Environmental Fluoride

...o. of ...ples	Weighted Exposure Mg. MF	Ratio to 2.5 Mg/MF
12	3.90	1.56
35	4.23	1.69
29	2.50	1.00
75	1.14	0.46
12	1.94	0.78
50	1.94	0.78
12	3.84	1.54
45	4.00	1.60
91	1.78	0.71
66	2.10	0.84
25	3.92	1.57
27	1.67	0.67
24	2.21	0.88
30	1.86	0.75
35	1.98	0.79
11	2.62	1.05
18	1.81	0.72
22	3.85	1.54
29	2.87	1.15
39	1.56	0.62
[illegible]	2.06	0.83
[illegible]	1.18	0.47
17	1.82	0.73
38	1.32	0.53
11	1.95	0.79
22	0.87	0.35
38	1.93	0.77
3	1.23	0.49
2	3.49	1.40
4	2.73	1.19
4	4.41	1.77
0	2.14	0.86
6	0.76	0.30
2	1.15	0.46
7	0.71	0.28
5	1.89	0.76
6	1.28	0.50
7	0.50	0.20
9	2.10	0.84
4	0.67	0.27
7	3.38	1.35
	7.73	3.09
	1.78	0.71
3	2.64	1.06
	8.32	3.33
	0.50	0.20
3	2.81	1.13
	8.32	3.33
	0.50	0.20

Methodology in Industrial Health Studies

The Demographic Approach

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There are many opportunities for investigators in the field of industrial health to design and conduct studies to evaluate the relationship between chronic illness and occupation. This area of study poses, however, some complex and difficult problems which require varied approaches.

In 2 papers consideration will be given to the application of epidemiology to industrial populations within the framework of the demographic and prospective or cohort approaches. This paper is concerned with the demographic approach, which is of basic importance in industrial health studies.

Demographic studies identifying characteristics of the general population and the pattern of disease distribution, as derived from vital statistics and other sources, represent an initial approach in epidemiologic methods relating to industrial populations. Such studies involve geographic areas, sex, color, age, country of birth, and socioeconomic status.

Demographic comparisons help to determine geographic and population characteristics associated with mortality or morbidity due to specific diseases. Urban-rural comparisons, for example, which indicate relatively high mortality in urban areas or in particular metropolitan counties represent initial clues to environmental influences, such as industry and air pollution, from which more refined epidemiologic studies can be derived. They further help to identify sex, color, nativity, and age groups with relatively high risk of specific diseases or causes of

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TABLE 1.—*Average Annual Age-Adjusted Death Rates* per 100,000 Population Due to ... White Male and White Female† Residents of Each of the Eight Metropolitan Counties ...*

Geographic Area	All Malignant Neoplasms (140-205) §	All Malignant Neoplasms Except Those of Breast & Reproductive Organs (140-165, 180-205) §	Neoplasm Site (and Cause of Death Code) Esophagus (150)	Stomach (151)	Pancreas (157)	Larynx (161)	Lung, Bronchus, & Trachea (162, 163)	Bladder & Other Urinary Organs (181)
				White Males				
State of Ohio	141.02	134.34	3.85	11.69	7.07	2.50	36.02	4.05
8 Metropolitan counties	155.33	148.41	4.86	12.60	7.56	2.89	40.87	4.44
Cuyahoga	167.30	159.92	6.10	16.59	8.23	3.27	41.26	4.47
Franklin	147.79	141.30	3.22	9.38	7.08	3.01	42.79	3.61
Hamilton	162.67	156.03	4.98	9.26	7.17	3.30	45.53	4.97
Lucas	153.56	147.11	5.23	11.75	7.43	2.84	43.91	5.16
Mahoning	162.00	155.97	4.92	16.31	9.18	2.95	41.13	4.57
Montgomery	136.02	129.08	4.12	9.51	6.46	2.08	36.21	3.13
Stark	139.12	132.45	3.68	10.85	7.10	2.18	36.36	4.42
Summit	137.15	130.76	3.41	10.80	6.91	2.09	34.29	4.77
				White Females				
State of Ohio	140.26	70.36	0.60	5.66	3.92	0.16	5.34	1.53
8 Metropolitan counties	145.25	73.18	0.69	6.30	4.04	0.17	5.70	1.60
Cuyahoga	148.71	76.08	0.84	8.14	4.12	0.08 ‖	6.18	1.54
Franklin	151.75	74.05	0.60 ‖	4.81	4.41	0.30 ‖	5.63	1.50
Hamilton	155.20	73.71	0.40 ‖	5.13	4.41	0.20 ‖	6.45	1.69
Lucas	140.14	67.24	0.62 ‖	4.81	4.42	0.18 ‖	4.92	1.96
Mahoning	146.29	90.23	0.89 ‖	10.32	3.54	0.30 ‖	7.23	1.03
Montgomery	134.51	64.26	0.68 ‖	4.19	2.58	0.10 ‖	4.04	1.46
Stark	125.34	65.38	1.03 ‖	4.34	2.42	0.14 ‖	5.21	1.42
Summit	142.77	76.07	0.61 ‖	6.00	4.93	0.34 ‖	4.24	2.29

*Mortality rates were computed on the basis of mortality data for the specified type of malignant neoplasm for white males and white females, classified by 5-year age groups, available in the Ohio Department of Health, and population data obtained by averaging population counts given by the decennial United States censuses of 1950 and 1960 for the corresponding sex, color, and age groups. Age adjustments were made by the direct method on the basis of the age distribution of the total population of the United States as shown by the 1960 United States census.

death. Such data provide a basic reference source for studies of industrial workers which, in turn, require similar classification by population characteristics. In this manner, it is possible to identify and eliminate the effect a particular variable, such as age, may have on mortality patterns observed in specific industries. Mortality rates of industrial workers by population characteristics, such as sex, color, and age, help to determine the possible effect of selective employment practices relative to such population characteristics on the morbidity and mortality experience of a given plant or industry.

Geographic Location

In studying geographic differences as basic epidemiologic leads in industrial health studies, a first consideration is urban-rural comparisons. These may provide initial clues relative to industrial and agricultural populations and furnish the basis for further epidemiologic efforts and other types of studies pertaining to air pollution, socioeconomic factors, and medical care.

Malignant Neoplasms of Selected Sites Among of Ohio, 25-64 Years of Age, 1950-1960

Kidney (180)	Bladder & Other Urinary Organs (181)	Brain & Other Parts of CNS (193)	Leukemia & Aleukemia (204)
3.76	4.05	6.40	6.63
4.07	4.44	6.84	7.30
4.05	4.47	6.92	7.59
3.36	3.61	5.96	6.89
3.78	4.97	6.88	6.76
3.85	5.16	7.15	7.67
5.97	4.57	6.75	8.16
4.03	3.13	6.40	6.35
5.07	4.42	6.47	6.72
3.58	4.77	7.70	7.90
1.72	1.53	3.98	4.82
1.81	1.60	4.13	5.05
1.85	1.34	4.47	5.33
1.81	1.80	4.80	5.15
2.46	1.69	3.42	5.15
1.97	1.96	4.00	4.40
1.48	1.03	2.77	4.91
1.81	1.46	3.43	4.33
1.26	1.42	3.83	4.98
0.85	2.29	5.21	5.16

† The nonwhite population group was defined to include Negroes, Indians, Japanese, Chinese, and other nonwhite races.

‡ The metropolitan counties were defined as those with cities of 100,000 population or more in 1950.

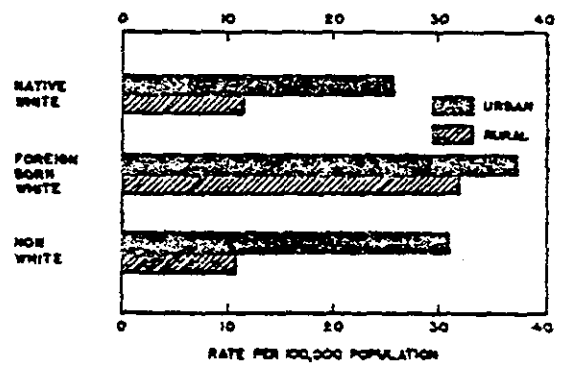
§ Neoplasms of lymphatic and hematopoietic tissues are included.

