Morbidity and Mortality Experience Among Chromate Workers

By HUGH P. BRINTON, Ph.D., ELIZABETH S. FRASIER, Litt.B., and A. LINK KOVEN, M.D.

The abnormally high rate for cancer of the respiratory system among workers in the chromate-producing industry was demonstrated by Machle and Gregorius (*1*) in 1948. At that time, so far as was known, nothing on morbidity experience and little on other causes of death among chromate workers had been published. The present report on morbidity and mortality among male workers in the seven chromate-producing plants in the United States is offered because of the increasing interest in problems related to specific health hazards in this industry.

In 1950–51 the Public Health Service made an engineering study of the working environment in all seven plants and a detailed medical study of workers in six of the plants. As part of these studies, data were collected on paid death claims and on claims for sickness and nonindustrial injuries disabling for eight calendar days or longer among members of sick-benefit plans. This morbidity and mortality report thus covers all workers who are members of sick-benefit plans in the seven plants in the United States engaged in the extraction of chromates from chemical-grade chromite ore. These plants are located in Maryland, New Jersey, New York, and Ohio. Periods for which accurate sickness and death records were available varied from 2 to 11 years. The rules and regulations of the sick-benefit plans may be summarized as follows:

In all of the plants, benefits began on the eighth day of disability. Prior to 1949 the maximum period for which benefits were paid was 13 weeks. With the passage of a sickness insurance law in New Jersey, effective on January 1, 1949, plants located in that State had maximum benefits extended to 26 weeks. However, in order that the data for all companies be comparable, cases of disability lasting longer than 98 days were arbitrarily closed at 98 days. The calendar days of disability, therefore, are defined as the number of calendar days from the date of onset of disability to the date of return to work or to the ninety-eighth day, inclusive, except when the employee died or was pensioned before the ninety-eighth day.

Before 1949 the probationary or waiting period between employment and eligibility for membership in the sickness insurance plan was 6 months for two plants, 3 months for one plant, and 1 month for three plants; one plant had no plan. After the New Jersey State sickness insurance law went into effect in January 1949 and a New York law became effective on July 1, 1950, workers in the plants in these areas were eligible for benefits as soon as they were employed. By the end of 1950, one plant still had a waiting period of 6 months, one plant had a waiting period of 1 month, and the remaining five plants, located in New York and New Jersey, had no probationary periods.

At first, membership in the sickness insurance plans was voluntary in all plants, but after the enactment of the New Jersey and New York laws, membership was compulsory for plant workers in those States. In the two plants where membership remained voluntary,

Dr. Brinton and Miss Frasier are with the statistical section of the Division of Occupational Health, Public Health Service; Dr. Koven is with the medical section of that division.

The data presented in this paper were collected in connection with the division's study of health among workers in the chromate-producing industry. A comprehensive report on the health of these workers will be published separately.

coverage was approaching 100 percent of all employees toward the end of the study period.

Although a medical examination was not required before a worker could become a member of a sickness insurance plan, all plants required a medical examination before employment. There were no age limits on eligibility for membership. However, some plants which allowed 26 weeks' benefits for each different disease during a year permitted only a total of 26 weeks per year for all diseases for persons over 60 years of age.

From the foregoing rules and regulations it is evident that the only newly employed workers included in the study were those who entered the New Jersey plants during 1949 and 1950 and the New York plant during the last 6 months of 1950. Neither the morbidity nor the mortality experience of employees during the probationary period (whether they quit or remained with the plant) was included.

The disability analysis is based on only those cases that occurred while a worker was a member of the sickness insurance plan. All disabilities that ended between January 1, 1946, and December 31, 1950, are included, provided that they lasted for 8 calendar days or longer. Hence, disabilities that began in 1945 and ended in 1946 are included. The actual number of days for all cases ending during the study period are counted up to the ninety-eighth day, inclusive. Industrial injuries and compensated cases of occupational disease are not included.

The mortality analysis is based on information from the records of the sick-benefit associations which contained data on death benefits. Only deaths of workers who were members of a sick-benefit association and died within one year after becoming disabled are included. Sudden deaths and deaths before the eighth day of disability are included; although these cases were not eligible for sickness benefits, they were eligible for death benefits. Deaths due to industrial injuries are not included. All deaths were classified by cause as given on the death certificate without additional verification.

Disability Experience, 1946–50

During the 5-year period 1946–50, for the seven chromate plants there was a total of 5,121 person-years of membership in sick-benefit plans, 3,663 for whites and 1,458 for nonwhites. It will be observed from table 1 that the proportion of nonwhites in the total membership declines rapidly after 55 years of age. In the age group 65 years and over there were 136 white males as compared with 9 nonwhite.

Table 1. Person-years of membership in sick-benefit plans, by age and race

Race	Total	Age, in years				
		15–34	35–44	45–54	55–64	65 and over
All males	5,121	1,497	1,457	1,212	810	145
White	3,663	1,014	1,015	803	695	136
Nonwhite	1,458	483	442	409	115	9

Six of the plants reported during the full 5-year period, with a steady increase in the average membership in sick-benefit plans from 1946 through 1949. The seventh, a small plant, reported only during the last 2 years, 1949 and 1950.

