*SHORT COMMUNICATION*

# FITTING CURVES TO PHYSIOLOGICAL DATA

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**Summary :** This paper deals with fitting of a parabola and three parameter logistic curve to relate heat output and initial index finger temperature with ambient temperature in human subjects. The coefficients of determination ($R^2$%) between observed and estimated values of heat output and initial index finger temperature were close to 98% indicating the high percentage of variation of the total sum of squares absorbed by the fit of the curves. The superiority of the fitted curves over the other curves have been proved. Thus it is concluded that parabola and three parameter logistic curve may explain the relationships of heat output and initial index finger temperature with ambient temperature more precisely than other curves.

**Key words :** parabola, logistic curve, heat output, index finger temperature, coefficient of determination

## INTRODUCTION

Fitting suitable curves to physiological data are of practical importance for better description of certain physiological phenomenon and attempts have been made in this direction for describing different biological phenomenon by several workers (1, 3, 4, 6, 7, 9, 11, 12, 16, 17). Similar attempts have also been made to evolve suitable curves in the field of exercise physiology (8, 13, 14). Recently, Verma *et al.* (15) have suggested the Gompertz curve to explain the phenomenon of thermoregulation efficiency of man. The present paper deals with fitting curves to physiological data for suggesting possible relationship between ambient temperature and heat output/initial index finger temperature.

## MATERIAL AND METHODS

*Physiological data and statistical analysis :*

The physiological data from the study of Rai *et al.* (10) who observed the effect of varying environmental temperature on heat output and finger skin temperature in six

healthy Gurkha subjects of age ranging from 26-30 years, have been utilized for this investigation. The values of heat output and initial index finger temperatures were recorded at ambient temperature of 5, 10, 15, 20, 25, 30 and 35°C.

On plotting the heat output against ambient temperature a curve similar to parabola was observed. Hence a parabola of the form : $Y = a + b\,x + c\,x^2$ was fitted to estimate heat output (Y) from ambient temperature (X). The values of a, b and c were calculated by the method of least squares. The significance of a, b and c of the parabola was tested by the method of analysis of variance using the theory of polynomial regression based on orthogonal transformation (2).

On plotting the initial index finger temperature of right and left hands with ambient temperature, symmetrical sigmoid curves were observed. Hence three parameter logistic curve of the form : $Y = K/(1 + 10^{a+bx})$ was fitted to relate initial index finger temperature with ambient temperature. The values of K, a and b were estimated by the method of selected points (5). The comparison of the logistic curve with some other possible curves has been made by using the criteria of absolute percentage variation and coefficient of determination ($R^2$%).

## RESULTS

The parabola was fitted to establish the possible relationship between heat output and ambient temperature measured on six healthy Gurkha male subjects. The values of a, b and c were found to be 5.3035, −0.9233 and 0.3917 respectively. Table I presents the analysis of variance table based on orthogonal transformation (2) for testing

TABLE I : Analysis of variance table for fitting parabola based on orthogonal transformation.

| *Source of variation* | *Df* | *SS* | *MS* | *F* | *P* |
|---|---|---|---|---|---|
| Between subjects | 5 | 32.714219 | 6.542844 | 6.14794 | <0.001 |
| Ambient temperature, linear | 1 | 338.613215 | 338.613215 | 318.17553 | <0.001 |
| Ambient temperature, quadratic | 1 | 77.291502 | 77.291502 | 72.62642 | <0.001 |
| Scatter | 4 | 3.543716 | 0.885929 | 0.83246 | NS |
| Subjects X linear | 5 | 28.640031 | 5.728006 | 5.38228 | <0.01 |
| Subjects X quadratic | 5 | 2.460190 | 0.492038 | 0.40756 | NS |
| Subjects X scatter | 20 | 24.145660 | 1.207283 | | |
| Total | 41 | 507.408533 | | | |
| Correction | 1 | 2442.973867 | | | |
| Pooled Error | 25 | 26.605850 | 1.064234 | | |

the significance of fitting the parabola. The coefficient of determination ($R^2$%) between observed and estimated heat output was calculated to be 99.14 per cent indicating the high percentage of variation of total sum of squares absorbed by the fit of the curve. Table I shows that the scatter about parabola is not significant, emphasizing the appropriateness of fitting the parabola over straight line.

A three parameter logistic curve was fitted to relate the initial index finger temperature of right and left hand with ambient temperature. The calculated values of K, a and b were 38.6555, 0.1861, –0.2571 for right hand and 38.6426, 0.2326, –0.2677 for left hand initial index finger temperatures. The coefficients of determination ($R^2$%) between observed and estimated initial index finger temperatures of right and left hand were found to be 98.35 and 98.45 per cent respectively. Table II exhibits the comparison of logistic curve with some other curves.

TABLE II : Comparison of logistic curve with some other curves.

| *Curves* | *Initial Index Finger Temperature of right hand* | | *Initial Index Finger Temperature of left hand* | |
|---|---|---|---|---|
| | *Absolute % variation ±SEM* | *Coefficient of determination ($R^2$%)* | *Absolute % variation ±SEM* | *Coefficien of determination ($R^2$%)* |
| Logistic | 2.87±2.54 | 98.35 | 3.30±2.79 | 98.45 |
| Gompertz | 4.39±2.31 | 97.91 | 4.64±2.47 | 98.07 |
| Modified Exponential | 5.34±2.98 | 96.96 | 5.94±3.17 | 97.10 |
| Logy = $ax^b$ | 5.88±1.59 | 95.61 | 6.27±1.68 | 95.71 |
| Y=a+b logx | 6.53±3.22 | 95.14 | 7.56±3.59 | 94.96 |

Obviously the coefficient of determination is higher and the average absolute percentage variation is lower in the proposed logisitic curve for both the cases as compared to the other curves fitted for the same physiological data.

## DISCUSSION

In the present paper a parabola has been fitted satisfactorily for suggesting a relationship between heat output and ambient temperature to simplify the intricate procedure

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of measuring heat output of a subject. It is also evident from Table I that fitting the parabola is a significant improvement over the fitting of straight line. This is due to the fact that a highly significant ($P<0.001$) curvature was observed indicating the inadequacy of fitting the straight line to this data.

A three parameter logistic curve fits well to the physiological data of initial index finger temperature and ambient temperature. The comparison of logistic curve with other curves (Table II) reflects the superiority of the first curve over the others. Thus the present approahes of fitting curves to physiological data are of practical importance for simplifying the intricate procedure of measuring heat output and initial index finger temperature of a subject .

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