

Heart disease mortality among black migrants: A study of Ohio residents (1960-1967)

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"Why should the American Negroes from different geographic divisions experience large differences in mortality for hypertensive disease? Is the difference primarily a resultant of biologic differences between the two groups of United States Negroes, in north and south, possibly caused by differential migration or, alternatively, is it a resultant of differences in their socioeconomic and sociocultural environment? Is the hypothesis of differential migration that hypertension-prone Negroes have remained in the South, whereas hypertension-resistant Negroes have moved to the North, valid?"¹ Is industrial employment a selective factor in cardiovascular mortality among the migrants?

Considerable emphasis has been given to the desirability of studying these geographic differences, particularly for the Negro, as a means of developing some further insight in the etiologic factors associated with specific forms of cardiovascular disease.¹

These questions posed for coronary heart disease and cerebrovascular diseases as well, are the basis for the present exploratory study. Although extensive mortality data have accumulated relative to cardiovascular disease since Enterline and Sauer²⁻⁴ identified and studied the magnitude and accuracy of geographic variation, there have been comparatively few studies on migration within the United States.

Sauer^{5, 6} conducted a series of studies on heart disease to ascertain whether the wide differences

in death rates observed geographically could be due to migration patterns. The studies, national in scope, were confined to whites. It was shown that people born in states with high rates for coronary heart disease, continued to have high rates regardless of where they were living at the time of death. Similarly, people born in states with low rates continued to have low rates after migration, although slightly higher than in states of origin. Further, it was observed that "out migrants" from the East South Central States, to the Middle Atlantic States, had higher cardiovascular disease death rates than "non-migrants" from these states. These observations indicate the possible influence of the early years of life on the subsequent development of coronary heart disease.

Our interest in migration stems from observations derived from our previous studies in which migrants, particularly the nonwhite born in the South, demonstrated an increase in risk in mortality for certain cancer sites.^{7, 8} It was also shown, in an analysis of steelworker, coke oven employees where a high risk for lung cancer has been recognized, that the excess of lung cancer was principally contributed by the black migrants from the South.⁹ Our present study constitutes an application of the same approach to cardiovascular diseases.

Our hypothesis relates to the "social and biological imprints" in the early years of life that combine with migration and subsequent environmental influences to bring about physiologic imbalances which supply the medium for the development of specific disease, disability, and mortality risks.^{7, 9}

Epstein¹⁰ and others have emphasized the importance of studying the influences of early life on the later development of chronic disease. The

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reports of coronary disease in soldiers and young persons has focused on the occurrence of such changes among the young.^{11, 12}

The recent experimental observation by Burch, Tsuie, and Harb¹³ that the virus, Coxsackie B4, can damage cells in the coronary arteries, and the development of the concept that exposure to viral infections in childhood can result years later in arteriosclerotic changes, has provided additional emphasis to the importance of the early years of life. This previously unrecognized possible relationship of viruses in the causation of heart disease provides an indication that similarly there may exist a large number of etiologic factors for each category of heart disease whose interrelationships have yet to be identified.

Lloyd and Ciocco¹⁴ observed in the steelworker prospective study that while the pattern of white/nonwhite mortality ratios by age and cause of death were similar for steelworkers and the general populations, the nonwhite deficit for arteriosclerotic heart disease (ASHD) was more marked for steelworkers. Emphasis was directed at the importance of selective factors of employment, the medical requirements of becoming employed and remaining employed, and the physical capability of continued effort as the basis of better mortality experience of the employed population, in contrast to the general population. This observation of markedly lower age-specific death rates for the employed population, compared with the general population, was previously demonstrated in an actuarial analysis by Myers.¹⁵

For approximately four decades there has been a continuous movement of the blacks from the rural south to the industrial centers of the north, with subsequent exposure to the industrial environment and urbanization. Actually, 1.6 million blacks, nearly one-sixth of the total southern black population, migrated north and west in search of job opportunities.¹⁶ This constitutes a substantial population to explore various hypotheses.

Our approach represents an initial step in this direction, for cardiovascular disease; the internal comparison of the mortality rates of Ohio black residents, for those born in Ohio and those born elsewhere, and the internal comparisons of a cohort of black steelworkers, residents and migrants, in the exploration of factors of selection in industrial employment.

