PHYSICAL TYPE IN PNEUMOCONIOSIS

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When a number of persons is exposed to a particular pneumoconiosis-producing dust for the same period under apparently similar conditions, some of them develop the disease while others escape. It is possible that the less easily affected group comprises merely those who by chance or through some inborn or acquired local physical difference, e.g. nose-breathing, receive smaller doses of the noxious dust into the lungs. It is also possible that they are a selected group of peculiar constitutional type. The latter view has been accepted by some authorities and used in practice in selecting entrants to the mining industry, on the ground that by excluding certain anthropometric types the incidence of pneumoconiosis, or of pneumoconiosis complicated by tuberculosis, would thereby be reduced, though no adequate statistical data have so far been published to support this hypothesis.

Irvine (1938), lately Chairman of the Miners' Phthisis Medical Bureau, Johannesburg, responsible for the gold miners on the Witwatersrand, has stated:

'(1) The "asthenic" type is under standard weight, tall in proportion to breadth, spare in face and body, and languid-eyed, flat-, narrow- and shallow-chested and with poor posture, but usually with good expansion.

'Well-marked cases of this type have poor constitutional stamina, are more prone to develop tuberculosis or may be in part the result of childhood tuberculosis, and are quite unsuitable for underground work. Individuals over 6 ft. in height are frequently asthenic, and unless well developed and robust, are unsuitable.

'(2) At the other extreme is the man who is unduly broad for his height (called the "pyknic" type), typically shortish and short-necked, over-weight, deep- and broad-chested, but with imperfect expansion, and with a well-marked tendency to early and increasing obesity. "The man who laughs with his belly" is the typical "pyknic". This type has good resistance to tuberculosis, but tends to early bronchitis and emphysema and later to cardiac and renal degeneration. Well-defined cases are therefore unsuitable for mining. The flabby, obese "pyknic" is a particularly bad subject.

'(3) Between these extremes is the normally proportioned "intermediate" or "muscular" type, of good muscular and chest development. These, provided their constitutional stamina is good, form the best material. They range on either side towards the two former types. The "intermediate to asthenic" type, rather under weight, small-boned and spare but hardy, wiry and of good constitutional stamina, is also suitable.

'Although these physical types are readily distinguishable by simple observation, the radiograph is a most valuable adjunct. The "asthenic" type has a characteristic radiograph, with narrow heart-shadow and prominent hilus and peribronchial markings, and frequently with evidence of limited foci of old healed infection in the root glands or in the lung fields, appearances which correlate closely with the physical type.'

On the other hand, Tsukata (1938) maintains 'that research effected in Japan pointed to the fact that susceptibility to the action of dust varied very much in individuals, though

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it was extremely difficult to distinguish constitutional types presenting the marked susceptibility alleged in the case of leptosomes and others'.

Differentiation into the physical types (asthenic, pyknic, etc.) used in South Africa probably owes its origin to the work of Kretschmer (1925, 1936), who correlated such types with differing predisposition to certain mental reactions and disorders. However, as regards physical disease he has stated, but in reference to no particular disease, that 'one cannot, therefore, mark down any one of the great classes of constitutions, as fundamentally healthier or unhealthier than the other'.

In the light of these conflicting opinions it seemed desirable to investigate the problem further, and that is the purpose of the present investigation, which is concerned with pneumoconiosis as seen in anthracite coalminers.

The ideal statistics for an investigation of this character would be those based on mining entrants who had an initial physical and clinical examination and whose subsequent morbidity experience was duly recorded. This would be the true scientific procedure, but it has a big disadvantage owing to the time lag it involves. There is a long interval between initial exposure and contraction by coalminers of pneumoconiosis in its more severe forms. If we require to give instant expression on the relationship between anthropometric type and susceptibility to this disease we are compelled to use less perfect material.

