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SOME RELATION BETWEEN OUR HEALTH AND OUR ENVIRONMENT

A STUDY OF THE PREVALENCE OF DISEASE IN THE CITY OF DETROIT WITH SPECIAL REFERENCE TO THE INFLUENCE OF THE TYPE AND SANITATION OF DWELLINGS UPON DISEASE

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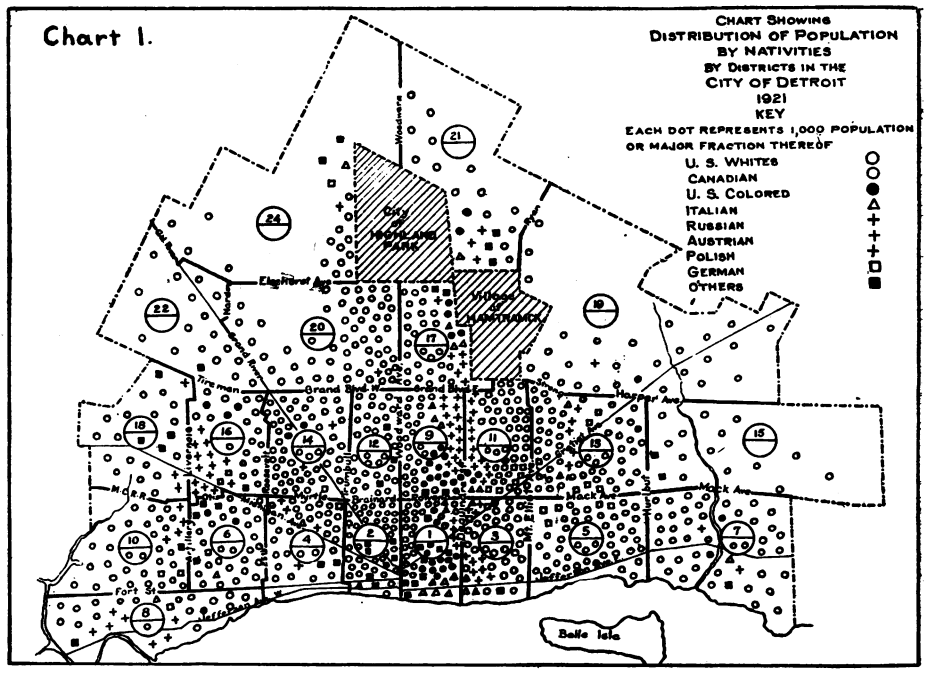
"It is not too much to say that an adequate solution of the housing question is the foundation of all social progress. Health, and housing, are indissolubly connected. If this country is to be the country which we desire, a great offensive must be taken against disease and crime, and the first point at which the attack must be delivered is the ugly, unhealthy, overcrowded house, in the mean street, which we all of us know too well.

"If a healthy race is to be reared it can be reared only in healthy homes. If infant mortality is to be reduced, and tuberculosis to be stamped out, the first essential is the improvement of housing conditions; if drink and crime are to be successfully combated, sanitary houses must be provided. If 'unrest' is to be converted to contentment, the provisions of good housing may prove one of the most potent agencies in that conversion."

NOTE.—Extract from the King's speech to representatives of the local authorities and societies at Buckingham Palace. Quoted from the London Times, April 12, 1919.

FEW opportunities are available for studying on a large scale the possible relation between public health and the housing of a community without the expenditure of considerable effort and money in gathering data through special surveys. Detroit, however, possessed such an opportunity during the years 1920 and 1921. The Board of Education made a complete census of the city in the spring of 1921, in which the data concerning each block was tabulated separately and from which data for larger units corresponding to the health districts established by the Department of Health were readily obtained. The growth of the city was rapid during 1920, but a business depression in the fall of that year caused an exodus which was estimated to have reduced the population by the later months of 1921 to a point only a little above what it was in January, 1920. Thus the result was a two-year period during which the population average remained nearly stationary. Because of



this, the disease and death rate figure based upon a reliable population figure were available for both years and permitted a comparison with the housing statistics compiled by the Department of Health with only slight additional effort.

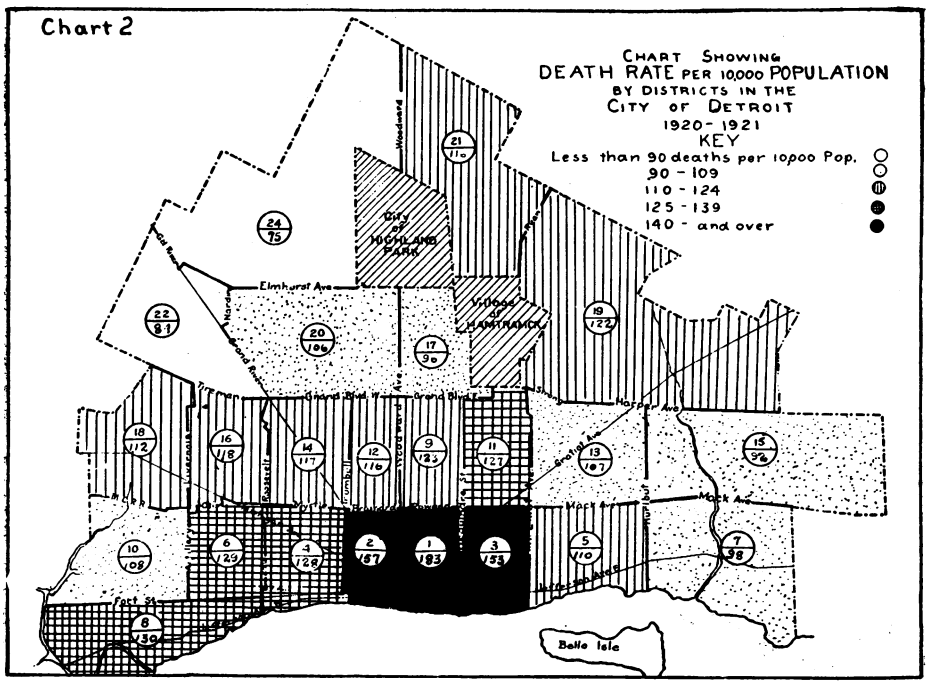
The census was sufficiently detailed in character to allow the computing of disease and death rates based upon the susceptible age groups in each district rather than upon the total population.

The city is 79 square miles in area and completely surrounds two municipalities, totaling nearly 100,000 people. It lies along the Detroit River, and is divided almost equally by its principal thoroughfare, Woodward Avenue. The older portion of the city developed around the intersection of Woodward Avenue and the river as a center. The growth has been semi-circular in nature and almost equal in all directions, forming concentric areas of new territories. Within the last six years Districts 18, 22, 24, 21, 19 and 15 have been added to the city's area. These districts are easily noted from Chart 1, which shows the distribution of population. These districts are not as yet fully occupied or developed. In fact, there are hundreds of acres in Districts 24, 21 and 19 in which no dwellings will be found. For this reason comparison of conditions in these areas with the more thickly filled up portions cannot be made directly, and consideration must always be had for their undeveloped character.

In order that conditions in all portions of the city may be easily comprehended and carried in mind, the principal data of the survey have been presented in chart form.

The city, for health purposes, has been divided into twenty-three districts, varying in size from District No. 2, which contains 877 acres, to District 19, which contains 6,125 acres. The populations of the districts vary considerably, from 10,494 in District 22 to 68,915 in District 11. Inasmuch as the outlying districts, however, will not be used in all comparisons, the difference in population will be somewhat reduced.

Chart 1 shows in general the distribution of population by nativity. Each symbol represents 1,000—or major fraction—of population of the nativity indi-



cated, and the distribution of nativities is shown as accurately as may be by this manner. It must be understood in considering this chart that nativity means the country of birth, and this holds for all age groups, consequently, even in the so-called foreign districts, the number of native born is very high, approximately two-thirds of the entire population being in this class.