Methodology

The methodology and analysis are the same as in the previous migrant and steelworker studies.^{7, 9, 14, 17-21}

The population examined in detail consists of Ohio residents born in Ohio and in Census designated regions of the United States: Northeast, North Central, West, South, and outlying areas. The figures for the State of Ohio are considered alone. All deaths of Ohio residents who died in the United States and Canada (1960-1967) were included. The causes of death used in this paper are the underlying causes as reported on death certificates and classified by the seventh revision of the International Statistical Classification of Diseases, Injuries, and Causes of Death.

Regional population data by specific characteristics used as a basis for computing death rates are from the 1960 United States Census. Ninety-eight per cent of the Ohio nonwhite (ages 25 through 64) in the 1960 census population, were Negroes. The place of birth for the deceased was taken from information provided for the death certificate by relatives or other persons completing the certificate. The regions of the United States used for the classification of place of birth were based on census groupings of the states. Data on dates of migration were not available.

Age groupings were based on the age of the person on the last birthday. Average annual age-specific death rates by color, sex, and nativity were computed on the basis of population data in the 1960 United States Census. The population for the inter-census years was estimated using a linear interpolation. Death rates, for the age span 45 through 64 years, were age-adjusted in 10-year groups by the direct method using as a basis the age distribution of the total population of the continental United States in 1960. The age group of 45 through 64 years was selected to provide a basis for comparison with earlier studies.^{2-4, 6}

The steelworkers data are from a cohort study of approximately 59,000 steelworkers employed in 1953 at seven steel plants in Allegheny County, Pa. Information obtained from plant personnel records included a complete work history from time of initial employment with the firm through 1966, birthdate, birthplace, race, as well as identifying information needed for follow-up. Only 54 individuals (less than 0.1 per cent) were lost to follow-up from 1953-1966. Copies of death certificates were obtained from appropriate state offices

Table I. Number of deaths and average annual death rates per 100,000 population for selected causes, Ohio black males, ages 45-64, age-adjusted to 1960 United States population

Place of birth*	All causes (001-999)	Coronary heart disease (420)	Endocarditis and myocardial degeneration (421-422)	Hypertensive cardiovascular diseases (440-447)	Cerebrovascular diseases (330-334)	Cardiovascular diseases (400-468)	Total diseases cardiovascular system (330-334) (400-468)
<i>Ohio:</i>							
Rates	1,352.1	381.2	16.8	118.8	127.0	596.0	723.0
Numbers	1,445	403	18	129	134	635	769
<i>Northeast:</i>							
Rates	2,319.5	698.1	18.9	144.2	169.2	974.0	1,143.2
Numbers	202	61	2	13	15	86	101
<i>North Central:†</i>							
Rates	1,490.3	427.8	22.6	129.1	134.3	660.6	794.9
Numbers	1,787	508	27	158	159	791	950
<i>South:</i>							
Rates	2,560.2	595.2	38.4	235.4	247.1	991.0	1,238.1
Numbers	10,136	2,356	152	932	978	3,923	4,901
<i>Total United States:</i>							
Rates	2,115.0	512.4	32.4	191.9	202.6	838.9	1,041.5
Numbers	12,353	2,956	187	1,111	1,169	4,845	6,014

*West not included—numbers too small.

†Includes Ohio.

of vital statistics, and the underlying cause of death was coded by a trained nosologist according to the Seventh Revision of the International List.

These analyses have focused upon the cumulative mortality, 1953-1966, from cardiovascular diseases observed among black steelworkers who were born outside of Pennsylvania, in comparison with those born in Pennsylvania. Unfortunately, the state of birth was not coded for the non-Pennsylvania births; hence, it was not possible to examine the mortality for those born in specific sections of the country. Review of original records, however, indicates that roughly 90 to 95 per cent of the individuals migrated to Pennsylvania from the Southeastern states.

Seventy-six per cent of the 7,277 black steelworkers in the study were born outside Pennsylvania. Most of these men came from the Southeast, many migrating to this area during and subsequent to the Second World War.

The relative risks are based on use of Pennsylvania-born black steelworker rates as a comparison. They have been adjusted for age in 1953 and calendar years of follow-up.