First it is essential to have some quantitative idea of the physical standards represented by the three anthropometric types. From the description given by the Medical Bureau, Johannesburg, it would seem that they take few measurements of the entrants for underground work, but make their anthropometric classification mainly by observation. Kretschmer attempted to give his types a numerical index. Unfortunately, he neither states the size of the population on which his results are based nor the degree of dispersion within each of the three groups. His mean values are:

	Asthenic	Athletic	Pyknic
Height, in.	66·3	66·9	66·1
Weight, lb.	111	139	150
Shoulder, in.	14·0	15·4	14·5
Chest, in.	33·0	36·1	37·2

The results for height are so surprising that they cast suspicion on the validity of his classification. In fact it would appear that he first grouped the data into what he considered to be the appropriate category, and afterwards calculated for each group the desired anthropometric indices. It will be noted that there is practically little difference between the mean heights of the two extremes—pyknic and asthenic—66·1 as against 66·3, yet from all available descriptive accounts the former is short and stockily built, the latter tall and thin. There is some evidence that the two types are identifiable in terms of weight, the range being 111–150, and although we have no means of testing the significance of this difference, it would appear superficially that the weight index is a fairly sound selective criterion.

DATA OF PRESENT INQUIRY

The data of the present analysis are derived from the population of an anthracite colliery in Carmarthenshire, which was one of the collieries investigated by two of us (E. A. A. and P. D'A. H.) during a survey under the direction of the Industrial Pulmonary Diseases Committee of the Medical Research Council. This colliery has a high incidence of pulmonary abnormality, shown both by X-ray and by the numbers of men certified by the Medical Board for Silicosis. The population on the colliery employment register, including both surface and underground workers and also thirty-seven silicosis compensation cases, made a total of 560 persons, of whom 540 have been studied.

The X-ray classification used is that adopted in the Medical Research Council survey: (*a*) normal, (*b*) reticulation, (*c*) nodulation, (*d–f*) major consolidation, and (*c–f*) all consolidation. Owing to the extreme difficulty of diagnosing with certainty the presence of tuberculosis complicating pneumoconiosis in coalminers no separate grouping of such cases has been attempted.

External measurements. The *standing* and *sitting heights* and the *weight* were taken with the subjects stripped to the waist and without boots: the height to the nearest ½ in. and the weight to the nearest lb. For the sitting height, the platform of the height standard was placed on a chair and the subject instructed to sit on it with the buttocks and the back of the head pressed against the upright scale, and with the top of the head horizontal: this method ensured a uniform sitting position. The *chest circumference* was measured on full inspiration, horizontally ½ in. below the nipple level, with the arms at the sides. The *chest antero-posterior diameter* was taken on full inspiration by a pelvimeter placed horizontally ½ in. below the nipple level in the mid-line, with the hands on the hips. The *chest lateral diameter* was taken also on full inspiration by a pelvimeter placed 2 in. below the nipple level at the maximum diameter, with hands on the hips. The *chest length* was taken with the pelvimeter from the suprasternal notch to the lowest point of the costal cartilages. All these external chest measurements were taken to the nearest ¼ in.

Radiological measurements. The radiological chest height/width × 100, an index introduced by Hurtado & Fray (1933), was obtained from the X-ray film. The height was determined by measuring the vertical distance from the dome of the diaphragm to the plane of the neck of the first rib on both sides and taking the mean. The width was obtained at the level of the ninth interspace posteriorly, the measurement being taken from the inner aspects of the ribs.

A general anthropometric picture of the present mining population is revealed in Table 1, in which for normals and for pneumoconiosis of varying degrees—reticulation and all consolidations—the mean values for:

Standing height,
Weight,
Weight/standing height,
Standing height/chest lateral diameter,
Chest lateral diameter/chest antero-posterior diameter,

have been calculated for various age groups. Taking each characteristic

separately and the contrasts of normals with consolidations we find the following results.

Standing height. The normals do not differ materially in height from those who had consolidation, but the trend of the measurements according to age are different in the two series. Under age 50 the normals are the taller, the values being 66·4 as against 65·7 at ages 30–39 and 65·5 against 65·1 at 40–49. At the higher ages the consolidations are the taller and at ages 60+ measurements are 64·8 ± 0·39 for normals and 65·5 ± 0·53 in. for consolidations.