¶ The death rate is based on a frequency of less than 10 deaths.

Our observations in Ohio cancer studies have emphasized the importance of such urban-rural comparisons, particularly by population subgroups. These studies have shown, for example, that (1) an "urban" influence existed for certain cancer sites and (2) lung cancer was relatively high among the foreign-born of both urban and rural areas (Figure).[29,30] Other studies have also emphasized urban-rural and related geographic considerations.[20,25,32,34]

Comparisons of cancer mortality in small geographic areas such as counties may provide further epidemiologic leads. Table 1 provides county comparisons of mortality due to specific cancer sites among white male and female residents of individual metropolitan counties of Ohio for the period 1950-1960. The table reveals individual county variation in cancer mortality for the specific sites considered. Lung cancer mortality among white males was, for example, relatively high in Hamilton County and relatively low in Summit County. Stomach cancer mortality among white males was, on the other hand, relatively high in Cuyahoga and Mahoning counties and relatively low in Franklin, Hamilton, and Montgomery Counties. These observations serve as a basis for further epidemiologic efforts.

In individual county comparisons it must also be realized that a single industry may not appreciably affect the specific disease rate in a county just as a high incidence of a specific disease in a single work department



Average annual age-adjusted death rates due to cancer of the lung among native white, foreign-born white, and nonwhite male residents of urban and rural areas of Ohio, who died in the state, ages 25-64 years, 1947-1951.

Mortality rates were computed on the basis of mortality data available in the Ohio Department of Health for the specified population, classified by age groups 25-44, 45-54, and 55-64 years, and population data in the 1950 U.S. Census for the corresponding population groups. Age adjustments were made by the direct method on the basis of the age distribution of the total population of continental United States as shown by the 1950 United States Census. The nonwhite population group was defined to include Negroes, Indians, Japanese, Chinese, and other nonwhite races. The native-born group included persons born in the United States or any of its territories or possessions. The classification of urban and rural areas was based on the definition of such areas used in the 1950 United States Census.

may not affect the rate for the disease of a large industry because of the dilution factor. This point was demonstrated in a study of the lung cancer mortality rate in Lake County, Ohio, although previous studies [27-29] had demonstrated an abnormal mortality rate for lung cancer in a chromate plant located in that county. When a large group of industries are located in a circumscribed area, such as a county, and are engaged in the same essential manufacturing processes or products, it can be expected, however, that the disease pattern of the county will reflect this concentration in the area if an environmental factor is involved.

Residence Duration

In studying diseases with long latent periods, it should be noted that the current place of residence of population groups under study may not be the place of environmental exposure and therefore consideration must be given to long-term residence histories. This applies to the following types of current residence: death residence, place of retirement, place to which an individual moves for special medical or surgical care, place to which there has been significant migration because of attractive climate and job opportunities, and places within a city to which there have been population shifts with respect to race, nationality, and socioeconomic status. These types of shift in residence, singly or in combination, bring about changes in the age distribution of the population, as well as in the types of illness and death, which thereby affect the illness and mortality pattern of a given locality. Residence history data are of basic importance in studying the possible association of such variables as occupation, atmospheric pollution, smoking, morbidity, and mortality.

There are various methods of exploring residence duration in epidemiologic studies. One is to obtain residence history data for specific population groups, by such means as checking city directories and employment records and querying relatives, friends, and other associates. This approach can provide information, for example, on the duration of residence in the county of residence at death, as shown on the death certificate. Another approach is to compare place of residence at death with the birthplace as specified on the death certificate, if one can assume that an individual born in a given county who died in that county lived a major portion of his life there. Both of these approaches are of assistance in comparing mortality rates due to long-term illness in different geographic areas as they relate to duration of residence, which is important because of the latent period between initial exposure and development of the chronic disease leading to death.

In considering residence data it is essential to keep in mind 2 points: (1) the interrelationships of residence and migration patterns with other factors such as socioeconomic phenomena, employment practices, and medical care and (2) geographic variations in the distribution of chronic illnesses depending on the latent period of the particular disease.

Sex

In industrial health studies, sex comparisons are essential in epidemiologic consideration. When there is employment selection by sex within an industry, the distribution of illness by sex may provide the means of excluding certain departments and exposures, in this way refining the epidemiologic study.

In some industries and occupations, women represent the predominant labor force. Under such circumstances, patterns of long-term illness or mortality in female employee populations may be studied in comparison with similar data on women in other industries and women not employed in industry. It is also of special interest to consider whether the occupation or pattern of living of the husband affects the illness and mortality experience of his wife.

Some cancer mortality data for Ohio shown in Tables 1 and 2 reveal characteristic patterns of sex difference in cancer mortality. The tables indicate, for example, that cancer mortality was generally higher among males

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than for others. The fe
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TABLE 2.—*Average Annua*
Neoplasms of Specified S
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Neoplasm Site (& Cause
Malignant neoplasms, including neo
& hematopoietic tissues (140-205
Buccal cavity & pharynx (140-148)
Digestive organs & peritoneum (15
Esophagus (150)
Stomach (151)
Small intestine, incl. duodenum
Large intestine, except rectum (1
Rectum (154)
Biliary passages & liver, stated a
Liver, secondary & unspecified (
Pancreas (157)
Peritoneum (158)
Unspecified digestive organs (15
Respiratory system (160-165)
Nose, nasal cavities, middle ear,
Larynx (161)
Lung, bronchus, & trachea (162,
Mediastinum (164)
Thoracic organs, secondary (165
Breast & genitourinary organs (17
Breast (170)
Cervix uteri (171)
Corpus uteri (172)
Other & unspecified parts of ute
Ovary, fallopian tube, & broad
Other & unspecified female geni
Prostate (177)
Testis (178)
Other & unspecified male genita
Kidney (180)
Bladder & other urinary organs
Other & unspecified sites (190-199
Melanoma of skin (190)
Other malignant neoplasm of sk
Eye (192)
Brain & other parts of nervous
Thyroid gland (194)
Other endocrine glands (195)
Bone (196)
Connective tissue (197)
Secondary & unspecified malig
nodes (198)
Other & unspecified sites (199)
Lymphatic & hematopoietic tissu
Lymphatic & hematopoietic tis
Leukemia & aleukemia (204)

* Mortality rates were computed
metropolitan counties of Ohio, clas
counts given by the decennial Ce
graphic area. Age adjustments we
United States as shown by the 19
† The nonwhite population grou
‡ The metropolitan counties we
§ The death rate is based on a fi

than females of each color for cancer sites common to both sexes and that these differences were more marked for some sites than for others. The females had, on the other hand, a considerable mortality due to cancer of the breast and reproductive organs, particularly in middle age. Individual metropolitan county variations by sex shown in Table 1 may be useful in selecting those cancer sites among the male population which

TABLE 2.—*Average Annual Age-Adjusted Death Rates* per 100,000 Population Due to Malignant Neoplasms of Specified Sites Among White and Nonwhite† Male and Female Residents of the Eight Metropolitan Counties of Ohio,‡ Ages 25-64 Years, 1950-1960*