Any study of the influence of race upon disease rates must take into consideration that the American, born of foreign parents, may possibly inherit racial tendencies to disease, or the tendency may be developed from environment, which may not be, strictly speaking, American.

Chart 2 shows the death rate per 10,000 of population by districts, and, if the general death rate is accepted as the index of a city's disease prevalence, is indicative of the composite hazard from all diseases, and one may compare the rates here expressed with a suitable measure of the housing conditions in the same district in an endeavor to determine whether or not any parallelism exists.

Charts 3 and 4 show the infant mortality by districts for the years 1920 and 1921, respectively. The rates for these years vary so widely that it was thought best to show the figures for both years. For some reason not entirely apparent the entire registration area during the year 1921 enjoyed a low infant mortality rate, which resulted in decreasing the rate in the districts of the city from 10 to 30 per cent. However, there is no indication that the influence effecting a lower general rate has changed the relative positions of the districts when arranged by rate. Those districts enjoying a low mortality in 1920 still enjoy low mortality in 1921, and those notorious for high rates in the previous year are no exception in the latter case.

Charts were prepared showing the percentage of children by districts; that is, the percentage of total population which was under ten years of age. Inasmuch as a study of the distribution of deaths from certain children's diseases, namely, diphtheria, scarlet fever, whooping cough and measles, show that 80 per cent or more occur in the first ten years of life, this age grouping has been set aside as the suscep-

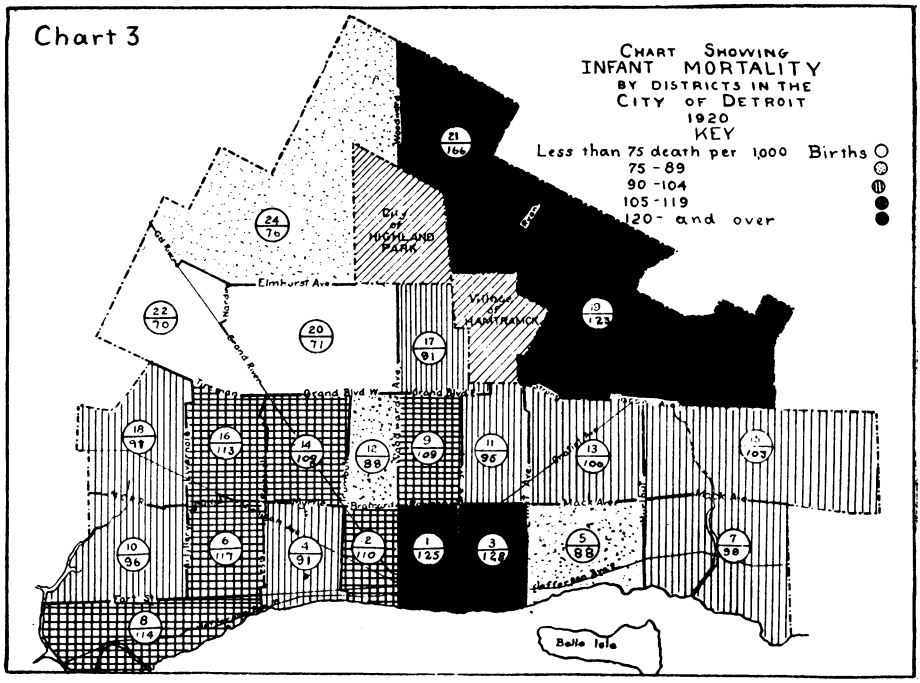


Chart 3
CHART SHOWING
INFANT MORTALITY
BY DISTRICTS IN THE
CITY OF DETROIT
1920
KEY
Less than 75 death per 1,000 Births
75 - 89
90 - 104
105 - 119
120 - and over
City of HIGHLAND PARK
Village of HAMTRAMCK
Elmhurst Ave
Grand Blvd W
Grand Blvd E
Jefferson Ave
Belle Isle

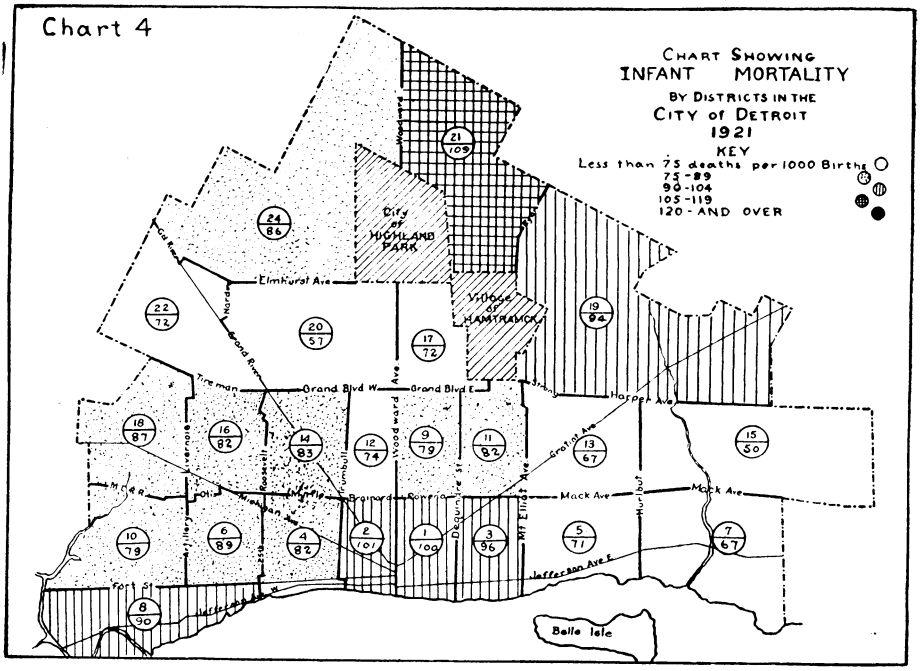


Chart 4
CHART SHOWING
INFANT MORTALITY
BY DISTRICTS IN THE
CITY of DETROIT
1921
KEY
Less than 75 deaths per 1000 Births
75 - 89
90 - 104
105 - 119
120 - AND OVER
City of HIGHLAND PARK
Village of HAMTRAMCK
Elmhurst Ave
Grand Blvd W
Grand Blvd E
Harper Ave
Mack Ave
Jefferson Ave E
Jefferson Ave W
Belle Isle

tible population in figuring the case rate, and the density of this child population was stated, first, by the percentage of total population which falls within the age group, and, second, by the density of this population per ten acres of area. Comparison was then made between these charts and charts showing the prevalence of diphtheria per 10,000 of susceptible population to determine whether or not this child density is an appreciable factor in the prevalence of these diseases. This comparison, however, fails to show any parallelism between the density of child population and the prevalence of diphtheria, scarlet fever and measles. Whether the periods considered are too short to show any relation between the factors, or whether there is some unknown quantity which is responsible for the distribution of these diseases, such as carriers, local neighborhood epidemics, or some other factor, such as susceptible population, etc., it is not possible to say from the data at hand.

While space will not permit the exhibiting of the detailed charts used in making these comparisons, the results have been summarized in charts which will be shown later where they are compared with the sanitary index of the district.

Charts were likewise made showing the death rate per 10,000 susceptible population from Bright's disease and chronic nephritis, apoplexy, heart disease and cancer respectively. For Bright's disease and nephritis and heart disease the entire population is almost uniformly susceptible, so that the rates here given are based upon the total population. In the case of apoplexy the population taken is both male and female over forty years. In the case of cancer, male and female over thirty years is used as the susceptible population.

The thought in mind in comparing the prevalence of these diseases is that they are probably as little associated with housing conditions as any of the diseases of equal prevalence, and that they might perhaps serve as a screen upon which to throw the picture of diseases commonly associated with bad housing; in an attempt to compare the distribution of tuberculosis and pneumonia with what may be termed a standard disease condition for the city, as shown by the distribution of these four diseases. It is noteworthy from a study of these charts that District 20, which is perhaps the best housed district of the city, is notably high, occupying either first or second place in all cases. One might argue, in the case of apoplexy, that a high rate denoted affluence. This perhaps is so. However, Districts 13 and 14 are homes of middle-class people of not unusual wealth, yet they rank near the top of the second highest group.