An expected number of deaths was calculated for each age and calendar year subgroup with the underlying assumption that the non-Pennsylvania birth group and the comparison group have

the same specific rate. The total expected number of deaths is the sum of the specific rates for each subgroup, multiplied by the number of non-Pennsylvania-born workers at risk in the subgroup. The relative risk is a weighted average of the observed and expected number of deaths in each subgroup, where the weights used are approximately proportional to the precision within each subgroup. Because the relative risk is a weighted average, it cannot be obtained directly by dividing the total observed deaths by the total expected deaths.

A chi-square test was used to test for significance of differences in risk between the non-Pennsylvania-born and the Pennsylvania comparison group of black steelworkers.²² In order to evaluate the findings further, results are also presented for certain selected work areas which had a sufficient number of black workers. Work area classification is based on jobs held by the men in 1953.

Findings

Ohio residents—migrant/nonmigrant.

All causes (001-999). As shown in Table I, the age-adjusted rate for United States-born black males (ages 45 through 64) was 2,115.0 and, when considered by region of birth, showed a lower rate for those born in Ohio (1,352.1), and much higher

Table II. Number of deaths and average annual death rates per 100,000 population for selected causes, Ohio black females, ages 45-64, age-adjusted to 1960 United States population

Place of birth*	All causes (001-999)	Coronary heart disease (420)	Endocarditis and myocardial degeneration (421-422)	Hypertensive cardiovascular diseases (440-447)	Cerebrovascular diseases (330-334)	Cardiovascular diseases (400-468)	Total diseases cardiovascular system (330-334) (400-468)
<i>Ohio:</i>							
Rates	891.8	214.6	16.4	107.4	111.7	385.1	496.8
Numbers	1,092	257	19	131	136	464	600
<i>Northeast</i>							
Rates	1,499.4	398.1	8.3	178.0	178.0	704.1	882.1
Numbers	151	39	1	18	18	70	88
<i>North Central:†</i>							
Rates	1,000.9	242.7	17.7	119.5	118.5	435.7	554.2
Numbers	1,358	323	23	161	160	582	742
<i>South:</i>							
Rates	1,854.5	377.1	30.1	233.2	237.4	743.3	980.7
Numbers	7,541	1,529	122	948	964	3,018	3,982
<i>Total United States:</i>							
Rates	1,505.5	317.0	24.7	188.0	191.5	613.8	805.3
Numbers	9,127	1,897	147	1,132	1,150	3,684	4,834

*West not included—numbers too small.

†Includes Ohio.

rates for those born in the Northeast (2,319.5), with the highest rates for those born in the South (2,560.2).

The pattern of the overall rates, for all causes, shows substantial differences by region of birth. It is evident that the findings by specific heart disease categories are not related to any selective diagnostic standards of heart disease and, therefore, provide support to the consistency of the observed differences found in heart disease mortality among black males and females.

Coronary heart disease (420). Table I shows that the United States-born Ohio black males had an age-adjusted rate (45 through 64) of 512.4 and, when divided by region of birth, showed lower rates for those born in Ohio (381.2) and higher rates for those born in the South (595.2).

Black females experienced similar relative changes in age-adjusted rates (45 through 64) when the total United States-born residents were divided by region of birth. Those born in Ohio had the lowest age-adjusted rate (214.6) and those born in the South, the highest rate (377.1) compared with 317.0 for total United States rates.

For both the males and females, the excess rate for residents born in the South compared with those born in Ohio, was consistently higher for each age group from age 35 on.

In the sex comparisons (Tables I and II), the black males show a marked and consistent excess in mortality rates over the black females for each age-specific group in all comparisons by total native-born and by region of birth. In the comparison by birth in Ohio, the male rate was three times that of the female in ages 35 through 44, and approximately one and a half to two times in the remaining age groups.

Endocarditis and myocardial degeneration (421-422). In the region of birth comparison (Table I) the age-adjusted rate for the black males born in the South showed 100 per cent excess compared with those born in Ohio (38.4 vs. 16.8). This trend was consistent with the excess for coronary heart disease among black males in a similar comparison.

Among the total black United States-born females (Table II), who had an age-adjusted rate of 24.7, those born in the South had a higher rate (30.1) than those born in Ohio (16.4) which was similar to the pattern of excess for coronary heart disease. (Numbers in the Northeast place of birth were too few for analysis among blacks).