Neoplasm Site (& Cause of Death Code)	Total	Males		Females	
		White	Nonwhite	White	Nonwhite
Malignant neoplasms, including neoplasms of lymphatic & hematopoietic tissues (140-205)	156.25	155.33	213.35	145.25	208.93
Buccal cavity & pharynx (140-148)	3.99	6.55	6.96	1.43	1.56
Digestive organs & peritoneum (150-159)	47.94	53.36	86.30	37.43	60.06
Esophagus (150)	3.36	4.86	14.59	0.69	3.37
Stomach (151)	10.51	12.60	29.03	6.30	13.40
Small intestine, incl. duodenum (152)	0.46	0.54	0.54 §	0.37	0.48 §
Large intestine, except rectum (153)	14.32	13.95	13.10	14.50	17.22
Rectum (154)	6.34	7.35	7.23	5.11	7.95
Biliary passages & liver, stated as primary site (155)	3.01	2.39	3.79	3.44	3.81
Liver, secondary & unspecified (156)	2.99	3.22	6.71	2.28	3.59
Pancreas (157)	6.11	7.56	9.97	4.04	9.00
Peritoneum (158)	0.55	0.65	0.54 §	0.49	0.22 §
Unspecified digestive organs (159)	0.29	0.24	0.80	0.21	1.02
Respiratory system (160-165)	26.18	44.51	58.78	6.39	10.08
Nose, nasal cavities, middle ear, & accessory sinuses (160)	0.32	0.37	1.04	0.21	0.22 §
Larynx (161)	1.56	2.89	3.06	0.17	0.85
Lung, bronchus, & trachea (162, 163)	23.82	40.57	54.06	5.70	8.75
Mediastinum (164)	0.32	0.49	0.32 §	0.17	0.26 §
Thoracic organs, secondary (165)	0.16	0.19	0.30 §	0.14	0
Breast & genitourinary organs (170-181)	48.08	15.43	25.39	75.48	107.03
Breast (170)	18.06	0.28	0.09 §	35.49	32.27
Cervix uteri (171)	5.73	—	—	14.98	36.31
Corpus uteri (172)	0.54	—	—	1.01	1.59
Other & unspecified parts of uterus (173, 174)	3.97	—	—	6.82	17.22
Ovary, fallopian tube, & broad ligament (175)	6.55	—	—	12.99	11.71
Other & unspecified female genital organs (176)	0.43	—	—	0.73	1.39
Prostate (177)	2.86	4.92	14.58	—	—
Testis (178)	0.64	1.46	0.19 §	—	—
Other & unspecified male genital organs (179)	0.15	0.26	0.73 §	—	—
Kidney (180)	2.95	4.07	4.47	1.81	1.94
Bladder & other urinary organs (181)	3.20	4.44	3.53	1.60	4.60
Other & unspecified sites (190-199)	15.75	17.76	18.72	13.29	17.62
Melanoma of skin (190)	1.15	1.52	0.53 §	0.93	0.37 §
Other malignant neoplasm of skin (191)	0.57	0.67	0.71 §	0.39	1.15
Eye (192)	0.16	0.16	0	0.15	0
Brain & other parts of nervous system (193)	5.27	6.54	4.21	4.13	2.55
Thyroid gland (194)	0.67	0.55	0.61 §	0.89	1.17
Other endocrine glands (195)	0.43	0.53	0.65 §	0.34	0.67 §
Bone (196)	1.03	1.26	1.09	0.75	1.25
Connective tissue (197)	0.53	0.51	0.62 §	0.51	0.73
Secondary & unspecified malignant neoplasm of lymph nodes (198)	0.26	0.26	0.23 §	0.24	0.46 §
Other & unspecified sites (199)	5.66	5.43	10.05	5.05	9.17
Lymphatic & hematopoietic tissues (200-205)	14.31	17.44	17.22	11.25	12.08
Lymphatic & hematopoietic tissues (200-203, 205)	8.22	10.14	10.60	6.20	7.50
Leukemia & aleukemia (204)	6.09	7.30	6.62	5.05	4.45

* Mortality rates were computed on the basis of mortality data available in the Ohio Department of Health for residents of the 8 metropolitan counties of Ohio, classified by sex, color, and 5-year age groups, and population data obtained by averaging population counts given by the decennial United States censuses of 1950 and 1960 for the corresponding sex, color, and age groups in this geographic area. Age adjustments were made by the direct method on the basis of the age distribution of the total population of the United States as shown by the 1900 United States Census.

† The nonwhite population group was defined to include Negroes, Indians, Japanese, Chinese, and other nonwhite races.

‡ The metropolitan counties were defined as those with cities of 100,000 population or more in 1960.

§ The death rate is based on a frequency of less than 10 deaths.

TABLE 3.—*Average Annual Death Rates* per 100,000 Population Due to Malignant Neoplasms of the Eight Metropolitan Counties of Ohio,‡ 25-64 Years of Age,*

Neoplasm Site (& Cause of Death Code)	Age Group					
	25-64	25-29	30-34	35-39	40-44	45-49
All malignant neoplasms, including neoplasms of lymphatic & hematopoietic tissues (140-205)	154.11	16.44	19.50	34.30	66.38	123.01
Esophagus (150)	4.83	0	0	0.41 §	0.63	3.24
Stomach (151)	12.51	0.45 §	0.91	1.68	4.32	8.07
Pancreas (157)	7.49	0.15 §	0.34 §	0.52 §	3.69	6.21
Larynx (161)	2.56	0	0	0.29 §	0.88	2.55
Lung, bronchus, & trachea (162,163)	40.51	0.77	2.07	5.27	14.22	33.60
Kidney (180)	4.03	0.15 §	0.17 §	0.88	2.19	3.45
Bladder & other urinary organs (181)	4.41	0.06 §	0.17 §	0.17 §	1.25	2.76
Brain & other parts of nervous system (193)	6.76	1.31	2.19	4.17	4.70	7.36
Leukemia & aleukemia (204)	7.26	3.04	2.82	3.65	5.26	5.31

50-54	55-59
225.95	351.34
7.90	13.27
19.05	31.13
12.56	15.45
4.70	8.57
67.42	108.58
5.59	10.37
5.59	11.90
10.66	13.15
10.07	13.90

* Mortality rates were computed on the basis of mortality data available in the Ohio Department of Health and population data obtained by averaging population counts given by the decennial United States censuses of 1950 and 1960. Age adjustments were made by the direct method on the basis of the age distribution of the total population of the United States as shown by the 1960 United States census.

† The definition of "white" males excluded Negroes, Indians, Japanese, Chinese and persons of other nonwhite races.

‡ The metropolitan counties were defined as those with cities of 100,000 population or more in 1950.

§ The death rate is based on a frequency of less than 10 deaths.

merit further study, particularly in reference to occupational or other environmental exposures peculiar to males.

Color

Color comparisons serve to separate some of the variables to be considered and to delineate avenues of investigation in epidemiologic studies. Although the environment of nonwhites has been identified to a certain extent, the epidemiologic potential of this population group has not been adequately explored.

In considering chronic illness, one must keep in mind, in addition to the latent period of the disease, the pattern of migration and employment of nonwhites over the years. Nonwhites may be affected to a different extent than whites by selection for certain types of work, shifts of jobs, and exposures within the same industry over a long period of time, as well as by changes to other industries. This influences consideration of disease development in the nonwhite race and emphasizes the importance of duration of employment in industrial population studies. These factors provide indications of differences in cultural and living patterns that may merit further study by other epidemiologic methods.

Table 2 illustrates color variations by specific cancer site for each sex as found in cancer studies of the 8 metropolitan counties in Ohio for the period 1950-1960. The color differences were particularly marked for cancer of the digestive organs and peritoneum, and for cancer of certain reproductive organs. Marked nonwhite excesses were observed, for example, for cancer of the esophagus and stomach for each sex; for cancer of the cervix, and other and unspecified parts of the uterus, excluding the corpus uteri, among females, and for cancer of the prostate among the males. A nonwhite excess for cancer of the lung was also found for each sex. On the other hand, relatively higher cancer mortality among the whites than among the nonwhites of each sex was found for melanoma of the skin and cancer of the brain and other parts of the nervous system. An earlier study revealed differences in cancer mortality among native and foreign-born subgroups of the white population which brought out the importance of studying nativity in color comparisons for specific types of cancer, such as cancer of the lung and of the brain and central nervous system.[30] Further refinements showing color as well as sex and nativity differences by

of Selected Sites Amon Classified by Age, 1950

individual counties : more specific envir

The large variat specific causes by a the age compositio groups by geograph the necessity of a mortality rates.

