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U. S. DEPARTMENT OF LABOR
U.S. BUREAU OF LABOR STATISTICS
ROYAL MEEKER, Commissioner

BULLETIN OF THE UNITED STATES BUREAU OF LABOR STATISTICS ... WHOLE NUMBER 231

INDUSTRIAL ACCIDENTS AND HYGIENE SERIES, NO. 17

MORTALITY FROM RESPIRATORY DISEASES IN DUSTY TRADES

(INORGANIC DUSTS)

BY FREDERICK L. HOFFMAN

CIRCUIT COURT FOR BALTIMORE COUNTY
PLAINTIFF'S EXHIBIT
No. 5 vs
A. M. 1017/57

SEP 13 1918
DEPT OF LABOR

JUNE, 1918

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

TABLE 69.—PROPORTIONATE MORTALITY FROM PULMONARY TUBERCULOSIS SPECIFIED INDUSTRIES OR OCCUPATIONS WITH EXPOSURE TO MINERAL DI INDUSTRIAL EXPERIENCE OF PRUDENTIAL CO., 1897 TO 1914, BY AGE PERIOD

Occupation group.	15 to 24 years.			25 to 34 years.			35 to 44 years.			45 to 54 years.		
	Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.	
		Number.	Per cent.		Number.	Per cent.		Number.	Per cent.		Number.	Per
Asbestos workers	3			3	1	33.3	3	2	66.7	1		
Brick, tile, and terra cotta	48	11	22.9	51	18	35.3	51	18	35.3	87	19	
Core makers	113	36	31.9	94	42	44.7	81	16	19.8	67	15	
Glassblowers	51	23	45.1	137	73	53.3	131	74	56.5	42	18	
Glass cutters	33	11	33.3	55	28	50.9	48	17	35.4	26	7	
Glassworkers, other	257	81	31.5	156	93	59.6	151	53	34.4	104	38	
Lime, cement, and gypsum	18	2	11.1	40	15	37.5	48	12	25.0	45	11	
Lithographers	70	37	52.9	81	42	51.9	69	27	39.1	53	17	
Marble and stone workers	99	23	39.3	229	121	53.1	403	179	44.4	317	200	
Molders	266	63	23.7	530	219	40.4	694	213	30.7	690	145	
Paint factories	10	4	40.0	26	6	23.1	33	10	30.3	13	3	
Paper hangers	57	20	35.1	122	54	44.3	124	74	59.7	134	37	
Plasterers	58	20	34.5	163	71	43.6	222	91	41.0	281	77	
Potteries	77	27	35.1	137	69	49.6	181	72	39.8	172	55	
Total	1,141	365	32.0	1,920	873	45.0	2,250	822	36.1	2,303	693	

Occupation group.	55 to 64 years.			65 years and over.			Age unknown.			Total, 15 years and over.		
	Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.	
		Number.	Per cent.		Number.	Per cent.		Number.	Per cent.		Number.	Per
Asbestos workers	1			2						13		
Brick, tile, and terra cotta	121	13	10.7	129	6	4.7				527		
Core makers	26	3	11.5	15						377	10	
Glassblowers	52	8	15.4	65	5	7.7				516	12	
Glass cutters	24	2	8.3	11	3	27.3	1			229	5	
Glassworkers, other	103	16	15.5	92	5	5.4				897	224	
Lime, cement, and gypsum	49	6	12.2	22	1	4.5				222	46	
Lithographers	32	4	12.5	19	2	10.5	1			325	125	
Marble and stone workers	506	135	26.7	312	29	9.4				2,032	711	
Molders	624	87	13.9	480	25	5.8				3,234	727	
Paint factories	15			14						121	24	
Paper hangers	36	11	11.3	72	3	4.2				704	214	
Plasterers	330	39	11.8	314	13	4.1				1,371	350	
Potteries	117	31	21.1	87	11	12.6				801	224	
Total	1,133	332	16.7	1,054	109	6.5	2			11,427	3,134	