Frequency by Year Case Ended

In 1946, the average annual number of cases of disability on account of sickness and nonindustrial injuries was 130.9 per 1,000 white and 186.2 per 1,000 nonwhite males, compared with 109.8 and 124.6, respectively, in 1950 (table 2). The rates for the broad cause groups are not shown in this table, but an examination of those rates reveals that the abnormally low rate for white males in the chromate industry in 1947 (86.0) is attributable to a marked decrease in respiratory diseases for that year. Nonwhite males also showed a decrease in the respiratory disease rate for 1947, but this was more than counterbalanced by an increase in nonrespiratory-nondigestive diseases. There was a slight upward trend in the rates for nonindustrial injuries, while the rates for digestive diseases and nonrespiratory-nondigestive diseases fluctuated, but not in one particular direction.

Duration According to Broad Cause Group

Disability frequency rates for white and nonwhite males under 55 years of age according to duration of case are presented in table 3 for the broad cause groups. For sickness and non-

Table 2. Frequency of sickness and nonindustrial injuries lasting 8 consecutive days or longer, according to year case ended, by race [1]

Year case ended	Annual number of cases per 1,000 males			Number of cases			Average person-years of membership in sick-benefit plan		
	Total	White	Non-white	Total	White	Non-white	Total	White	Non-white
1946–50	128. 3	116. 3	158. 4	657	426	231	5, 121	3, 663	1, 458
1946	147. 3	130. 9	186. 2	123	77	46	835	588	247
1947	120. 7	86. 0	200. 0	115	57	58	953	663	290
1948	145. 6	137. 8	164. 5	151	101	50	1, 037	733	304
1949	119. 6	117. 6	125. 0	141	101	40	1, 179	859	320
1950	113. 7	109. 8	124. 6	127	90	37	1, 117	820	297

[1] Industrial injuries and venereal diseases are not included. The data include experience of 6 plants during 1946–50, and the seventh plant during 1949–50 only.

industrial injuries the rate for nonwhites for each duration is more than one and one-half times the rate for whites for the corresponding duration. The excess in the rate for nonwhites over the rate for whites is greatest for the respiratory diseases, next for the digestive diseases, and lowest for the nonrespiratory-nondigestive diseases. These differences cannot be

Table 3. Frequency of sickness and nonindustrial injuries among males under 55 years of age, according to duration, by race and cause [1]

Duration of case in calendar days	Annual number of cases per 1,000 males					
	White	Nonwhite	White	Nonwhite	White	Nonwhite
	Sickness and nonindustrial injuries		Nonindustrial injuries		Total sickness	
8 days or longer	86. 2	156. 7	8. 1	17. 3	78. 1	139. 4
15 days or longer	68. 5	121. 4	5. 6	15. 0	62. 9	106. 4
22 days or longer	45. 2	86. 2	3. 2	8. 2	42. 0	78. 0
29 days or longer	34. 3	60. 7	2. 5	5. 2	31. 8	55. 5
43 days or longer	23. 3	35. 2	1. 8	2. 2	21. 5	33. 0
57 days or longer	15. 9	29. 2	1. 1	1. 5	14. 8	27. 7
92 days or longer	10. 2	15. 7	. 3	0	9. 9	15. 7
	Respiratory diseases		Digestive diseases		Nonrespiratory-nondigestive diseases [2]	
8 days or longer	34. 3	79. 5	15. 9	26. 2	27. 9	33. 7
15 days or longer	25. 4	63. 0	13. 8	20. 2	23. 7	23. 2
22 days or longer	10. 9	45. 0	11. 3	16. 5	19. 8	16. 5
29 days or longer	7. 1	26. 2	8. 5	16. 5	16. 2	12. 8
43 days or longer	4. 6	12. 8	5. 3	11. 2	11. 6	9. 0
57 days or longer	3. 9	10. 5	2. 8	9. 0	8. 1	8. 2
92 days or longer	2. 8	6. 8	1. 4	2. 2	5. 7	6. 7
Average number of person-years of membership	2, 832	1, 334	2, 832	1, 334	2, 832	1, 334

[1] Industrial injuries and venereal diseases are not included. Data include experience of 6 plants during 1946–50, and the seventh plant during 1949–50 only. [2] Ill-defined and unknown causes are included.

attributed to difference in age since the two races have approximately the same age distribution.