Table 3 provid mortality by specific males residing in th of Ohio in the peri rates generally sh with age which w some sites than fo for most of the can for example, negli age groups, 25-34 y tance, of varying later years. Morta and aleukemia, an other parts of the the other hand, hig sites at ages 25-3 marked rise with other sites studied

There are a n involved in consi industrial employ ferent age groups may reflect variati ment, and occupa

of Selected Sites Among White† Male Residents Classified by Age, 1950-1960

			Age Adjusted
50-54	55-59	60-64	25-64
228.95	381.34	633.30	155.33
7.90	13.57	23.18	4.86
15.05	31.13	61.01	12.60
12.90	18.48	31.40	7.56
4.70	8.57	11.29	2.59
67.42	108.88	167.39	40.57
5.59	10.57	15.55	4.07
5.59	11.90	23.05	4.44
10.66	13.15	17.73	6.84
10.07	13.90	22.48	7.30

individual counties may provide the basis for more specific environmental studies.

Age

The large variations in mortality due to specific causes by age and the differences in the age composition of various population groups by geographic areas have emphasized the necessity of age-specific morbidity and mortality rates.

Table 3 provides age comparisons of mortality by specific cancer site among white males residing in the 8 metropolitan counties of Ohio in the period 1950-1960. Mortality rates generally showed a marked increase with age which was, however, greater for some sites than for others. Mortality rates for most of the cancer sites considered were, for example, negligible in relatively young age groups, 25-34 years, and assumed importance, of varying magnitude, in middle or later years. Mortality rates due to leukemia and aleukemia, and cancer of the brain and other parts of the nervous system, were, on the other hand, higher than for other cancer sites at ages 25-34 years and showed a less marked rise with age than for most of the other sites studied.

There are a number of special factors involved in considering age in relation to industrial employment. For example, different age groups of industrial populations may reflect variations in duration of employment, and occupational diseases may occur in different age groups depending on the latent period of the disease. There may be a shift of mortality to the younger age groups when occupational cancer is involved. In considering age it is also important to r e the dates of installation of control measures and to determine whether particular groups of workers were exposed before or after such installations.

Employment requirements and policies may affect age patterns as well as types of illness in industrial groups. The employment requirements of certain industries may be such that the young and very strong are selected and therefore constitute the predominant population. Older age groups may, on the other hand, be proportionately greater in other industries, such as those with relatively large proportions of highly skilled craftsmen. Retirement, seniority, and sick leave policies and practices may also affect the age composition of the work force as well as the scope of the epidemiologic study. The age at entrance to exposure has some bearing on the age at onset of occupational diseases such as cancer.

Country of Birth

Nativity has become recognized as an important population characteristic for consideration in epidemiologic and biostatistical studies.[13,21,26,29,30,37] A point of interest with reference to conditions following migration of the foreign-born is the tendency observed for specific nativity groups to settle in particular areas in which they often live and work together, possibly associating with a specific industry or occupation group, and maintain the cultural characteristics of their nativity group. The migration patterns of the foreign-born make it important to consider any industrial and occupational concentration of migrating groups in relation to their geographic location and other environmental characteristics.

The long latent period for some diseases, such as cancer, makes it necessary to consider factors in both the country of birth and the place to which migration occurred in terms of circumstances which prevailed as long as

20 or 30 years or more ago. Table 4 provides an exploration of this point in comparing lung cancer mortality among native and immigrant populations of Cuyahoga County, Ohio, the county which had the highest white male lung cancer mortality rate of any of the 88 counties of Ohio in the period 1947-1951.[29] Table 4 shows that the mortality rate due to lung cancer among male immigrants to Cuyahoga County from England and Wales was considerably lower than among the male population of England and Wales but slightly higher than the death rate for this cause among the native white males of Cuyahoga County and considerably higher than the lung cancer death rate among the native white male residents of Ohio. The lung cancer mortality rate among male immigrants from Italy to Cuyahoga County was, on the other hand, similar to the male lung cancer rate in Italy but considerably lower than the lung cancer death rate among native white male residents of Cuyahoga County and approximately the same as the lung cancer mortality rate among the native white male residents of Ohio. This is of interest in comparison with the results of a study by Eastcott of cancer mortality among native and immigrant groups in New Zealand.[13]

TABLE 4.—*Average Annual Age-Adjusted Death Rates per 100,000 Population Among Selected Native White Male and Immigrant Male Population Groups Residing in Ohio, the Eight Metropolitan Counties and Cuyahoga County in Ohio, and the Male Population of England and Wales, and Italy, Ages 25-64, Selected Years Around 1950* *

Population Group & Period of Years	Average Annual Age-Adjusted Death Rate per 100,000 Population, Ages 25-64
Native-born white males residing in Ohio, 1947-1951	20.53
8 metropolitan counties of Ohio, 1947-1951	23.47
Cuyahoga County, Ohio 1947-1951	23.75
Immigrants from all foreign countries residing in Ohio, 1947-1951	36.67
8 metropolitan counties of Ohio, 1947-1951	35.31
Cuyahoga County, Ohio, 1947-1951	35.11
Cuyahoga County residents who immigrated from:	
England & Wales, 1947-1951	31.75
Italy, 1947-1951	18.61
Resident population of:	
England and Wales, 1950	55.48
Italy, 1951	16.26

* Mortality rates for England and Wales were computed on the basis of mortality data supplied by the World Health Organization and population data in United Nations publications; all other rates were computed on the basis of mortality data available in the Ohio Department of Health and population data in the 1950 United States Census or estimated on the basis of data in this Census by methods described on page 81 of *Reference 30*. Age adjustments were made by the direct method on the basis of the age distribution of the total population of the United States as shown by the 1950 United States Census. The nonwhite population group was defined to include Negroes, Indians, Japanese, Chinese, and other nonwhite races. The native-born group included persons born in the United States or any of its territories or possessions. Metropolitan counties were defined as those with cities of 100,000 population or more in 1950.

Socioeconomic Comparisons

Just as geographic exposure, race, or country of birth may influence chronic illness and mortality patterns, so may the socioeconomic status of a given population. Efforts have been directed toward determining the association of socioeconomic factors and mortality in studies conducted in England and Wales and the United States for a number of years.[31]

Two approaches have been used in providing socioeconomic comparisons of mortality. One is to compare mortality rates by socioeconomic characteristics of the individual, such as occupation, occupation and broad social class, and occupation of the husband for married women. The other type of approach is to compare over-all mortality in geographic areas of different socioeconomic characteristics, such as census tracts, classified by one or more specific characteristics like rent or income. Both approaches can, of course, be used in studying mortality by specific cause of death.

In industrial health studies socioeconomic factors represent an index, to a certain extent, of the employment and exposure of the individual worker, since occupational classifications are related to wages. This may provide a means not otherwise available of

* References 1-3, 5, 10, 31-34, 36, 39

...broadly sorting or diff...tional groups by type of ... exposure. Laborers an... well as management m... differentiated.

The influence of wor... standards of the family ... housing, medical care, ... suggests that industrial h... extend their concern to ... patterns of the families ...

Summa...

This paper provides a ... the demographic approa... health of industrial po... mention was made of the ... on geographic location, ir... and county residence, du... sex, color, age, country ... economic factors. Parti... made to the interrelatio... factors.

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Demographic studies ... ence data on diseases an... tion groups of different ... geographic location an... ologic clues which are f... ing more refined invest... industrial groups.

We wish to express ou... technical and related assista... Veigel, Chief, Mrs. Elizab... members of the Division of ...

Thomas F. Mancuso, M.... cupational Health, Gradu... Health, Pittsburgh, Pa. ...

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broadly sorting or differentiating occupational groups by type of job, department, and exposure. Laborers and skilled groups as well as management may be grossly differentiated.

The influence of work income on living standards of the family, such as nutrition, housing, medical care, and education, also suggests that industrial health studies should extend their concern to illness and mortality patterns of the families of workers.

