Contributions to vital statistics, obtained by means of a pneumatic apparatus for valuing the respiratory powers with relation to health / by John Hutchinson.

CONTRIBUTIONS

TO

VITAL STATISTICS,

OBTAINED BY MEANS OF A PNEUMATIC APPARATUS FOR VALUING THE RESPIRATORY POWERS WITH RELATION TO HEALTH.

By JOHN HUTCHINSON, Esq., Surgeon, F.S.S.

[*Read before the Statistical Society of London, June 17th*, 1844.]

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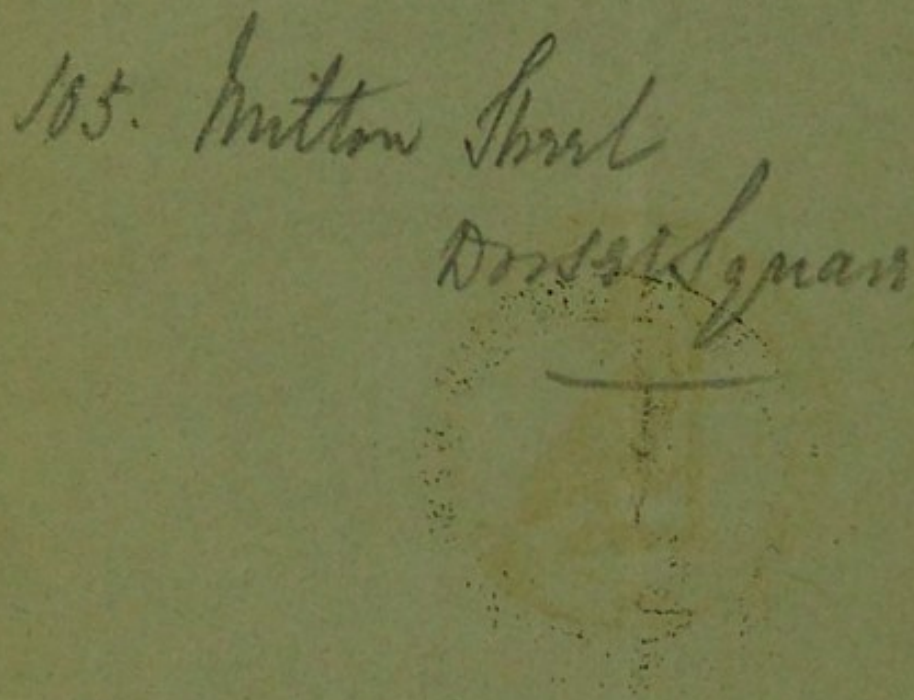
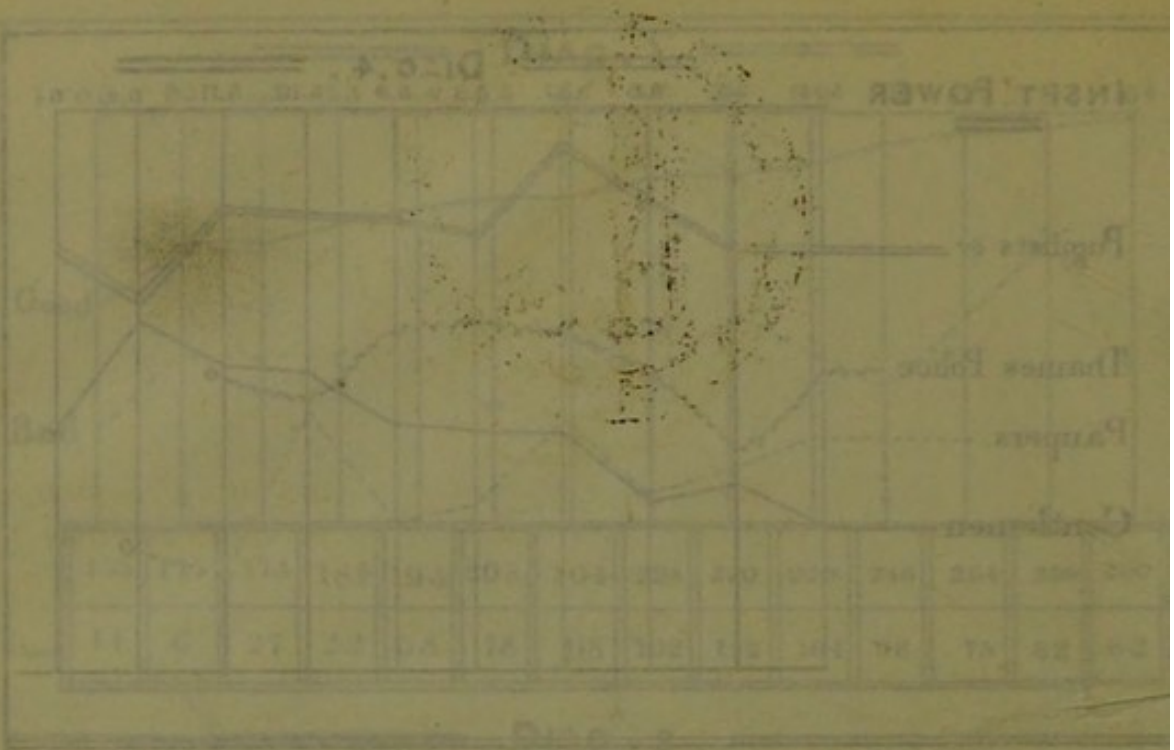
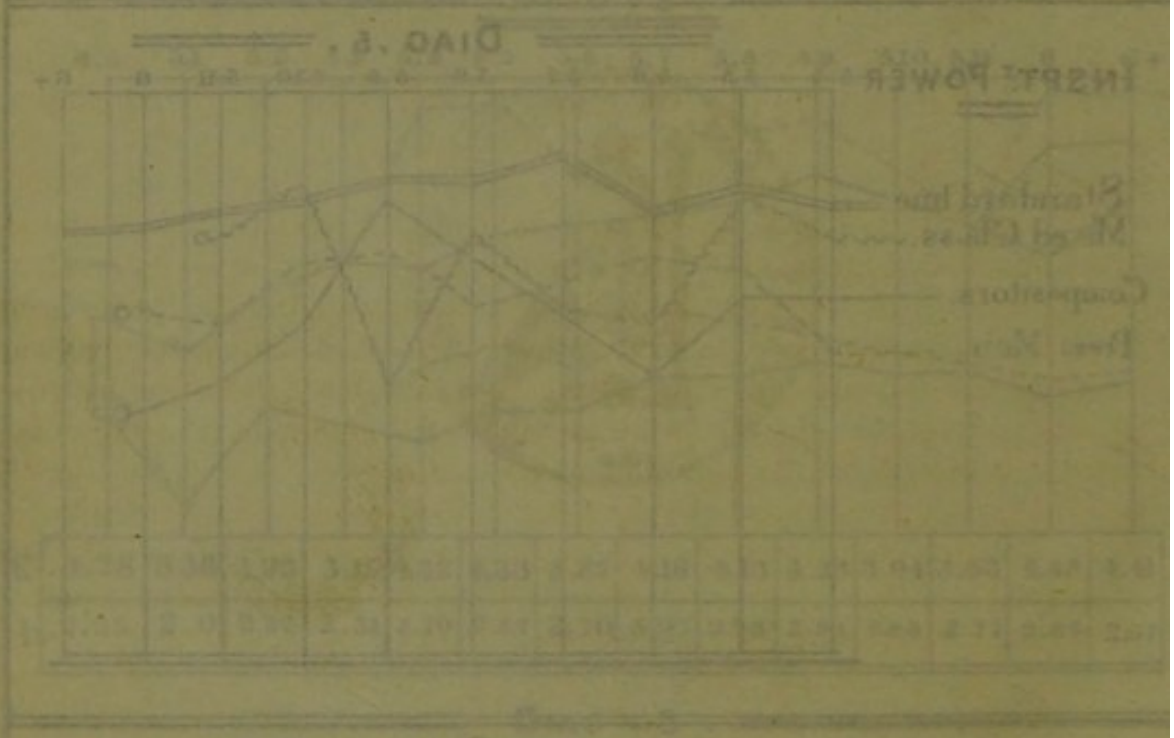
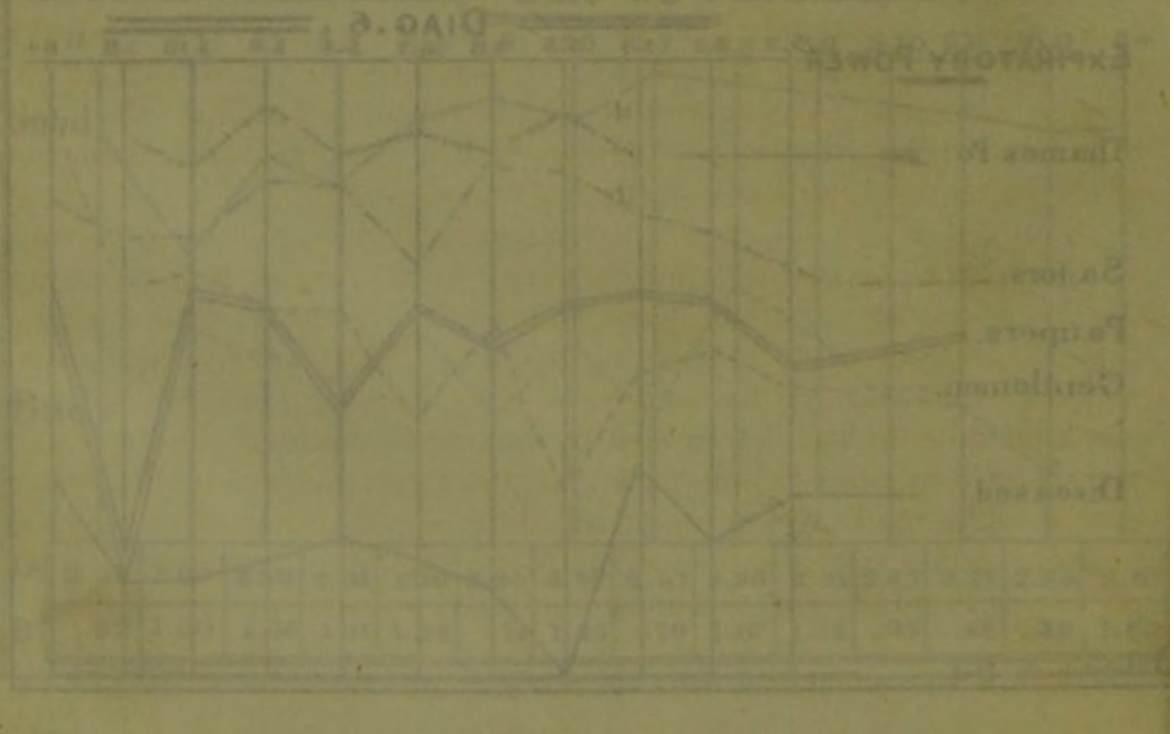
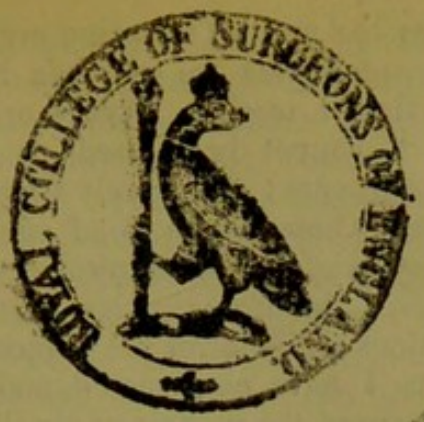



