Long-Term Mortality Study of Steelworkers

II. Mortality by Level of Income in Whites and Non-Whites

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Collection of data pertaining to this paper and their first analyses were carried out in the Department of Biostatistics, Graduate School of Public Health, University of Pittsburgh, in partial fulfillment of the requirements for a doctoral degree, with support from USPHS Training Grant No. 5 T01 GM00039. Analysis was completed at the present address with support from USPHS Grant No. 4 R01 AM-12049.

This paper describes an index of income based on a steelworker's job classification scheme, and estimates the mortality of white and non-white steelworkers in terms of this index. The data were obtained as part of a collaborative study carried out by the Department of Biostatistics, Graduate School of Public Health, University of Pittsburgh, and the National Cancer Institute, in cooperation with the American Iron and Steel Institute. The details of the population studied and the data collection were discussed by Lloyd and Ciocco.[1]

Social Factors vs Disease and Mortality

It has long been recognized that there is a strong association between poverty and disease, and many studies have been made in an attempt to identify the aspects of poverty that contribute to this association. In a comprehensive review of the literature, Ciocco and Perrott concluded that, when legislation and other community actions have been developed to mitigate the effects of unemployment, low wages and other factors bearing directly on economic status, disease and its effects are becoming numerically more important as causes of poverty.[2] The two major variables in mortality are considered to be the pre-disease, economic status of the individual and family, and the nature of the disease itself.

In Great Britain, since 1911, the Registrar General has published census information on mortality according to social class. Five social classes are used; these are obtained by grouping together occupations which are considered to be of the same kind. The 1931 supplement of the Registrar General's Reports for England and Wales listed, for the first time, the mortality statistics of married women, who were analyzed and grouped in the same social class as their husbands.[3] The rationale for this is that the mortality of males is influenced more by the conditions of life inherent in various occupations than by the specific occupational risks. In other words, if the wife suffers as much excess risk as the husband, the husband's occupation cannot be regarded as directly prejudicial to health. The British reports show that, in general, for both husbands and wives, the lower social classes exhibit excess mortality compared to the upper classes.

Job Classification

The index employed is the job score derived from the job classification of workers, which was introduced in 1947, following joint negotiations between the steel producing subsidiaries of the United States Steel Corporation and the United Steelworkers of America (CIO). Under the job classification scheme (as described by J. Steiber[4]), each job is assigned a *total score,* with a corresponding hourly wage. Twelve elements make up the total score for each job, and these elements are grouped into four broad headings (Table I). Since the total job

TABLE I

THE TWELVE ELEMENTS OF TOTAL SCORE AND THE MAXIMUM WEIGHTS OF THESE ELEMENTS IN THEIR CONTRIBUTION TO TOTAL SCORE

Element	Max. Wt. Element
Skill:	
Pre-employment training	1.0
Employment training and experience	4.0
Mental Skill	3.5
Manual Skill	2.0
Responsibility for:	
Materials	10.0
Tools and equipment	4.0
Operations	6.5
Safety of others	2.0
Effort:	
Mental	2.5
Physical	2.5
Working Conditions:	
Surroundings	3.0
Hazard	2.0

TABLE II

FREQUENCIES OF WORKERS IN JOBS WITH SCORES, JOBS WITHOUT SCORES, AND OUT OF THEIR PLANT OF EMPLOYMENT IN JANUARY 1953

Status	No. Workers
Jobs With Scores	51,865
Jobs Without Scores	5,430
Out of the Plant	1,487
Total	58,782

score is the basis for salary classes, it is also a measure of worker income. Moreover, since the score is heavily weighted by the skill and responsibility elements of the job, it reflects the educational and work experience of the workers.

In this study, the total job score is used to investigate the relationship between income level and mortality in a cohort of steelworkers, followed from the beginning of 1953 to the end of 1961. A feature of the job classification scheme which is most desirable for long-term studies of mortality is that it maintains a relative stability in spite of external economic forces. For example, a study of absolute income level or income changes could be confounded by factors stemming from changes in the over-all national economy. Inflation could result in workers receiving an "across the board" increase in pay. The job classification scheme does not reflect these changes since the total job scores maintain the relative positions occupied by workers in the industry wage structure. This is an essential feature of the scheme for a study such as this, which is designed to identify the relationships between mortality and job characteristics resulting from the deficiencies or endeavors of individual workers.