Sickness According to Detailed Cause

The annual number of cases per 1,000 males, the annual number of days disabled per male, and the average number of days per disability case are shown for both white and nonwhite males under 55 years of age in table 4. Specific causes which have a frequency rate for nonwhite males more than twice that for white males include nonindustrial injuries, tuberculosis of respiratory system, influenza and grippe, pneumonia, other respiratory diseases, diarrhea and enteritis, hernia, other digestive diseases, cancer, and diseases of organs of movement except diseases of joints. Diseases which occurred more frequently among the whites than among the nonwhites include diseases of stomach except cancer, appendicitis, neuralgia, neuritis, sciatica, other diseases of

Table 4. Frequency and number of days per male and per case for sickness and nonindustrial injuries lasting 8 consecutive days or longer among males under 55 years of age, according to detailed cause group, by race [1]

Cause	Annual number of cases per 1,000 males		Annual number of days per male [2]		Average number of days per case [2]	
	White	Nonwhite	White	Nonwhite	White	Nonwhite
Sickness and nonindustrial injuries	86. 2	156. 7	3. 05	5. 29	35. 4	33. 8
Nonindustrial injuries	8. 1	17. 3	0. 23	0. 48	28. 4	27. 7
Sickness	78. 1	139. 4	2. 82	4. 81	36. 1	34. 5
Respiratory diseases	34. 3	79. 5	. 93	2. 44	27. 0	30. 8
Tuberculosis of respiratory system	. 7	5. 3	. 07	. 51	98. 0	98. 0
Influenza, grippe	9. 5	25. 5	. 21	. 57	22. 2	22. 5
Bronchitis, acute and chronic	9. 5	12. 0	. 24	. 26	25. 3	21. 6
Pneumonia, all forms	5. 7	18. 7	. 22	. 56	38. 2	29. 7
Diseases of pharynx and tonsils	3. 6	6. 0	. 08	. 12	23. 0	20. 6
Other respiratory diseases	5. 3	12. 0	. 11	. 42	20. 0	34. 8
Digestive diseases	15. 9	26. 2	. 62	1. 10	38. 9	41. 8
Diseases of stomach except cancer	4. 2	3. 7	. 15	. 24	35. 3	63. 6
Diarrhea and enteritis	1. 8	3. 7	. 04	. 07	24. 6	18. 6
Appendicitis	4. 2	3. 7	. 13	. 13	31. 1	35. 6
Hernia	3. 2	9. 8	. 18	. 50	55. 9	51. 4
Other digestive diseases	2. 5	5. 3	. 12	. 16	46. 9	29. 6
Nonrespiratory-nondigestive diseases	27. 2	33. 7	1. 25	1. 27	46. 1	37. 7
Infectious and parasitic diseases [3]	1. 8	3. 0	. 06	. 05	36. 0	17. 5
Cancer, all sites	1. 8	6. 0	. 14	. 43	80. 6	71. 6
Rheumatism, acute and chronic	2. 8	4. 5	. 14	. 17	49. 9	39. 0
Neuralgia, neuritis, sciatica	1. 1	. 8	. 06	. 01	55. 7	14. 0
Other diseases of nervous system	2. 8	. 8	. 16	. 01	55. 6	11. 0
Diseases of heart	3. 2	2. 2	. 23	. 17	74. 2	74. 7
Other diseases of circulatory system	2. 8	1. 5	. 07	. 03	23. 6	22. 5
Diseases of genitourinary system	1. 8	2. 2	. 05	. 03	26. 0	13. 0
Diseases of skin	2. 5	2. 2	. 06	. 03	24. 6	13. 0
Diseases of organs of movement except diseases of joints	1. 0	4. 5	. 02	. 08	15. 7	17. 5
All other diseases	5. 6	6. 0	. 26	. 26	47. 1	42. 8
Ill-defined and unknown causes	. 7	0	. 02	0	26. 5	----------
Average number of person-years of membership	2, 832	1, 334	2, 832	1, 334	2, 832	1, 334

[1] Industrial injuries and venereal diseases are not included. Data include experience of 6 plants during 1946–50, and the seventh plant during 1949–50.

[2] The number of days of disability is the number of calendar days from the date disability began to the date of return to work, or to the 98th day, except in the event the employee died or was pensioned before the 98th day.

[3] Exclusive of influenza and grippe, respiratory tuberculosis, and venereal diseases.

Table 5. Frequency of sickness and nonindustrial injuries lasting 8 consecutive days or longer, according to age, by race and broad cause group [1]

Age group, by years	Annual number of cases per 1,000 males								
	Total	White	Nonwhite	Total	White	Nonwhite	Total	White	Nonwhite
	Sickness and nonindustrial injuries			Nonindustrial injuries			Total sickness		
All ages	128. 3	116. 3	158. 4	10. 6	8. 5	15. 8	117. 7	107. 8	142. 6
Under 35	99. 5	78. 9	142. 9	12. 7	9. 9	18. 7	86. 8	69. 0	124. 2
35–44	89. 2	71. 9	129. 0	10. 3	6. 9	18. 1	78. 9	65. 0	110. 9
45–54	143. 6	113. 3	202. 9	9. 9	7. 5	14. 7	133. 7	105. 8	188. 2
55 and over	213. 6	219. 0	177. 4	8. 4	9. 6	0	205. 2	209. 4	177. 4
	Respiratory diseases			Digestive diseases			Nonrespiratory-nondigestive diseases [2]		
All ages	52. 5	41. 5	80. 2	20. 9	18. 8	26. 1	44. 3	47. 5	36. 3
Under 35	46. 1	31. 5	76. 6	21. 4	16. 8	31. 0	19. 3	20. 7	16. 6
35–44	40. 5	31. 5	61. 1	14. 4	12. 8	18. 1	24. 0	20. 7	31. 7
45–54	61. 9	41. 1	102. 7	22. 3	18. 7	29. 3	49. 5	46. 0	56. 2
55 and over	69. 1	66. 2	88. 7	28. 3	28. 9	24. 2	107. 8	114. 3	64. 5
	Average number of person-years of membership								
All ages	5, 121	3, 663	1, 458	5, 121	3, 663	1, 458	5, 121	3, 663	1, 458
Under 35	1, 497	1, 014	483	1, 497	1, 014	483	1, 497	1, 014	483
35–44	1, 457	1, 015	442	1, 457	1, 015	442	1, 457	1, 015	442
45–54	1, 212	803	409	1, 212	803	409	1, 212	803	409
55 and over [3]	955	831	124	955	831	124	955	831	124