ROYAL COLLEGE OF SURGEONS OF ENGLAND









Contributions to Vital Statistics, obtained by means of a Pneumatic Apparatus for valuing the Respiratory Powers with relation to Health. By John Hutchinson, Esq., Surgeon, F.S.S.

[*Read before the Statistical Society of London, June 17th*, 1844.]

If in the present day there is one subject pre-eminently engaging the public mind, it appears to be, the best means of preserving the public health. And if any one among the various divisions of that subject can be ranked before another on the score of utility, it should seem to be, that regarding the effects produced on individual health by particular occupations.

The earliest original contribution to this branch of knowledge which has come under my notice, is that by Ramazzini, of Padua, published in English in 1705, and which much redounds to the credit of the author. The only other book of which I am aware, is that written in the present time by our countryman Thackrah, whose labour in this cause has far surpassed that of all others. Many journals have bestowed praise on this author, but it appears to me they have all come short of the commendation which is due to his industry and accuracy.

It is generally the custom to estimate the healthiness of a trade by the mortality among the individuals employed in it; but, however correct this system may be, it is an expensive method of coming to the conclusion; since, in this way, we do not count the effect of a certain trade upon health until so many per cent. *have* fallen victims to it. Deducting from these a given number of cases as uncertain, this *fatal* list is still of little value until compared with other fatal lists. The object of the present paper is to make known some researches, the result of which induces me to venture a new method of determining the effect of trades upon health, by ascertaining the *presence* of disease, and the extent of deterioration in the health of a living individual.

The pathologist, in the present day, not only weighs and measures the dead subject as a whole, but carefully weighs every internal organ, and often ascertains the cubic measurement of the heart also, that he may inform himself as to the seat of disease. Here we see that *measurement* is made one of his guides in thus inquiring into the seat of disease; for after he has determined by numerous observations the natural weight or dimensions of an organ, he justly concludes that all similar organs, if differing from this standard, differ so on account of disease. Such is the grand harmony of our structure, that proportion and symmetry are as much displayed amidst the internal organs as in the external form.

And again, the physician, when inquiring into the state of his patient,

desires to know whether the natural secreting organs are acting in excess or in deficiency, and upon this he grounds his opinion as to the healthiness of the particular organs. Every organ, then, has its appropriate action, which cannot be altered to any material amount without the presence of disease; and surely this argument applies with some force to an organ whose action is of such vital importance that its suspension for a very brief period terminates our life. I mean, the "*respiratory functions*," the investigation of the different states of which in various conditions of life forms the subject of the present paper.

With the instruments I have constructed, and which are now before the Society, I have measured the *volume* of air that a man can force out of his chest, together with his *power* of inspiration and expiration; these observations I have connected with the state of his health, because I find this to vary according to his volume and power of expiration and inspiration.

Simple as this method appears to be, it is extraordinary that up to this time very few have been the physical experiments made upon the lungs, so as to determine with any accuracy even their absolute capacity; and we are perfectly ignorant as to how much air is necessary for our well-being; nevertheless, this knowledge is perfectly accessible, and the present observations will assist in forming that chain of inquiry.

Physiologists generally divide respiration into three or four different stages, and these again will admit of numerous subdivisions.

My object has been, first of all, to determine *what quantity of air we are able to expel from the lungs by the greatest voluntary effort* we are capable of exercising. Owing to the various terms given to designate the different divisions of respiration, I have found it difficult to separate this division from the chaos of physical experiments hitherto made upon the lungs. And what I have gathered from them is of *little* value, not being connected with any other observations upon the human frame. Another object of my inquiry has been, to determine the *power* of the *inspiratory* and *expiratory* muscles; so that observations upon the *volume* of the lungs, and the *power* of these two classes of muscles, form the foundation of the present research, combined with certain external measurements.

I may here mention that, for brevity's sake, I have used the term "*capacity*" to signify that quantity of air which an individual can force out of his chest by the greatest voluntary expiration, after the greatest voluntary inspiration.

With these introductory remarks, I now proceed to the matter of this paper.

One thousand one hundred and fifty-one individuals, of different occupations, have been carefully examined; and, by Table C, now suspended before the Society, the various classes, also the numbers composing those classes, are thus arranged:—

TABLE C.

