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Response of the Heart to Exercise of Graded Intensity.

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Changes in the heart rate produced by different degrees of activity have been used as a basis in many of the tests of physical efficiency. If the changes in heart rate are not directly proportional to the amount of exercise performed, then tests of physical efficiency based on this principle are not reliable.

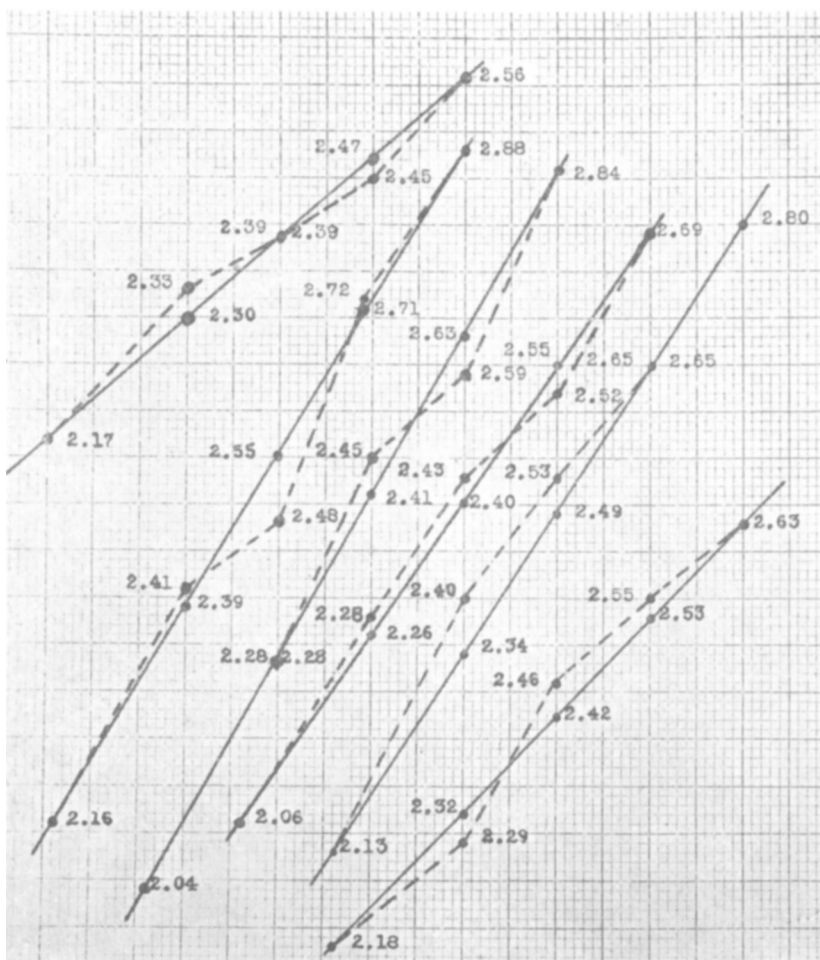


FIG. 1.

Data obtained from 6 typical cases of a group of 75 which have been examined are presented to show the frequency response of the heart to exercise of graded intensities.

The frequency responses of the heart are based on the pulse-ratio. This is determined by dividing the pulse for 2 minutes after a known amount of exercise by the normal sitting pulse for one minute.

The exercise consists of mounting a stool 13 inches high a definite number of times in one minute. Suppose, for example, that after mounting the stool 18 times in one minute the resulting pulse-rate for 2 minutes is 135. Assuming the normal pulse to be 60, then 18 steps of the exercise produce a pulse-ratio of 2.25.

If the response of the heart as indicated by the pulse-ratio is directly proportional to the amount of exercise performed, then the curve which results from plotting a number of pulse-ratios of an individual against the amount of work done to produce them, is a straight line. The results of such an experiment involving 6 subjects are shown in Fig. 1. In each case, 18 steps is the initial exercise and 40 steps the most strenuous.

If, as is the case with one of the subjects, 18 steps per minute produce a pulse-ratio of 2.17 and 40 steps give 2.63, then by the graphic method, 25 steps should produce a pulse-ratio of 2.33, 30 steps 2.43 and 35 steps 2.53. By actual performance 25, 30 and 35 steps produced pulse ratios of 2.29, 2.46 and 2.55. The differences between the plotted and experimental values are 0.04, 0.03, and 0.02. A comparison of the plotted and experimental values is shown in the figure.

The differences between the plotted and experimental values as shown in the figure appear large but this is due to the fact that the pulse-ratios are plotted to the scale 0.01 pulse-ratio equals 1 mm. on the ordinate and 2 mm. on the abscissa equals one step. The greatest difference between plotted and experimental values is 0.07 of a pulse-ratio which represents a difference of 2 steps per minute. A difference as large as this is well within experimental error. An error in counting amounting to 4 beats in 2 minutes is sufficient to account for all of this difference. Furthermore, an error of from one to 2 beats per minute in counting the normal pulse is sufficient to produce the difference.

The results of an experiment which covers a study of 75 cases of which only 6 are reported, show that the increase in the rate of the heart beat is directly proportional to the amount of exercise performed.