Status of Workers at the Beginning of 1953

At any time from the beginning of 1953 to the end of 1961, the status of a worker could be any one of the following:

(a) In a steel plant, in a job with a score.
(b) In a steel plant, in a job without a score. Some workers have jobs without scores because they are salaried; in other cases, the job descriptions were inadequate for the assignment of job scores.
(c) No longer at the steel plant in which he was employed at the beginning of this study. Some of the workers subsequently returned to their plant of employment.
(d) Retired.
(e) Dead.

The frequency of workers in jobs *with scores,* in jobs *without scores,* or out of their plant of employment, in January 1953, is shown in Table II. Workers listed as out of the plant had employment history in their steel plant at some time in 1953. This presentation will consider only workers in jobs *with scores* at the beginning of 1953. A future paper will study the mortality characteristics of workers in the other categories.

A frequency distribution of total scores was made for all workers who were in jobs with scores at the beginning of 1953. This distribution was not a recognizable one, and it is interesting to speculate on two possible explanations. The first explanation may be related to the production of job scores by the job classification scheme. The factor scores are derived empirically by reference to certain standard jobs. When these factor scores are summed to give the *total score,* clustering, or high frequencies, of workers occur at certain score values, and yet adjacent scores show low worker frequencies. For example, the distribution for total score exhibited clustering at a score value of 57, with low frequencies at the adjacent score values of 56 and 58. However, since the total score reflects income, for all practical purposes these scores can be considered the same.

The second explanation may be related to the way the steel industry draws workers from the general population. Workers are selected to satisfy specialized industry needs, i.e., the selection process is not random, and the distribution of total score represents the frequency of certain payments necessary to satisfy those needs.

The cumulative frequency distribution (Fig. 1) is shown as a rough guide to the distribution of worker frequency over the range of total score. Interesting features of this distribution are the points of discontinuity. At these points, the cumulative frequencies exhibit sharp increases, reflecting the occurrences of scores with high

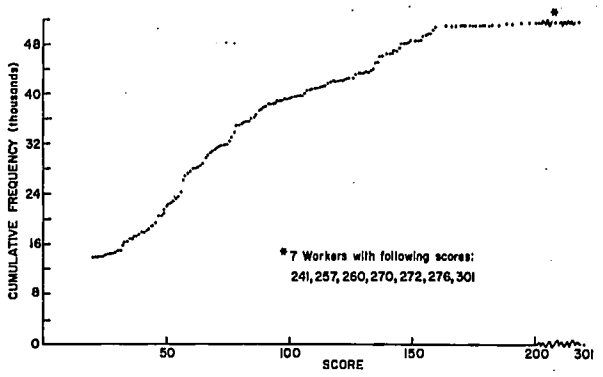

Fig. 1. Total score of 1953 worker cumulative frequency distribution.

frequencies. (For example, Fig. 1 shows discontinuities at score values of 20, 32, 46, etc.)

To simplify both analysis and the presentation of the results of that analysis, the job scores were incorporated into *score groups.* The discontinuities in the job score distribution would have been logical points at which to separate the score groups. However, in view of other subdivisions of the population, four score groups were created, containing, as nearly as possible, equal number of workers, i.e., the best approximations to the quartile ranges of score. The cumulative distribution was used to find these approximate quartile ranges. The stratification of workers in jobs with scores at the beginning of 1953, into the four levels of total score is presented in Table III.

For further analysis purposes, these workers were also assigned to age groups, based on their age in January 1953, and retained in these *entry age cohorts* until death, or the end of 1961. In other words, as the cohort aged, workers were not assigned to higher age groups. The entry age cohorts were:

Years
< 25
25 - 34
35 - 44
45 - 54
55 - 64
> 65

Worker Changes in Status, 1953-1961

For workers present in the steel industry in jobs with scores at the beginning of 1953, major changes in status occur when:

(a) Workers leave the plant at which they were employed at the beginning of 1953. It is possible for them to leave and return to employment more than once.
(b) Workers retire.
(c) Workers die.

