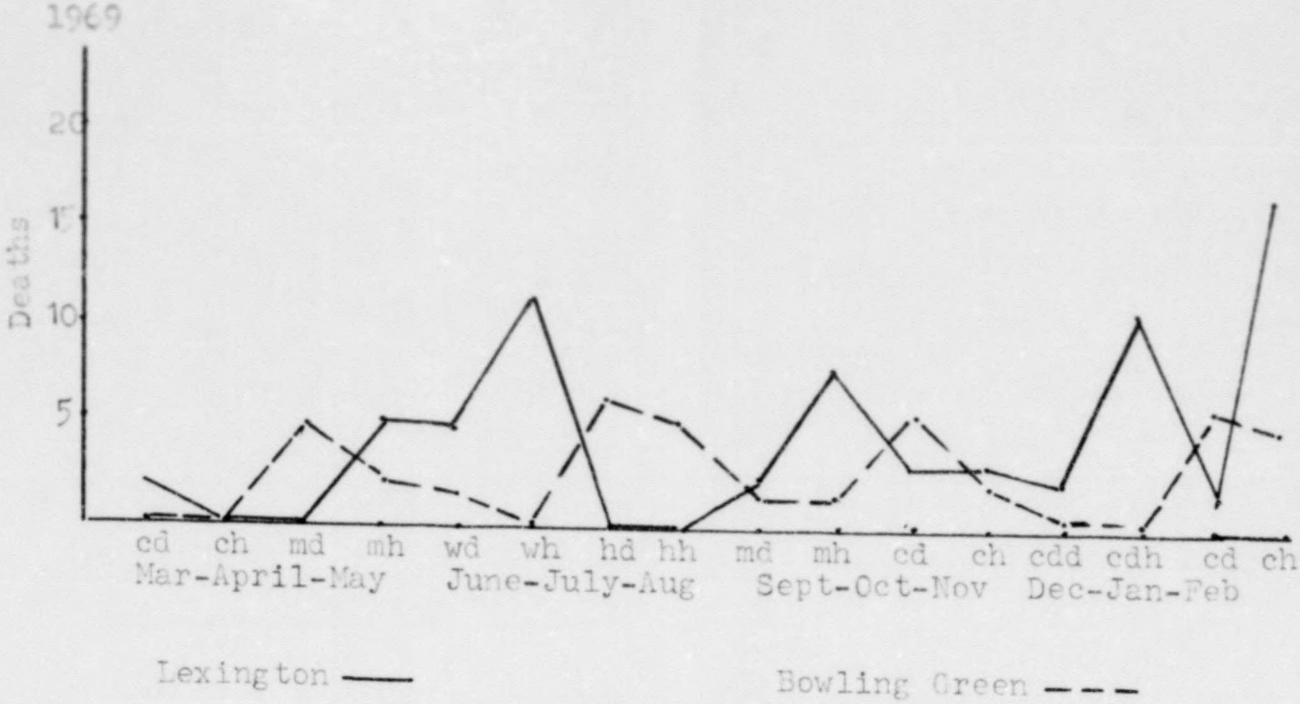
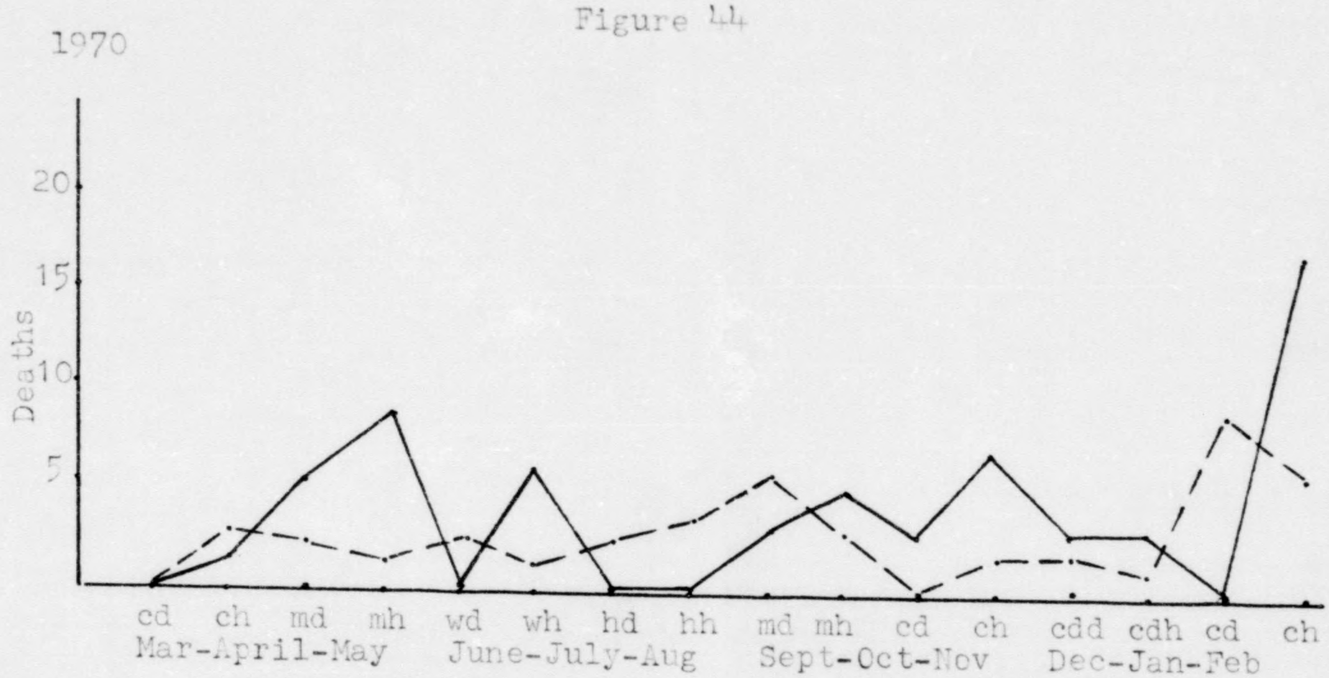