In the case of heart disease, the more strenuous life, which might be associated with slum conditions or conditions of poor housing, is sometimes suggested as a predisposing factor. This may possibly be so, as we find Districts 1, 2, 3 and 4, which are the older districts of the city, occupying the front ranks. To be sure, our knowledge of the causative agents of these diseases is limited, and not too great weight can be placed upon comparisons with them.

Chart 5 shows the prevalence of tuberculosis deaths. In studying tuberculosis, it is found that the susceptible population includes the males from zero to fifty-nine, but not the females for the last decade, the point of greatest susceptibility being the two decades twenty to thirty-nine inclusive, and here the incidence among males thirty to thirty-nine is 50 per cent greater than among females. Attention is directed to the crowding of the higher rates into the older downtown districts, which are more congested and in which housing ills are more numerous, while the outlying districts, with a more spacious and newly built up environment, enjoy a lower rate.

Chart 6 shows the prevalence of pneumonia per 10,000 susceptible population—in this instance the total population is

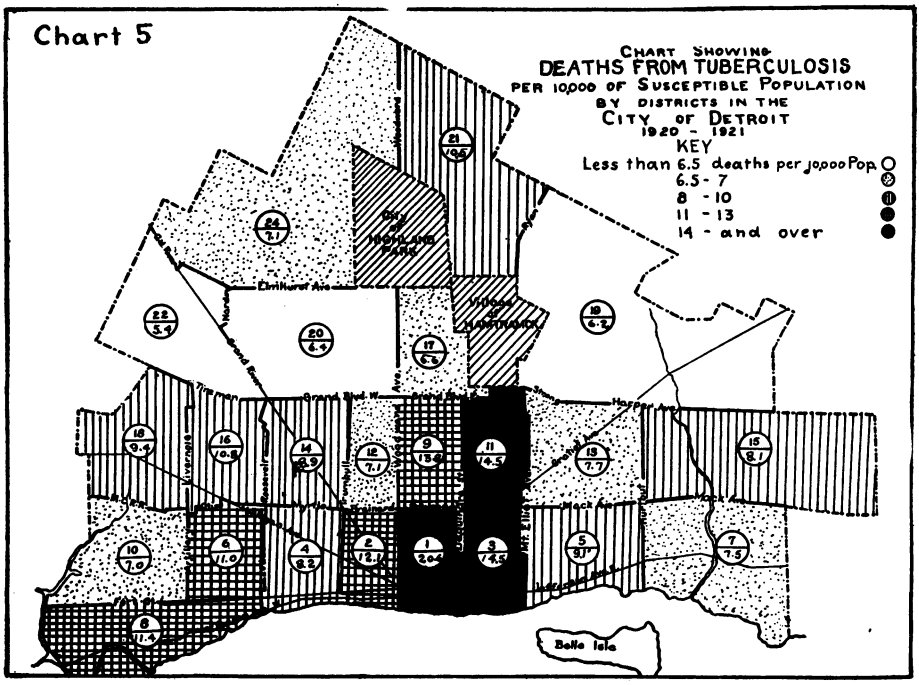


Chart 5
CHART SHOWING
DEATHS FROM TUBERCULOSIS
PER 10,000 OF SUSCEPTIBLE POPULATION
BY DISTRICTS IN THE
CITY OF DETROIT
1920 - 1921
KEY
Less than 6.5 deaths per 10,000 Pop.
6.5 - 7
8 - 10
11 - 13
14 - and over
City of HIGHLAND PARK
Village of HAMTRAMCK
Belle Isle

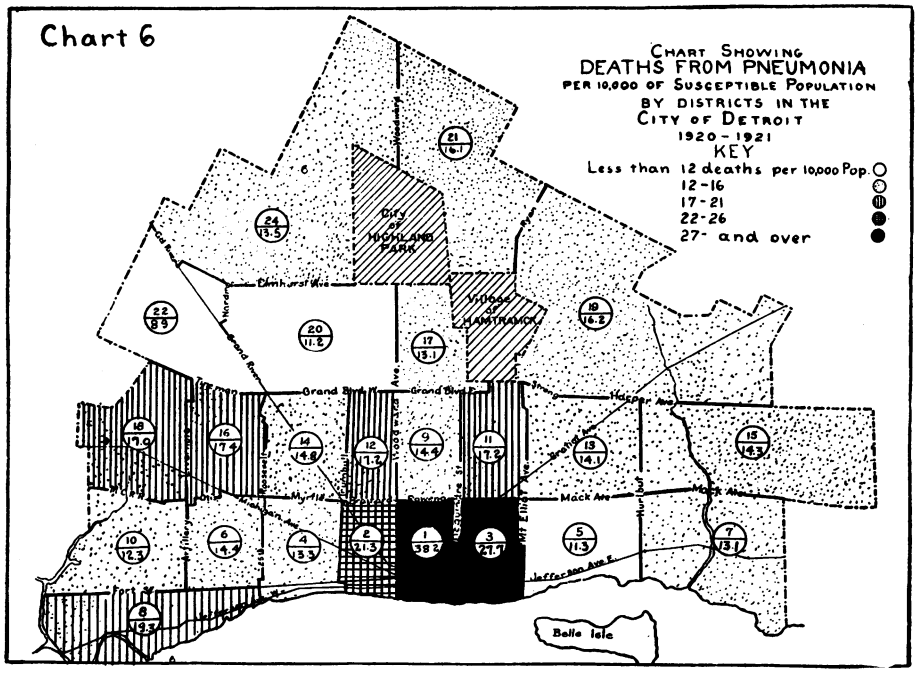


Chart 6
CHART SHOWING
DEATHS FROM PNEUMONIA
PER 10,000 OF SUSCEPTIBLE POPULATION
BY DISTRICTS IN THE
CITY OF DETROIT
1920 - 1921
KEY
Less than 12 deaths per 10,000 Pop.
12 - 16
17 - 21
22 - 26
27 - and over
City of HIGHLAND PARK
Village of HAMTRAMCK
Belle Isle

used, as comparison shows that the distribution of death follows very closely the distribution of population by age groups. These charts illustrating the prevalence of principal respiratory diseases all show a high incidence in Districts 1, 2 and 3, which are the older and more poorly housed portions of the city. Districts 5 and 20, however, which are without question the better housed districts, are shown to have a lower disease incidence.

To one familiar with the character of the districts of the city, it is a comparatively easy matter to correlate mentally the data embodied in these charts with the housing conditions which exist. In order, however, that a measure of the type of block, type of dwelling, and the sanitary conditions might be available for the use of those not thoroughly familiar with the districts, a scheme was devised for recording this data, and a block to block study of all the districts in the thickly built up portion of the city; that is, with the exception of the outer fringe of districts, namely, 10, 18, 22, 24, 21, 19, 16 and 7, has been made and summarized.* The field work for this study was done by one individual who had a wide experience as a housing inspector, and was ably qualified to make such a study. Upon viewing a block the inspector determined, first, whether the majority of that block was (a) residential, (b) residential and commercial, (c) commercial, (d) industrial. The data were recorded by block and summarized to determine the character of the districts. Second, the type of dwelling prevalent in each block was tabulated, as to (a) whether the majority of the block was composed of single residences, (b) two or four family residences, (c) multiple dwellings of Class A, that is, apartment houses in the strict sense, (d) multiple dwellings of Class B, that is, apartment houses of the rooming or boarding house type and the cheaper lodging and boarding houses. This data gave an index to the type of dwellings in each district.

For the purpose of establishing a sanitary index, two extremes were selected: the first, representing the best housed districts, is in the area from Atkinson Avenue to Chicago Boulevard, between Woodward Avenue and Hamilton Boulevard. In this district the dwellings are all single houses, with generous yard space on either side. The alleys are paved, the rooms of the dwellings are adequately lighted; garbage and refuse collection is sufficient to the needs of the district, it is removed from unusual contamination of smoke and fumes from factories, contains a park comprising one ordinary city block, and is in every respect a desirable place in which to live.