Weight. This factor, contrary to expectation, is fairly well correlated with age for the two contrasted groups. Assuming the disease to be a function of age, one would have expected the weight of the consolidations to show a decrease, but from this experience it will be seen that the weight for consolidations at age 60 and upwards is heavier than that at ages 30–39, but not significantly so, the respective values being 142·9 ± 8·6 and 137·7 ± 2:8. At each age period the normals are heavier than the consolidations, and at ages under 50 the difference is between 6 and 7 lb., but in no case is the difference statistically important.

Weight/standing height. This ratio would usually be a good representation of physique but, in this particular instance, it can be no better as a standard than weight alone, because, as we have previously indicated, the height measurements for the two contrasted groups do not differ appreciably at any age period. The index is definitely correlated with age for both consolidations and normals, but in no age group does the value for the former differ significantly from the latter. The values for the normals were 2·14 at ages 30–39, 2·17 at ages 40–49, 2·21 at 50–59 and 2·25 for men aged 60 and upwards. The corresponding ratios for consolidation cases were 2·07, 2·10, 2·16 and 2·20.

Standing height/chest lateral diameter. This index is of a fairly constant size with age. For normals aged 30–39 the value is 5·94 ± 0·05 and for those aged 50–59, 5·83 ± 0·05. The corresponding ratios for men who had consolidation were 5·89 ± 0·06, and 5·84 ± 0·09. It will be noted that at ages under 50 the normals had larger values than the consolidations, but not statistically so; at ages 50 and over they were the smaller; and in the age group 60+ the ratio for the consolidation cases was 6·12 ± 0·18 as against 5·81 ± 0·07 for the normals, but this difference of 0·31 is nevertheless within the limits in which it could arise by chance.

Chest lateral diameter/chest anterior-posterior diameter. This measurement is, as will be seen in the table, inversely related to age. For the controls under age 30 the mean value is 1·40 ± 0·011; while for those aged 50–59 the ratio has dropped to 1·24 ± 0·016, a significant decline. For consolidation cases aged 30–39 the average was 1·35 ± 0·020; and for men aged 60+ it was 1·18 ± 0·049, also a significant decline. But a comparison between the results for normals and consolidations reveals no important differences.

It may be argued that the statistics in Table 1 afford an imperfect anthropometric comparison between a pneumoconiotic and a normal population,

Table 1. *Showing the mean value, according to age, for certain anthropometric measurements of 540 coalminers, with and without pneumoconiosis*

Age ...	Under 30		30–39		40–49		50–59		60 and over	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Standing height in inches:										
Normals	83	66·0 ±0·28	74	66·4 ±0·28	65	65·5 ±0·27	51	64·8 ±0·30	34	64·8 ±0·39
Reticulation	19	65·5 ±0·49	40	65·5 ±0·40	25	65·1 ±0·47	24	64·6 ±0·43	13	65·6 ±0·52
Consolidations			41	65·7 ±0·31	33	65·1 ±0·31	27	64·9 ±0·47	11	65·5 ±0·53
Weight in lb.:										
Normals	82	137·9 ±2·1	74	143·2 ±2·4	65	143·2 ±2·8	50	143·4 ±3·7	34	147·0 ±4·7
Reticulation	19	140·9 ±3·6	40	143·2 ±3·8	25	137·3 ±3·9	24	139·1 ±4·2	13	145·7 ±6·5
Consolidations			41	137·7 ±2·8	33	136·3 ±3·4	27	141·9 ±3·8	12	142·9 ±8·6
Weight/standing height:										
Normals	82	2·06 ±0·03	74	2·14 ±0·03	65	2·17 ±0·04	50	2·21 ±0·05	34	2·25 ±0·06
Reticulation	19	2·13 ±0·05	40	2·17 ±0·05	25	2·08 ±0·05	24	2·13 ±0·06	13	2·22 ±0·10
Consolidations			41	2·07 ±0·04	33	2·10 ±0·04	27	2·16 ±0·05	11	2·20 ±0·12
Standing height/chest lateral diameter:										
Normals	83	5·88 ±0·04	74	5·94 ±0·05	65	5·95 ±0·05	49	5·83 ±0·05	33	5·81 ±0·07
Reticulation	19	5·74 ±0·07	40	5·85 ±0·05	25	6·06 ±0·08	24	5·88 ±0·08	13	5·98 ±0·13
Consolidations			41	5·89 ±0·06	33	5·94 ±0·06	27	5·84 ±0·09	10	6·12 ±0·18
Chest lateral diameter/chest anterior-posterior diameter:										
Normals	82	1·40 ±0·011	74	1·32 ±0·015	64	1·28 ±0·017	48	1·24 ±0·016	32	1·25 ±0·025
Reticulation	19	1·39 ±0·025	40	1·31 ±0·020	25	1·25 ±0·030	24	1·30 ±0·024	13	1·29 ±0·040
Consolidations			41	1·35 ±0·020	33	1·27 ±0·021	27	1·29 ±0·023	10	1·18 ±0·049