Summary

This paper provides a brief discussion of the demographic approach to studying the health of industrial populations. Specific mention was made of the importance of data on geographic location, including urban-rural and county residence, duration of residence, sex, color, age, country of birth, and socioeconomic factors. Particular reference was made to the interrelation of some of these factors.

Conclusion

Demographic studies provide basic reference data on diseases and deaths in population groups of different characteristics and geographic location and furnish epidemiologic clues which are fundamental in guiding more refined investigations of specific industrial groups.

We wish to express our appreciation for the technical and related assistance of Mr. William H. Veigel, Chief, Mrs. Elizabeth Everett, and other members of the Division of Vital Statistics.

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Methodology in Industrial Health Studies

The Demographic Approach

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There are many opportunities for investigators in the field of industrial health to design and conduct studies to evaluate the relationship between chronic illness and occupation. This area of study poses, however, some complex and difficult problems which require varied approaches.

In 2 papers consideration will be given to the application of epidemiology to industrial populations within the framework of the demographic and prospective or cohort approaches. This paper is concerned with the demographic approach, which is of basic importance in industrial health studies.

Demographic studies identifying characteristics of the general population and the pattern of disease distribution, as derived from vital statistics and other sources, represent an initial approach in epidemiologic methods relating to industrial populations. Such studies involve geographic areas, sex, color, age, country of birth, and socioeconomic status.

Demographic comparisons help to determine geographic and population characteristics associated with mortality or morbidity due to specific diseases. Urban-rural comparisons, for example, which indicate relatively high mortality in urban areas or in particular metropolitan counties represent initial clues to environmental influences, such as industry and air pollution, from which more refined epidemiologic studies can be derived. They further help to identify sex, color, nativity, and age groups with relatively high risk of specific diseases or causes of

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Environmental Fluoride

...s. of ...ples	Weighted Exposure Mg. M³	Ratio to 2.5 Mg/M³
32	3.90	1.56
85	4.23	1.69
29	2.50	1.00
78	1.14	0.46
82	1.94	0.78
90	1.94	0.78
72	3.84	1.54
145	4.00	1.60
91	1.76	0.71
56	2.10	0.84
235	3.92	1.57
27	1.67	0.67
54	2.21	0.88
30	1.86	0.75
35	1.98	0.79
11	2.62	1.05
18	1.81	0.72
22	3.85	1.54
122	2.87	1.15
49	1.56	0.62
8	2.06	0.83
7	1.16	0.47
17	1.82	0.73
18	1.32	0.53
11	1.95	0.79
22	0.87	0.35
58	1.93	0.77
8	1.23	0.49
2	3.49	1.40
4	2.73	1.19
4	4.41	1.77
9	2.14	0.86
8	0.76	0.30
2	1.15	0.46
7	0.71	0.28
5	1.89	0.76
5	1.26	0.50
7	0.50	0.20
9	2.10	0.84
4	0.67	0.27
17	3.38	1.35
	7.73	3.09
	1.75	0.71
15	2.64	1.06
	8.32	3.33
	0.50	0.20
13	2.81	1.13
	8.32	3.33
	0.50	0.20

TABLE 1.—*Average Annual Age-Adjusted Death Rates* per 100,000 Population Due to Malignant Neoplasms, White Male and White Female† Residents of Each of the Eight Metropolitan Counties‡*

Geographic Area	Neoplasm Site (and Cause of Death Code)							
	All Malignant Neoplasms (140-205) §	All Malignant Neoplasms Except Those of Breast & Reproductive Organs (140-165, 180-205) §	Esophagus (150)	Stomach (151)	Pancreas (157)	Larynx (161)	Lung, Bronchus & Trachea (162, 163)	Bladder & Other Urinary Organs (181)
White Males								
State of Ohio	141.02	134.34	3.85	11.69	7.07	2.50	36.02	4.05
8 Metropolitan counties	155.33	148.41	4.86	12.60	7.56	2.89	40.87	4.44
Cuyahoga	167.50	160.92	6.10	16.59	8.23	3.27	41.26	4.47
Franklin	147.79	141.30	3.22	9.38	7.08	3.01	42.79	3.61
Hamilton	162.07	156.03	4.98	9.26	7.17	3.30	45.33	4.97
Lucas	153.56	147.11	5.23	11.75	7.43	2.84	43.91	5.16
Mahoning	162.00	155.97	4.92	16.31	9.16	2.95	41.13	4.57
Montgomery	136.02	129.08	4.12	9.51	6.46	2.08	38.27	3.13
Stark	139.12	132.45	3.68	10.85	7.10	2.18	36.36	4.42
Summit	137.15	130.78	3.41	10.80	6.91	2.09	34.29	4.77
White Females								
State of Ohio	140.26	70.36	0.80	5.66	3.92	0.16	5.34	1.53
8 Metropolitan counties	145.25	73.18	0.89	6.30	4.04	0.17	5.70	1.60
Cuyahoga	146.71	76.06	0.84	8.14	4.12	0.08 ‖	6.19	1.34
Franklin	151.75	74.05	0.60 ‖	4.81	4.41	0.30 ‖	5.62	1.50
Hamilton	155.20	78.71	0.40 ‖	5.13	4.41	0.20 ‖	6.43	1.69
Lucas	140.14	67.24	0.62 ‖	4.81	4.42	0.18 ‖	4.92	1.96
Mahoning	146.29	80.23	0.89 ‖	10.32	3.54	0.30 ‖	7.23	1.03
Montgomery	134.51	64.26	0.68 ‖	4.19	2.58	0.10 ‖	4.64	1.46
Stark	125.34	65.38	1.03 ‖	4.34	2.42	0.14 ‖	5.21	1.42
Summit	142.77	76.07	0.61 ‖	6.00	4.93	0.34 ‖	4.34	2.29

*Mortality rates were computed on the basis of mortality data for the specified type of malignant neoplasm for white males and white females, classified by 5-year age groups, available in the Ohio Department of Health, and population data obtained by averaging population counts given by the decennial United States censuses of 1950 and 1960 for the corresponding sex, color, and age groups. Age adjustments were made by the direct method on the basis of the age distribution of the total population of the United States as shown by the 1960 United States census.

† The nonwhite populat... groups, Indians, Japanese, C...

‡ The metropolitan coun... of 100,000 population or mo...

§ Neoplasms of lymphat... excluded.

‖ The death rate is based ...

death. Such data provide a basic reference source for studies of industrial workers which, in turn, require similar classification by population characteristics. In this manner, it is possible to identify and eliminate the effect a particular variable, such as age, may have on mortality patterns observed in specific industries. Mortality rates of industrial workers by population characteristics, such as sex, color, and age, help to determine the possible effect of selective employment practices relative to such population characteristics on the morbidity and mortality experience of a given plant or industry.

Geographic Location

In studying geographic differences as basic epidemiologic leads in industrial health studies, a first consideration is urban-rural comparisons. These may provide initial clues relative to industrial and agricultural populations and furnish the basis for further epidemiologic efforts and other types of studies pertaining to air pollution, socioeconomic factors, and medical care.

Malignant Neoplasms of Selected Sites Among of Ohio, 25-64 Years of Age, 1950-1960

Kidney (180)	Bladder & Other Urinary Organs (181)	Brain & Other Parts of CNS (193)	Leukemia & Aleukemia (204)
3.76	4.05	6.40	6.63
4.07	4.44	6.84	7.30
4.05	4.47	6.92	7.39
3.36	3.61	5.96	6.89
3.78	4.97	6.88	6.76
3.85	5.16	7.15	7.67
5.97	4.57	6.75	8.16
4.03	3.13	6.40	6.35
5.07	4.62	6.47	6.72
3.58	4.77	7.70	7.90
1.72	1.53	3.96	4.52
1.81	1.60	4.13	5.05
1.85	1.34	4.47	5.33
1.81	1.80	4.80	5.15
2.48	1.69	3.42	5.15
1.97	1.96	4.00	4.40
1.48	1.03	2.77	4.91
1.81	1.46	3.43	4.35
1.26	1.42	3.53	4.96
0.55	2.29	5.21	5.16

† The nonwhite population group was defined to include Negroes, Indians, Japanese, Chinese, and other nonwhite races.