Sailors	121	Pressmen	30
Fire Brigade	82	Compositors	43
Police, Metropolitan	144	Draymen	20
Police, Thames	76	Gentlemen	98
Paupers	129	Diseased cases	60
Mixed Class (Artisans)	162	Miscellaneous cases	13
First Battalion Grenadier Guards	87		
Royal Horse Guards (Blue)	59	Total	1,151
Pugilists, &c.	24		
Anomalous cases	3		

I must here pause a moment to express my thanks to certain gentlemen, who with the greatest liberality and politeness have rendered me every assistance in their power to obtain these cases, and any other facility I might require towards my object: viz., Mr. Farr; Dr. Balfour; Surgeon-Major Johnston, and Assistant Surgeon Mr. Hurthwaite, of the first battalion Grenadier Guards; Mr. Gulliver, of the Royal Horse Guards; Mr. Fisher, for the police force; Dr. Boyd, for the paupers in the Mary-le-bone infirmary; Captain Bazalgette, for the sailors; Mr. Braidwood, who twice summoned his whole brigade force for my examination; Mr. Taylor, for the printers; Dr. Taylor and Dr. Williams for the diseased cases; also to Mr. Tibson; and last, though not least, for the liberal assistance of Mr. Brent, whose acquaintance with the physical proportions of man I believe to surpass that of all other men in Europe.

Each of these 1151 individuals was submitted to the observations given in Table B, here suspended, viz.:—

Number of cubic inches given by a full expiration.
Power of inspiration.
Power of expiration.
Height.
} Height.

Circumference of the chest over the nipples.
Weight.
Pulse.
Number of respirations per minute.
Age.
Temperature of the air expired into the receiver.

The detailed accounts of these observations upon this multitude are given in full, MS. Table, where it will be seen that upwards of 10,000 facts have been gathered together.

Each individual breathed three times into the machine, because, either from timidity or inexperience, the first observation was frequently not a correct experiment, but by three observations it is possible correctly to ascertain the point. But if more observations than three be made at the same time, the number of cubic inches of air will, from fatigue, be found to decrease. Moreover, so constant is the quantity of air in the lungs, that I have frequently examined men 18 months or two years afterwards, and have never found a variation exceeding two cubic inches: and although I have blown into this instrument not less than 2000 times, I cannot exceed 247 cubic inches at 60°. The operator in a little time becomes so well acquainted with the process of taking an observation, that he can readily tell when the individual under examination has done his utmost, and also determine the correctness of the experiment. The time required to pass a person through the whole of these observations, is three minutes.

A minute description of the mechanical construction of the two principal instruments, I have already read before the Society of Arts (29th May); therefore I will not detain the present meeting upon this branch of the subject; different sections of the instruments are represented by diagrams here exhibited, and may be referred to if required. Yet I may briefly state that the three observations, viz., those of the capacity, power of inspiration, and power of expiration, are determined by two instru-

ments;—the *capacity* by the large brass machine, now before the Society; the *power* of the two classes of muscles by the other instrument on the right. The breathing machine is principally constructed as an ordinary gasometer, one vessel inverted within the other; the outer cylinder contains water, the inner receives the breath, by which it is elevated, assisted by counterbalance weights. This receiver is graduated into cubic inches; therefore to whatever height the receiver is raised by the breath, the cubic inches are determined. Fig. 1* is a front section of this instrument with the receiver partly elevated. Fig. 2 is a ground plan of the same. Figures 4 and 5 are lateral sections of the same. The instrument for valuing the respiratory power is represented by Fig. 6; the resistance is a column of mercury in a tube which, upon being elevated or depressed, moves the index on the dial, which is divided into inches and tenths, with certain words differing in meaning, fixed opposite certain figures, their position having been determined by 1200 experiments. The words and figures are given on Table A; on the left side are the figures for *inspiratory* power; on the right those for *expiratory* power.

Power of Inspiratory Muscles. Inches.		Power of Expiratory Muscles. Inches.
1·5	Weak	2·0
2·0	Ordinary	2·5
2·5	Strong	3·5
3·5	Very Strong	4·5
4·5	Remarkable	5·8
5·5	Very Remarkable	7·0
6·0	Extraordinary	8·5
7·0	Very Extraordinary	10·0

It will be observed that the power of expiration is nearly one third *stronger* than that of inspiration. This power is taken by the nostrils; I first used the mouth, but the tongue and cheeks possessing a strength six or seven times greater than that of the true inspiratory muscles, and the difficulty of separating these two powers, compelled me to make all the experiments by the nostrils.

The *order* of taking the observations given on Table B was in the following manner. The hand of the person to be examined was placed over the abdomen, in the sitting posture; the pulse was numbered, and also the respirations per minute; this twofold operation was kept secret from the individual, or the number of his respirations would have been modified. I next took his height, weight, and circumference of his chest; then three forced and full expirations were made into the spirometer; and, lastly, his power of inspiration and of expiration was tested. I cannot here give time to explain how errors may be detected; they sometimes arise from simple mistake; sometimes from an intention to deceive; but with a little skill on the part of the operator, *no* deception can be successfully practised. When the two experiments upon the inspiratory and expiratory muscles are properly made, there is a peculiar look in the eyes and over the whole countenance. There is not the least danger to be apprehended in this operation. I have found nothing injurious occur out of 1200 persons submitted to this test, including the diseased cases.

The whole matter of the present research may be divided into the

* All the "*Figures*" refer to coloured diagrams exhibited before the Society, but which are not here introduced.

consideration, first of the healthy cases, and secondly of the diseased cases.

It will be self-evident that until a healthy standard be determined, I have no means of detecting by measurement the inroads made upon the organs by disease: therefore I have collected as many classes of men as possible, and submitted them carefully to the test of these instruments; and I believe that I have made experiments enough to point out what is the *healthy standard*, and hence to deduce what may be considered as an indication of disease.

My first object was, to discover whether any relation existed between this "*capacity*" of the lungs, inspiratory and expiratory power, and any other external and physical sign; therefore I submitted the whole number of subjects to all the observations enumerated in Table B (page 3), and to my gratification I *did discover* a relation *intimately existing* between this capacity and power, and the *height* of the individual, as I have indicated by the bracket on that table. I shall demonstrate most clearly to this Society, that so uniform is this relation, that if I be allowed to take a man's height, I can tell what the capacity of his lungs and his inspiratory and expiratory powers should be, to constitute him a healthy individual.

Therefore, as height can with ease be definitely determined, and is less changeable than any other of the physical observations taken, we have at *all* times a simple method of determining the presence of disease, first in the chest, and secondly in the head and abdomen, or trunk, of the body.

These two tables, C and B, admit of numerous interesting calculations, many of which have been gone through, and remarks will be made upon them as may be required.

The first *grand point* I wish *especially* to draw the attention to, is the capacity of the lungs of what may be considered healthy individuals. Let us turn to Diag. 1, where I have drawn fourteen perpendicular lines, which are to indicate different heights: the first line on the left is to indicate all heights up to and including 5 feet: the second line includes all FROM 5 feet to and including 5 feet 1 inch, the next FROM 5 feet 1 inch to and including 5 feet 2 inches, and so on, increasing inch by inch, up to 6 feet; all above 6 feet come under 6 feet +. The horizontal line or curve indicates the capacity or quantity of air that 1088 individuals manifested by this "breath-meter," the difference of quantity being denoted by the elevation or depression of this curve, as it passes over the perpendicular lines. The number of cases examined under each height is given in the bottom row of figures, a point most necessary to be acquainted with, as that stamps the value of the curve as it passes over the lines for indicating heights. The row of figures above this are the number of cubic inches obtained from the mean of so many cases as are marked in the bottom row of figures: thus, under the height 5 feet 8 inches, 172 persons have blown, and the *mean* of these men will be seen as 220 cubic inches,—32 of these men out of 172 were below 200 cubic inches, the rest above; so that I expect every man between 5 feet 7 inches and 5 feet 8 inches, if healthy, to blow out of his lungs *about* 220 cubic inches of air at 60°; but if he cannot throw out of his lungs *more* than 185 cubic inches, I should most decidedly suspect disease to be present; and again, if a 6 foot man,

whose capacity is marked as 255 cubic inches, could only blow 200 or 220, the healthy mark for the 5 feet 8 man, I should in like manner suspect disease. The exceptions to be made, are for *very stout* and *corpulent* individuals, whose capacity I find to stand the lowest. Very fat men of any stature, therefore, may blow 40 or 50 cubic inches less than the mean, and yet not be diseased in the chest. It simply requires more observations upon the corpulent than I have had an opportunity of making, to determine their capacity. So beautifully regular is the increasing capacity with the height, that the curve on Diag. 1 is nearly a perfect ascending line; and I have no doubt but that if I had examined twice the number, the line would have been elevated in a perfect arithmetical progression. In confirmation of this, I will call the attention of the Society to the following table, *singularly gratifying* to me, and which I feel fully to reward my labour in working out this subject.