MORTALITY FROM NONTUBERCULOUS RESPIRATORY DISEASES

On account of the importance of nontuberculous respiratory diseases,[1] Table 70 is included, showing the proportionate mortality from asthma, bronchitis, pneumonia, and other respiratory diseases

[1] On the nontuberculous respiratory diseases, see "Diseases of the Bronchi, Lungs, and Pleura," by Frederick T. Lord, M. D., Philadelphia and New York, 1910, in "System of Medicine," edited by Sir Clifford Allbutt and Humphrey Davy Rolleston, London, 1909.

among workers in occupations with exposure to mineral dust, without reference to divisional periods of life:

TABLE 70.—PROPORTIONATE MORTALITY FROM NONTUBERCULOUS RESPIRATORY DISEASES IN SPECIFIED INDUSTRIES OR OCCUPATIONS WITH EXPOSURE TO MINERAL DUST, INDUSTRIAL EXPERIENCE OF PRUDENTIAL CO., 1897 TO 1914.

Occupation group.	Deaths caused by nontuberculous respiratory disease.									
	Asthma.		Bronchitis.		Pneumonia.		Other.		Total.	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
[illegible] workers					2	15.3			2	15.3
[illegible], tile, and terra cotta	8	1.1	5	0.9	68	12.9	10	1.9	89	16.9
[illegible] workers			1	.3	40	11.2	7	2.0	48	13.4
[illegible]workers	3	.5	6	1.1	32	5.9	8	1.5	49	9.0
[illegible]workers	1	.5	1	.5	21	9.5	2	.9	25	11.4
[illegible] workers, other	4	.4	6	.7	71	7.9	13	1.4	94	10.5
Lime, cement, and gypsum	2	.9	3	1.4	15	6.8	5	2.3	25	11.3
Lithographers			3	.9	35	10.8	3	.9	41	12.7
Window and stone workers	28	1.4	52	2.5	198	9.6	49	2.4	327	15.9
Miners	25	.8	51	1.5	463	14.1	65	2.0	604	18.3
Quarries	1	.8			11	8.9			12	9.7
Quarrymen	1	.1	8	1.1	61	8.6	9	1.3	79	11.2
Stonecutters	9	.7	23	1.7	135	9.8	9	.7	176	12.8
Potters	25	3.1	14	1.7	46	5.7	19	2.4	104	13.0
Total	103	.9	173	1.5	1,193	10.5	199	1.7	1,675	14.8

It does not seem necessary, as observed in the discussion of occupations with exposure to metallic dust, to enlarge upon the facts disclosed by the preceding comparative statistics, which emphasize with sufficient degree of scientific conclusiveness the obviously health-injurious consequences of considerable and continuous exposure to the inhalation of mineral dust. It is clearly recognized that the statistical data utilized for the present purpose are of rather limited intrinsic value, but they are in the main quite fully confirmed by the more extended consideration of occupations in detail where the exposure to mineral dust is sufficient to warrant their inclusion within the plan and scope of the present discussion.

ENGLISH OCCUPATIONAL MORTALITY DATA.

In conclusion, however, it has seemed advisable to add to the present observations a table obtained from English official sources which shows the combined mortality of glassworkers, potters, paper hangers, plasterers, and lithographers, and which may safely be considered sufficiently representative of the entire group of occupations with exposure to mineral dust, in the absence of more extensive information which unfortunately is not available.

TABLE 71.—MORTALITY FROM ALL CAUSES, FROM PULMONARY TUBERCULOSIS, AN FROM OTHER RESPIRATORY DISEASES IN OCCUPATIONS EXPOSED TO MINER DUST, COMPARED WITH THAT OF ALL OCCUPIED MALES, IN ENGLAND AN WALES, 1900 TO 1902, BY AGE GROUPS.

[Source: Part II, Supplement to the Sixty-fifth Annual Report of the Registrar-General of Births, Deat and Marriages in England and Wales.]

