Estimate of the Metabolic Rate from Bicycle Ergometric Data

This article describes a procedure for obtaining an approximate value of a person's resting metabolic rate by evaluating the data from a bicyle ergometric test of the subject.

Method
A detailed analysis of published data (1, 2) as well as of 56 individual exercise data sheets (3) (private communications from T. Bourdin [Centre Cardiologique de la Maye, Versailles, France, 1997] and H. Heck [LSt. f. Sportmedizin, Ruhr-Universität, Bochum, Germany, 1998]) suggests that the increase in heart rate P (in bpm) with increasing effort N (work rate or power, in Watt) follows the subsequent relationship:

$$P = P_0\left(\frac{N+N_0}{N_0}\right)^{2/3} \qquad (1)$$

where P_0 is the resting heart rate. The parameter N_0 (in Watt) seems to be a person's characteristic feature and perhaps as essential as P_0 or blood pressure at rest. The term $(N+N_0)/N_0$ in Eq.(1) is a measure of the body's relative total effort, i.e. the power generated by cycling plus what is metabolically needed to keep the body functioning.

The general idea of the present paper is, that N_0 is closely related with the resting metabolic rate of the subject. It might be an indication of physical and mental fitness.
The upshot is, that the numerical value of N_0 can be calculated, using the least squares method on Eq.(1) in order to find the curve that best fits to the set of data from an ergometric test:

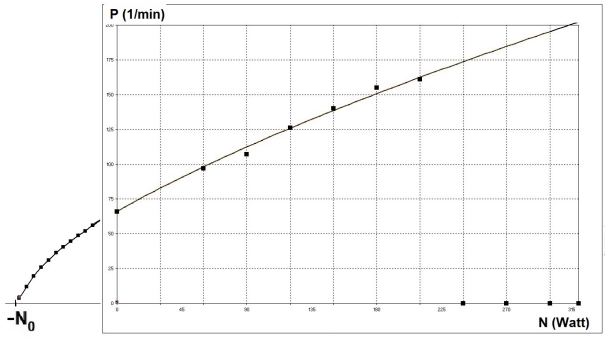
$$\sum_i N_i\left(N_i+N_0\right)^{-1/3}\left[P_i - P_0\left(\frac{N_i+N_0}{N_0}\right)^{2/3}\right] = 0 \qquad (2)$$

(where P_i is the heart rate at work rate N_i). Eq.(2) can be solved for N_0 by the mathematical method of successive approximation.
The procedure is equivalent to extrapolating the P-versus-N history to a hypothetical heart rate of Zero, where $N = -N_0$. The resting pulse P_0 used in the calculation is essential, because it affects the result.

Result
The Diagram below shows the result of a representative computation, with the data from a test in which the power level had been raised in steps of 30 Watt; the dotted line leading to $N = -N_0$ has been added for illustration. The values of N_0 found in this manner seem to lie fairly well within the range of metabolic rates as found by traditional methods.

Ready-to-use EXCEL-Progams for computing the values of N_0 from test data sets can be downloaded from: www.gomeraflora.de/step15.xls, /step20.xls, and /step25.xls (for level steps of 15, 20, and 25 Watt).

The significance of N_0 for diagnostics and prevention would have to be studied separately, as it might reflect the test subject's current condition.



References

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