The three columns of figures exhibits the relation between height and "*capacity.*" The first column contains the various heights between 5 feet and 6 feet; the second column, the series of cubic inches derived from observation under each height; and the third column, the series of cubic inches in arithmetical progression: thus,

Heights.				Series derived from Observation.	Series in Arithmetical Progression.
		Mean.			
Ft.	In.	Ft.	In.	Cubic Inches.	Cubic Inches.
5 0 5 2		5	1	175·0	174·
5 2 5 4		5	3	188·5	190·
5 4 5 6		5	5	206·	206·
5 6 5 8		5	7	222·	222·
5 8 5 10		5	9	237·5	238·
5 10 6 0		5	11	254·5	254·

Hence I deduce a rule, viz. that "FOR EVERY INCH OF HEIGHT (FROM 5 FEET TO 6) 8 ADDITIONAL CUBIC INCHES OF AIR AT 60° ARE GIVEN OUT BY A FORCED EXPIRATION." Here at once is a guide for the operator, and a rule given that will enable us to compare men of different stature and different trades one with another, which may be done by referring to a table (I. page 15), where the mean capacity from whence I deduced this rule will be seen, and any comparison among thirteen classes of men may be made. In this table, the similarity is remarkable between the second and third columns: if we mark out the unit figures in each, the numbers become, with one exception only, quite the same; and where this difference is, viz. at 5 feet 3 inches, 188·5 instead of 190, the number of persons here examined are so few compared with the numbers examined under the heights following, that this may account for the trifling difference here apparent.

The mechanical act of respiration depends essentially upon increasing the cavity of the thorax; this is accomplished principally by flattening

the arched floor of the chest (the diaphragm). It is attempted to illustrate this by Fig. 7; C is the space allotted to the organs of respiration; the black outline is to represent the chest filled to its maximum with air after the deepest inspiration; the black line E may be considered as the floor or diaphragm; the inner and red line is to represent the chest after a forced and full expiration has been made, when, it will be observed, the arch of the diaphragm E is considerably increased, and the red line G is considerably depressed. Thus we may liken the act of respiration to the operation of a pair of common bellows; it follows, that the space existing between the red and black line, marked B B, is measured by the spirometer; hence it is certain that whatsoever disease impedes this mobility of the walls and floor of the chest, the amount of impediment will be manifested by this machine; moreover, it is *self-evident*, that as the lungs are the sole receptacle for the air we breathe, whatever disease there may be which affects their permeability for air, it will be manifested by the spirometer; and I believe that *no* disease can be detected in the chest that will not be found attended by a change in the bulk of air in the lungs.

If this be granted, how important is it to examine the *capacity*, as an *adjunct* to the other means of *detecting* disease amidst these vital organs.

I will now draw attention to the observations I have made upon diseased cases, which confirm me in this last assertion. On Diag. 1, I compare the diseased with the healthy cases. The upper line is the same as already noticed, to which is affixed the word "*good:*" the lower line contains the diseased cases. The difference between the two classes is very marked, and must forcibly impress us that this method of detection is highly worthy of attention.

I am sorry that the number of diseased cases is so small, but this even speaks more favourably for the distinction between the healthy and diseased cases; for had there been more cases, the curved line would have been much less curved. Whereas, with few cases, *one* disturbing observation is clearly seen. We here see that the mean capacity of the diseased scarcely exceeds one half of that of the healthy, if it be so much.

The full particulars of the diseased cases have been taken down in the table of observations; amongst which there will be seen 20 cases of consumption in various stages. There are 12 cases in the earliest stage of this disease. I shall here give the capacity of these as observed, compared with the mean of the healthy cases of the same stature.

TABLE Q.

Early Stage of Consumption.

Capacity of Diseased. Cubic Inches.	Capacity of Healthy. Cubic Inches.
113	220
105	173
128	220
100	193
100	204
136	229
115	173
130	204
120	229
140	246
110	220
135	204

In the more advanced stage of the disease, the difference is much more considerable: thus,—

Advanced Stage of Consumption.

Capacity of Diseased. Cubic Inches.	Capacity of Healthy. Cubic Inches.
59	135
89	224
108	254
72	135
80	229
75	254
34·5	246
18	183

It is truly interesting to witness the broad difference here exhibited.

Not only does disease in the chest limit the natural capacity; but also an enlargement of any of the visceral organs, acting so as to prevent the arch of the diaphragm freely alternating in its curve. A moderate meal reduces the "capacity" from 4 to 6 cubic inches, and a plentiful dinner from 9 to 14 inches, according to the powers of the individual at table. The capacity of those who suffer from curvature of the spine is most remarkably small. One person was so low as 27 cubic inches, being the utmost quantity he could throw out of his chest by one full expiration.

The greatest capacity I have ever witnessed was that of Freeman and Randall, both measuring upwards of 6 feet 11½ inches. Freeman's capacity was 432 cubic inches, and Randall's 464 cubic inches. The lowest healthy capacity I have examined is that of Robertson, height 3 feet 9 inches, being 80 cubic inches; and it is worthy of mention that when you reduce the giant Randall down to the size of Robertson, *i. e.* by taking off $\frac{1}{3}$, and $\frac{1}{6}$ of his height, breadth, and depth, the capacity of the giant is then reduced to 79·56 cubic inches, which is *within* half an inch of the actual quantity blown by Robertson.

The capacity of all the classes examined may be compared by referring to a table here suspended. (See Table I., p. 15.)

The relation between the capacity of the lungs and circumference of the chest appears as yet so feeble, that it is no guide to me.

I have combined this calculation of circumference and capacity, which will be seen amongst the other tables handed round; where, it may be observed, that the mean of 11 men of 5 feet 8 inches, whose chests measure 35 inches in circumference, has a capacity of 235 cubic inches, while that of 10 men of the same height, whose chests are 38 inches, is only 226, being 9 cubic inches less. I may here mention, that it was in consequence of so often witnessing tall, narrow-chested men blowing so much more than broad-chested men, that I was induced to combine the height of the individual with the capacity. The only parallel remark I have seen in physiological writers upon respiration is that by Müller, who says (page 294, 1st ed., vol. i.)—"Herbst found that adults of large stature, when breathing tranquilly, inspired and expired from 20 to 25 cubic inches; persons of smaller stature 16 or 18 cubic inches."

I must now pass on to the other *grand* series of observations, upon the "*power*" of the inspiratory and expiratory muscles of the healthy in different classes, and of the diseased.

By the power of inspiration and expiration, I mean the greatest effort that can be employed by all those muscles used in performing

that function; and it will be found that if this observation be connected with the "*capacity*," we possess a *sure method* of detecting disease in the most important part of the human frame. The instrument with the dial face is that with which the observations have been made.