Table 2. *Showing the anthropometric measurements of coalminers with nodulation and major consolidation*

Age ...	Nodulation				Major consolidation			
	30–39		40 and over		30–39		40 and over	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Standing height (in.)	26	65·5 ±0·42	26	65·4 ±0·36	15	66·0 ±0·43	45	64·9 ±0·33
Weight (lb.)	26	140·3 ±3·6	26	143·8 ±4·2	15	133·2 ±4·1	46	137·4 ±3·2
Weight/standing height	26	2·12 ±0·05	26	2·19 ±0·06	15	2·00 ±0·05	45	2·11 ±0·04
Standing height/chest lateral diameter	26	5·81 ±0·08	25	5·93 ±0·07	15	6·03 ±0·07	45	5·93 ±0·07
Chest lateral diameter/chest anterior-posterior diameter	26	1·36 ±0·026	25	1·40 ±0·021	15	1·32 ±0·032	45	1·27 ±0·021

since we combined the data for men with nodulation and those with major consolidation and thus may have weakened the comparison. To test the validity of this possible criticism and to measure the degree of comparability between values for the nodulations and major consolidations, the ratios for these two categories have been calculated separately. The results are given in Table 2 for two age periods, 30–39 and 40 and upwards, a more detailed age classification being inadvisable owing to the smallness of the population. Confining our attention to the higher age group because the numbers are larger, it will be seen that there is some evidence that men with major consolidation are physically rather different from those with nodulation. They are slightly the shorter ($64{\cdot}9 \pm 0{\cdot}33$ as against $65{\cdot}4 \pm 0{\cdot}36$ in.), and the weight is the lower ($137{\cdot}5 \pm 3{\cdot}2$ as compared with $143{\cdot}8 \pm 4{\cdot}2$ lb.). The difference in weight is understandable as it is probably due to further intensification of the disease. There is no difference between the two series for standing height/chest lateral diameter, the value for each being 5·93; but they differ significantly for chest lateral diameter/chest anterior-posterior diameter, the respective values being, nodulation, $1{\cdot}40 \pm 0{\cdot}021$, and major consolidation, $1{\cdot}27 \pm 0{\cdot}021$—yielding a difference of $0{\cdot}13 \pm 0{\cdot}03$ which is outside the limits of chance variation.