Age at death.	Death rate per 1,000 due to all causes among—		Death rate per 1,000 due to pulmonary tuberculosis among—		Death rate per 1,000 d to other diseases the respiratory among—	
	All occupied males.	Occupations exposed to mineral dust.	All occupied males.	Occupations exposed to mineral dust.	All occupied males.	Occupation exposed to mineral dus
15 to 19 years	2.44	2.25	0.54	0.55	0.24	
20 to 24 years	4.41	4.02	1.56	1.44	.48	
25 to 34 years	6.01	5.24	2.03	2.01	.77	
35 to 44 years	10.22	12.46	2.74	3.98	1.66	
45 to 54 years	17.73	23.74	3.04	4.91	3.32	
55 to 64 years	31.01	40.23	2.16	3.94	6.54	1
65 years and over	88.39	92.60	1.11	1.13	17.77	2

GENERAL CONCLUSIONS.

Table 71 brings out clearly the fact that the mortality in pulmonary tuberculosis among men in occupations with exposu to mineral dust is decidedly excessive at ages 35 to 64, but the mortality at the other ages is not appreciably lower than f occupied males generally. Death rates are, however, not as usef and conclusive for purposes of industrial hygiene as the proportio ate mortality figure which precisely emphasizes the quantitative im portance of a given disease or cause of death. The proportiona mortality from pulmonary tuberculosis and nontuberculous respir tory diseases is excessive at all ages among men with exposure mineral dust, although the relative death rate per thousand expos to risk is not, at least according to English experience, decided excessive at certain periods of life. The data are not of sufficie importance to invalidate the general conclusion, and in the main t death rates sustain the proportionate mortality figure, although th is not invariably the case. The death rate from nontuberculo respiratory diseases among men employed in occupations with e posure to mineral dust, according to the English experience, is the older ages so decidedly excessive that obviously much mo extended scientific consideration should be given to this group diseases than has heretofore been given it. At ages 35 to 64, f illustration, in the English experience there is an actual excess the mortality from all causes among men exposed to mineral dust 9.22 per 1,000, equivalent to 29.7 per cent, but in the mortality fro pulmonary tuberculosis there is an excess of 1.78 per 1,000, equi lent to 82.1 per cent, against an excess of 0.32 per 1,000 in the no

tality from nontuberculous respiratory diseases, equivalent to 96.6 per cent. The results of this analysis, therefore, reemphasize the scientific conclusiveness of the extended discussion on "Industrial pneumoconiosis with special reference to dust phthisis," by Edgar L. Collis, in the Milroy Lectures of 1915, and the corresponding observations on pneumoconiosis by Sir Thomas Oliver in Allbutt & Rolleston's System of Medicine, Volume V, Diseases of the Respiratory System.

Of interest in this connection are the observations by Dr. J. S. Haldane contained in a contribution to the Proceedings of the Institution of Mining Engineers, abstracted in a letter from London to the Journal of the American Medical Association, August 19, 1916. In the paper referred to Dr. Haldane pointed out "that while up to the age of 50 the death rate from lung disease is much lower among colliers than in the rest of the population, above 50 the opposite holds, and there is a marked excess of deaths from bronchitis." In continuation, however, he stated that "the deaths from this disease have greatly diminished since 1890, for which improved ventilation seems to be the cause. Fifty years ago miners often worked in air containing so much black damp that lamps and candles burned dimly. In such air there is usually 2 or 3 per cent of carbon dioxide, which enormously increases the breathing during muscular exertion. The breathing is exactly regulated so as to keep an average of about 5.6 per cent carbon dioxide in the alveolar air; and with 3 per cent of this gas in the air, a man breathes twice as much air, so as to keep the alveolar percentage right. A man doing moderate muscular work in pure air breathes about five or six times as much air as during rest. In air containing 3 per cent of carbon dioxide he would be breathing ten or twelve times as much air as during rest, and his breathing would be taxed to the utmost. He would thus be much more liable to contract emphysema. The better ventilation of coal mines is largely a consequence of the greater amount of fire damp and great heat encountered as mines have become deeper."