Hypertensive cardiovascular diseases (400-447). The division by region of birth of the United States-born black males who had an overall age adjusted rate at 191.9 shows that there was a markedly higher age adjusted rate for those born

Table III. Comparison of cardiovascular mortality by selected work areas and birthplace for black steelworkers; observed and expected deaths, 1953-1966, and relative risks* for heart disease

	<i>Arterio- sclerotic heart disease (420)</i>	<i>Hyperten- sive heart disease (440-447)</i>	<i>Vascular lesions of the central nervous system (330-334)</i>	<i>Cardiovascu- lar diseases (400-468)</i>
<i>All work areas:</i>				
<i>Number non-Pennsylvania-born</i>	5,558			
Observed deaths	245	62	116	377
Expected deaths	243.0	62.8	109.8	377.1
Relative risk†	1.01	0.98	1.07	1.00
<i>Selected work areas:</i>				
<i>Coke plant:</i>				
<i>Number non-Pennsylvania-born</i>	721			
Observed deaths	31	5	15	43
Expected deaths	28.6	5.5	14.0	42.5
Relative risk†	1.20	0.82	1.17	1.03
<i>Blast furnace:</i>				
<i>Number non-Pennsylvania-born</i>	823			
Observed deaths	24	4	10	40
Expected deaths	23.3	4.6	10.1	40.2
Relative risk†	1.04	0.85	0.98	1.00
<i>Open hearth:</i>				
<i>Number non-Pennsylvania-born</i>	1,404			
Observed deaths	59	11	28	87
Expected deaths	58.1	10.1	25.8	85.0
Relative risk†	1.02	1.13	1.12	1.03
<i>Foundry:</i>				
<i>Number non-Pennsylvania-born</i>	196			
Observed deaths	10	0	4	12
Expected deaths	11.3	—	3.8	13.4
Relative risk†	0.72	—	1.09	0.75
<i>Billet, bloom, and slab mills:</i>				
<i>Number non-Pennsylvania-born</i>	179			
Observed deaths	8	3	7	13
Expected deaths	7.9	2.8	6.6	12.5
Relative risk†	1.02	1.12	1.10	1.06
<i>Merchant mills:</i>				
<i>Number non-Pennsylvania-born</i>	286			
Observed deaths	18	4	5	26
Expected deaths	16.9	4.3	5.1	25.9
Relative risk†	1.10	0.90	0.99	1.01

*Pennsylvania-born steelworkers used as comparison group.

†Significance of relative risk based on summary chi-square with one degree of freedom.

in the South (235.4) compared with those born in Ohio (118.8) (Table I).

For the black females there was a decrease in rate to 107.4 for those born in Ohio compared with an increase of 100 per cent among those born in the South (233.2). The principal contribution to the overall *resident* Ohio rate for both the males and females was from those born in the South.

In the sex comparison (Tables I and II) the black males and females had approximately the same age-adjusted rates by region of birth, with a

slight increase for males born in Ohio (age-adjusted rate 118.8 vs. 107.4).

Cerebrovascular diseases (300-334). For the black males and females (Tables I and II) the same pattern as was observed with hypertensive cardiovascular diseases occurred; there was a marked difference in the total native-born rate when divided by region of birth with the Ohio-born rate less, and a comparative 100 per cent increase in the rate for those born in the South.

Cardiovascular diseases (400-468). For the black males and females, as evident in Tables I

and II, the combined category emphasizes the differences observed. There were marked differences in rates, notably a decrease in the age-adjusted rates for those born in Ohio and, in contrast, an exceptional excess for those born in the South compared with those born in Ohio. Although the numbers are small, the rates for those born in the Northeast were also markedly elevated.

Total diseases cardiovascular system (300-334) (400-468). Among the black males and females (Tables I and II), the addition of the cerebrovascular diseases emphasizes still further the relative differences by region of birth. The substantial excess of the age-adjusted rate for those born in the Northeast, and still higher rate for those born in the South, compared with those born in Ohio, stands out.

Steelworker migrant and nonmigrant. Table III indicates that the black steelworkers who migrated experienced the same mortality overall from heart disease as did the Pennsylvania-born steelworkers. The observed and expected mortality for arteriosclerotic heart disease, hypertensive heart disease, and vascular lesions of the central nervous system for the selected work areas is also consistent with similar levels of risk in the industry regardless of birthplace.