The proportions of workers who experienced these changes by age and level of total score, at some time between February 1953 and the end of 1961, may be found in Tables IV and V. The mortality rates are for all causes of death. Examination of the findings for white workers (Table IV) and the corresponding findings for non-white workers (Table V) reveals:

1. As expected, retirement increases with age. The rate is about the same in both color groups.
2. Age is also a factor in determining the proportion of those who leave the plant. In both color groups, a steady decline in the proportion of workers who left the plant in 1953, as age increased to 55 years, is observed. This trend is reversed for the white worker, 55 years and over; the pattern for the non-white worker is not so clear.
3. Job score is also affected by age. The proportion of workers with higher job scores increases with increasing age.
4. In each age group, the proportion of white workers with higher job scores is greater than that of the non-white (Fig. 2).
5. With the exception of the youngest age group, mortality during the 1953-1961 period is lower in the high job score groups than in the lower groups. This association is not as evident for non-whites as it is for whites.

In summary, examination of Tables IV and V reveals that job score is affected by age, and differs between white and non-white workers. Job scores of white workers are apparently related to subsequent mortality; non-white workers do not show this association (perhaps due to their small number). Another contributing factor could be the higher proportion of non-white workers who leave the plant. This matter will be considered in a future paper.

White mortality is lower than that of the non-white except for those aged 65 and over (Table VI). This is consistent with the findings of Lloyd and Ciocco.[1] However, when Tables IV and V are compared, it is clear that, for white–non-white contrasts to be meaningful, account must be taken of differences in the distributions

TABLE III
ASSIGNMENT OF WORKERS TO TOTAL SCORE GROUPS BASED ON THEIR JOB SCORES AT THE BEGINNING OF 1953

Score Group	Range of Score	Workers in Score Group No.	%
1	0 - 20	13,891	26.8
2	21 - 57	12,416	23.9
3	58 - 96	12,631	24.4
4	97 - 301	12,927	24.9
	Total	51,865	100.0

TABLE IV

WHITE WORKER CHANGES OF STATUS 1953-1961

BY ENTRY AGE COHORT AND GROUPED LEVELS OF TOTAL SCORE

Entry Age Cohort (Yr.)	Score Group	Workers At Risk No.	%	Proportions Who: Leave the Plant*	Retire	Mortality Per 10^5 Workers
⟨ 25	1	2,825	54.0	.935	-	991
	2	1,420	27.2	.858	-	634
	3	642	12.3	.824	-	1,090
	4	343	6.5	.822	-	1,749
	Total	5,230	100.0			
25-34	1	3,225	25.8	.769	.001	2,140
	2	3,551	28.4	.552	.001	1,408
	3	2,949	23.6	.508	.002	1,729
	4	2,769	22.2	.447		1,120
	Total	12,494	100.0			
35-44	1	2,138	17.8	.567	.005	5,098
	2	2,887	24.0	.315	.006	4,399
	3	3,416	28.4	.245	.006	4,245
	4	3,574	29.7	.238	.005	3,805
	Total	12,015	100.0			
45-54	1	1,132	14.6	.462	.042	11,042
	2	1,574	20.3	.230	.035	11,118
	3	2,314	29.8	.182	.039	10,933
	4	2,738	35.3	.202	.045	10,409
	Total	7,758	100.0			
55-64	1	949	16.0	.744	.565	25,935
	2	1,237	20.9	.828	.564	23,767
	3	1,505	25.4	.833	.566	22,791
	4	2,226	37.6	.849	.567	11,770
	Total	5,917	100.0			
⟩ 65	1	304	20.4	.891	.550	42,432
	2	351	23.6	.920	.571	38,461
	3	365	24.5	.921	.648	32,603
	4	467	31.4	.948	.670	24,868
	Total	1,487	100.0			