Dr. Haldane is inclined to think "that both the fire damp and the heat have indirectly caused great improvement to the health of miners. Where there is plenty of fire damp there is usually also plenty of fresh and dry air, and no harmful excess of carbon dioxide. The proportion of deaths from bronchitis among old miners was higher in Staffordshire in 1890–1892 and 1900–1902 than in any of the other coal fields; and Staffordshire mines are exceptionally subject to black damp. The excess in bronchitis among old coal miners has been attributed to the breathing of dust," and Dr. Haldane was previously inclined to agree with this theory. But it is difficult to see why, if dust is the cause, there has been so great a diminution in

the bronchitis mortality in recent years. Coal mines have, on whole, become drier and more dusty with increasing depth and be ventilation; and, if dust were the cause, one would have expected bronchitis to increase, whereas it has greatly diminished. Certai an excess in mortality from bronchitis is associated with the brea ing of harmful dust. But this excess is accompanied by a far grea excess in mortality from phthisis, and begins comparatively early life, unlike the bronchitis mortality in colliers. Experiments animals carried out by J. M. Beattie show that both coal dust and shale dust usually associated with it on mine roads are relativ harmless."

It is therefore quite clear that much remains to be ascertained concerning the true nature and extent of dust phthisis and that in the solution of this important industrial problem a considerable advance is necessary in the practice of medicine, which much larger degree should be made to rest upon knowledge concerning disease causation ascertained by means of autopsies in indu trial districts subject to an excessive mortality from pulmon tuberculosis and nontuberculous respiratory diseases.

ASBESTOS.

The number of men employed in trades and industries involv exposure to asbestos dust in the United States is unknown. As from the mining of asbestos, in which exposure is rather limi there are numerous processes involving the conversion or remanufacture of the materials which are distinctly more serious in th effects on health and longevity. Asbestos weaving and spinning described by Netolitzki on the basis of observations in Bohem where the conditions were found to be decidedly unfavorable. I this country our information is very limited, although the quant of asbestos used is very large. Its fire-resisting properties ha led to its extensive employment for the covering of pipes, furnac etc., as well as its use in the form of wall plaster, roofing ma rial, etc. On account of its nonconducting qualities it is exte sively employed by electricians and also in the construction of st age rooms of refrigerating plants.

METHODS OF MINING.

"Geologically," according to the Technical World Magazine,[1] "a bestos is a fibrous form of serpentine rock, occurring in strata crystalline limestone. The veins run in an average thickness of o fourth to one-half inch, but sometimes attain to as much as 6 inch

[1] "Mining mineral wool," by Aubrey Fullerton, in Technical World Magazine, N

The asbestos fibers are, as nearly as possible, crystals of serpentine rock." According to the same magazine—

The ore is mined mostly in open quarries. Overlying soil, to a thickness of sometimes 20 or 30 feet, but quite often forming only a thin layer on top, has first to be removed; and as soon as the asbestos veins are thus laid bare, the actual quarrying operations may begin. The rock is cut in a series of terraces, reaching a total depth of sometimes 150 or 200 feet. Underground work has not proved successful, the open quarry having been found both more economical and more effective, despite the disadvantages of exposure to the weather. Drilling and blasting are employed much the same as in ordinary stone quarrying.

When the rock is thus broken up it is rough sorted at the quarry. Two or more grades are selected, according to the length of the fiber, and are then sent on to the "cobbing sheds," where the further process of dressing goes on. This process is merely the separation of the asbestos fibers from the dead rock, and is done in some cases by hand, but to an increasing extent by machine. Hand cobbing is the very simple method of breaking the stone by small sledge hammers, throwing the fiber into one box and the waste into another. This separation is ordinarily not difficult, since the fiber lies in layers more or less loosely clinging to the rock, and can frequently be picked off with the fingers. The crude fiber, thus separated as cleanly as possible from the waste rock and looking very much like mineralized wool, is packed in 100-pound bags, in which form it goes to the market and the manufacturer.