The other extreme, or worst condition, that was selected as the foot of the scale, is the district at the end of Goldner Avenue, which is south of Michigan Avenue, parallel to the Michigan Central and Lake Shore railroad tracks. In this area the houses are built directly on the ground without basements, the floors are particularly damp, all sanitary facilities, such as water supply and toilets, are located in a common yard used by a number of families. The dwellings have but two rooms, which are inadequately lighted and ventilated; the alley is unpaved, yards not sodded, garbage and rubbish collections are not sufficient to the needs of the district. No person would select this as a place in which to live unless pressed by economic necessity, or a lack of appreciation of a normal home life. Also, in this class were included apartment houses of the poorer type. Between these limits were ranged eight conditions, all typified by a particular small area of the city, which might be used as a standard of comparison for the field worker in making his notation as to sanitary conditions. For example, a district composed of single dwellings on smaller yards placed closely together, of a little poorer construction than those in the first district, resulting in closer crowding of the population, less

* Entire city since covered and included in Charts 7, 8 and 9.

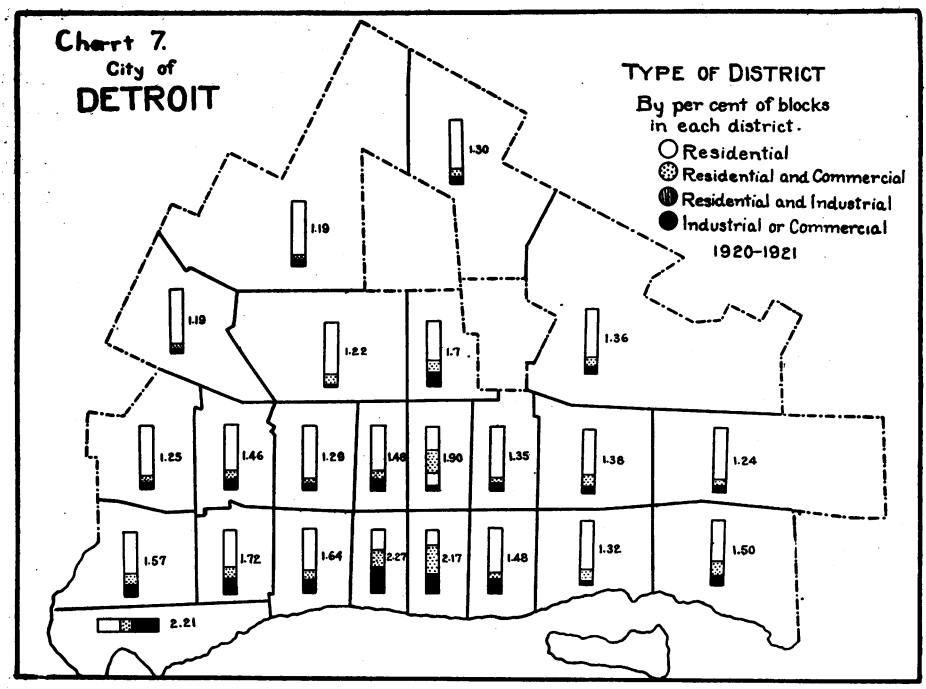


Chart 7.
City of
DETROIT
TYPE OF DISTRICT
By per cent of blocks
in each district.
Residential
Residential and Commercial
Residential and Industrial
Industrial or Commercial
1920-1921
1.30
1.19
1.19
1.22
1.7
1.36
1.25
1.46
1.29
1.48
1.90
1.35
1.38
1.24
1.57
1.72
1.64
2.27
2.17
1.48
1.32
1.50
2.21

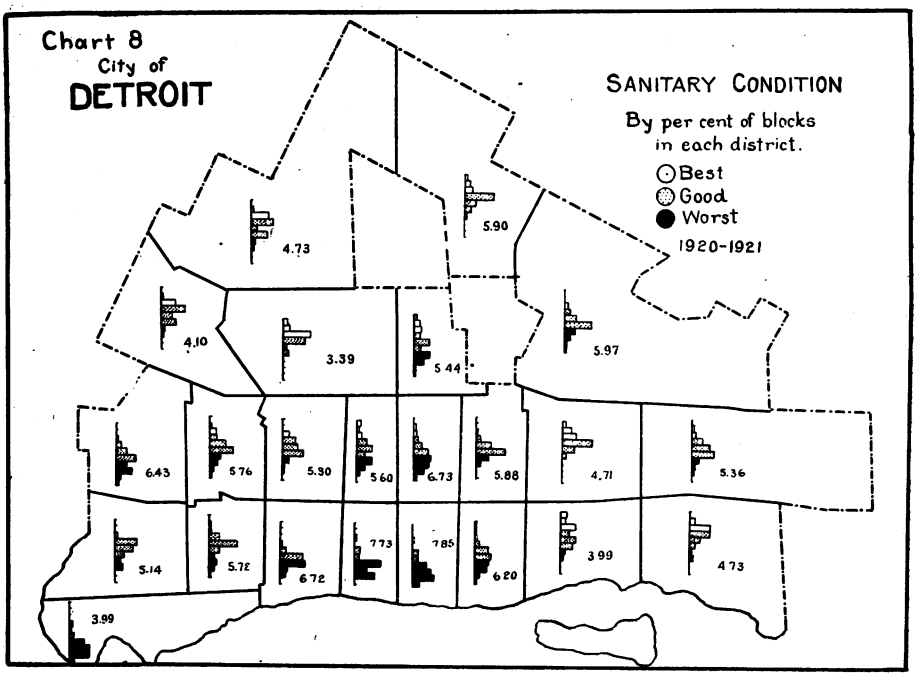


Chart 8
City of
DETROIT
SANITARY CONDITION
By per cent of blocks
in each district.
Best
Good
Worst
1920-1921
4.73
5.90
4.10
3.39
5.44
5.97
6.43
5.76
5.30
5.60
6.73
5.88
4.71
5.36
5.14
5.72
6.72
7.73
7.85
6.20
3.99
4.73
3.99

light in a room, less play space on the lot, and greater confusion, was placed second.

Next came a district of two-family flats, also including the better type of apartment houses, having plenty of open space. All of these possessed in general paved alleys, paved streets, adequate water supply and toilet accommodations. Fourth on the scale was placed an area of still smaller single houses on smaller lots, with less room between, resulting in greater darkness in the rooms, greater crowding of the streets, and a generally poorer housing condition. The fifth class included an older portion of the city, which had begun to show signs of dilapidation, but had once been quite good. This class also included all apartment houses which are built contiguously. Class 6 included an area in the outlying portion of the city, newly built up, but with outside toilets, mostly unpaved streets, all alleys unpaved, inadequate garbage and refuse collection; also all apartment houses built with inner lot line courts, which resulted in dark, improperly ventilated rooms, and great congestion of population on the lot, and frequently congestion of persons per room. Class 7 was very similar to Class 6, yet with a little greater congestion. Class 8 was similar to District 7, but with still greater congestion and more dilapidation. Class 9 included an old portion of the city in which dilapidation and ill repair are found on every side; also extreme crowding of the dwellings, lack of sanitary conditions, inadequate garbage and refuse collection, dark rooms, dwellings crowded close to factories and subject to smoke, fumes and noise of industry. Each block, as it was studied in the field, was compared with this scale and given a rating from 1 to 10, as best fitted its average condition.

Chart 7 shows the character of districts as to per cent of residential blocks in each district. It is a simple matter from this chart to construct a picture of the industrial areas of the city, and those which are almost entirely residential.