The resistance afforded to test these muscles was that of mercury, and according to the inches elevated by the respiratory muscles, in proportion was the index hand moved opposite certain figures, by which figures I denominate a certain power either of inspiration or expiration, so that, according to the value of the figure, such is the relative power required to elevate the index to that figure. Hence the resistance is perfectly the same, whether we draw out of or blow into this tube, and *must* therefore measure the relative difference between inspiration and expiration. By a comparison of these efforts in different classes, I estimate the health of men employed in different trades, as will be shown. Certain words are affixed to these figures, as exhibited on Table A. (page 4); the figures on the right side denote the powers of inspiration; those on the left, those of expiration. It will be observed that the figures on the right are much higher than those on the left, because the power of *expiration* is greater than the power of *inspiration:* thus a "*remarkable*" inspiration is 4·5 inches, while that of expiration is rated at 5·8 inches. These words are engraved on the dial, and are so fixed according to the result of 1100 observations. Diag. 2 is given to illustrate, upon the same principle as Diag. 1, the *power* of inspiration of 13 different classes; the perpendicular lines indicate the gradation of heights from 5 feet to 6 feet. The direction of the black curve marks the power of these 13 different classes; it will be seen to ascend gradually up to 5 feet 9 inches, from thence as gradually to descend; therefore the power of all these classes is greatest at 5 feet 9 inches. This line must not be taken as the true line of health. The line which I mark immediately above it is the one I term the "standard of health," because this dotted line is calculated from four classes of men, selected by surgeons as healthy, viz. Firemen, Metropolitan police, Thames police, and Royal Horse Guards (Blue).* In this standard line, the men of 5 feet 7 inches elevate 3·07 inches of mercury; and those of 5 feet 8 inches, 2·96 (nearly 3 inches); whereas in the black line, the course of the mixed multitude, the men of 5 feet 7 inches and 5 feet 8 inches elevate only 2·65; and the 5 feet 9 inches men, 2·75. This depression of the black curve is in consequence of the weakness of the paupers, gentlemen, mixed class, and printers, being here included. According to the dotted line, the most powerful men are found at the height of between 5 feet 7 inches and 5 feet 8 inches.

For the convenience of the members present, I have reduced the height between 5 feet and 6 feet into four divisions, with the powers of inspiration and expiration of all the 13 classes, so that any combination of comparison between the different bodies of men may be made. (For the complete table see page 16.) The conclusion to be drawn from the inspiratory power is, that a man of 5 feet 7 inches or 5 feet 8 inches, if healthy, should elevate 3 inches of mercury. If this be recollected, we see the gentlemen stand very much below this mark, only 2·15 inches; so that I am compelled to call a gentleman a

* Their powers are given in Table II. (p. 16, 17), as "the mean of four healthiest classes."

tolerably good gentleman of the middle stature, who can elevate 2·5 inches by his inspiratory muscles; but it is curious to remark, that at 5 feet 9 inches, 5 feet 10 inches, and 5 feet 11 inches, they stand better than the Thames police, and nearly as good as the fire brigade—the two best classes of men which have been submitted to this test.

It will be seen that in this table the Grenadier Guards stand very high between 5 feet 3 inches and 5 feet 6 inches; but it must be recollected there are only four examined under this height; and the fact of their being *fifers*, whose vocation is the constant use of the respiratory muscles, causes this class to stand high at this particular height. Let us now turn to Diag. 2, where the expiratory power is compared with the inspiratory power. The upper black curve is the expiratory power of the 13 classes; the broken highest line is the expiratory power of the four healthiest classes: there will be seen a vast difference between these two classes of muscles, which must be interesting to the physiologist. Here is exhibited the result of upwards of 1000 cases, which demonstrate that expiration is about one-third stronger than inspiration. And moreover, I confidently affirm that if the expiratory muscles are not stronger than the inspiratory muscles, disease is the cause of this variation.

The test upon the expiratory muscles peculiarly tries the abdominal viscera. I have frequently detected hernia (rupture) by this means: but where persons have a hernia, well supported by a truss, and have no *fear*, they may pass detection; but this has seldom occurred during the observations I have made. I have also often detected those who are subject to severe head-aches and fits by these means, and frequently rupture of the drum of the ear. It is also worthy of remark, that I have found rupture of the drum of the ear manifested only in one direction; hence the expiratory force may detect it, and not the inspiratory; or the contrary may occur. Sometimes the rupture is detected by both the experiments, but this is rare. I mentioned this fact to Mr. Gulliver, who said it perfectly corresponded with what he was induced to believe through other means.

I may mention a case in point, of a strong drayman, whose power of expiration naturally was manifested at ·55 of an inch; but when I requested him to stop up his ears with his fingers, his expiratory power was 5·50 inches, while his inspiratory power in both cases, *i. e.* with his ears open or shut, remained at 3·70; hence, when I found his *expiratory* power nearly 10 times less than his *inspiratory*, it was evident that something was wrong.

This, together with other facts, may be seen upon referring to the manuscript table of diseased cases, which I here hand round to the members.

The crossed line at the termination of the expiratory curve (Diag. 2.) marks the direction the cases would take were the Horse Guards omitted. These men being enlisted under the superintendance of Mr. Gulliver, the curve exhibits the skill of selection; hence it mounts considerably at its termination.

Had I not examined this regiment, I should, from past experience, have considered 6 feet men much weaker; I do not believe any other regiment of 6 feet men to possess such power. The inspiratory power of twelve 6 feet men in the first battalion Grenadier Guards was only 1·92

inches, while that of 31 of the same height of the Blues was 2·71 inches; the latter elevating by the diaphragm *many* pounds of mercury more than the former. I am induced to believe that the test upon the inspiratory muscles is a sure guide to the state of a man's health. The expiratory muscles, owing to a man's vocation, may be trained to an enormous extent, as I noticed in the fifers. I have remarked the same in jewellers who use the blow-pipe much. Therefore, when a man's trade is such as to call these muscles much into use, we must rate his expiratory power at a higher figure. I shall show this shortly by the tables here suspended.

We have seen the "capacity" of the lungs of the healthy and diseased cases compared; now I will exhibit, by Diag. 3, the like comparison of the *inspiratory power* between the same.

The upper line to which is affixed the word *good*, is the same noticed as the lower broken line in Diag. 2; the lower black line is the curve of the diseased. The weakness induced by disease in the trunk of the body is here as *broadly* indicated as that of the capacity, being about one-half: had the cases been more numerous, this curve would have been more regular, and I believe lower than it appears at present; therefore the few cases test the comparison the better. When we combine the capacity and power together, there is a certain harmony which must pervade the three observations, *provided* the individual is *healthy*. Hence, I venture to say, the instruments for estimating *capacity* and *power* will clearly test the presence of disease.

I shall now pass on to exhibit the effect of occupations upon the inspiratory power: as I believe the inspiratory power to indicate the state of the general health, the comparison will be interesting; and if it be found to agree with what other observers have mentioned, this will prove its correctness also.

Diag. 4 shows the comparison between four classes—pugilists, Thames police, paupers, and gentlemen. The black continuous line at the bottom is the path of the gentlemen; the next above, that of the paupers: it will be seen, these two classes struggle in company up to 5 feet 7 inches, at which height the gentlemen mount up to a superior elevation.

The waved line represents the Thames police, a remarkably fine class of men, the sudden fall, observed at 5 feet 10 inches, and 5 feet 11 inches, is owing to the comparatively few numbers examined at this height. A slight cold in the head (as it is termed) of one individual, may have occasioned this.

Above all these are the pugilists, without exception the finest class of men I have examined: in fact we may consider each man of this class as a series of men, for we know not how many fall down the ladder of their fame, before they arrive at that step where I examined these. I may mention it was not a little difficult for me to examine these people, since the correctness of the observation depends upon the air passage in the nostrils being free, and I have not unfrequently found these passages stopped up, from the consequences of their professional *engagements:* I therefore had recourse to testing with the mouth, a method always liable to error, from the power of the cheeks and tongue interfering.

According to the elevation of these lines I estimate the vital powers.

I here exhibit a similar table of comparison between the standard line

of health, and the paupers: how far poor-house diet may be connected with this lowering of the line, I must leave for others to determine. Age doubtless must be taken into account, but, it appears to me, not until after 50.