*Anytime in the period 1953-1961

TABLE V

NON-WHITE WORKER CHANGES OF STATUS 1953-61

BY ENTRY AGE COHORT AND GROUPED LEVELS OF TOTAL SCORE

Entry Age Cohort (Yr.)	Score Group	Workers at Risk No.	%	Proportions Who: Leave the Plant*	Retire	Mortality Per 10^5 Workers
⟨ 25	1	474	73.8	.937	-	2,531
	2	99	15.4	.881	-	10,101
	3	53	8.3	.792	-	0
	4	16	2.5	.700	-	0
	Total	642	100.0			
25-34	1	1,078	55.2	.793	.001	2,597
	2	369	18.9	.668	.005	2,168
	3	362	18.5	.561	.003	1,381
	4	144	7.4	.556		2,083
	Total	1,953	100.0			
35-44	1	728	45.3	.680	.005	4,532
	2	310	19.3	.458	.006	9,032
	3	380	23.6	.434	.002	6,315
	4	189	11.8	.376		4,232
	Total	1,607	100.0			
45-54	1	625	37.4	.475	.060	10,400
	2	353	21.1	.348	.044	15,297
	3	416	24.9	.276	.037	12,500
	4	278	16.6	.219	.067	11,151
	Total	1,672	100.0			
55-64	1	349	37.2	.315	.471	21,489
	2	215	22.9	.293	.468	23,255
	3	205	21.9	.229	.500	17,073
	4	169	18.0	.160	.532	23,076
	Total	938	100.0			
⟩ 65	1	64	42.1	.156	.547	34,375
	2	50	32.9	.140	.569	34,000
	3	24	15.8	.416	.583	37,500
	4	14	9.2	.714	.714	14,285
	Total	152	100.0			

*Anytime in the period 1953-1961

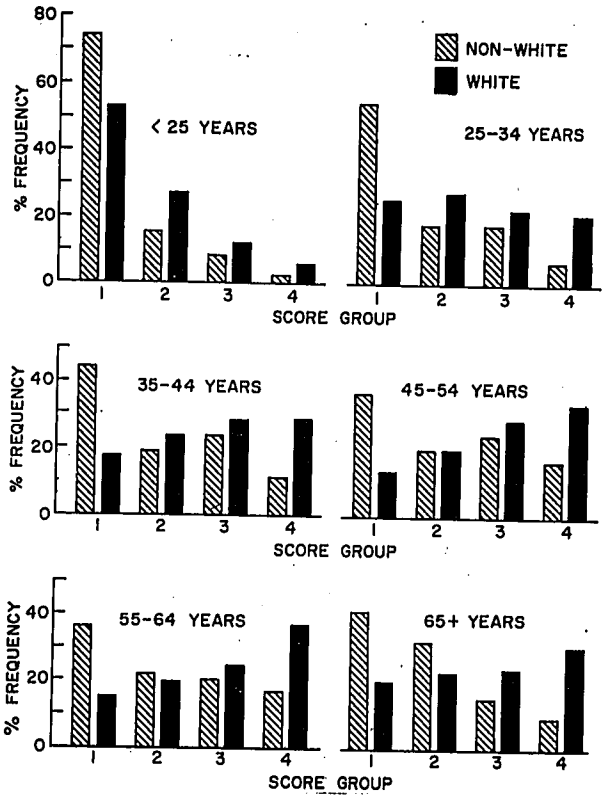

Fig. 2. Relative frequency distributions of workers in score groups by age (White vs. Non-white).

of persons with job scores in the several age-color groups (Fig. 2).

When workers are stratified by both *age* and *level of score* at the beginning of 1953, the differences in white and non-white mortality rates for the 1953-1961 period vary in sign and magnitude (Table VII). In 13/24 of these sub-groups, non-white mortality is greater than white mortality (a result which is in close agreement with the expected 12/24 ratio on the assumption of no difference existing between white and non-white mortality). However, there is still an age distribution effect, with indications that adjusting by level of score still results in higher *non-white* mortality in the *younger* age groups, but in higher *white* mortality in the *older* age groups. The relative periods of time that younger and older workers have held jobs at the various levels of score may be a factor. It is reasonable to assume that older workers, on the average, have been in their score groups longer; in other words, the level of score effect on equalizing white and non-white mortality may be time-dependent. Over-all, when workers are classified by *level of total score* or *income* (Table VII), white and non-white mortality regresses to a common level.