The statistics so far produced have been given with the purpose of conveying a broad picture of the physique of this particular mining population. They are unsuitable for our specific purpose of testing whether there is or is not a correlation between any particular anthropometric type and susceptibility to pneumoconiosis. In our mining population we know that some workers did contract pneumoconiosis whilst others did not, and that those who contracted it did so in varying degrees. Hence, before attempting to attribute this varied experience to possible difference in physique it is absolutely necessary, as far as possible, to be certain that all the workers were equally exposed to the risk of contracting pneumoconiosis. We know that this is not true for all those whom we have previously described as 'normals', some of whom worked above ground whilst others worked underground. Accordingly, to obtain a more accurate representation for 'exposure to risk', we have confined the subsequent analysis to those men who had been employed as colliers and who had worked in this capacity for 15 years or more. An exposure of this duration at the coalface was sufficiently long for pneumoconiosis to manifest itself in a high proportion of men at this colliery. In the light of our experience in South Wales our specification is extensive, but as a consequence, it has reduced appreciably the usable population. Although we have sacrificed quantity for quality we are satisfied that we have been compensated by the increased reliability of our data. The number of men it was found possible to include was 86:

20 Normals
30 With reticulation
22 With nodulation
14 With major consolidation.

Since most recruits for mining work enter at age 15, it is probable that in the present selection the respective populations differ inappreciably in their age constitution. But to make certain we calculated the mean age for each classification and obtained the following results:

Normal	...	...	43·6 years
Reticulation	...	...	42·4 ,,
Nodulation	...	...	40·0 ,,
Major consolidation	...		43·4 ,,

In all, thirteen measurements were recorded, and one of these, chest height/chest width, was made from the X-ray plates (see p. 171). The average value for each measurement, with its standard error, for normals or controls, reticulation, nodulation and major consolidation is given in Table 3.

Table 3. *Showing the average measurements of eighty-six men who had worked as colliers* 15 *years or more* (*with or without pneumoconiosis*)

umber exposed	Normals 20	Reticulation 30	Nodulation 22	Major consolidation 14
anding height in in.	65·6 ±0·51	65·3 ±0·38	65·4 ±0·42	66·0 ±0·48
eight in lb.	147·0 ±5·7	146·8 ±3·8	140·6 ±3·4	143·5 ±5·2
eight/standing height	2·24 ±0·08	2·23 ±0·05	2·15 ±0·05	2·16 ±0·07
est lateral diameter/chest anterior-posterior diameter	1·30 ±0·028	1·28 ±0·023	1·31 ±0·027	1·27 ±0·031
anding height/chest lateral diameter	5·71 ±0·09	5·82 ±0·06	5·88 ±0·08	5·94 ±0·09
anding height/chest anterior-posterior diameter	7·33 ±0·17	7·41 ±0·11	7·64 ±0·16	7·55 ±0·14
anding height/chest circumference	1·77 ±0·03	1·79 ±0·01	1·83 ±0·02	1·82 ±0·02
hest length/chest lateral diameter	1·10 ±0·02	1·13 ±0·01	1·13 ±0·02	1·13 ±0·02
hest length/chest anterior-posterior diameter	1·41 ±0·04	1·44 ±0·03	1·46 ±0·03	1·43 ±0·03
hest length/chest circumference	0·34 ±0·006	0·35 ±0·003	0·35 ±0·005	0·35 ±0·005
eg length × 10^3/sitting height × chest anterior-posterior × chest lateral diameter	8·60 ±0·31	8·92 ±0·18	9·20 ±0·28	9·18 ±0·20
-ray chest height/chest width, percentage	85·8 ±2·35	89·0 ±1·13	84·1 ±1·88	90·0 ±1·80

If we make the stringent comparison—controls with major consolidation—we find that for *height* and *weight* respectively the former were the shorter and also the heavier. The comparable values for standing height were 65·6 ± 0·51 and 66·0 ± 0·48 in.; for weight 147·0 ± 5·7 and 143·5 ± 5·2 lb., but the observed differences in neither instance are statistically significant.

Weight/standing height. The combination of these two measurements in the ratio weight/standing height conveys a more adequate anthropometric picture of the individual than either can separately. The ratio for the controls was the larger, 2·24 ± 0·08 as compared with 2·16 ± 0·07, but the difference lies within the limits of chance variation.