In Diag. 5, I compare three very unhealthy classes with the standard line. The continuous line at the bottom, represents the compositors, the very *worst* men I have examined; they even stand below the paupers, except at the heights of 5 feet 8 inches and 5 feet 9 inches. The broken line are the pressmen, a better class of men altogether, with the exception of one dip between 5 feet 8 inches and 5 feet 9 inches, but this was caused by one solitary instance, and that was at the height of 5 feet 9 inches. Nearly between these two classes will be seen the waved line indicating the course of the artizans, a very poor set of men. The double line is the standard line, above all.

Numerous other comparisons of the inspiratory powers may be made between different classes, by referring to Table II. p. 16. I shall now pass on to the expiratory power.

Diag. 6, gives the expiratory power, and exhibits by the bottom line the diseased cases: the dotted line above that is the curve for the gentlemen, the double line above is the paupers, and these two, for the most part, are closely mingled together, up to 5 feet 10 inches. It cannot be said that the paupers here are the worst. The broken line above that, are the sailors; and above them again, the crossed line are the Thames police.

As an illustration of employment increasing the expiratory power over the inspiratory power, I would just refer to Table II. p. 16, wherein the inspiratory power of the Thames police, and that of the Metropolitan appear as nearly equal as possible; but if we look at another of these tables, we see the expiratory power of the Thames police greatly exceeding that of the Metropolitan police. This minute separation of power between these two classes is very satisfactory, exhibiting that the one class of men use their upper extremities more than the other. The Metropolitan policeman deters the thief by the activity of his lower extremities; the Thames policeman, by that of his upper extremities. Many other interesting combinations might be made from the 10,000 facts I have gathered: thus, for instance, we see, the prevalent weight of the 1151 individuals, is from 10½ to 11 stone; next, 12 stone; next, 12½ stone; next, 9½ stone; next, 13 stone; next, 13½ and 14 stone; and lastly, 7½ and 15 stone.

Table V. (p. 20), shows the number of ordinary respirations per minute, observed when in the sitting posture. It will be seen that the greatest number of individuals breathe 20 times a minute; next to this, is 16 times per minute; then, 24; these, it will be seen, are the prevailing numbers; the lowest was 9 respirations, and the highest 40 respirations, per minute. It is worthy of mention that by this table the respirations appear more generally an *even* number of times per minute than otherwise.

Table VI. (same page) exhibits in like manner the beats or pulsations of the heart per minute: 80 is the prevailing number; next to this, 84; next, 100; and next, 92, &c.: the lowest pulsation was 48, and the highest 180 per minute. These were all taken in the sitting posture. Care was taken never to note the pulse when excited by physical ex-

ertion; but if by any other stimulant through the medium of the mind, then it was taken exactly as it appeared. I believe it always best in statistical research, to note the cases, whatever they may be, exactly as they present themselves, and not to wait until the case *comes* to what we *wish* it to be. That we may be kept steady in a research, we must note and believe what we see—not see what we believe. By these two last tables the prevailing numbers run as 4 beats of the heart to one respiration.

By another table I illustrate the circumference of the chest, both of the total numbers examined, and of the several classes, by distinguishing colours. The figures at the left hand, are to signify the increasing dimensions of the chest, from above downwards, increasing by half an inch; the length of the lateral lines, is to represent the different number under each of these measurements of the chest. It will first be seen that 37-inch chest is the prevailing size; next to this, 35-inch; and in detail it will be seen that the colouring indicates the measurement of the different classes. Thus K, the gentlemen, measure from 34 to 35 inches as their average; A, the sailors, from 37 to 37½ inches in circumference; the fire brigade, B, from 38 to 39½ inches; C, the metropolitan police, from 34 to 36 inches, and at 37 are most numerous; D, the paupers, are mostly placed between 31 and 34 inches; E, the artizans, are most numerous from 30 to 36 inches; and so on.

I will now draw attention to another diagram, which, on the same plan, exhibits the heights; and as the relation between height, capacity, and power, are shown to be so strongly connected, a table of heights will almost give us a table of power also. The prevailing heights are 5 feet 8 inches and 5 feet 9 inches. B, the firemen, are well selected, principally measuring from 5 feet 6 inches to 5 feet 9 inches. The Metropolitan police are a taller set of men, therefore of less physical strength; on the other hand, D, the paupers, are low of stature, ranging chiefly between 5 feet 2 inches and 5 feet 6 inches. L, are the Horse Guards, which do not commence until all the rest have nearly disappeared, *i. e.* at 6 feet; they terminate at the indefinite height of 6 feet +.

I now draw the attention of the members to Table IV., (page 18,) of the capacity compared with weight. Where height and weight correspond, there will be found a relation between weight and capacity; but, as height and weight do not always correspond, the disturbing cases of fat men here account for the relation between weight and capacity of the lungs appearing feeble. I shall in future separate the weight of the corpulent and spare individuals, to determine this point more clearly.

With these remarks I conclude the subject of the tables, which still contain a vast quantity of matter not even hinted at, and no less valuable than what has been touched upon.

The tables of calculations, which afforded me the matter for the diagrams here exhibited, may all be examined; not *one* case that I ever examined has been kept back, and not one fictitious case has been added. During the time of my research I examined every person I could possibly obtain, from the scavenger, the hawker, or the street mountebank, up to the affluent gentleman: all were requested to submit themselves to these tests. By so doing, I trust that a foundation sufficiently broad and firm has been made for me to request the attention of all the gentlemen

present to an examination of the utility of such a method for testing the vital powers (if I may be allowed the term) of men to be selected for any public service. I believe at present *no* such test is used in the army or any other organised force. By these means I have frequently detected men as diseased, that were considered not so. I may mention one case (though several might be cited) of a man 6 feet 4 inches in the Queen's Company, Grenadier Guards, whose capacity was only 102 cubic inches instead of 300 cubic inches. This man was given to me as a healthy case; but I classed him among the diseased; and, upon inquiry, it was found that he had solicited to be relieved from certain physical duties: others, again, that have considered their lungs to be in a bad state, have, by this test, been convinced that they were not so, to their great satisfaction, and improvement in health and spirits.

I would also respectfully invite the attention of prison inspectors to this apparatus. Let every man that enters a prison be tested on entering, and again on leaving; the comparison of the two observations will determine his loss or gain in strength and health. Also I solicit the attention of those who examine for insurance offices; since even non-professional men can make these experiments with certainty: by these means a vast amount of facts would be gathered together, so that the tables of heights might be graduated into decimal parts of an inch, instead of whole inches. And, lastly, I would recommend it to the consideration of all who examine into the effect of employments upon health; for by it I show how low the printers and artisans stand.

An idea of this kind occurred to a no less accurate observer than Thackrah, but of this I was not aware until I had completed all these observations. Thackrah mentions, page 21, that he inverted a glass jar, filled with water, and measured the quantity displaced by "one expiration." He submitted 19 individuals of the 14th Light Dragoon Guards to this test, whose average capacity was 217 cubic inches; therefore they must have been about 5 feet 8 inches high. He adds, "this test affords useful information in diseases of the lungs, as well as a ready index to the native power of the respiratory organs." "It would afford (continues our author) an important assistance, I conceive, in examining recruits for the army." He also examined some shoemakers and tailors by this method; but he connected no other observations with this than that of the circumference of the chest; therefore his observations would not be of much value. Until I connected the height with the capacity, I found all was confusion: after examining upwards of 100 persons, I was nearly giving up the research, when the idea fortunately occurred to me, of connecting heights with the capacity, &c.

Some strong persons have wondered that they could not elevate more than three inches of mercury: but when we recollect the hydrostatic law, it will be found that the power thus exerted by the floor of the chest is equal to elevating a cylinder full of mercury whose base is commensurate with the area of the diaphragm, and its height equal to three inches; so that the floor of the chest at that time sustains a weight equal to many pounds.

With these remarks I leave the subject for the discussion of the Society.