‡ The metropolitan counties were defined as those with cities of 100,000 population or more in 1950.

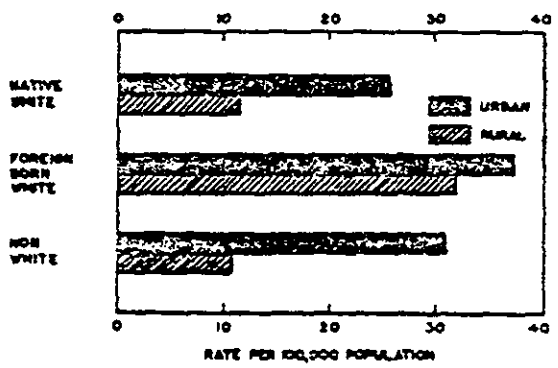
§ Neoplasms of lymphatic and hematopoietic tissues are included.

‖ The death rate is based on a frequency of less than 10 deaths.

Our observations in Ohio cancer studies have emphasized the importance of such urban-rural comparisons, particularly by population subgroups. These studies have shown, for example, that (1) an "urban" influence existed for certain cancer sites and (2) lung cancer was relatively high among the foreign-born of both urban and rural areas (Figure).[29,30] Other studies have also emphasized urban-rural and related geographic considerations.[20,25,32,38]

Comparisons of cancer mortality in small geographic areas such as counties may provide further epidemiologic leads. Table 1 provides county comparisons of mortality due to specific cancer sites among white male and female residents of individual metropolitan counties of Ohio for the period 1950-1960. The table reveals individual county variation in cancer mortality for the specific sites considered. Lung cancer mortality among white males was, for example, relatively high in Hamilton County and relatively low in Summit County. Stomach cancer mortality among white males was, on the other hand, relatively high in Cuyahoga and Mahoning counties and relatively low in Franklin, Hamilton, and Montgomery Counties. These observations serve as a basis for further epidemiologic efforts.

In individual county comparisons it must also be realized that a single industry may not appreciably affect the specific disease rate in a county just as a high incidence of a specific disease in a single work department



Average annual age-adjusted death rates due to cancer of the lung among native white, foreign-born white, and nonwhite male residents of urban and rural areas of Ohio, who died in the state, ages 25-64 years, 1947-1951.

Mortality rates were computed on the basis of mortality data available in the Ohio Department of Health for the specified population, classified by age groups 25-34, 35-44, 45-54, and 55-64 years, and population data in the 1950 U.S. Census for the corresponding population groups. Age adjustments were made by the direct method on the basis of the age distribution of the total population of continental United States as shown by the 1950 United States Census. The nonwhite population group was defined to include Negroes, Indians, Japanese, Chinese, and other nonwhite races. The native-born group included persons born in the United States or any of its territories or possessions. The classification of urban and rural areas was based on the definition of such areas used in the 1950 United States Census.

may not affect the rate for the disease of a large industry because of the dilution factor. This point was demonstrated in a study of the lung cancer mortality rate in Lake County, Ohio, although previous studies [27-29] had demonstrated an abnormal mortality rate for lung cancer in a chromate plant located in that county. When a large group of industries are located in a circumscribed area, such as a county, and are engaged in the same essential manufacturing processes or products, it can be expected, however, that the disease pattern of the county will reflect this concentration in the area if an environmental factor is involved.

Residence Duration

In studying diseases with long latent periods, it should be noted that the current place of residence of population groups under study may not be the place of environmental exposure and therefore consideration must be given to long-term residence histories. This applies to the following types of current residence: death residence, place of retirement, place to which an individual moves for special medical or surgical care, place to which there has been significant migration because of attractive climate and job opportunities, and places within a city to which there have been population shifts with respect to race, nationality, and socioeconomic status. These types of shift in residence, singly or in combination, bring about changes in the age distribution of the population, as well as in the types of illness and death, which thereby affect the illness and mortality pattern of a given locality. Residence history data are of basic importance in studying the possible association of such variables as occupation, atmospheric pollution, smoking, morbidity, and mortality.

There are various methods of exploring residence duration in epidemiologic studies. One is to obtain residence history data for specific population groups, by such means as checking city directories and employment records and querying relatives, friends, and other associates. This approach can provide information, for example, on the duration of residence in the county of residence at death, as shown on the death certificate. Another approach is to compare place of residence at death with the birthplace as specified on the death certificate, if one can assume that an individual born in a given county who died in that county lived a major portion of his life there. Both of these approaches are of assistance in comparing mortality rates due to long-term illness in different geographic areas as they relate to duration of residence, which is important because of the latent period between initial exposure and development of the chronic disease leading to death.

In considering residence data it is essential to keep in mind 2 points: (1) the interrelationships of residence and migration patterns with other factors such as socioeconomic phenomena, employment practices, and medical care and (2) geographic variations in the distribution of chronic illnesses depending on the latent period of the particular disease.

Sex

In industrial health studies, sex comparisons are essential in epidemiologic consideration. When there is employment selection by sex within an industry, the distribution of illness by sex may provide the means of excluding certain departments and exposures, in this way refining the epidemiologic study.

In some industries and occupations, women represent the predominant labor force. Under such circumstances, patterns of long-term illness or mortality in female employee populations may be studied in comparison with similar data on women in other industries and women not employed in industry. It is also of special interest to consider whether the occupation or pattern of living of the husband affects the illness and mortality experience of his wife.

Some cancer mortality data for Ohio shown in Tables 1 and 2 reveal characteristic patterns of sex difference in cancer mortality. The tables indicate, for example, that cancer mortality was generally higher among males

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TABLE 2.—*Average Annu*
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Neoplasm Site (& Cause
Malignant neoplasms, including neo
& hematopoietic tissues (140-205
Buccal cavity & pharynx (140-148)
Digestive organs & peritoneum (15
Esophagus (150)
Stomach (151)
Small intestine, incl. duodenum
Large intestine, except rectum (1
Rectum (154)
Biliary passages & liver, stated a
Liver, secondary & unspecified (
Pancreas (157)
Peritoneum (158)
Unspecified digestive organs (15
Respiratory system (160-165)
Nose, nasal cavities, middle ear,
Larynx (161)
Lung, bronchus, & trachea (162,
Mediastinum (164)
Thoracic organs, secondary (165
Breast & genitourinary organs (17
Breast (170)
Cervix uteri (171)
Corpus uteri (172)
Other & unspecified parts of ute
Ovary, fallopian tube, & broad
Other & unspecified female geni
Prostate (177)
Testis (178)
Other & unspecified male genita
Kidney (180)
Bladder & other urinary organs
Other & unspecified sites (190-199)
Melanoma of skin (190)
Other malignant neoplasm of sk
Eye (192)
Brain & other parts of nervous
Thyroid gland (194)
Other endocrine glands (195)
Bone (196)
Connective tissue (197)
Secondary & unspecified malig
nodes (198)
Other & unspecified sites (199)
Lymphatic & hematopoietic tissu
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* Mortality rates were computed
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† The nonwhite population cons
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than females of each color for cancer sites common to both sexes and that these differences were more marked for some sites than for others. The females had, on the other hand, a considerable mortality due to cancer of the breast and reproductive organs, particularly in middle age. Individual metropolitan county variations by sex shown in Table 1 may be useful in selecting those cancer sites among the male population which

TABLE 2.—*Average Annual Age-Adjusted Death Rates* per 100,000 Population Due to Malignant Neoplasms of Specified Sites Among White and Nonwhite† Male and Female Residents of the Eight Metropolitan Counties of Ohio,‡ Ages 25-64 Years, 1950-1960*

