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Some observations on the lung capacity of young people living in New Mexico

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SOME OBSERVATIONS ON THE LUNG CAPACITY OF YOUNG PEOPLE LIVING IN NEW MEXICO.[1]

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In the spring of 1898, regular physical examinations were begun in connection with the gymnastic exercises of the students in the University of New Mexico. A review of the data thus obtained, seemed to indicate that our western young people have a lung capacity considerably above the eastern average for the same age. We found, upon inquiry, a popular belief that the high altitude of our vicinity ([3]) produced increased lung expansion. Among physicians generally it is held that pneumonia and phthisis clear up better and more quickly in high than in low altitudes. Dr. S. E. Solly says: "The amount of air taken in at each breath becomes greater and the air-cells, many of which are, at lower altitudes, often unused, are dilated ([4])."

It appeared, therefore, that our data exemplified a law, but the proof of this law, or the extent of its workings, could not be ascertained from the limited literature at our command. We determined to extend our observations relative to lung capacity to young people in other schools of the Territory, and from these

[1]Had the author lived to write this paper, a much more complete presentation would have been made. A short paper presenting the facts was read before the Territorial Teachers' Association in 1899, the outline of which has been followed as far as practicable. It is not known what the author's explanation of the phenomenon observed was. The editor assumes responsibility for what is given under this heading.—JOHN WEINZIRL, Editor.

[2]Deceased.

[3]The altitude of Albuquerque, N. M., is about 5000 feet.

[4]Medical Climatology, p. 43, 1897.

sources a considerable body of data has been accumulated (1). These data have been tabulated and a summary will be recorded presently.

The instrument used for determining lung capacities was that designed by Dr. Charles Dennison and manufactured in Denver, Colorado. This instrument is essentially a pair of bellows which are inflated, and the volume is read on a sliding scale. No opportunity was afforded for comparing this instrument with other makes. A somewhat crude test or check upon it indicated a low reading, varying from 5 to 10 per cent. below the actual. If a lower reading than the actual is recorded, this is probably due to slight leakage. Considerable care had to be exercised in preventing such leakage.

Some tests were also made relative to lung strength, the Dennison manometer (mercury) being used. Several of the young men in the University, who were native born, could easily blow the mercury out of the instrument. In attempting to use a Sargent manometer, no satisfactory tests could be obtained. For these reasons the tests were not continued, though it is believed they would have proved of great interest and value. It my be added that in a letter from Dr. Dennison, he stated that no person had ever been known who was capable of blowing the mercury out of his instrument.

In making comparisons, Dr. Sargent's Anthropometric charts f[illegible] men, and the Oberlin charts for women were used as standards. For this purpose, two charts were constructed—one giving the normal according to age and height, the other for age and weight. These two normals were averaged for a final normal for each of our cases. It was thought that such a normal would afford a more just basis for comparison, than one based upon fewer elements.

In making the above comparisons, it was thought advantageous to divide the persons whose capacities had been taken, into three groups, as follows:

[1]Credit is due to President E. L. Hewitt of the Las Vegas Normal University, for a considerable number of examinations made at that school; also to Miss Catherine Fields, Director of the Woman's Gymnasium of the University of New Mexico, who made the lung tests in the spring of 1900; also to Professors W. S. Cummings and Sarah Brooke Farquhar of Swarthmore College, Penn., for furnishing extensive lists of measurements for comparison. For these and other favors, especial thanks are due.

Group I. To contain all persons native born.

Group II. To contain all persons not native born, but who had resided here two years or more.

Group III. To contain all persons who had lived here less than two years.

An examination of groups II and III showed them to be nearly identical, so that they have been joined in group II. It must be added that the number of persons in group III, as originally constructed, was relatively small—two small to permit the positive assertion that persons do not gain in lung capacity (relative to eastern standards) after two years of residence at our altitude. It does appear, however, that in normal cases any gain in lung capacity, due to altitude, takes place within two years. Our table included a number of persons who had resided in the West for about six months only. It would appear, too, that the altitude actually produced an increased lung capacity within that relatively short time. It is not meant by this that abnormal cases, such as present histories of pneumonia, phthisis, etc., show an increase within the time above mentioned, or that they may not increase after a much longer period. Such cases necessarily present widely different histories in this respect, many of them never showing any increase either relative or absolute.

During the course of our examinations probably about 300 cases were examined; but the data of part of these have been lost, and a number have been excluded for lack of completeness (1). It has not been thought worth while to record the entire list of examinations; but a summary of the 209 cases, divided into two groups as before mentioned, is given below.

TABLE I.—Giving Summary of the Measurements Taken.

Class.	Average Age (yrs.)	Average Weight. (lbs.)	Average Height. (inches.)	Average Normal Lung Capacity (cu. in.)	Average Actual Lung Capacity (cu. in.)	Average Difference. (cu. in.)	Average Residence. (yrs.)	Number of Cases.
I.	16.03	112.6	62.4	150.	201.4	51.4	Native born.	85
II.	18.	114.5	63.3	161.7	206.1	44.4	7.8	124

[1]Had the writer lived to write this paper, undoubtedly he could have completed his cases from the very full data that were taken. The original notes having been lost, the editor has been forced to rely almost wholly upon tables constructed with other points in view.—Ed.

From the table it is seen that young people residing in a high altitude for some time show an absolute increase over eastern standards of 44.4 cubic inches of lung capacity over persons residing at low altitudes. Similarly those born in a high altitude show an absolute increase of 51.4 cu. in., or 7 cu. in. over those of group II. These figures have reference to normals for persons of corresponding age, height and weight, as previously explained.

The great increase over normal is certainly most remarkable. This fact is especially emphasized by the original tables which give only 9 per cent. of the cases as falling below normal. It is still further emphasized by the following individual cases of exceptionally high lung capacities.