Hand dressing is not, however, an absolutely thorough method. The waste material from the cobbing tables and the fine pickings from the quarries have still some fiber in them, and the utilization of this frequently represents the largest profits of the mine. All these fine pickings are mechanically dressed. In case the asbestos contains a large percentage of water, the moisture is first dried out, by exposure to the air, by steam pipes, or by rotary driers, and the rock is then passed on to the crushers, where it is broken by successively finer-set rolls. Cylindrical fiberizers and the cyclone machine reduce it still further. The latter is the most effective apparatus yet devised for asbestos separation. It consists of two beaters, one of the screw-propeller type, driven within a cast-iron chamber at a violent speed, reducing the particles of stone almost to a powder. This is then passed over a shaking screen to remove the sand, and in some mills strong electric magnets are used to take up the particles of iron.

In all of these operations there must necessarily be a considerable degree of dust exposure, which, however, becomes exaggerated in the spinning and weaving processes in connection with the manufacture of asbestos yarn and cloth. These processes are briefly referred to in an article in the Engineering Magazine,[1] in part, as follows:

The spinning and weaving of asbestos have offered many difficulties, as the asbestos fibers have no rough surface like wool or cotton, but

[1] "Asbestos, its mining, preparation, markets, and use," by E. Schaaf Regelmann, Engineering Magazine, Oct. 1907.

are very smooth, and thus have a tendency to slip by one
when twisted and subject to tension. An admixture of vege
animal fiber was therefore often necessary, but, while thes
tated the manufacturing operations, they impaired the fire re
of the fabric, and special machinery and ingenious devices
be invented to enable the successful spinning of a pure asbest
It is, however, now possible to make a single asbestos thread
though weighing no more than 1 ounce per hundred yards, ha
strength, and braided material can be made much more resi
torsion and tension, while asbestos ropes, chiefly used by
department, can be strengthened either by interwoven wire
having a wire-rope core.

HEALTH-INJURIOUS OCCUPATIONAL CONDITIONS.

On account of the rather limited extent of the asbestos i
in the United States, at least in the large centers of populat
industrial insurance mortality experience data are insuffici
definite conclusions. During the period 1907 to 1914 in the Pr
experience there were only 13 deaths, of which 3, or 23.1 p
were from pulmonary tuberculosis. At ages 25 to 44, there
deaths, of which 3, or 50 per cent, were from this disease.
dust is not described in the extensive consideration of Dust i
by Hayhurst, nor by W. Gilman Thompson in his treatise
Occupational Diseases. In 1914 the production of asbestos
United States was only 1,247 tons, or much less than in earlie
indicating a very limited available source of supply. Most
asbestos used in the United States is mined in Canada, and a
lent report on "Asbestos, its occurrence, exploitation, and us
been published by the mines branch of the Department of the
of the Dominion of Canada (Ottawa, 1905), which contain
scriptive account of mining methods and of the dressing of
by hand or by mechanical treatment, including the final crusi
means of rollers, fiberizers, beaters, cyclones, and pulverizers.
these processes unquestionably involve a considerable dust haz
the hygienic aspects of the industry have not been reported u
may be said, in conclusion, that in the practice of Americ
Canadian life insurance companies asbestos workers are ge
declined on account of the assumed health-injurious condit
the industry.[1]

It is regrettable that there should be no further information
able regarding the asbestos industry in its various branches,
ing the utilization of by-products of manufacture, on account
self-evident injuriousness of asbestos dust as a predisposing c
pulmonary tuberculosis. The subject is not referred to by

[1] For a descriptive account of the Canadian asbestos district, see Engineering
ing Journal, New York, Apr. 30, 1910.