Neoplasm Site (& Cause of Death Code)	Total	Males		Females	
		White	Nonwhite	White	Nonwhite
Malignant neoplasms, including neoplasms of lymphatic & hematopoietic tissues (140-205)	156.25	155.33	213.55	145.25	208.93
Buccal cavity & pharynx (140-148)	3.99	6.55	6.96	1.43	1.56
Digestive organs & peritoneum (150-159)	47.94	53.36	86.30	37.43	60.06
Esophagus (150)	3.36	4.66	14.59	0.89	3.37
Stomach (151)	10.51	12.60	29.03	6.30	13.40
Small intestine, incl. duodenum (152)	0.48	0.54	0.54 §	0.37	0.48 §
Large intestine, except rectum (153)	14.32	13.95	13.10	14.50	17.22
Rectum (154)	6.34	7.35	7.23	5.11	7.95
Biliary passages & liver, stated as primary site (155)	3.01	2.39	3.79	3.44	3.81
Liver, secondary & unspecified (156)	2.99	3.22	6.71	2.28	3.59
Pancreas (157)	6.11	7.56	9.97	4.04	9.00
Peritoneum (158)	0.55	0.65	0.54 §	0.49	0.22 §
Unspecified digestive organs (159)	0.29	0.24	0.80	0.21	1.02
Respiratory system (160-165)	26.18	44.51	58.78	6.39	10.08
Nose, nasal cavities, middle ear, & accessory sinuses (160)	0.32	0.37	1.04	0.21	0.22 §
Larynx (161)	1.56	2.89	3.06	0.17	0.85
Lung, bronchus, & trachea (162, 163)	23.52	40.57	54.06	5.70	8.75
Mediastinum (164)	0.32	0.49	0.32 §	0.17	0.26 §
Thoracic organs, secondary (165)	0.16	0.19	0.30 §	0.14	0
Breast & genitourinary organs (170-181)	48.08	15.43	25.59	75.48	107.03
Breast (170)	18.06	0.28	0.09 §	35.49	32.27
Cervix uteri (171)	5.73	—	—	14.98	36.31
Corpus uteri (172)	0.54	—	—	1.01	1.59
Other & unspecified parts of uterus (173, 174)	3.97	—	—	6.82	17.22
Ovary, fallopian tube, & broad ligament (175)	6.55	—	—	12.99	11.71
Other & unspecified female genital organs (176)	0.43	—	—	0.78	1.39
Prostate (177)	2.86	4.92	14.58	—	—
Testis (178)	0.84	1.46	0.19 §	—	—
Other & unspecified male genital organs (179)	0.15	0.26	0.73 §	—	—
Kidney (180)	2.95	4.07	4.47	1.81	1.94
Bladder & other urinary organs (181)	3.20	4.44	5.53	1.60	4.60
Other & unspecified sites (190-199)	15.75	17.76	15.72	13.29	17.52
Melanoma of skin (190)	1.13	1.52	0.55 §	0.95	0.37 §
Other malignant neoplasm of skin (191)	0.57	0.67	0.71 §	0.39	1.15
Eye (192)	0.16	0.16	0	0.15	0
Brain & other parts of nervous system (193)	5.27	6.54	4.21	4.13	2.55
Thyroid gland (194)	0.67	0.55	0.61 §	0.69	1.17
Other endocrine glands (195)	0.45	0.53	0.65 §	0.34	0.67 §
Bone (196)	1.03	1.26	1.09	0.75	1.25
Connective tissue (197)	0.53	0.51	0.62 §	0.51	0.73
Secondary & unspecified malignant neoplasm of lymph nodes (195)	0.25	0.26	0.23 §	0.24	0.46 §
Other & unspecified sites (199)	5.66	5.43	10.05	5.05	9.17
Lymphatic & hematopoietic tissues (200-205)	14.31	17.44	17.22	11.25	12.08
Lymphatic & hematopoietic tissues (200-203, 205)	8.22	10.14	10.60	6.20	7.50
Leukemia & aleukemia (204)	6.09	7.30	6.62	5.05	4.45

* Mortality rates were computed on the basis of mortality data available in the Ohio Department of Health for residents of the 8 metropolitan counties of Ohio, classified by sex, color, and 5-year age groups, and population data obtained by averaging population counts given for the decennial United States censuses of 1950 and 1960 for the corresponding sex, color, and age groups in this geographic area. Age adjustments were made by the direct method on the basis of the age distribution of the total population of the United States as shown by the 1960 United States Census.

† The nonwhite population group was defined to include Negroes, Indians, Japanese, Chinese, and other nonwhite races.

‡ The metropolitan counties were defined as those with cities of 100,000 population or more in 1960.

§ The death rate is based on a frequency of less than 10 deaths.

TABLE 3.—*Average Annual Death Rates* per 100,000 Population Due to Malignant Neoplasms of the Eight Metropolitan Counties of Ohio,‡ 25-64 Years of Age,*

Neoplasm Site (& Cause of Death Code)	Age Group					
	25-64	25-29	30-34	35-39	40-44	45-49
All malignant neoplasms, including neoplasms of lymphatic & hematopoietic tissues (140-205)	154.11	16.44	19.50	34.30	66.35	123.01
Esophagus (150)	4.53	0	0	0.41 §	0.63	3.24
Stomach (151)	12.51	0.45 §	0.91	1.68	4.32	8.07
Pancreas (157)	7.49	0.18 §	0.34 §	0.52 §	3.69	6.21
Larynx (161)	2.56	0	0	0.29 §	0.85	2.25
Lung, bronchus, & trachea (162,163)	40.51	0.77	2.07	5.27	14.22	33.60
Kidney (180)	4.03	0.18 §	0.17 §	0.63	2.19	3.45
Bladder & other urinary organs (181)	4.41	0.06 §	0.17 §	0.17 §	1.25	2.76
Brain & other parts of nervous system (193)	6.76	1.31	2.19	4.17	4.70	7.36
Leukemia & aleukemia (204)	7.26	3.04	2.92	3.65	5.26	5.31

* Mortality rates were computed on the basis of mortality data available in the Ohio Department of Health and population data obtained by averaging population counts given by the decennial United States censuses of 1950 and 1960. Age adjustments were made by the direct method on the basis of the age distribution of the total population of the United States as shown by the 1960 United States census.

† The definition of "white" males excluded Negroes, Indians, Japanese, Chinese and persons of other nonwhite races.

‡ The metropolitan counties were defined as those with cities of 100,000 population or more in 1950.

§ The death rate is based on a frequency of less than 10 deaths.

merit further study, particularly in reference to occupational or other environmental exposures peculiar to males.

Color

Color comparisons serve to separate some of the variables to be considered and to delineate avenues of investigation in epidemiologic studies. Although the environment of nonwhites has been identified to a certain extent, the epidemiologic potential of this population group has not been adequately explored.

In considering chronic illness, one must keep in mind, in addition to the latent period of the disease, the pattern of migration and employment of nonwhites over the years. Nonwhites may be affected to a different extent than whites by selection for certain types of work, shifts of jobs, and exposures within the same industry over a long period of time, as well as by changes to other industries. This influences consideration of disease development in the nonwhite race and emphasizes the importance of duration of employment in industrial population studies. These factors provide indications of differences in cultural and living patterns that may merit further study by other epidemiologic methods.