[1] Industrial injuries and venereal diseases are not included. Data include experience of 6 plants during 1946–50, and the seventh plant during 1949–50.

[2] Ill-defined and unknown causes are included.

[3] Of the 831 white person-years of membership 136 or 16 percent were 65 years and over; of the 124 nonwhite person-years of membership 9 or 7 percent were 65 years and over.

nervous system, diseases of heart, other diseases of circulatory system, and diseases of skin.

With regard to race, the number of days of disability per male follows much the same pattern as the frequency rate.

Days per case averaged 35.4 for white males and 33.8 for nonwhite. With the exception of influenza and grippe, other respiratory diseases, diseases of the stomach except cancer, appendicitis, diseases of heart, and diseases of organs of movement except joints, the average days per case for the whites are equal to or greater than those for the nonwhites.

Age and Broad Cause Group

Table 5 shows the effect of age on the frequency of sickness and nonindustrial injuries. For both races the sickness rate tends to increase with advancing age. Among white males 55 years of age and over, the nonrespiratory-nondigestive disease rate is more than five times that for persons under 35 years. Among nonwhite males the older group has a frequency rate almost four times that of the younger group. Respiratory diseases are much more common among nonwhite males at each age group, but the relative excess was less among persons 55 years of age and over.

Comparative Sickness Experience

In table 6, the sickness experience during 1946–50 for white male chromate workers is compared with a large group of industrial workers (predominantly white). The annual number of cases of sickness per 1,000 males was 107.8 for chromate workers and 96.3 for other industrial workers.

In general, the rates for specific causes of

disability among chromate workers are not greatly different from those found for other industrial workers. However, it will be observed that illness from cancer appears excessive among chromate workers—7.1 compared with 0.7 for workers in other industries. Respiratory diseases are slightly more frequent among chromate workers, the major part of the excess being due to higher rates for influenza and grippe, bronchitis, acute and chronic, and pneumonia. When cancer is omitted the rate for nonrespiratory-nondigestive diseases is very similar for the two groups, except for a slightly higher heart disease rate among chromate workers.

Disability and Deaths From Cancer

Cancer disability and death data during the 11-year period 1940–50, inclusive, are based on the experience of members of two plants during 1940–50, one plant during 1943–50, three plants

Table 6. Frequency of sickness and nonindustrial injuries lasting 8 consecutive days or longer, among workers in chromate-producing plants and in various other industries, according to cause [1]

Cause	Annual number of cases per 1,000 males		Number of cases	
	Chromate	Various industries [2]	Chromate	Various industries [2]
Sickness and nonindustrial injuries	116.3	108.4	426	112,803
Nonindustrial injuries	8.5	12.1	31	12,566
Sickness	107.8	96.3	395	100,237
Respiratory diseases	41.5	34.0	152	35,406
Tuberculosis of respiratory system	*3 .8*	.6	3	644
Influenza, grippe	13.1	11.9	48	12,389
Bronchitis, acute and chronic	11.7	5.5	43	5,731
Pneumonia, all forms	6.3	4.2	23	4,407
Diseases of pharynx and tonsils	3.6	3.7	13	3,865
Other respiratory diseases	6.0	8.1	22	8,370
Digestive diseases	18.8	17.6	69	18,356
Diseases of stomach except cancer	4.9	5.5	18	5,749
Diarrhea and enteritis	1.9	2.3	7	2,347
Appendicitis	3.8	3.6	14	3,774
Hernia	4.4	2.7	16	2,842
Other digestive diseases	3.8	3.5	14	3,644
Nonrespiratory-nondigestive diseases	46.7	41.6	171	43,287
Infectious and parasitic diseases [4]	1.4	2.6	5	2,726
Cancer, all sites	7.1	.7	26	750
Rheumatism, acute and chronic	4.1	4.0	15	4,186
Neuralgia, neuritis, sciatica	1.6	2.4	6	2,490
Other diseases of nervous system	3.5	3.7	13	3,851
Diseases of heart	7.9	4.6	29	4,739
Other diseases of circulatory system	6.0	6.3	22	6,591
Nephritis, acute and chronic	*3 .6*	.4	2	405
Other diseases of genitourinary system	3.0	3.4	11	3,518
Diseases of skin	3.0	3.6	11	3,686
Diseases of organs of movement except diseases of joints	1.9	3.3	7	3,459
All other diseases	6.6	6.6	24	6,886
Ill-defined and unknown causes	*3 .8*	3.1	3	3,188
Average number of person-years of membership	3,663	1,040,707	3,663	1,040,707

[1] Industrial injuries and venereal diseases are not included. Data include experience of 6 plants during 1946–50, and the seventh plant during 1949–50.