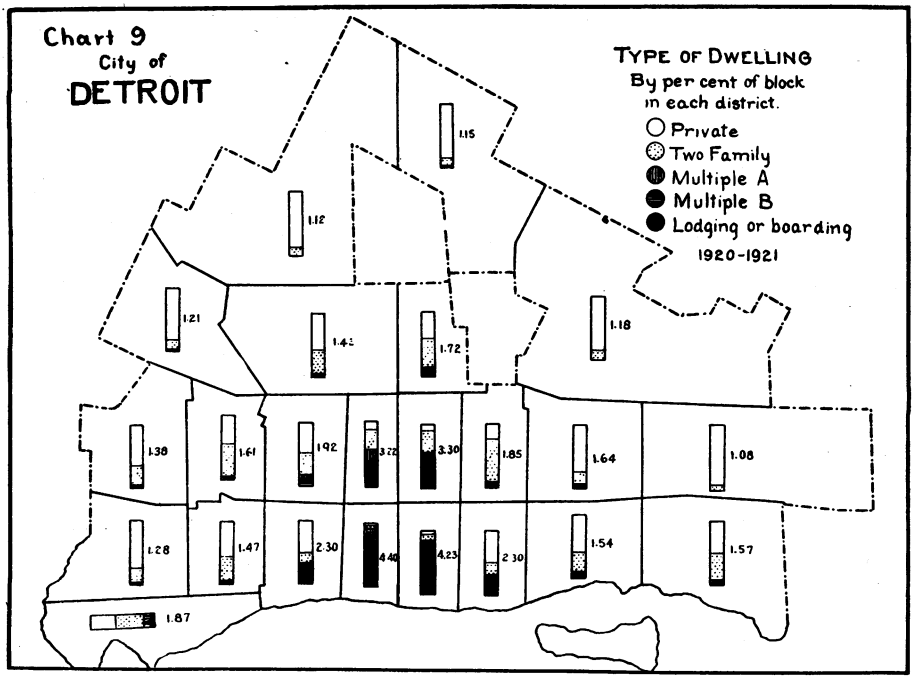
Chart 8 shows the result of the sanitary survey of the city by districts, summarized to show the extreme conditions, bad, good or intermediate and worse.

Chart 9 shows the type of dwelling in each district by per cent of blocks in each district. In such a chart the areas of single homes are readily distinguishable from the apartment and lodging house areas. A careful study of these charts will give one a fairly accurate idea of the average character of each district.

In order that these conditions might be compared directly with disease rates, an average value for each of these three factors was worked out by multiplying the number of blocks in each class by the number of the class, as, for example, the number of purely residential blocks was multiplied by one, the blocks having residence and commerce combined by two; the blocks having residence and industry by three, etc., and then dividing by the total number of blocks. This amounts to determining the center of gravity of each of the shaded areas about the upper corner.

The results for District 1 are as follows: index as to type of block shown in Chart 7, 2.17, which means that the average type of block for this district lies between a mixture of residence with commerce, and a mixture of residence with industry. The value of type of dwelling, as shown in Chart 9, is 4.23, which means that the average type of dwelling for District 1 is between a multiple dwelling of Class B and a boarding or lodging house. The sanitary index, as shown in Chart 8, for District No. 1, is 7.85, which interpreted by reference to our scale would mean the average condition of a block in this district lay midway between the conditions that you would find in a new area built without restriction, with insufficient garbage and refuse collection and an old dilapidated district which is undergoing a change from residence to commerce and industry.

In the next six charts, known as Chart 10, these indices have been placed upon a percentage basis, that is, the highest value



is given a rating of 100, and all others a proportionate rating, and then compared with the disease rates for the various districts, placed upon the same scale. In Chart 10–1 are compared the sanitary conditions and persons per acre. The heavy black line represents the range of the sanitary index by districts. The districts are purposely arranged in order of increasing value of sanitary index. It is easy to see here that beginning at the left there is a tendency toward correlation up as far as District 4. But from here on the correlation is not so close. District 8, perhaps, should have been left off of this consideration as even in this district large areas are given up to industries which are still incompletely developed, resulting in open spaces, which undoubtedly improve the general sanitary condition of the district. In Chart 10–2 are correlated infant mortality and total deaths with the sanitary index. The relation here is quite worthy of consideration. Probably the carrying on of these figures over a period of years would show a much closer parallelism. In the case of measles correlated in Chart 10–3, it is clearly evident that no relation does exist. In Chart 10–4 sanitary conditions are correlated with type of district and type of dwelling. Chart 10–5, –6, –7, –8 and 9, inclusive, compare whooping cough, scarlet fever, cancer, heart disease, Bright's disease and nephritis, apoplexy and diphtheria, respectively, with the sanitary index. It is evident that for the period considered these diseases are independent of the sanitary environment. In the case of tuberculosis, both cases and deaths, and pneumonia deaths as shown in Chart 10–10 and 10–11, while the curves are not in juxtaposition, they are shown to be very nearly parallel, and the average curve for tuberculosis cases and deaths would run practically parallel with the sanitary index. The case of smallpox is not so well marked. Here the correlation is somewhat doubtful.

In order to ascertain how these data would stand mathematical analysis, the coefficient of correlation between the sanitary index and tuberculosis cases, deaths and pneumonia deaths, as also the relation between persons per acre and tuberculosis deaths has been worked out.

Chart 10 - (1)

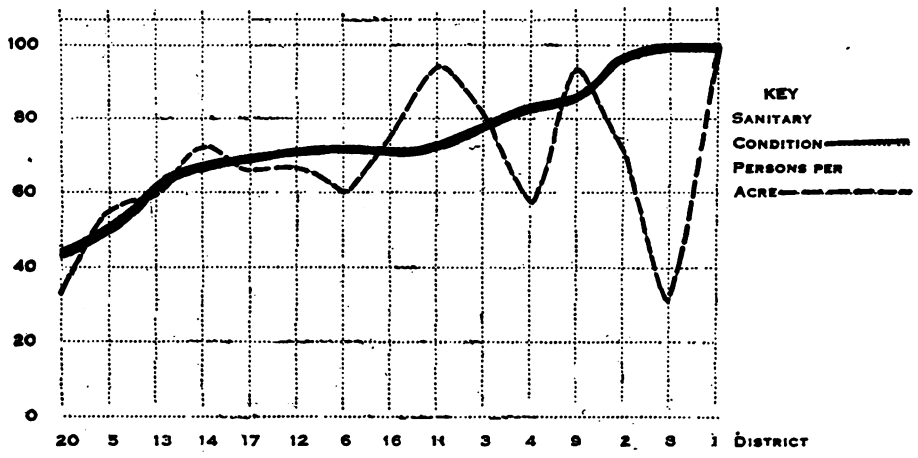
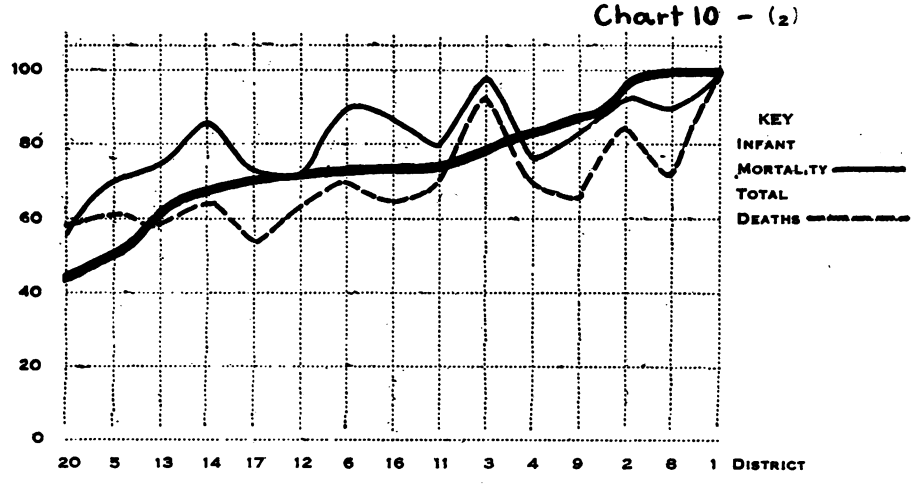


Chart 10 - (2)



NOTE - SANITARY CONDITION BY DISTRICTS SHOWN

The coefficient of correlation as derived by Karl Pearson is expressed by the formula CR (coefficient of correlation) $= \frac{\Sigma(xy)}{n\sigma_1\sigma_2}$. Where x is the deviation from the average value for the first variable, A and y the deviation from the average value for the second variable, B, and n the number of observations, the standard deviation expressed by $\sigma_x = \sqrt{\frac{\Sigma x^2}{n}}$ and $\sigma y = \sqrt{\frac{\Sigma y^2}{n}}$. Using this formula and the data at hand, the coefficient of correlation for these variables, *i.e.*, the sanitary condition of the district and the tuberculosis death rate is +.69.