Table I.—*The Mean Capacity of the Lungs of* 13 *Classes, with the Total Mean of the Mean.*

Class.	0 to 5 ft.		5 ft. to 5 ft. 1 in.		5 ft. 1 in. to 5 ft. 2 in.		5 ft. 2 in. to 5 ft. 3 in.		5 ft. 3 in. to 5 ft. 4 in.		5 ft. 4 in. to 5 ft. 5 in.		5 ft. 5 in. to 5 ft. 6 in.	
	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.
Seamen	151	5	206	1	192	7	219	1	218	10	213	9	217	15
Firemen	..	..	..	..	..	..	..	..	210	1	208	2	218	20
Metropolitan Police	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Thames Police	158	1	..	..	..	..	..	..	187	6	206	9	228	9
Paupers	151	7	166	3	162	10	180	10	174	21	191	20	189	19
Mixed Class (Artisans)	80	1	185	1	162	5	181	5	185	17	191	16	192	20
Grenadier Guards	..	..	..	..	..	..	168	1	..	..	218	1	199	2
Compositors	..	..	..	..	176	3	165	2	196	5	188	6	208	7
Pressmen	..	..	152	1	..	..	..	..	..	..	213	2	203	8
Draymen	..	..	..	..	..	..	..	..	..	..	..	..	192	1
Gentlemen	..	..	..	..	145	1	161	1	156	7	177	9	189	14
Pugilists, &c.	..	..	..	..	202	1	218	2	218	1	211	4	217	3
Horse Guards (Blue)	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total Mean	135	14	177	6	173	27	184	22	193	68	208	78	204	118

Class.	5 ft. 6 in. to 5 ft. 7 in.		5 ft. 7 in. to 5 ft. 8 in.		5 ft. 8 in. to 5 ft. 9 in.		5 ft. 9 in. to 5 ft. 10 in.		5 ft. 10 in. to 5 ft. 11 in.		5 ft. 11 in. to 6 ft.		6 ft. +	
	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.	Cub. in.	No.
Seamen	226	14	229	15	239	11	258	18	273	12	270	6	246	2
Firemen	215	17	231	26	231	20	237	3	260	1	249	2	..	..
Metropolitan Police	234	4	228	33	226	46	248	22	234	13	262	12	281	11
Thames Police	222	15	246	17	250	10	240	5	257	3	..	..	..	..
Paupers	210	10	187	9	199	10	242	1	240	3	..	..	..	..
Mixed Class (Artisans)	210	20	222	28	238	16	246	14	238	7	269	9	..	..
Grenadier Guards	..	..	228	7	233	22	240	16	232	11	253	9	258	14
Compositors	227	5	215	8	214	6	231	3	..	..	253	1	..	..
Pressmen	204	3	223	7	245	1	239	4	247	2	..	..	..	..
Draymen	241	1	218	3	223	4	245	1	261	6	248	4	..	..
Gentlemen	208	10	208	18	208	16	236	8	254	12	250	5	262	5
Pugilists, &c	267	3	206	1	243	2	273	3	272	5	248	2	..	..
Horse Guards (Blue)	..	..	..	..	..	..	..	..	..	..	255	30	275	26
Total Mean	224	102	220	172	229	164	246	98	254	75	255	82	260	62

TABLE II.—*The Mean Power of Inspiration and Expiration of all the Cases presenting the ordinary*

Class.	0 to 5 ft.			5 ft. to 5 ft. 1 in.			5 ft. 1 in. to 5 ft. 2 in.		
	Insp.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.
Seamen	3·17	3·44	5	2·20	2·60	1	2·03	3·48	7
Firemen	..	..	..	..	..	..	..	..	..
Metropolitan Police .	..	..	..	..	..	..	..	..	..
Thames Police . .	2·55	3·28	1	..	..	..	..	..	..
Mixed Class . . .	3·00	3·74	1	2·00	3·36	1	2·52	3·25	5
Grenadier Guards .	..	..	..	..	..	..	..	..	..
Pugilists, &c. . .	..	..	..	..	..	..	3·80	4·75	1
Draymen	..	..	..	..	..	..	..	..	..
Gentlemen . . .	..	..	..	..	..	..	1·50	2·80	1
Horse Guards (Blue)	..	..	..	..	..	..	..	..	..
Total Mean . .	2·90	3·48	7	2·00	2·98	2	2·46	3·57	14
Mean of Diseased Cases . . .	0·82	1·37	5	1·30	3·00	1	1·16	2·14	4
Mean of four Healthiest Classes . . .	2·55	3·28	1	..	..	..	..	..	..

Class.	5 ft. 6 in. to 5ft. 7 in.			5 ft. 7 in. to 5 ft. 8 in.			5 ft. 8 in. to 5ft. 9 in.		
	Insp.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.
Seamen	2·63	3·56	15	2·87	4·15	14	3·11	4·19	9
Firemen	3·17	3·95	15	3·02	4·09	15	3·08	4·50	18
Metropolitan Police .	3·07	4·05	4	2·89	4·07	39	2·81	4·10	46
Thames Police . .	2·97	4·44	16	3·08	4·31	16	3·05	4·66	11
Mixed Class . . .	2·31	3·38	21	2·16	3·17	27	2·46	3·50	17
Grenadier Guards . .	..	..	..	2·68	3·83	8	2·94	3·89	19
Pugilists, &c. . . .	4·20	6·42	2	3·65	4·61	2	3·70	4·84	1
Draymen	2·80	3·55	1	2·73	4·59	3	2·37	4·16	3
Gentlemen . . .	2·35	2·62	12	2·35	3·30	16	2·40	3·30	16
Horse Guards (Blue)	..	..	..	..	..	..	..	..	..
Total Mean . .	2·93	3·99	86	2·82	4·12	140	2·88	4·12	140
Mean of Diseased Cases . . .	0·79	1·70	4	1·67	1·88	7	1·32	1·78	8
Mean of four Healthiest Classes . . .	3·07	4·18	35	2·96	4·13	70	2·91	4·28	75

ined in 10 different Classes, without any separation for disease; thus age of Health or Power.

2 in. to 5 ft. 3 in.			5 ft. 3 in. to 5 ft. 4 in.			5 ft. 4 in. to 5 ft. 5 in.			5 ft. 5 in. to 5 ft. 6 in.		
).	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.
0	3·74	1	2·48	3·89	9	2·68	4·23	8	2·84	4·25	15
	..	..	2·70	4·51	2	2·21	3·82	3	2·80	3·84	19
	..	..	..	..	..	..	..	..	..	..	..
	..	..	2·70	4·26	6	3·05	4·50	9	2·58	4·34	9
1	3·15	5	1·85	2·69	17	2·30	3·05	18	2·40	3·37	16
0	5·36	1	..	..	..	4·50	5·10	1	2·70	2·90	2
0	2·41	2	3·50	3·74	1	3·53	5·29	3	3·86	4·75	3
	..	..	..	..	..	..	..	..	1·30	1·70	1
5	3·00	1	1·77	2·92	6	2·01	2·10	7	1·94	3·21	11
	..	..	..	..	..	..	..	..	..	..	..
3	3·53	10	2·50	3·66	41	2·89	4·01	49	2·55	3·54	76
0	1·81	4	1·34	2·30	4	0·74	1·00	1	1·25	1·52	9
	..	..	2·70	4·32	8	2·84	4·33	12	2·70	3·87	29