[2] Based on data periodically received by Division of Occupational Health, Public Health Service.

[3] Rates italicized are based on less than 5 cases.

[4] Exclusive of influenza and grippe, respiratory tuberculosis, and venereal diseases.

during 1946–50, and one plant during 1949–50, which yielded a total of 7,818 person-years of membership in sick-benefit plans, of which 5,502 person-years were for white and 2,316 were for nonwhite males.

Deaths

During the 11-year period there were 44 deaths from cancer occurring within 1 year after the chromate worker had ceased employment because of disability due to cancer. An additional 4 deaths occurred among persons disabled for more than a year. For the former group, table 7 shows the length of terminal sickness according to age and race.

It would appear that half of the white and half of the nonwhite males died in less than 100 days after becoming disabled with cancer. With increasing age there was a tendency for the length of the terminal sickness to increase.

According to site (as recorded on death certificate), respiratory cancers accounted for 16 of the 22 cases lasting less than 100 days, 12 of the 17 cases lasting 100 to 199 days, and 4 of the 5 cases lasting 200 days and over. Seven persons lived from 164 to 327 days after being disabled from respiratory cancer.

No Record of Death During Period of Study

Nine cases of sickness due to cancer originated during 1940–50 for which there was no record of fatal termination in this period. One case of stomach cancer began in 1947 and lasted 39 days. In 1949 a case of lip cancer lasted 55 days. A gastrointestinal and a respiratory cancer each caused disability lasting beyond the maximum benefit period of 98 days. The worker with the gastrointestinal cancer had not returned to work by 1951, but there was no record of his death. The worker with the respiratory cancer died in 1951. There were five cases of disability due to cancer which began during 1950. One man with gastrointestinal cancer returned to work after an absence of 57 days. Another man with cancer of the lip was disabled 11 days. Two men with respiratory cancers and one man with cancer of the prostate were still sick at the end of 1950. Sickness of these men had already lasted 6, 11, and 7 months, respectively.

Table 7. Length of terminal sickness, by age and race

Number of days disabled before death	Total	Age at death in years		
		Under 50	50–59	60 and over
	White males			
Total	24	9	8	7
Less than 100	12	6	4	2
100–199	10	3	3	4
200–365	2	0	1	1
	Nonwhite males			
Total	20	10	10	0
Less than 100	10	5	5	0
100–199	7	4	3	0
200–365	3	1	2	0

Deaths From Cancer and Other Causes

Death rates from cancer and other causes, 1940–50, are based on the same plants and the same years as in the previous section, namely, 7,818 person-years of membership. For the period covered by the sickness survey age-specific death rates have been calculated. All rates are expressed as deaths per 100,000 males on an annual basis.

Death Rates by Race and Age

It will be noted from table 8 that the cancer death rate for all males (562.8) represents 39 percent of the entire rate for all causes (1,458.2). The cancer rate for white males is 32 percent and for nonwhite males is 51 percent of the corresponding total death rates. At ages 45–54 and 55–64 years the cancer death rate among nonwhite chromate workers is higher than the rate for all other causes. In the general population of the United States the death rate from cancer had not reached one-fifth of the total rate even in those age groups where cancer is most important.

A racial comparison of cancer death rates shows a rate of 133.8 for whites under 35 years of age and 1,579.0 for those 65 years of age and over, with no deaths among nonwhites

observed in these age groups. In the most important productive years, namely, 35–44 and 45–54, the cancer rate for nonwhites was more than three times the rate for whites, and at 55–64 years it is more than double.

Death Rates by Race and Detailed Cause

Table 9 gives the number of deaths and death rates per 100,000 male chromate workers by race and specific cause. Of interest is the difference in the classification of causes of death by system for the white and for the nonwhite males.

Of the 75 deaths among white males, 34 (45 percent) were due to diseases of heart, arteriosclerosis, cerebral hemorrhage, and thrombosis, and yielded a total rate of 617.9. Nineteen (25 percent) were due to diseases of the respiratory system, including cancer of respiratory system, 14; tuberculosis of respiratory system, 2; and other respiratory diseases, 3. These diseases yielded a total rate of 345.3. Diseases of the digestive system, including cancer of digestive organs and peritoneum, caused 6 deaths; cirrhosis and other diseases of liver, 3; and other digestive diseases, 2; a total of 11, or a rate of 200.0 deaths per 100,000 white males. Of the remaining 11 deaths, 1 was due to cancer of nasopharynx, 1 to cancer of genitourinary organ, 1 to leukemia, 1 to Hodgkin's disease, 1 to nephritis, 1 to alcoholic psychosis, 1 to diabetes, 3 to nonindustrial injuries, and 1 to an ill-defined cause.