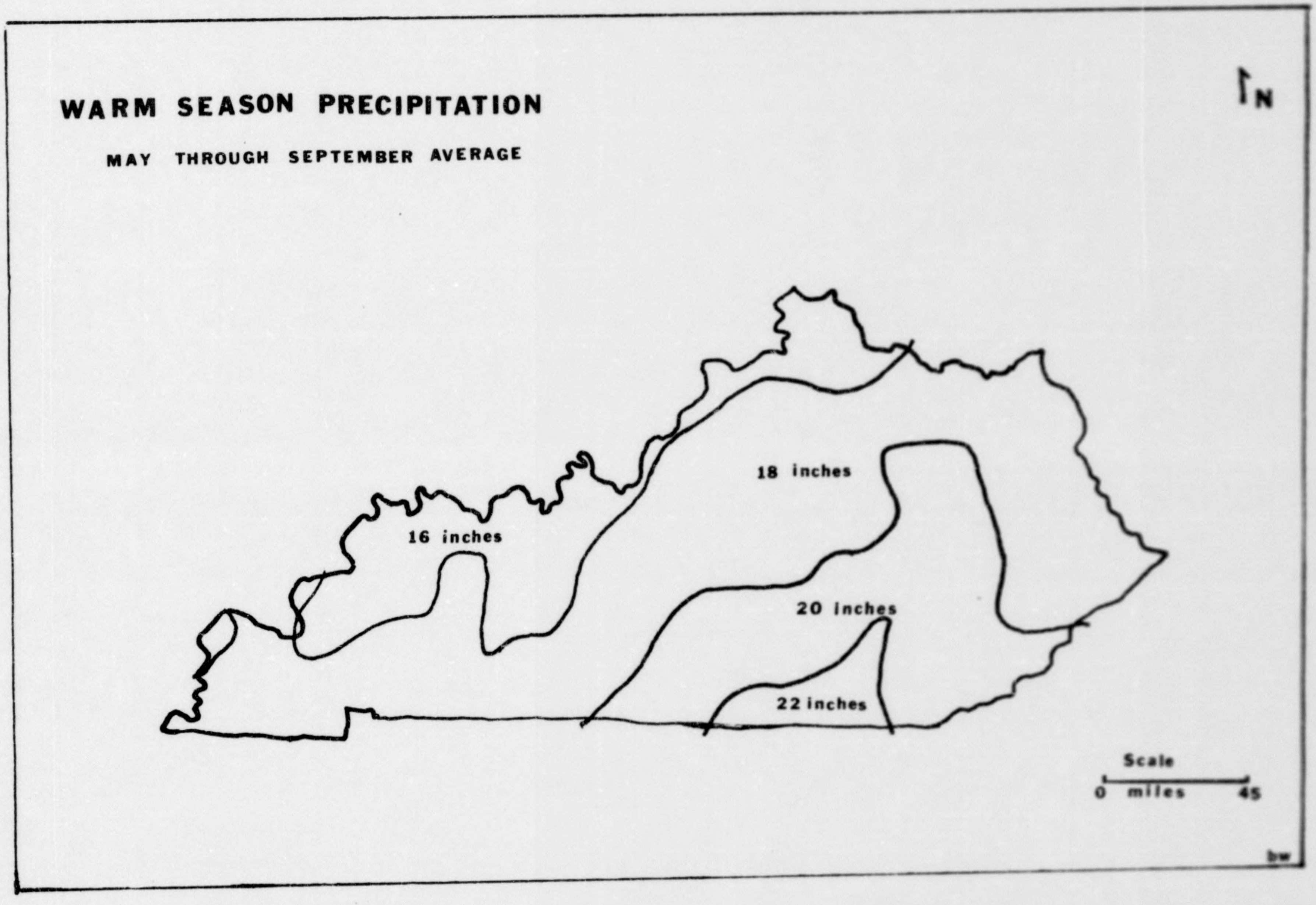