Table 2 illustrates color variations by specific cancer site for each sex as found in cancer studies of the 8 metropolitan counties in Ohio for the period 1950-1960. The color differences were particularly marked for cancer of the digestive organs and peritoneum, and for cancer of certain reproductive organs. Marked nonwhite excesses were observed, for example, for cancer of the esophagus and stomach for each sex; for cancer of the cervix, and other and unspecified parts of the uterus, excluding the corpus uteri, among females, and for cancer of the prostate among the males. A nonwhite excess for cancer of the lung was also found for each sex. On the other hand, relatively higher cancer mortality among the whites than among the nonwhites of each sex was found for melanoma of the skin and cancer of the brain and other parts of the nervous system. An earlier study revealed differences in cancer mortality among native and foreign-born subgroups of the white population which brought out the importance of studying nativity in color comparisons for specific types of cancer, such as cancer of the lung and of the brain and central nervous system.[30] Further refinements showing color as well as sex and nativity differences by

of Selected Sites Among Classified by Age, 1950

50-54	55-59
228.95	351.34
7.90	13.27
19.05	31.13
12.90	15.35
4.70	6.57
67.42	106.55
5.59	10.37
5.59	11.90
10.66	13.15
10.07	13.90

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of Selected Sites Among White† Male Residents Classified by Age, 1950-1960

			Age Adjusted
50-54	55-59	60-64	25-64
225.95	381.34	633.30	155.33
7.90	13.67	23.18	4.56
15.05	31.13	61.01	12.60
12.90	18.48	31.40	7.56
4.70	8.37	11.29	2.59
67.42	108.88	157.89	40.57
5.59	10.57	15.55	4.07
5.59	11.90	23.05	4.44
16.66	13.15	17.73	6.84
10.07	13.90	22.48	7.30

individual counties may provide the basis for more specific environmental studies.

Age

The large variations in mortality due to specific causes by age and the differences in the age composition of various population groups by geographic areas have emphasized the necessity of age-specific morbidity and mortality rates.

Table 3 provides age comparisons of mortality by specific cancer site among white males residing in the 8 metropolitan counties of Ohio in the period 1950-1960. Mortality rates generally showed a marked increase with age which was, however, greater for some sites than for others. Mortality rates for most of the cancer sites considered were, for example, negligible in relatively young age groups, 25-34 years, and assumed importance, of varying magnitude, in middle or later years. Mortality rates due to leukemia and aleukemia, and cancer of the brain and other parts of the nervous system, were, on the other hand, higher than for other cancer sites at ages 25-34 years and showed a less marked rise with age than for most of the other sites studied.

There are a number of special factors involved in considering age in relation to industrial employment. For example, different age groups of industrial populations may reflect variations in duration of employment, and occupational diseases may occur in different age groups depending on the latent period of the disease. There may be a shift of mortality to the younger age groups when occupational cancer is involved. In considering age it is also important to r e the dates of installation of control measures and to determine whether particular groups of workers were exposed before or after such installations.

Employment requirements and policies may affect age patterns as well as types of illness in industrial groups. The employment requirements of certain industries may be such that the young and very strong are selected and therefore constitute the predominant population. Older age groups may, on the other hand, be proportionately greater in other industries, such as those with relatively large proportions of highly skilled craftsmen. Retirement, seniority, and sick leave policies and practices may also affect the age composition of the work force as well as the scope of the epidemiologic study. The age at entrance to exposure has some bearing on the age at onset of occupational diseases such as cancer.

Country of Birth

Nativity has become recognized as an important population characteristic for consideration in epidemiologic and biostatistical studies.[13,21,26,29,30,37] A point of interest with reference to conditions following migration of the foreign-born is the tendency observed for specific nativity groups to settle in particular areas in which they often live and work together, possibly associating with a specific industry or occupation group, and maintain the cultural characteristics of their nativity group. The migration patterns of the foreign-born make it important to consider any industrial and occupational concentration of migrating groups in relation to their geographic location and other environmental characteristics.

The long latent period for some diseases, such as cancer, makes it necessary to consider factors in both the country of birth and the place to which migration occurred in terms of circumstances which prevailed as long as

20 or 30 years or more ago. Table 4 provides an exploration of this point in comparing lung cancer mortality among native and immigrant populations of Cuyahoga County, Ohio, the county which had the highest white male lung cancer mortality rate of any of the 88 counties of Ohio in the period 1947-1951.[28] Table 4 shows that the mortality rate due to lung cancer among male immigrants to Cuyahoga County from England and Wales was considerably lower than among the male population of England and Wales but slightly higher than the death rate for this cause among the native white males of Cuyahoga County and considerably higher than the lung cancer death rate among the native white male residents of Ohio. The lung cancer mortality rate among male immigrants from Italy to Cuyahoga County was, on the other hand, similar to the male lung cancer rate in Italy but considerably lower than the lung cancer death rate among native white male residents of Cuyahoga County and approximately the same as the lung cancer mortality rate among the native white male residents of Ohio. This is of interest in comparison with the results of a study by Eastcott of cancer mortality among native and immigrant groups in New Zealand.[13]

TABLE 4.—*Average Annual Age-Adjusted Death Rates per 100,000 Population Among Selected Native White Male and Immigrant Male Population Groups Residing in Ohio, the Eight Metropolitan Counties and Cuyahoga County in Ohio, and the Male Population of England and Wales, and Italy, Ages 25-64, Selected Years Around 1950* *

Population Group & Period of Years	Average Annual Age-Adjusted Death Rate per 100,000 Population, Ages 25-64
Native-born white males residing in Ohio, 1947-1951	20.55
8 metropolitan counties of Ohio, 1947-1951	25.47
Cuyahoga County, Ohio 1947-1951	28.75
Immigrants from all foreign countries residing in Ohio, 1947-1951	36.67
8 metropolitan counties of Ohio, 1947-1951	35.31
Cuyahoga County, Ohio, 1947-1951	38.11
Cuyahoga County residents who immigrated from:	
England & Wales, 1947-1951	31.75
Italy, 1947-1951	18.61
Resident population of:	
England and Wales, 1950	55.48
Italy, 1951	16.26

* Mortality rates for England and Wales were computed on the basis of mortality data supplied by the World Health Organization and population data in United Nations publications; all other rates were computed on the basis of mortality data available in the Ohio Department of Health and population data in the 1950 United States Census or estimated on the basis of data in this Census by methods described on page 81 of Reference 30. Age adjustments were made by the direct method on the basis of the age distribution of the total population of the United States as shown by the 1950 United States Census. The nonwhite population group was defined to include Negroes, Indians, Japanese, Chinese, and other nonwhite races. The native-born group included persons born in the United States or any of its territories or possessions. Metropolitan counties were defined as those with cities of 100,000 population or more in 1950.

Socioeconomic Comparisons

Just as geographic exposure, race, or country of birth may influence chronic illness and mortality patterns, so may the socioeconomic status of a given population. Efforts have been directed toward determining the association of socioeconomic factors and mortality in studies conducted in England and Wales and the United States for a number of years.[31]

Two approaches have been used in providing socioeconomic comparisons of mortality. One is to compare mortality rates by socioeconomic characteristics of the individual, such as occupation, occupation and broad social class, and occupation of the husband for married women. The other type of approach is to compare over-all mortality in geographic areas of different socioeconomic characteristics, such as census tracts, classified by one or more specific characteristics like rent or income. Both approaches can, of course, be used in studying mortality by specific cause of death.

In industrial health studies socioeconomic factors represent an index, to a certain extent, of the employment and exposure of the individual worker, since occupational classifications are related to wages. This may provide a means not otherwise available of

* References 1-3, 5, 10, 31-34, 36, 39.

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Summa

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broadly sorting or differentiating occupational groups by type of job, department, and exposure. Laborers and skilled groups as well as management may be grossly differentiated.

The influence of work income on living standards of the family, such as nutrition, housing, medical care, and education, also suggests that industrial health studies should extend their concern to illness and mortality patterns of the families of workers.

Summary

This paper provides a brief discussion of the demographic approach to studying the health of industrial populations. Specific mention was made of the importance of data on geographic location, including urban-rural and county residence, duration of residence, sex, color, age, country of birth, and socioeconomic factors. Particular reference was made to the interrelation of some of these factors.

Conclusion

Demographic studies provide basic reference data on diseases and deaths in population groups of different characteristics and geographic location and furnish epidemiologic clues which are fundamental in guiding more refined investigations of specific industrial groups.

We wish to express our appreciation for the technical and related assistance of Mr. William H. Veigel, Chief, Mrs. Elizabeth Everett, and other members of the Division of Vital Statistics.

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