MEASUREMENT OF MUSCLE POWER: A FOLLOWUP REPORT

Anand B. Shetty
Jerry N. Barham
Mechanical Kinesiology Laboratory
Department of Kinesiology
University of Northern Colorado
Greeley, Colorado

An original formula for the measurement of muscle power from displacement data obtained from a filmed vertical jump was reported by Paul A. Lightsey (1985) at the third ISBS Symposium held in Greeley, Colorado, June, 1985. This formula was:

$$\bar{P} = mg(h_2/h_1)\sqrt{1/2g(h_2 - h_1)} \qquad \text{(Equation 1)}$$

where $\bar{P}$ is average muscle power
m is the mass of the subject
g is the acceleration due to the force of gravity
h_1 is the distance that the center of mass is raised during surface contact
h_2 is the distance between the location of the center of mass at the jumper's lowest crouched position and its location at the jumper's highest position in the air.

A second paper that was presented in Greeley was by Shetty, et. al. (1985), which described a pilot study designed to validate the Lightsey formula. In this study a group of subjects performed vertical jumps from the surface of a Kistler force platform while being filmed with a 16mm camera. The force platform yielded force/time data for the precise measurement of power through use of the following equation which was also developed by Lightsey (1985).

$$\begin{aligned}\bar{P}(t) &= F(t) \quad V(t) \\ &= F(t)\int_0^t [F(t')/m - g]\, dt' \qquad \text{(Equation 2)}\end{aligned}$$

where $\bar{P}(t)$ is average power as a function of time
$F(t)$ is ground reaction forces as a function of time
$V(t)$ is velocity as a function of time
m is the jumper's mass
g is the acceleration due to the force of gravity
mg is the jumper's weight
$F(t') - mg$ is the net force acting on the jumper.

That is, the power at time t is the force at time t multiplied by the impulse from t = 0 to time t divided by the mass.

TABLE 1

PRESENTATION OF AVERAGED SUBJECT POWER SCORES, BODY WEIGHTS AND JUMP HEIGHTS

SUBJECT	MUSCLE POWER	BODY WEIGHT	JUMP HEIGHT
1	1219	170	1.25
2	1580	153	1.75
3	1752	160	2.00
4	1759	220	1.50
5	1361	152	1.58
6	857	153	1.25
7	1423	195	1.66
8	1405	200	1.87
9	1825	195	1.33
10	1438	173	2.00
11	1545	160	2.00
12	2190	175	1.91
13	938	124	1.50
14	1789	190	2.00
15	1233	188	1.66
16	1168	145	1.50
17	1606	155	2.08
18	1168	145	1.75
19	1460	142	2.00

The units of measurement are: Power (ft-lb/sec)
Weight (lb)
Height (ft)

TABLE 2

MEANS AND STANDARD DEVIATIONS OF MUSCLE POWER, BODY WEIGHT AND JUMP HEIGHT DATA

VARIABLE	N	MEAN	STANDARD DEVIATION
POWER	19	1458.73	328.84
WEIGHT	19	168.15	24.51
HEIGHT	19	1.71	0.27

TABLE 3

INTERCORRELATION OF MUSCLE POWER, BODY WEIGHT AND JUMP HEIGHT MEASURES

	POWER	WEIGHT	HEIGHT
POWER	1.00	0.48	0.47
WEIGHT		1.00	-0.04
HEIGHT			1.00

The 16mm films were digitized to obtain the two heights, h_1 and h_2, necessary for the calculation of power through the use of Equation 1. The force/time data obtained through the force platform was used for the calculation of a second set of power scores by means of Equation 2. The correlation coefficient calculated between the two sets of power scores was 0.95.

The purpose of the present paper is to report the findings obtained in a follow-up study. The experimental design used in the pilot study was further refined and the study was replicated during the fall of 1985. In this follow-up study 19 male subjects executed three vertical jumps each from the surface of the force platform while being filmed. Power was again calculated using equations 1 and 2 and the correlation between the two sets of scores was 0.96, which was nearly identical to the 0.95 correlation obtained six months earlier.

A further analysis of the data was made to determine if power could be estimated through a regression equation using only body weight and the height obtained in the airborne phase of the jump (Δh, where Δh is $h_2 - h_1$). The power, weight, and height of the jumps recorded for each of the 19 subjects are presented in Table 1. Means and standard deviations are presented in Table 2, and the correlation matrix is given in Table 3. As can be seen in Table 3, the coefficient of correlation between muscle power and weight was 0.48, and between power and height it was 0.47. The correlation between body weight and height of the jump, was -0.04.

The regression equation that was computed using weight and height of the jump as the independent variables for the prediction of power was:

$$R = -707.66 + 597.02(\text{height}) + 6.79(\text{weight}) \qquad \text{(Equation 3).}$$

This two variable model yielded a multiple correlation of 0.67. Even though this correlation is significant at the .05 level, it is our opinion that power measured through use of Lightsey's formula is more valid, and thus this is the test that we recommend for use by practioners in the field in assessing the performance of their athletes.

For a further discussion on this topic see the paper by Barham and Shetty also published in these proceedings.

REFERENCES

Lightsey, P. A. A Formula for Measurement of Leg Power in the Vertical Jump. Biomechanics in Sports II, edited by Juris Terauds and Jerry N. Barham. Research Center for Sports, Del Mar, California, 1985.

Shetty, A., K. Spooner, J. N. Barham, and P. A. Lightsey. Validation of Lightsey Leg Power Formula. Biomechanics in Sports II, edited by Juris Terauds and Jerry N. Barham. Research Center for Sports, Del Mar, California, 1985.