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Relation of Respiratory Ventilation to Basal Metabolism in Thyroid Disorders.

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An analysis of basal metabolism records made available to one of us (ATB) from the files of the United States Veterans' Facility, Fort Miley, California, shows a relation between respiratory ventilation and metabolism which we believe has not been reported previously. The coefficient of ventilation (CV), or volume percent removed as oxygen from the tidal volume,[1] has been used as a measure of respiratory activity. All data were obtained by one of us (ATB), using a conventional closed-circuit metabolism apparatus, with 16-minute recording periods.

Ventilation, due to the mechanism of control normally depending on the CO_2 content of the blood, makes available, under ordinary circumstances, a considerable surplus of oxygen over the metabolic needs. Thus at rest the average man uses only 4% of the tidal volume (CV = 4) or about one-fifth of the oxygen available. This factor of safety of 5 for oxygen may be increased to 20 by overventilation, that is, the CV may fall as low as one. The data contained 76 records from 37 persons diagnosed as suffering from various thyroid disorders. Combining all types the BMR ranged from −54% to 114% (Aub-DuBois standards). The CV for a group of 14 having "normal" BMR (mean +0.857%) is 4.393, slightly above the 3.996 found for normal men. With either raised or lowered metabolism the value of the CV falls in a degree roughly proportionate to the severity of the metabolic disturbance. The means of the groups are given in Table I. The falling trend in either direction is clear but the variability is so great that the reliabilities must be considered. The probabilities (Fisher's *t* method), expressed as chances per hundred, that a difference as great or greater than that recorded would arise by random sampling from a population in which no difference existed are given in Table II. The average CV of persons with normal BMR is doubtfully above the mean of the group with lowered metabolism (P = 10 times in 100). The normals are not significantly above the group having the next higher BMR but are significantly higher than the second group (1.5 in 100). It is thus clear that the fall of CV with raised metabolism

[1] Zeigler, E. E., *Med. Annal. Dist. Columbia*, 1933, **2**, 225.

TABLE I.
Mean Coefficients of Ventilation for Various Levels of Basal Metabolic Rate.

No.	BMR%	CV
12	— 24.500	+3.550
14	+ 0.857	+4.393
18	+ 18.833	+3.511
15	+ 35.467	+3.100
10	+ 59.200	+2.340
2	+ 79.000	+2.200
2	+107.500	+2.100

TABLE II.
Probabilities for Various Intercomparisons of Coefficients of Ventilation.

Values of CV compared		Probability, chances per hundred
4.393	3.550	10.0
4.393	3.511	20.0
4.393	3.100	1.5
3.511	3.100	50.0
3.100	2.340	15.0

is statistically significant, and that with lowered BMR, suggestive. More data might be expected to make this significant. One retest on an individual tends to support this conclusion. A man suffering from hypothyroidism and using thyroid extract for many years, entered the hospital for a periodic checkup. The oxygen consumption was 285 ml (standard conditions) per minute (BMR −1%) and the respiratory minute volume 6400 ml; the CV, 4.5. When thyroid administration was stopped for 10 days the BMR fell to −26% (212 ml per minute) while the respiratory minute volume rose to 12,900 ml, slightly more than twice the original volume, giving a CV of 1.6. Both times the test was in duplicate. This is a clear case of great overventilation accompanying a marked fall of metabolism known to be due to reduced thyroid influence.

To summarize, deviations in either direction from normal metabolism due to thyroid dysfunction are accompanied by overventilation. This fall is statistically valid for increased and highly probable for decreased BMR. The variability is so great, however, that this trend may fail to show in many individual observations. If we assume with Simonson[2] that the degree of overventilation is a measure of the sensitivity of the respiratory center, we would conclude that both excess and deficiency of the thyroid secretion increases the sensitivity of this part of the central nervous system. This is generally accepted as true in man of the hyperthyroid but not of the hypothyroid condition.

[2] Simonson, E., *Pflügers Arch.*, 1926, **214**, 380; 1926-27, **215**, 752.