According to Pearson, a coefficient of +1 indicates perfect direct correlation, and a value of 0 indicates no correlation whatever; a value of —1 indicates perfect correlation, but an inverse relation.

Chart 10-(3)

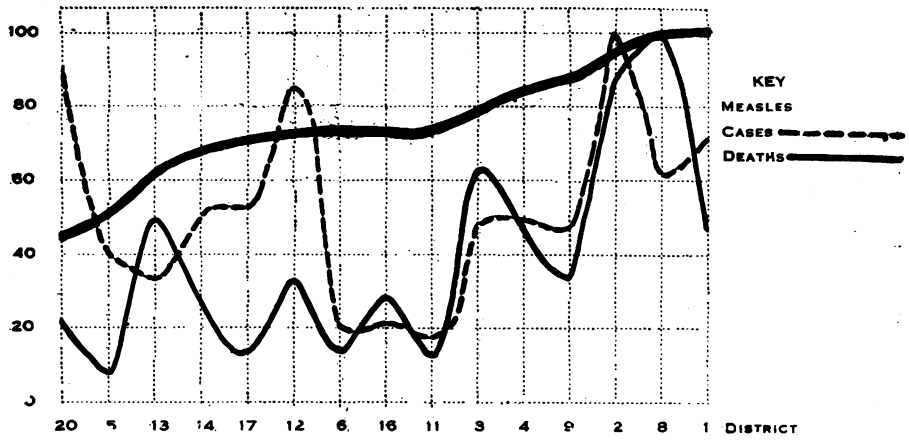
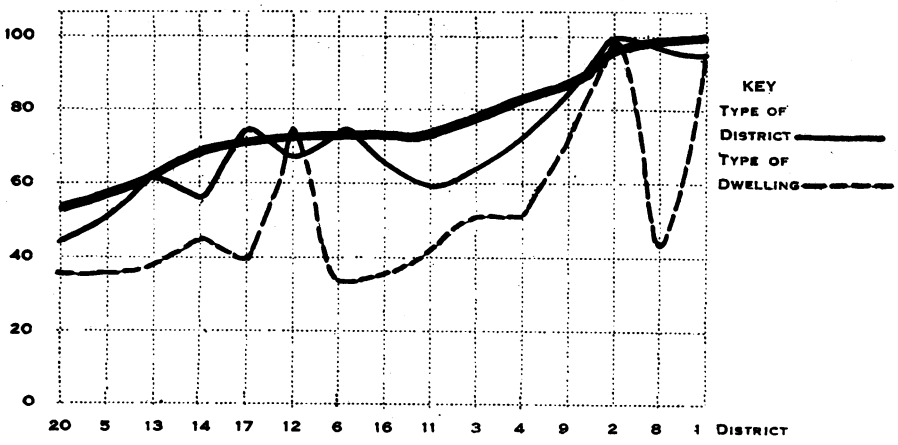


Chart 10-(4)



NOTE - SANITARY CONDITION BY DISTRICTS SHOWN

King, in his "Elements of Statistical Methods," states that if the coefficient of correlation is less than .30, the correlation cannot be considered marked, but if the coefficient of correlation is above .50 the relation is very decided.

Using this data, the probable error by the formula $PE_{xy} = \frac{.67(1-r)}{n}$ is found to be $\pm.0905$. Applying the King interpretation, it is found that the coefficient of correlation .69 is more than 6 times the probable error, and is over .50. It is safe to conclude from this that the death rate from tuberculosis as shown by the data collected in Detroit for the years 1920 and 1921 bears some definite relation to the sanitary conditions of the district in which the patient lives.

Using these formulæ the death rate from pneumonia correlated with the sanitary index of the districts shows a coefficient of correlation of +.638 and a

Chart 10-(5)

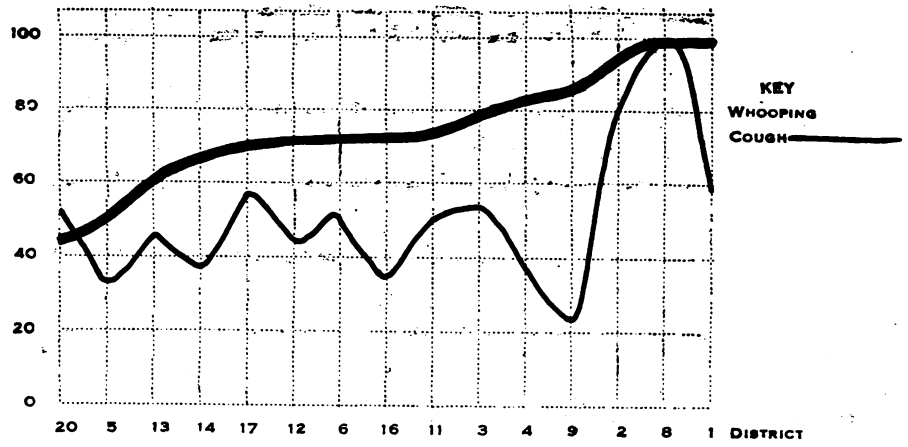
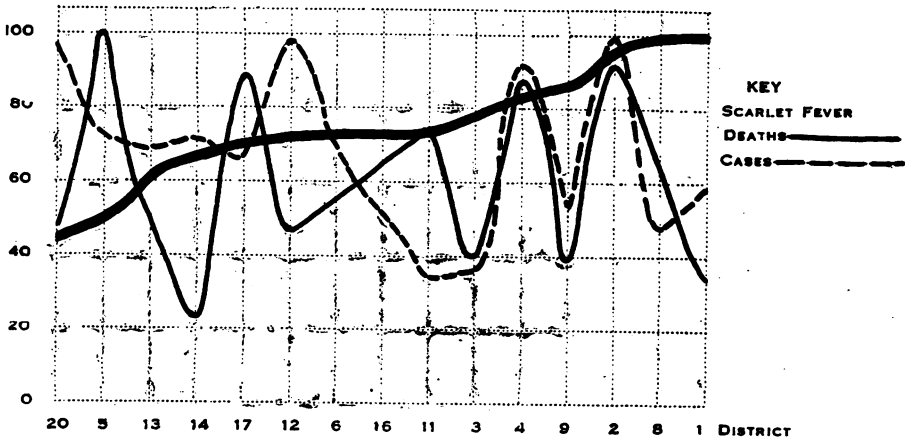


Chart 10-(6)



NOTE - SANITARY CONDITION BY DISTRICTS SHOWN

probable error of ±.103. Cases of tuberculosis correlated with the sanitary condition gives a correlation factor of +.82 and a probable error of ±.057. Tuberculosis cases, on the other hand, correlated with persons per acre give a factor of +.633 and a probable error of ±.1045, indicating a less degree of relationship between land crowding and tuberculosis, than exists between sanitary environment of the people and tuberculosis.