Table 8. Deaths from all causes and from cancer, according to age, by race [1]

Age group, by years	Annual number of deaths per 100,000 males [2]			Number of deaths [2]			Average number of person-years of membership
	All causes	Cancer, all sites	All other causes	All causes	Cancer, all sites	All other causes	
	All males						
All ages	1,458.2	562.8	895.4	114	44	70	7,818
Under 35	402.7	89.5	313.2	9	2	7	2,235
35–44	709.2	221.6	487.6	16	5	11	2,256
45–54	1,908.2	928.3	979.9	37	18	19	1,939
55–64	3,465.8	1,352.5	2,113.3	41	16	25	1,183
65 and over	5,365.8	1,463.4	3,902.4	11	3	8	205
	White males						
All ages	1,363.1	436.2	926.9	75	24	51	5,502
Under 35	334.4	133.8	200.6	5	2	3	1,495
35–44	517.5	129.4	388.1	8	2	6	1,546
45–54	1,335.4	471.3	864.1	17	6	11	1,273
55–64	3,406.8	1,102.2	2,304.6	34	11	23	998
65 and over	5,789.5	1,579.0	4,210.5	11	3	8	190
	Nonwhite males						
All ages	1,683.9	863.5	820.4	39	20	19	2,316
Under 35	540.5	0	540.5	4	0	4	740
35–44	1,126.8	422.5	704.3	8	3	5	710
45–54	3,003.0	1,801.8	1,201.2	20	12	8	666
55–64	3,783.8	2,702.7	1,081.1	7	5	2	185
65 and over	0	0	0	0	0	0	15

[1] Industrial injuries are not included. Data include experience of 2 plants during 1940–50, 1 plant during 1943–50, 3 plants during 1946–50, and 1 plant during 1949–50.

[2] 11 members who had been disabled more than 1 year and died during 1940–50 are not included. Of these, 4 white members died of cancer; 4 white and 3 nonwhite members died of other causes.

Table 9. Deaths from cancer (by site) and from other causes, by race [1]

Cause	Annual number of deaths per 100,000 males [2]			Number of deaths [2]		
	All males	White	Nonwhite	All males	White	Nonwhite
All causes	1,458.2	1,363.1	1,683.9	114	75	39
Cancer, all sites	562.8	436.2	863.5	44	24	20
Respiratory system	409.3	254.4	777.2	32	14	18
Digestive organs and peritoneum	89.5	109.1	43.1	7	6	1
Buccal cavity and pharynx	25.6	18.2	43.2	2	1	1
Genitourinary organs	12.8	18.2	0	1	1	0
Leukemia and Hodgkin's disease	25.6	36.3	0	2	2	0
Diseases of heart and arteriosclerosis	383.7	454.3	215.9	30	25	5
Cerebral hemorrhage and thrombosis	127.9	163.6	43.2	10	9	1
Tuberculosis of respiratory system	102.3	36.3	259.1	8	2	6
Other respiratory diseases	76.8	54.6	129.5	6	3	3
Cirrhosis and other diseases of liver	38.3	54.5	0	3	3	0
Other digestive diseases	25.6	36.4	0	2	2	0
All other diseases	64.0	72.7	43.2	5	4	1
Nonindustrial injuries	76.8	54.5	129.5	6	3	3

[1] Industrial injuries are not included. Data include experience of 2 plants during 1940–50, 1 plant during 1943–50, 3 plants during 1946–50, and 1 plant during 1949–50.

[2] 11 members who had been disabled more than 1 year and died during 1940–50 are not included. Of these, 4 white members died of cancer; 2 white and 2 nonwhite members died of tuberculosis of respiratory system; 2 white members died of heart disease, and 1 nonwhite member died of pneumonia.

NOTE: Average number of person-years of membership: white, 5,502; nonwhite, 2,316.

Of the 39 deaths among the nonwhites, 27 (69 percent) were due to diseases of the respiratory system, including cancer of the respiratory system, 18; tuberculosis of the respiratory system, 6; and other respiratory diseases, 3. The total rate for diseases of the respiratory system, cancerous and noncancerous, was 1,165.8 deaths per 100,000 nonwhite males. Six deaths due to diseases of heart, arteriosclerosis, cerebral hemorrhage, and thrombosis yielded a total rate of 259.1 per 100,000 nonwhite males. Of the remaining 6 deaths, 1 was due to cancer of the digestive system, 1 to cancer of nasopharynx, 1 to meningitis, and 3 to nonindustrial injuries.

Comparative Mortality

The frequency of respiratory cancer apparently was above normal among chromate workers. Hence, an estimate of the excess in the number of deaths should be of interest. In table 10, death rates based upon the white and nonwhite male population of the United States, 1940–48, are compared with death rates for similar age groups among chromate workers.

During the 9-year period 1940–48, two plants reported during 1940–48; one plant, during 1943–48; and three plants, during 1946–48. The number of person-years of membership in sick-benefit plans for each of the five age groups is shown in table 11.