and Hanson in their recently published treatise on Diseases of Occupation and Vocational Hygiene, nor by Sir Thomas Oliver in his recent work on Diseases of Occupations. The rapidly increasing development of industries using asbestos, as ascertained from domestic or foreign sources, suggests the urgency of more qualified medical consideration than has heretofore been given the subject. There are no references to asbestos in the Index Catalogue of the Surgeon General's Library, which, however, brings the literature of the subject down only to 1896. The discussion of asbestos in the annual reports of the United States Geological Survey on Mineral Resources is limited entirely to the technical aspects of the mining industry, which during recent years has experienced a rather retrograde movement in that the production has diminished from a maximum of 7,600 tons in 1911 to 1,247 tons in 1914. In contrast, however, there has been a gradual increase in the quantity of the unmanufactured asbestos imported, chiefly from Canada. The American production is practically limited to the States of Arizona, California, Georgia, and Vermont. Georgia has for years been one of the chief producers of asbestos in the United States, but no medical observations are on record as regards the possibly injurious results experienced in the mining and manufacturing of asbestos materials in that State. The industry itself has been described, however, in a report on the asbestos, talc, and soapstone deposits of Georgia in Bulletin No. 29 of the Georgia Geological Survey, 1914.

EVIDENCE OF DUST EXPOSURE.

The relation of asbestos dust to pulmonary tuberculosis is reported upon at some length in the Annual Report of the Chief Inspector of Factories and Workshops for England and Wales for 1910. The investigation was made by Dr. Collis, who states, in part, that—

> Following up information received from the registrar-general, it was found that five deaths of persons suffering from phthisis had occurred in five years among a staff of under 40 workers employed at a factory where asbestos is woven. The process which appeared most dangerous is the production of asbestos mattresses. These mattresses, which are composed of bags of woven asbestos filled with short asbestos fiber, are placed on a table and beaten out flat by a man with a wooden flail, from which process much dust arises. Women who sew the mattresses into sections with asbestos threads worked close to the man who beat the mattresses and of necessity inhaled the dust. The reorganization of this process with the application of localized exhaust draft was called for, and an annual medical examination of the workers by the certifying surgeon has been instituted in the hope of detecting and removing from exposure to dust those showing early signs of respiratory disease. Weaving asbestos has only become an important industry during the last 15 years. Two other large asbestos factories were visited, each of which was found to have its own specialty in the production of which dust prevention is required.

There is evidently an urgent need for a more qualified and
ve investigation of the health aspects of asbestos manuf
especially so, in view of the fact, as observed in the Scientific
can (August 1, 1916), that, on account of the restrictions place
shipments of asbestos from Canada, the possibilities of utiliz
asbestos deposits of this country are increased, as well as bec
the much larger demand for asbestos products on account
recognized value of asbestos for protective purposes in the f
ance of the industrial safety movement. Of value in th
nection is the evidence of Dr. H. M. Murray before t
partmental Committee on Industrial Diseases, limited, h
to the single case of an asbestos worker, verified as
diagnosis by a post mortem examination. In reply to
tion by the chairman of the committee as to whether, in
the fact "that there is something characteristic in the earlie
of dust phthisis in the predominance of shortness of breat
physical signs become very obvious," such a condition ha
observed in the case of the asbestos worker under treatmen
Murray, and under observation for fourteen months, the doc
that it had been noticed in the case in question, and
other words, there was a definite relation between the co
phthisis and the physical incapacity resulting from the ini
of asbestos dust. It is therefore to be anticipated that the co
of asbestos workers will attract more qualified attention
country in the future than it has in the past.

MICA.

No special investigation has been made to ascertain the
less health-injurious effects of mica dust. According to W.
Thompson the dust is slightly irritating to the respiratory
like dust containing any sharp solid particles, but as a gene
clusion he states that the dust does not appear to be part
injurious. Mica is extensively used in the manufacture of e
machinery, as well as in the glazing trade, as a substitute fo
and in the decorative trades, including the manufacture
paper. There are two principal varieties of mica, known as
vite and phlogopite, but whether there is any essential di
between the physical and mechanical properties of the dust
been determined. There are mica deposits in some 20 State
United States, but the annual production has fluctuated consi
reaching the lowest point in the last decade during 1914.
there are any special hazards in mica mining in consequenc
dust has not been ascertained. The occurrence, exploitation,
of mica have been admirably described in a report published
mines branch of the Department of the Interior of Canada.