John J. Clark, in his book, "The Housing Problem, Its Growth, Legislation and Procedure," quotes vital statistics relating to unhealthy areas dealt with under Part I of the Housing of the Work Classes Act in England of 1890:

"Statistics have been compiled in relation to a large insanitary area situated near the center of the city of Liverpool and in immediate proximity to three areas of new dwellings erected by the Corporation. The figures have been taken for the years 1913, 1914 and 1915,

Chart 10 - (7)

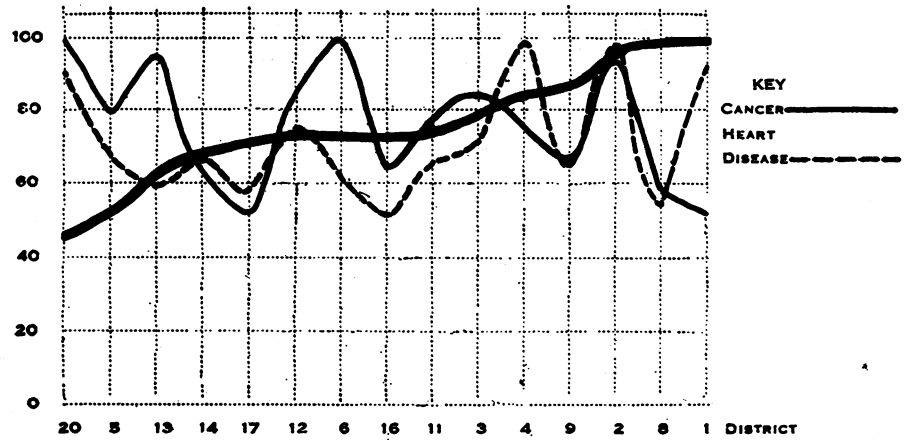
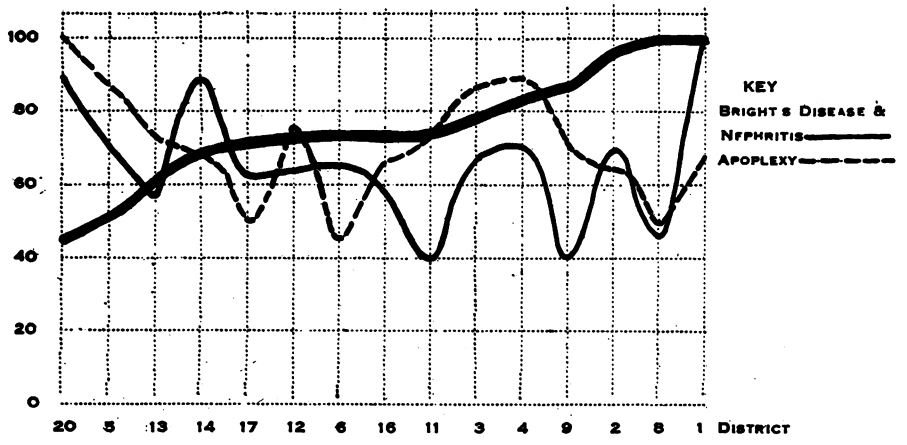


Chart 10 - (8)



NOTE - SANITARY CONDITION BY DISTRICTS SHOWN

and the following table will show the comparison between the insanitary areas, that of the new dwellings, and that for the entire city in respect of births, deaths, infantile mortality and phthisis mortality."

	Rate for insanitary area	Rate for entire city	Rate for corporation dwellings
Deaths	37.89	18.50	27.82
Infant mortality..	246.43	134.93	167.24
Tuberculosis	3.94	1.50	1.67

That housing and environment, particularly in so far as they influence the amount of light which the human organism receives, have a very definite effect upon the development of the body, is clearly demonstrated by the recent development in the study of the etiology of rickets. Paton, Findlay and Watson in 1918, in order to settle the etiology of rickets, attempted a crucial experiment by keeping pups of two litters in the laboratory and feeding them on plenty of whole milk and porridge, and two pups of each

Chart 10-(9)

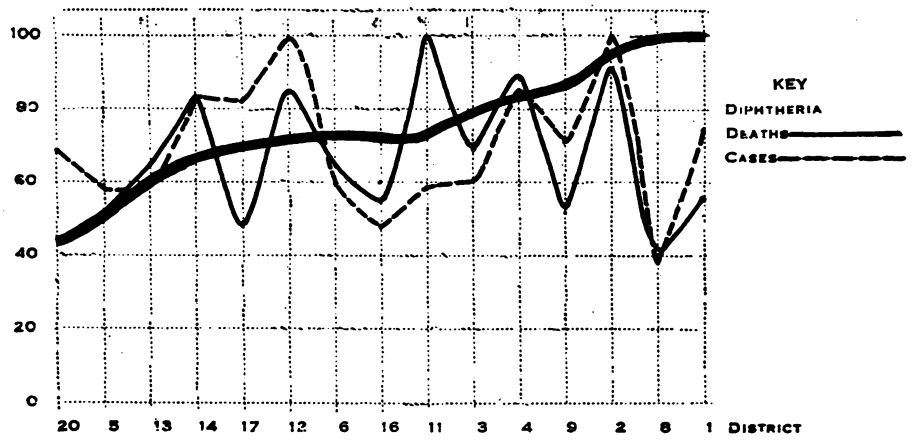
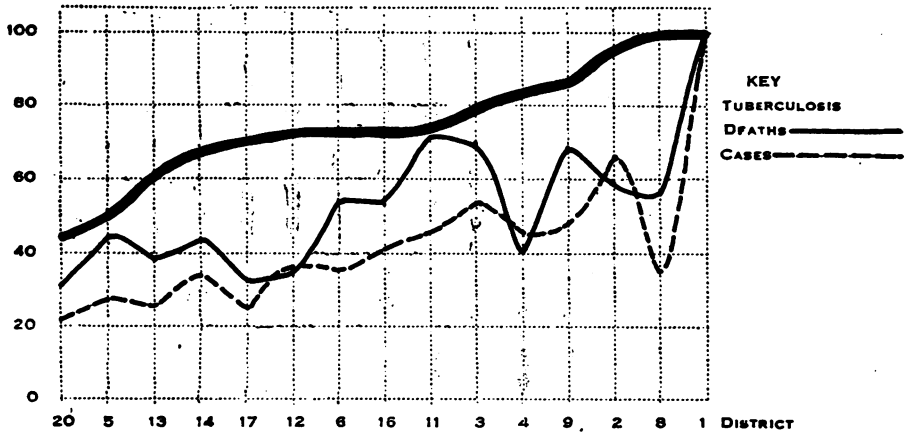


Chart 10 - (10)

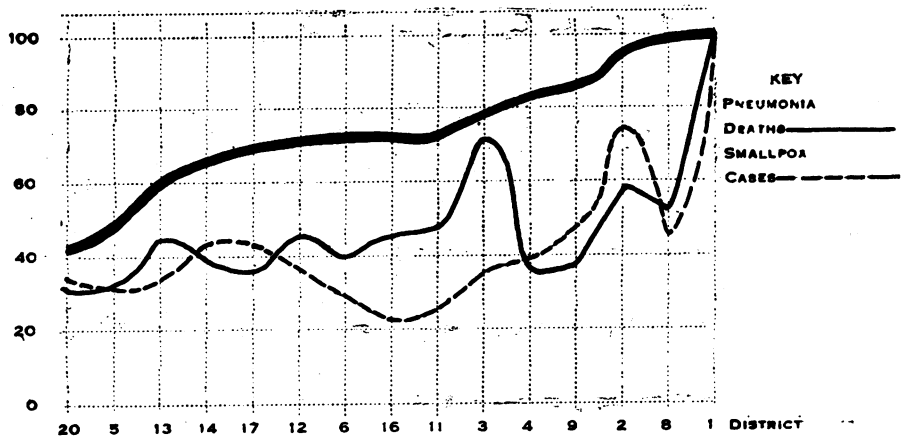


NOTE - SANITARY CONDITION BY DISTRICTS SHOWN

of the litters in the country and feeding them on skimmed milk and oatmeal. The former developed rickets, while the latter did not do so. A remarkable point is that the artificial conditions produced and arranged by these investigators were found by Hutchinson and Shah to be naturally present at Nasik, India. Here they studied two classes which will be known as Class I and II. The individuals of Class I included lawyers, priests, merchants, storekeepers, and government clerks with their families, who often owned the houses which they occupied, and their financial status was considerably above the average.