Only in the oldest age group, 65–74 years, in the population of the United States were there an appreciable number of males not in the labor force; thus, the death rates for males aged 15 to 74 are based essentially on the working population. Because of the small number of person-years of membership in sick-benefit plans among chromate workers, attention should be centered on general trends rather than on particular age-specific rates.

Deaths Among All Males

In table 10 it will be noted that among all males the ratio of actual to expected number of deaths from all causes except cancer declines steadily with advancing age until it becomes favorable for chromate workers. For cancer, all sites, the actual number of deaths was approximately four and one-half times the number that would have been expected, based upon occurrence in the total male population of the

Table 10. Death from cancer and from all causes except cancer among males in chromate-producing industries and among all United States males, according to age, by race [1]

Cause of death and age group, in years	Ratio of actual to expected number of deaths	Number of deaths		Annual number of deaths per 100,000 males	
		Actual	Expected [2]		
	Chromate			Chromate	United States [3]
	All males				
All causes, except cancer					
Total, 15–74	1. 16	51	44. 0	923. 6	797. 5
15–34	2. 63	5	1. 9	317. 6	121. 8
35–44	1. 69	10	5. 9	618. 8	366. 6
45–54	1. 17	15	12. 8	1, 063. 1	905. 5
55–64	1. 10	17	15. 4	2, 135. 7	1, 940. 7
65–74	. 75	4	5. 3	3, 200. 0	4, 238. 7
Cancer, all sites					
Total, 15–74	4. 44	32	7. 2	579. 5	130. 3
15–34	20. 00	2	. 1	127. 1	9. 1
35–44	5. 00	3	. 6	185. 6	39. 3
45–54	7. 50	15	2. 0	1, 063. 1	140. 4
55–64	3. 45	10	2. 9	1, 256. 3	363. 6
65–74	2. 22	2	. 9	1, 600. 0	757. 9
Cancer of respiratory system, except larynx					
Total, 15–74	28. 89	26	. 9	470. 8	16. 7
15–44	40. 00	4	. 1	125. 4	2. 5
45–54	30. 00	12	. 4	850. 5	25. 8
55–74	20. 00	10	. 5	1, 085. 8	57. 2
Cancer, all other sites					
Total, 15–74	. 95	6	6. 3	108. 7	113. 6
15–44	2. 00	1	. 5	31. 3	15. 7
45–54	1. 88	3	1. 6	212. 6	114. 6
55–74	. 49	2	4. 1	217. 1	448. 5
	White males				
All causes, except cancer					
Total, 15–74	1. 24	36	29. 1	941. 6	760. 6
15–34	2. 00	2	1. 0	192. 1	98. 8
35–44	1. 76	6	3. 4	550. 0	312. 0
45–54	1. 07	8	7. 5	870. 5	816. 5
55–64	1. 31	16	12. 2	2, 427. 9	1, 857. 3
65–74	. 85	4	4. 7	3, 539. 8	4, 167. 1
Cancer, all sites					
Total, 15–74	2. 94	15	5. 1	392. 4	133. 6
15–34	20. 00	2	. 1	192. 1	9. 2
35–44	2. 50	1	. 4	91. 6	38. 3
45–54	3. 08	4	1. 3	435. 3	137. 1
55–64	2. 50	6	2. 4	910. 5	365. 7
65–74	2. 22	2	. 9	1, 769. 9	774. 8

See footnotes at end of table.

Continued ▶

Table 10. Deaths from cancer and from all causes except cancer among males in chromate-producing industries and among all United States males, according to age, by race [1]—Continued

Cause of death and age group, in years	Ratio of actual to expected number of deaths	Number of deaths		Annual number of deaths per 100,000 males	
		Actual	Expected [2]		
	Chromate			Chromate	United States [3]
	White males				
Cancer of respiratory system, except larynx					
Total, 15–74	14. 29	10	. 7	261. 6	17. 4
Cancer, all other sites					
Total, 15–74	1. 14	5	4. 4	130. 8	116. 2
	Nonwhite males				
All causes, except cancer					
Total, 15–74	. 77	15	19. 5	882. 9	1, 149. 7
15–34	1. 76	3	1. 7	562. 9	316. 2
35–44	. 87	4	4. 6	761. 9	869. 7
45–54	. 77	7	9. 1	1, 422. 7	1, 845. 6
55–64	. 24	1	4. 1	929. 9	2, 974. 0
65–74	----------	0	. 6	0	5, 206. 5
Cancer, all sites					
Total, 15–74	10. 00	17	1. 7	1, 000. 6	98. 5
15–34	----------	0	----------	0	8. 6
35–44	6. 67	2	. 3	381. 0	49. 3
45–54	12. 22	11	. 9	2, 235. 8	174. 4
55–64	8. 00	4	. 5	2, 919. 7	336. 6
65–74	----------	0	. 1	0	529. 5
Cancer of respiratory system, except larynx					
Total, 15–74	80. 00	16	. 2	941. 7	10. 0
Cancer, all other sites					
Total, 15–74	. 67	1	1. 5	58. 9	88. 5

[1] Violent and accidental deaths are not included. Data for chromate workers include experiences of 2 plants during 1940-48, 1 plant during 1943-48, 3 plants during 1946-48.