9 in. to 5 ft. 10 in.			5 ft. 10 in. to 5 ft. 11 in.			5 ft. 11 in. to 6 ft.			6 ft. to 6 ft. +		
).	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.
6	3·84	18	2·41	3·86	12	2·61	4·15	6	2·00	4·00	1
9	3·33	5	2·40	3·74	1	3·65	6·81	2	2·10	2·80	1
2	4·00	23	2·78	3·41	12	2·33	3·23	12	2·75	3·77	8
4	4·27	5	2·78	4·45	3	..	..	..	..	..	..
1	3·67	15	2·07	2·45	7	2·14	3·08	11	2·77	4·10	2
3	3·49	18	2·56	3·76	11	1·92	3·17	12	2·46	3·82	14
8	4·38	2	3·77	4·89	4	3·25	4·93	2	3·52	4·64	2
0	5·43	3	3·21	4·30	6	2·02	3·13	2	3·15	5·00	1
4	3·59	7	2·84	3·49	12	3·12	4·94	5	2·38	3·70	4
	..	..	..	..	..	2·71	4·84	31	2·68	4·66	27
4	4·00	96	2·72	3·81	68	2·68	4·29	83	2·64	4·05	60
3	1·60	3	0·88	1·59	3	0·40	2·25	1	1·65	4·02	1
3	3·94	33	2·77	3·63	16	2·65	4·48	45	2·67	4·41	36

TABLE III.—*Mean of the Respiratory Power o*

Class.	0 to 5 ft.			5 ft. to 5 ft. 1 in.			5 ft. 1 in. to 5 ft.	
	Insp.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.
Paupers, Mean . .	1·79	2·45	7	1·46	1·93	3	2·52	2·96
Compositors, Mean .	..	..	..	..	..	..	2·32	2·96
Pressmen, Mean . .	..	..	..	2·20	5·00	1	..	..
Total Mean of Mean of Printers . . .	..	..	..	2·20	5·00	1	2·32	2·96

Class.	5 ft. 6 in. to 5 ft. 7 in.			5 ft. 7 in. to 5 ft. 8 in.			5 ft. 8 in. to 5 ft.	
	Insp.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.
Paupers, Mean . .	2·45	3·33	10	1·96	2·71	8	1·87	3·33
Compositors, Mean .	2·05	3·10	5	2·43	3·22	7	2·83	3·41
Pressmen, Mean . .	2·10	2·95	3	2·62	3·58	8	1·65	2·05
Total Mean of Mean of Printers . . .	2·07	3·02	8	2·52	3·40	15	2·24	2·73

TABLE IV.—*The Mean capacity of the C*

Class.	7 to 7½	No.	7½ to 8	No.	8 to 8½	No.	8½ to 9	No.	9 to 9½	No.	9½ to 10	No.	10 to 10½
Seamen . . .	208	8	132	1	196	4	203	2	206	11	232	7	234
Firemen . . .	..	..	..	..	..	..	..	..	206	2	199	4	213
MetropolitanPolice	..	..	..	..	..	..	..	..	198	5	212	10	227
Thames Police .	..	..	..	..	..	..	158	1	209	4	208	5	240
Paupers . . .	..	..	173	2	178	8	163	14	141	14	176	27	192
Mixed Class (Artisans) . . .	164	1	160	6	173	8	199	11	202	23	199	25	220
Grenadier Guards	..	..	..	..	..	..	186	2	..	..	209	4	234
Pugilists . . .	..	..	..	..	211	2	198	1	..	..	211	2	195
Pressmen. . .	..	..	..	..	..	..	199	5	210	1	194	5	213
Compositors . .	..	..	..	..	174	7	206	7	206	5	185	6	227
Draymen . .	..	..	..	..	..	..	..	..	..	..	..	..	..
Horse Guards (Blue) . .	..	..	..	..	..	..	..	..	..	..	..	..	230
Gentlemen . .	149	1	171	3	184	3	193	4	192	11	199	10	220
Total mean .	173	10	159	12	186	32	189	47	196	76	202	105	220

pers and the Printers, (Compositors and Pressmen).

. 2 in. to 5 ft. 3 in.			5 ft. 3 in. to 5 ft. 4 in.			5 ft. 4 in. to 5 ft. 5 in.			5 ft. 5 in. to 5 ft. 6 in.		
p.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.
08	3·30	10	2·30	3·38	21	2·17	3·30	20	1·93	3·13	19
55	2·52	1	2·13	3·23	5	2·17	2·91	4	1·65	2·85	7
35	4·20	1	..	..	..	2·81	4·17	3	2·04	3·27	8
50	3·36	2	2·13	3·23	5	2·49	3·54	7	1·84	3·06	15

9 in. to 5 ft. 10 in.			5 ft. 10 in. to 5 ft. 11 in.			5 ft. 11 in. to 6 ft.			6 ft. +		
p.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.	Insp.	Exp.	No.
5	3·46	1	1·47	1·67	2	1·61	3·70	4	..	..	..
0	2·39	2	..	..	..	1·50	1·91	1	..	..	..
5	3·93	3	2·62	3·72	2	..	..	..	..	..	..
7	3·16	5	2·62	3·72	2	1·50	1·91	1	..	..	..

pared with the Weight of the Body (stone of 14 lb).

No.	11 to 11½	No.	11½ to 12	No.	12 to 12½	No.	12½ to 13	No.	13 to 13½	No.	13½ to 14	No.	14 to 14½	No.	14½ to 15	No.
15	257	20	236	9	254	8	271	5	290	1	205	1	..	..	..	..
11	235	11	226	18	223	10	219	7	233	3	212	5	224	1	570	3
23	237	29	244	23	255	18	248	8	284	3	237	2	..	..	..	..
23	245	11	236	9	198	3	196	4	..	..	258	2	203	1	212	1
12	183	10	210	7	176	5	..	..	174	3	..	..	256	1	..	..
20	233	10	249	14	237	8	269	6	227	3	226	6	237	1	..	..
11	234	8	247	19	241	18	251	10	267	4	228	2	307	1	..	..
1	225	3	265	3	..	..	297	2	279	3	204	2	290	1	..	..
8	237	3	..	..	..	..	..	..	186	1	..	..	..	..	..	..
5	207	3	230	2	212	1	216	1	219	1	..	..	..	..	..	..
..	192	1	234	4	236	3	254	5	..	..	272	2	227	2	231	3
1	262	5	261	8	267	13	260	10	286	6	252	7	273	6	318	1
17	228	14	218	4	246	4	233	8	224	4	237	3	202	2	220	2
147	228	128	239	120	231	91	245	66	242	33	233	32	246	16	310	10

TABLE V.—*Number of Respirations per Minute, observed when in the Sitting Posture, in* 1,080 *Cases considered to be Healthy.*

No. of Respirations per Min.	No. of Cases.	No. of Respirations per Min.	No. of Cases.	No. of Respirations per Min.	No. of Cases.	No. of Respirations per Min.	No. of Cases.
9	1	18	81	27	2	36	1
10	2	19	11	28	26	37	..
11	1	20	384	29	2	38	..
12	16	21	31	30	5	39	..
13	10	22	67	31	..	40	1
14	12	23	11	32	6		
15	9	24	153	33	..	Total	1,080
16	157	25	15	34	1		
17	71	26	4	35	..		

TABLE VI.—*Number of Pulsations per Minute, taken in the Sitting Posture, in* 1,086 *Cases considered to be Healthy.*

Pulse per Min.	No. of Cases.	Pulse per Min.	No. of Cases.	Pulse per Min.	No. of Cases.	Pulse per Min.	No. of Cases.
48	1	69	3	87	1	108	9
52	1	70	14	88	71	110	1
53	2	72	74	89	15	112	15
56	2	73	50	90	19	113	3
57	2	74	2	92	66	116	10
58	1	75	2	93	3	118	2
59	1	76	72	94	3	120	16
60	22	78	12	95	9	124	2
61	1	79	2	96	47	128	2
62	3	80	226	97	1	130	1
64	15	81	..	98	2	132	1
65	2	82	6	100	103	133	1
66	6	84	118	102	2	140	1
67	2	85	1	104	27	144	1
68	3	86	4	106	1	180	1

Pulse per Min.	No. of Cases.	Pulse per Min.	No. of Cases.	Pulse per Min.	No. of Cases.
48		53		62	
52		56		68	No. of Cases.
58		57		69	3
59		65		93	
61	No. of Cases.	67	No. of Cases.	94	
85		74		113	
87	1	75	2		
97		79			No. of Cases.
130		98			
132		102		86	4
140		118			
144		124			
180		128			

TABLE(S)
RUN INTO
GUTTER