TABLE II.—Giving Some Exceptionally High Lung Capacities.

Age.	Weight.	Height.	Normal Lung Capacity.	Actual Lung Capacity.	Difference.	Residence.
14–10	106	64	112	240	128	Native born.
15	121	62	113	225	112	"
13–10		57	65	170	105	"
17–7		60	117	220	103	"
16–7		59	102	250	148	"
18		61	127	235	108	"
23	116	64	175	294	119	"
17	154	72.5	303	415	112	"
17	115	67	201	310	109	"
16	122	63.5	123	290	167	"
17	131	66	147	260	113	"
16	156	70.4	281	410	129	5 yrs.
21	150	71	286	400	114	7 "
19	142	70 7	268	390	112	18 "
19	142	69	253	360	107	2 "
17	117	65	185	255	170	5 "
22	120	63.6	163	257	112	2 "
19	170	72.5	323	450	127	8 mos.

The great divergence from the standards usually given, merits comment. In the first place, it is not believed that the entire increase in lung capacity is due to altitude changes. It is well known that persons residing in the country present higher averages than those raised in the city. Undoubtedly our western young people who lead a very free and out-door life, owe part of their superior lung capacity to this fact. It is difficult to estimate the extent of the workings of this factor; but it is not believed, however, that it can account for the entire increase. Indeed, it probably does not account for the major part even. To what factor, then, shall this increase be ascribed? The usual answer, and probably the correct one, is altitude. This appears a most natural inference, since altitude produces such profound changes in atmospheric pressure and in the amount of oxygen present in the air. The barometric pressure for Albuquerque is approximately 25 in. of mercury, the corresponding pressure at sea-level being 30 in. This means a much rarer atmosphere, which might be expected to exert an influence upon the lungs, since they have to do very largely with the handling of air.

The usual explanation given for the phenomenon we have observed, is as follows: The supply of air (or oxygen) being diminished, it becomes necessary for the lungs to take in larger quantities in order to satisfy the demands of the tissues for oxygen. It is plain enough that air at this altitude contains about 1-6 less oxygen per volume than at sea-level. We might expect from this, that the increased lung expansion should be about 1-6 of the normal capacity. In fact, however, the increase is about 1-3 over normal.

But in view of the fact that the union between oxygen and hemoglobin is chemical, and consequently independent of the law of absorption of gases due to partial pressure (1), it is not easy to see why an increase in lung capacity should take place here. Further, it is known that the internal and external pressures soon neutralize each other, so that diminished external pressure is quickly followed by decreased internal pressure. Of course this has no effect upon the amount of oxygen brought to the lungs, but it is a fact that needs to be borne in mind in this connection. It is also known that the partial-pressure within the lungs is not as great as that of the external air, being estimated at 10 and 20 per cent. respectively. So far as we are aware, there is as yet no evidence that the partial-pressure of the oxygen within the lungs varies with altitude. Only this much appears certain, that the amount of oxygen constantly present in the lungs is far in excess of that required by the body. That nature should be lavish and keep a large excess of oxygen in the lungs, might be expected; otherwise slight changes in the atmosphere such as result from the presence of other gases, dimin-

[1]See the editor's paper in this bulletin, on "The Effect of Altitude Upon the Blood."

ished pressure, etc., would present very grave conditions. That alterations in these factors may take place, with relatively little or no inconvenience, is a familiar fact. Perhaps in keeping up her relatively large excess of oxygen in the lungs, nature requires that an increase in capacity shall take place, so as to guard against future changes in this regard, which might prove serious.

PRACTICAL APPLICATIONS.

Whatever the explanation may be with respect to the relatively large increase in lung capacity that we have observed, it is not difficult to see how this fact is of practical advantage to medicine and otherwise. In the case of phthisis, pneumonia, and possibly asthma, the expansion of the air cells of the lungs must aid materially in clearing them up. In other words, the thorough aeration promotes the removal of exudates. It is very probable, too, that the removal of the exudates and degenerative materials permits the healing of lesions. This may be due in part to the removal of bacteria and their destructive influences. At any rate, the great reduction in numbers must be regarded as of decided advantage.

It is quite likely, also, that the toxin absorption is much reduced. This is more especially true of phthisis. The fact is frequently observed that fever and more especially night sweats, soon disappear after coming to a high altitude. To what extent diminished toxin absorption can account for this, cannot be stated; but if toxins are held accountable for much of the dammage done in phthisis, and if these are more completely removed at high altitudes, then we can explain in part how it is that cases of phthisis with cavities and numerous bacilli present, can still live for years in our climate, or may even be cured.

In this connection, the author's history may be of interest. He came to New Mexico December, 1896, having one lung completely consolidated and numerous bacilli present in the sputum. The lung capacity taken nearly a year later, was only 125 cu. in. During the three following years, nearly all the symptoms improved. The work of director of the gymnasium was regularly performed, and tennis and base ball freely indulged in. Up to the time of taking pleurisy, there seemed t be constant improvement.

Whether more oxygen is absorbed by the blood in consequence of increased lung capacity, must for the present remain a mooted question. Certain it is, however, that the total quantity within the lungs is very materially increased, and this undoubtedly serves an important purpose.

A point apparently not generally appreciated, is the corrective force exerted upon young people with poorly developed chests. Undoubtedly it is from this class that the army of tuberculous cases which comes to the arid southwest, is largely recruited. If the boys and girls of high school age, who are growing rapidly, but show weak lungs, poorly developed chests, and a tendency to take cold, could be sent for a year or two to a high altitude, it can confidently be predicted that many would develop into strong, healthy individuals, instead of weaklings, who soon join the vast army of sufferers from the white plague.