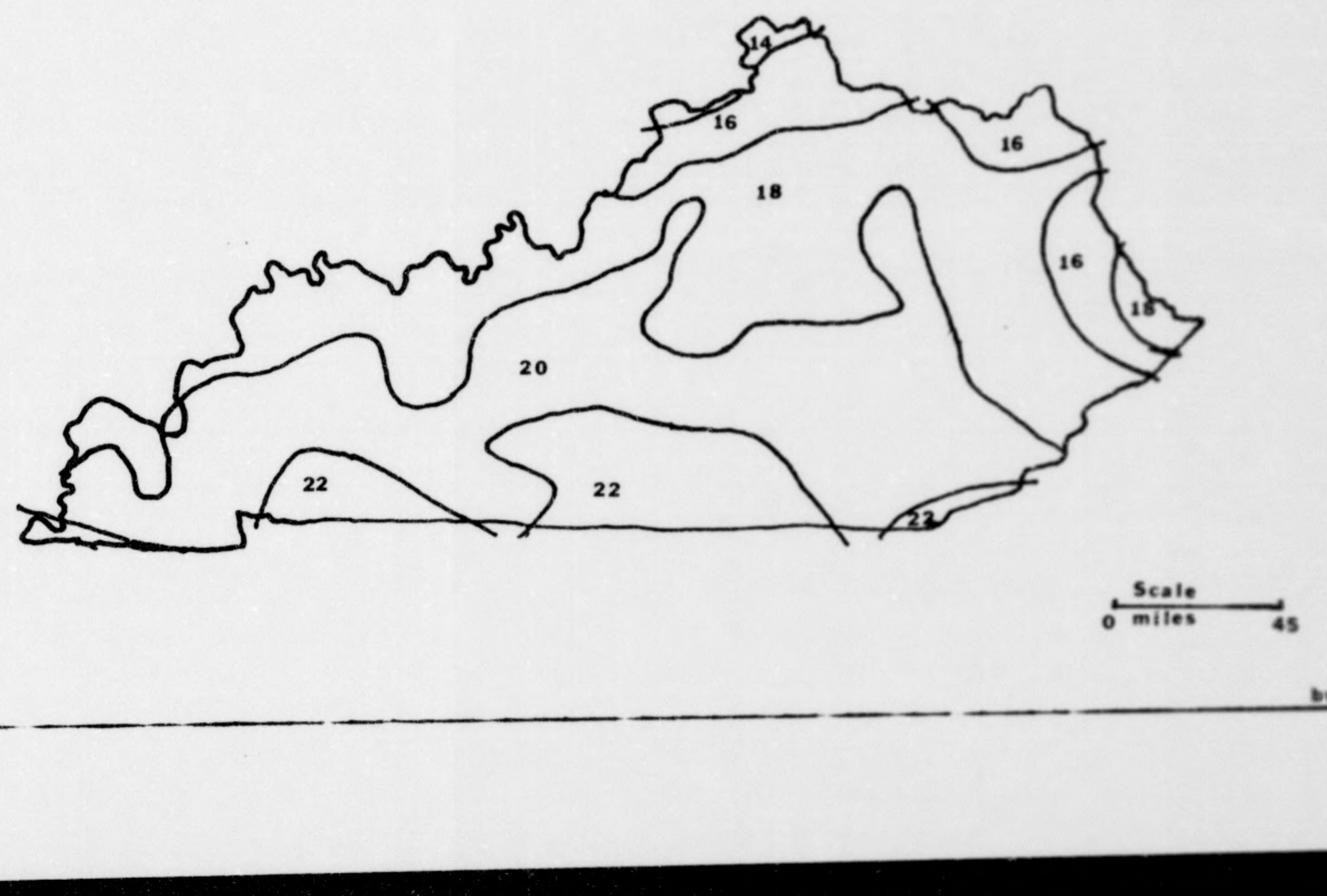
Figure 44




WARM SEASON PRECIPITATION
MAY THROUGH SEPTEMBER AVERAGE
N
16 inches
18 inches
20 inches
22 inches
Scale
0 miles 45
bw

COOL SEASON PRECIPITATION

NOVEMBER THROUGH MARCH AVERAGE
(inches)



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