Although the relative risks of death from these causes differ somewhat among the work areas, all differences are small enough to be attributable to random fluctuation.

Discussion

Our study has taken the established geographic pattern of marked variation in resident mortality due to cardiovascular disease one step further, and defined for one state, by separation, black Ohio-born and migrant populations and, grossly, their degree of risk. Further, similar analyses of a large cohort of steelworkers contribute some interesting insights on the factors of selection in industrial employment.

Ohio residents. In the evaluation of the findings we have been concerned with the extent that observed differences may be due to errors of the 1960 census. In Siegel's²³ recent comprehensive analysis, preferred estimates were developed relative to both the 1960 and 1970 census (Table 5, Set D). The net per cent undercount for males for Negro and other races for ages 35 through 39 and each succeeding five-year age group, was: 12.1, 11.0, 10.2, 11.9, 3.4, 14.6, and overcount 0.2 in ages

65 through 69. For the nonwhite females for comparable ages, the per cent of net undercount was: 3.6, 4.4, 6.9, 12.3, 6.8, 18.3, and 5.3.

It is apparent that the consistent marked excesses of 60 to 100 per cent that we have observed in death rates of selected categories of cardiovascular disease for the black Ohio residents born in the South versus those born in Ohio, could not be attributed to net undercount of the census in 1960.

The relative pattern in our study of age-specific death rates for males and females for the State is remarkably similar to that reported for the total United States.¹ We have also considered the question of cause of death coding on death certificates. All causes of death were coded by the same nosologist in the same state for that period of years and it is extremely unlikely that the attending physicians throughout the state would be making their designation of the cause of death selectively by place of birth of the patient. We have also considered age distribution and the age-specific rates for ages 45 to 54 and 55 to 64 for black males and females, which show the same patterns of differences.

The fact that both the Ohio resident black males and females share this excess risk of a markedly elevated death rate for those born in the South compared with those born in Ohio for each of the major categories of cardiovascular disease, indicates that at least some common factors are affecting both sexes to a certain level, and some additional factors are affecting the males to account for the much higher rate over that of the females.

The impression is that of a carry-over among the blacks of a higher cardiovascular risk from the South among the migrants to Ohio. Some support to this concept is indicated when the Ohio black male residents born in the South are further divided by region of the South. The age-adjusted rates (45 to 64) for black males born in the South Atlantic division were notably higher than the rates for those born in the South; 612.5 for coronary; 260.1 for hypertensive, and 265.5 for cerebrovascular heart diseases. The South Atlantic division with the highest rate for the specific category of heart disease in our study, coincides geographically with very high rates in the United States data.¹

In a prior United States study, it was found that "for residents of the Middle Atlantic and East North Central divisions, the nonwhite

reported as 'life-time migrants'* had nearly twice the rates for hypertensive heart disease than those reported born in these divisions. The rates for the nonwhite 'life-time migrants' were intermediate between the high rates observed for residents of the South and low rates for those born in the northern divisions."¹

On the basis of our findings it may be postulated that, in general, the blacks who migrated to Ohio were more susceptible to hypertensive heart diseases. Further, the susceptibility may be a reflection of a complex of endemic factors sustained in the early years of life. Generally, in the South, most markedly among the black, the succeeding generations have been exposed to a socioeconomic climate of deprivation which has developed among some portion of the population, social and biologic imprints which constitute the physiologic imbalance, the acquired milieu for subsequent risk to environmental stresses and the development of specific diseases. Conversely, following migration for some population subgroups, an improvement in the standard of living as well as medical care, may result in a reduction of certain diseases.

The Ohio-born black residents with the markedly lower rate for each of the categories of cardiovascular diseases, in particular hypertensive heart disease, would constitute first and second generations of the migrants from the South. It could be postulated that adaptation by these population groups, over time, to whatever endemic, socio-environmental, and medical factors were involved in Ohio, provided a basis for the marked decline in rate. The basic observation of change in mortality experience among migrants and descendants has been well established in inter-country studies.

The migrants from the South, although sustaining an overall increased mortality risk for cardiovascular disease, nevertheless, most likely consist of population subgroups with a wide range of biologic attributes and capacities. In turn, each of such population subgroups may be subjected, after migration, to the same and different complexing factors which may adversely affect or improve their health risk to specific causes of death.