[2] The average death rate for the United States for the 9 years, 1940-48, multiplied by the appropriate person-years of membership in the chromate plants.

[3] Data are from references *2*, *3*, and *4*.

United States. When cancer of the respiratory system was observed separately, the excess for chromate workers was greatly increased. Nearly 29 times as many deaths due to respiratory cancer were found as would have been expected. For three ascending age groups, respiratory cancer was 40, 30, and 20 times as common among male chromate workers as among other males. All other types of cancer failed to show an excess among chromate workers.

Deaths Among Males, By Race

A comparison of respiratory cancer deaths, by race, shows that the ratio of actual to expected number was 14.29 for whites and 80.00 for nonwhites. On the other hand, the ratio of actual to expected deaths from cancer of all

Table 11. Person-years of membership in sick-benefit plans, by age and race

Race	Age, in years					
	Total 15–74	15–34	35–44	45–54	55–64	65–74
All males	5, 522	1, 574	1, 616	1, 411	796	125
White	3, 823	1, 041	1, 091	919	659	113
Nonwhite	1, 699	533	525	492	137	12

other sites was about what would be expected for whites (1.14), but was less than expected for nonwhite chromate workers (0.67).

For all causes of death except cancer the death rate for whites (941.6) was somewhat over, and the death rate for nonwhites (882.9) was somewhat under, that found in the general population (760.6 and 1,149.7, respectively). With advancing age, chromate workers of both races showed a decreasing trend in the ratio of actual to expected deaths from causes other than cancer.

The number of recorded deaths from respiratory cancer among the chromate workers is minimal for the following reasons:

1. Deaths of employees who were not members of a sick-benefit association are not included.
2. Persons who worked in chromates but left the industry prior to their terminal illness are not included.
3. Members who died over a year after onset of disability due to cancer are not included.
4. Several members who had a clinical course consistent with the presence of cancer of the respiratory tract are not included because cancer was not recorded on their death certificates.
5. Some members whose deaths were not recorded as cancer died without a complete medical examination or biopsy.

Summary

The morbidity and mortality experience of male members of sick-benefit associations in seven chromate-producing plants are described. Sickness among a group of white male chromate workers was compared with that of a large group of industrial workers. It was observed that the annual number of cases of sickness and nonindustrial injuries per 1,000 white males was 116.3 for chromate workers and 108.4 for other industrial workers.

For all specific causes except cancer the chromate workers had frequency rates that were not greatly different from other workers. Cancer, with a rate of 7.1 for chromate workers compared with 0.7 for workers in other industries, stands out as markedly in excess for chromate workers.

The frequency of sickness among chromate workers has shown a trend downward during the past 5 years. The most marked decline has occurred among respiratory diseases.

Nonwhite chromate workers under 55 years of age had a higher rate for sickness and nonindustrial injuries than had the white workers. For cases lasting 8 days or longer the former had a frequency rate of 156.7 per 1,000 compared with 86.2 for the latter.

During the 9-year period 1940–48, the average annual death rate per 100,000 males aged 15 to 74 years for all causes was 1,503.1 for chromate workers and 927.8 for the corresponding male population of the United States; for all causes except cancer the death rates were 923.6 and 797.5, respectively.

For cancer, all sites, the actual number of deaths of chromate workers was approximately four and one-half times the number that would have been expected had the cancer rates for all males in the United States prevailed. When cancer of the respiratory system was observed separately for chromate workers, nearly 29 times as many deaths as were expected were found. Deaths from all other types of cancer failed to show an excess among chromate workers. A racial comparison of respiratory cancer deaths showed that the ratio of actual to expected number of deaths was 14 for whites and 80 for nonwhites; for cancer, all other sites, the two ratios were markedly lower.

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Body's Ability to Handle Fats

The identification and partial purification of two plasma components and one tissue component, which act in conjunction with heparin to clear lipoproteins produced in blood by heavy fat diets, has been accomplished by scientists at the National Heart Institute, National Institutes of Health, Public Health Service. Physical studies of plasma, employing a fast-spinning ultracentrifuge, indicate that clusters of low-density lipoprotein molecules are broken down into smaller components as a result of chemical reaction in the blood serum when suitable amounts of those components are added.

Important in the study of the causes and treatment of hardening of the arteries, these findings, which stem from research on the role of heparin in the body's ability to handle fat, are preliminary. Additional studies are needed before the data can be fully interpreted.

Accumulated evidence, substantiated by this study, strongly indicates that enzyme and hormonal factors play an important part in the clearance of lipoproteins in the blood, and suggests, therefore, that diet may not be the only factor—and possibly not even an important factor—in the body's ability to handle fats.

The scientists point out that although the means are available, the manufacture of a clearing factor in the body may only occur in response to the need at the time. The defect in metabolism may, therefore, lie in the inability of the mechanism to spring into action. This may be due to lack of one or more of the necessary factors involved in the clearing reaction.

A complete report of the research study was published in *Science*, May 30, 1952.