Chest lateral diameter/chest anterior-posterior diameter. According to this index there is an inappreciable difference between the controls and the

pneumoconiotics. The ratio for controls is $1{\cdot}30 \pm 0{\cdot}028$, and is slightly smaller, $1{\cdot}27 \pm 0{\cdot}031$, for the cases of major consolidation.

$$\frac{\text{Standing height}}{\text{Chest lateral diameter}}\text{'} \quad \frac{\text{Standing height}}{\text{Chest anterior-posterior diameter}}\text{'} \quad \frac{\text{Standing height}}{\text{Chest circumference}}\text{.}$$
(A) (B) (C)

For each of these standards it will be seen that the ratio for the controls is smaller than that for men with major consolidation: for A the comparable values were $5{\cdot}71 \pm 0{\cdot}09$ as against $5{\cdot}94 \pm 0{\cdot}09$, yielding a difference of $0{\cdot}23 \pm 0{\cdot}13$ which approaches the level of significance. For B and C the observed differences between the two series are less defined.

$$\frac{\text{Chest length}}{\text{Chest lateral diameter}}\text{'} \quad \frac{\text{Chest length}}{\text{Chest anterior-posterior diameter}}\text{'} \quad \frac{\text{Chest length}}{\text{Chest circumference}}\text{.}$$
(D) (E) (F)

According to each of these anthropometric standards there is no evidence that the controls can be differentiated from those who contracted the disease, the values for both being almost identical.

For D the comparable indices are $1{\cdot}01 \pm 0{\cdot}02$ and $1{\cdot}13 \pm 0{\cdot}02$; for E they are $1{\cdot}41 \pm 0{\cdot}04$ and $1{\cdot}43 \pm 0{\cdot}03$; and for F they are $0{\cdot}34 \pm 0{\cdot}006$ and $0{\cdot}35 \pm 0{\cdot}005$.

It has been stressed by Wertheimer & Hesketh (1926) that the measurement which best differentiates asthenics from pyknics is

$$\frac{\text{Leg length} \times 10^3}{\text{Transverse chest diameter} \times \text{sagittal chest diameter} \times \text{trunk height}}\text{.}$$

The nearest approach to this index that our material permitted was

$$\frac{\text{Leg length} \times 10^3}{\text{Sitting height} \times \text{chest anterior-posterior} \times \text{chest lateral diameter}}\text{'}$$

and we applied this standard to our data. We found that the value for the controls was smaller than that for men with major consolidation, the figures being $8{\cdot}60 \pm 0{\cdot}31$ for the former and $9{\cdot}18 \pm 0{\cdot}20$ for the latter. But the difference of 0·58 is 1·6 times its standard error and accordingly does not attain the usually accepted limit of significance.

Measurement from X-ray plates. Finally, we come to our last criterion in Table 3, the measurements of chest height and chest width obtained from X-ray readings. We have previously indicated the positions from which these were recorded, and it seemed that these assessments might constitute the most accurate anthropometric indices. We calculated the ratio chest height/chest width on a percentage basis, and from the values obtained it will be observed that the ratio for colliers with major consolidation is greater than that for the controls, the figures being $90{\cdot}0 \pm 1{\cdot}80$ as against $85{\cdot}8 \pm 2{\cdot}35$; but the difference 4·2 is only 1·4 times its standard error and is therefore not significant.

DISCUSSION

In the previous pages we have described broadly the anthropometry of 540 men with and without pneumoconiosis, working in a particular colliery in South Wales in which the incidence of pulmonary abnormality is high; and we have analysed in greater detail a particular section of this population, eighty-six colliers, who had experienced an exposure at the coalface of not less than 15 years. It has been suggested by some authorities, without adequate support by published statistical data, that asthenics have a greater susceptibility than pyknics to certain forms of silicosis. Admittedly our population is small, but from the many measurements which we have recorded we should at least be able to give a partial answer. The issue is very important because if it is possible to identify a type, then, by careful selection of the entrants, the incidence of serious silicosis could be reduced. But it is at first essential to have a clear concept of what is an asthenic and what is a pyknic. The general acceptance is that the former is 'tall and thin', the latter 'short and tubby'. There is much indefiniteness in this classification, which correlates badly with the measurements originally made by Kretschmer on the two types. According to his figures asthenics could not be differentiated from pyknics in terms of height, but there is some evidence that they varied in weight. In our series there is no evidence that the normals or controls are identical with pyknics, and the major consolidations with asthenics. The average height of either type differs inappreciably from a mean value of roughly 65·5 in. Hence we maintain that standing height alone cannot be utilized as a criterion for selection.