Steelworker population. The observation de-

Native-born residing in states other than state of birth at the time of census enumeration and a native-born decedent whose residence at the same time of death is not his state of birth.¹ (page 168).

rived in this study of an equal risk in the coronary heart disease among black migrant steelworkers, in comparison with Pennsylvania-born steelworkers, was unexpected and poses a number of questions. In contrast, as previously mentioned, we had observed for another cause of death, lung cancer among coke oven workers, that the excess of risk occurred primarily among the migrants from the South (33 of the 35 lung cancer cases were from the South).

In the evaluation of the findings on cardiovascular disease, one should consider that all specific work areas presented here involve basic production and thus selective factors were in operation: all workers would have to be physically fit at time of employment in order to meet the job requirements. This pre-employment medical selection would tend to select out any individuals with obvious predisposing risk factors for cardiovascular disease. The selective factors would further retain those workers with the capacity to consistently perform strenuous physical work. Further, assuming that hypertensive heart disease would have a latent period if endemic factors were involved in the early years of life then, somehow, in the group employed either these factors were not present or, if present, they were mitigated by the combination of the selective employment, the nutritional requirements of heavy industry, and the improved standard of living.

We have no way of determining just what combination of circumstances was in operation that leads to an equal mortality risk for coronary and hypertensive heart disease among black migrant and nonmigrant steelworkers, other than the selective factors mentioned. We recognize, however, that a further comparative refinement of these employed populations in selected work areas, by duration of employment, would be appropriate. Environmental and health data during intervening years since migration are also highly desirable but are not available.

Our findings should provide the basis for more questions and perhaps a redirection of some epidemiologic approaches in the eventual analysis of the combination of the early events of life and the subsequent events of migration.

Migrant methodology. In consideration of mortality experience of black vs. white populations by region of birth, Table IV for coronary heart disease, age-adjusted rate (45 to 64), is included for comparison.

Table IV. Coronary heart disease (420)

Place of birth	White males	White females
Ohio	600.6	153.8
Northeast	668.8	187.3
South	630.1	177.9
West	509.3	128.0

Basically, for coronary heart disease (420) the white males and females show the highest rates for those born in the Northeast and the lowest rates for those born in the West. Among the males, the white have a much higher rate than the black for each region of birth, except for the Northeast. Among the females, the black have a much higher rate than the white, 214.6 vs. 153.8 for those born in Ohio and 377.1 vs. 177.9 for those born in the South.

In terms of methodology, our basic migration resource which is available in each of the states has been proved effective as a means of further refining the characteristics of study populations in the analysis of mortality risks for cardiovascular disease.

The application of this approach to industrial prospective studies has further enabled a more accurate assessment of selective factors which influence mortality due to cardiovascular disease.

It is hoped that other investigators conducting similar studies will be able, in progressive steps, to develop appropriate linkage data on migrants relative to endemic factors in the early years of life, the patterns of migration, and the subsequent sequence of social, environmental, and industrial influences.

Summary and conclusions

In a demographic study, the black Ohio residents were characterized by those born in Ohio and those born in other regions of the United States, and comparisons were made of rates for all deaths (1960-1967) for coronary heart disease (420), endocarditis and myocardial degeneration (421-422), hypertensive cardiovascular diseases (440-447), cerebrovascular diseases (300-334), cardiovascular diseases (400-468), and total diseases of the cardiovascular system (300-334) (400-468).

The division of the total United States-born Ohio residents by region of birth provided marked differences in the age-adjusted rates in the relative comparisons.

The black males and females born in the South had a markedly higher age-adjusted death rate (ages 45 to 64) than those born in Ohio in each of the categories of cardiovascular diseases studied.

For coronary heart disease, the age-adjusted death rate for the black males showed a marked excess over the black females, for each region of birth, whereas for hypertensive cardiovascular diseases the black males and females had similar age-adjusted rates for each region of birth.

The findings indicate a carry-over among the black of a higher cardiovascular risk among those born in the South and lend support to the concept of the influence of the endemic factors in the early years of life.

In the prospective study of black steelworkers, it was observed that migrant and nonmigrant workers had approximately the same mortality for cardiovascular disease overall, and when specific work areas were considered. Selective factors of employment, of medical screening, and capability of continued employment in strenuous environments, were considered the most likely basis for the similar mortality experience.

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