Summary

The two main findings of this study were:

1. A negative association exists between level of total job score or income and mortality for white workers.
2. Surplus non-white mortality is eliminated when workers are classified by level of total score or income.

TABLE VI

DIFFERENCES IN WHITE AND NON-WHITE MORTALITY RATES BY AGE GROUP

Age group (Yr.)	Mortality Per 1000,000 Workers		Differences in Mortality White–Non-white
	White	Non-white	
⟨25	956	3,426	-2,470
25-34	1,609	2,253	-644
35-44	4,303	5,786	-1,483
45-54	10,802	12,081	-1,279
55-64	19,533	21,215	-1,682
⟩65	33,566	32,895	+671

TABLE VII

WHITE VS NON-WHITE MORTALITY

Age Group (Yr.)	Score Group	White–Non-white Mortality Per 100,000 Workers
⟨25	1	- 1,540
	2	- 9,467
	3	+ 1,090
	4	+ 1,749
25-34	1	- 457
	2	- 760
	3	+ 348
	4	- 963
35-44	1	+ 566
	2	- 4,633
	3	- 2,070
	4	- 427
45-54	1	+ 642
	2	- 4,179
	3	- 1,567
	4	- 742
55-64	1	+ 4,446
	2	+ 512
	3	+ 5,718
	4	- 11,306
⟩65	1	+ 8,057
	2	+ 4,461
	3	- 4,897
	4	+10,583

The observation of a negative association between income level and mortality is a confirmation of the findings of the British Registrar General's Reports and of similar findings by other workers. It is interesting to speculate as to why non-white workers do not exhibit this association. The small numbers of non-white workers at risk was discussed earlier. Another possible reason may be related to the comparatively high proportion of

non-white workers who left their first plant of employment sometime in the period 1953-1961. If workers who leave their plants have a different mortality rate than do those who remain in their plants, this difference may account for the lack of association between income level and mortality in the non-white cohort. This question will be examined in a future paper.

The initial findings of surplus non-white mortality are a further confirmation of the well-documented fact that non-whites have higher mortality rates than whites. Lloyd and Ciocco in the first paper of this series, found a higher mortality for non-whites (20%) than for whites in the study county; whereas non-white workers in the cohort had eight per cent higher mortality than their white colleagues.[1] This study found surplus non-white mortality in all but the highest age group. A possible explanation for the high white mortality in this age group (>65) may be related to the findings of Lloyd and Ciocco, of high white mortality rates for arteriosclerotic and degenerative heart disease at all ages.

The finding of a decreased differential in white and non-white mortality (in steel industry employment when compared to the general population) presents an interesting pattern. Moreover, when workers are stratified by level of income, mortality differences disappear, and white and non-white mortality regresses to a common level.

Grateful acknowledgment is made to Mr. Hugh W. Rush, for assistance with editing and classification of workers into job scores, and to Mr. Arthur Legasse, for assistance with data editing and computer programming.

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The Deaf Favored

Ripped from his bed by a socially approved jackhammer, our urban early riser finds himself at breakfast listening to a high-level food-blender racket, and intense noises from exhaust fans over range hoods, dishwashers, garbage disposal units, and vacuum cleaners. En route to work, the urban man endures 90 or more decibels of noise, no matter whether he travels by subway, by bus, or by automobile with the window open.

At work he may be assaulted by high-level, ear-damaging noise from automated clerical and computing equipment of the type used in the check-tabulating room of a large New York bank. According to the National Association of Hearing and Speech Agencies, this bank, which had experienced a high degree of employee turnover because of noisy work conditions, finally resorted to hiring the deaf. . . .

Noise abatement is a problem of astronomical size, involving us all. There must be a confrontation, and the medical and public health professions must be in the forefront. It is also high time that the otologists, who have borne the brunt of the work in occupational noise, be augmented by neurologists, endocrinologists, psychiatrists—the entire spectrum of the medical profession. We must learn more about the non-auditory effects of noise. A systems approach is needed.

—From "Noise and Urban Man" by Robert Alex Baron, in Am. J. Pub. Health, Vol. 58, November, 1968.