There is, however, some evidence that standing height in relation to certain other standards, more especially standing height/chest lateral diameter, is the best differentiator available between normals and advanced pneumoconiosis. According to our results the value for the collier normals is $5{\cdot}71 \pm 0{\cdot}09$, for colliers with major consolidation $5{\cdot}94 \pm 0{\cdot}09$, a difference which, although not significant, is 1·8 times its standard error. Furthermore, there was a progressive increase in the size of the ratio as one passes from normal to the more marked changes, the value for reticulation being $5{\cdot}82 \pm 0{\cdot}06$, nodulation $5{\cdot}88 \pm 0{\cdot}08$ and major consolidation $5{\cdot}94 \pm 0{\cdot}09$. This is the only anthropometric index which had this correlation. It should be recognized that even this correlation might be a secondary consequence of changes in configuration of the chest (e.g. through contraction) due to progression of the disease, and not an indication of varying predisposition. On the other hand, it might equally well be argued that the disease tended to produce such changes in configuration (e.g. emphysema) as would obscure a *greater* correlation due to predisposition.

The next best selective standard in our experience was that modified from the index used by Wertheimer & Hesketh:

$$\frac{\text{Leg length} \times 10^3}{\text{Sitting height} \times \text{chest anterior-posterior} \times \text{chest lateral diameter}}$$

which for collier controls yielded a value of $8{\cdot}60 \pm 0{\cdot}31$, as compared with $9{\cdot}18 \pm 0{\cdot}20$ for colliers with major consolidation. The observed difference is 1·6 times its standard error.

We were inclined to regard the readings chest height/chest width as obtained from X-ray plates as possibly affording a better demarcation between pneumoconiotics and normals than standing height/chest lateral diameter. Contrary to our expectation, however, they failed to separate satisfactorily the two types. Thus, when the difference between the values for collier controls and for colliers with major consolidation was tested for significance it was found to be only 1·4 times its standard error.

Since, as we have already shown, standing height in terms of lateral diameter was revealed to be the best criterion we made a more stringent test on this index. We selected twenty-two observations which had the lowest ratios, and twenty-two which had the highest, and allocated them to the respective categories of normal, reticulation, nodulation and major consolidation, with the following results:

	Total	Normal	Reticulation	Nodulation	Major consolidation
With lowest ratios	22	9	6	5	2
With highest ratios	22	4	7	5	6

and found that the difference between these distributions was no greater than that which could arise by mere chance. Hence, although the difference obtained when standing height/chest lateral diameter is used as an index is the nearest approach to significance, yet it is not sufficiently large to be capable of identifying the future pneumoconiotic case.

As regards chest length in combination with the other three anthropometric standards, there is little or no divergence between the comparable values. For chest length/chest lateral diameter the ratio for the collier normals was $1{\cdot}10 \pm 0{\cdot}02$, and for colliers with major consolidation $1{\cdot}13 \pm 0{\cdot}02$, an insignificant increase; and it will be noted further that, for colliers in different stages of pneumoconiosis, the value was static at 1·13. For the other two combinations the statistical experience is similar to that just described. Hence it will be seen that the external measurements of chest length, no matter with which particular combination, appear to be of little use for selective purposes.

Conclusion

From the analysis which we have made we can conclude that, according to our data, there is a slight correlation between an anthropometric type and susceptibility to pneumoconiosis, but it is not possible to forecast with any degree of accuracy that one particular examinee is more likely than another to develop pneumoconiosis.

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