"The individuals of Class I were composed of agriculturists and laborers. It included the lower Hindu caste, the poorer Mohammedans, the large class of untouchable Hindus, and the oppressed outcasts. These two classes are sharply differentiated one from the other. There is no question of personal intercourse between them, and marriage is strictly confined to caste. The general conditions of life are much the same as regards climate, sanitation,

Chart 10 - (11)



early marriage, incidence of malaria, clothing, etc. The women of Class I, however, lead a secluded life and even when they travel in a carriage or a cart have to be screened from public view. They practically never leave the house except to visit relatives, and as a result of this the children are seldom taken out. In any case a newly born child is not usually taken out for three or four months, and this period is very considerably prolonged if by any chance the child is suffering from a slight cold, malnutrition, or any other complaint. Even if the children are healthy, the very nature of the mother's existence prevents their being taken out regularly. When a baby is born the mother must not leave her room for three months. During the first month, at least, the room is carefully closed so that the mother and child may not catch cold, and during this period the rooms are kept almost entirely shut."

"In the second class, composed primarily of laborers, on the other hand, the women are forced to assist their husbands in the fields and principally take their children with them, laying the babies on mats under the trees. Their houses, though usually one room and poorly built, are often made of bamboo or matting, and are the direct opposite to Class I as to light and air. This class is practically in the open all day."

Although breast feeding is the general thing with both classes, when supplemental feeding occurs in Class I it is usually provided by goat's milk, while in Class II the supplemental feeding is almost entirely cereals. Hutchinson states that the total percentage of rickets among the Hindus of Class I is 38.2 and for Class II but 6.4.

Because of the custom of child marriages, usually occurring at the age of twelve, he also found a number of cases of late rickets or rachitis tarda, concerning which he makes the following remarks:

"In late rickets, then, we have a condition resembling clinically early rickets, which from the etiological point of view presents the following features: (1) It occurs in the well-to-do and not in the poorer classes. The former, we have seen, obtain a much larger supply of fat soluble vitamines. (2) It occurs where the secluded or semi-secluded life is adopted, that is, in the Brahmin and well-to-do Mohammedan families. (3) It occurs soon after the secluded life is adopted, and this change of life is not accompanied by any change of diet. It does not occur in the poorer classes or in men, who do not adopt the secluded life. As already stated, early rickets and late rickets both occur after the secluded life is adopted, that is, in infancy, and about the age of twelve. In the former both sexes are affected because both are confined in the house. In the latter only females, because they only remain secluded after the age of twelve. (4) Its occurrence is not affected by diet, that is, if diet is the cause, the incidence of late rickets would not be affected by seclusion, but it is.

If seclusion is the cause it should not be affected by diet and it is not, because we find the disease where the diet is best and do not find it where the diet is worst. It does not occur among the poor who eat a diet poor in fat soluble vitamine but who receive plenty of fresh air and light.

"' The same conclusion is therefore arrived at, as in the case of early rickets, that is, 'late rickets is the result of a secluded or semi-secluded mode of life.' This is confirmed by the results of treatment, other things being equal. Removal of the cause removes the effect. In six cases of late rickets treated by open air and light, all of the cases lost their pain very rapidly and were able to walk much longer distances than they could before. In no case was medicine prescribed, and the diet taken was brought from the patient's house and was exactly what she had always been eating."

Following this thought and associating it with the housing problem, a study was made of some fifty cases, thirty-six of which had rickets more or less severely. Fourteen children did not show any signs of rickets. Of the children who had rickets, seven belonged to the negro race and six were marked white race. An examination of this last group indicated that two were born of native-born American parents, three were born of Italian parents, and two of Jewish parents.

Of the children examined who did not have rickets, four belonged to the negro race and ten were marked belonging to the white race, but examination of this group indicated that six were born of native-born American parents, one of Italian, one of Armenian, one of Porto Rican, and one of Ukrain, so that there was a considerable diversity of nationality in the groups of cases studied. The children, for the most part, were under one year. However, a few were two or three years old. Of the group that developed rickets, all showed a marked tendency to a development in the winter and early spring months.

In all cases a careful history was obtained of the dietary of the child, and if breast fed, of the mother. Also careful photometric observations were made in the center of the room which the baby occupied during the day, and at the same time photometric observations of the sky brightness outside of the house were made. From these readings the intensity of light in the living room of the child was expressed as a percentage of the outside light intensity at that time. It was found in this study that the mean intensity of light in the rooms occupied by the children who developed marked rickets was but 0.25 of 1 per cent of the outside light intensity at that time; while of the fourteen children who did not develop rickets the mean intensity of light in the rooms occupied by these children was 0.44 of 1 per cent of that existing outside at the same time. While individual exceptions occurred, in each group, exactly as would be expected from the fact that light is not the sole cause, but that diet may be a significant factor, it is pretty clearly evident that while for a cure it is necessary that light impinge directly, without intervening glass, upon the exposed surface of the body, the amount of light received in average dwellings, even through glass, is a significant factor in considering the development of rickets. As light is necessary to vegetation for the proper development of chlorophyl in the leaves, so it is demonstrated to be necessary to the higher animals for the proper functioning of body cells.

When it is considered that the cases which did not develop rickets lived in rooms which had but 0.44 of 1 per cent of the outside light intensity and that those cases which developed rickets lived in rooms which averaged only 0.25 of 1 per cent of the outside light intensity and that there are thousands of rooms in every city which are inhabited and whose light intensity averages as low as 0.15 of 1 foot candle, with the outside intensity at the same time ranging as high as 1,000 to 1,100 foot candles, resulting in a percentage intensity of 0.015 of 1 per cent of the outside light intensity at that time within the room it may properly be asked

if these conditions are not more far-reaching than is at the present time admitted.

CONCLUSION

In the early part of the present century we passed through a period when many ills were attributed to housing. Plumbing codes were written with great rigidity. Diphtheria and scarlet fever were attributed to leaky and defective plumbing which permitted sewer air and gas to escape into the room. Lack of ventilation and foul odors were blamed for tuberculosis and malaria. With the greater knowledge of the germ theory of disease and the modes of transmission, the pendulum swung to the other extreme when direct contact, or at least very close contact, was held to be of prime importance in disease transmission and prevalence.

The time is now at hand for the proper correlation of these factors relative to housing. The data herewith presented indicates quite clearly for the period covered a relationship between the sanitary environment and infant mortality, tuberculosis and pneumonia, which should not be considered lightly. Secondly, the relation of light to the development of rickets and the general welfare of child life has become an established fact. These results should be sufficient to stimulate interest in the improvement of housing conditions, and the formulation of Housing Codes, which will insure the lighting of all rooms used for habitation to an extent equal at least to one-half of 1 per cent of the outside light intensity.

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THE ECONOMICS OF HEALTH SUPERVISION IN INDUSTRY

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IN a recent paper dealing with the principles of health supervision in industry, I pointed out that this work should not be a substitute for any fundamental phase or factor of industrial relations nor a form of philanthropy or paternalism. Moreover, the essentials which determine to a great extent not only the degree of success but also the stability and permanence of such supervision were summarized as follows:

1. It should be exactly as it is represented.
2. It should embody the spirit of service.
3. It should be developed as the expanding consciousness of the workers enables them to appreciate its benefits.
4. It should include preventive as well as curative measures.
5. It should take into consideration home and community conditions.
6. It should produce results that will justify the operating overhead.

The present paper, which is concerned with the economics of health supervision in industry, will touch upon those factors which constitute a basis for arriving at an evaluation of the tangible returns.

The obvious impossibility of assigning financial equivalents to many of the results and influences of industrial health work, which are far too intricate and subtle to lend themselves readily to monetary calculations, has brought about a tendency to disregard the dollars and cents benefits. On the other hand, many of the premises which have been used to demonstrate tangible monetary returns have been unsound; untenable assumptions have been introduced and unwarranted deductions have been made. Furthermore, much harm has been done health supervision in industry by elabo-