THE RELATIONSHIP BETWEEN ANTHROPOMETRIC BODY DIMENSIONS AND A MODEL FOR WEIGHT LIFTING TECHNIQUE

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INTRODUCTION

The basic problem in learning weight lifting techniques is to define the optimum track of the barbell. The primary difficulty in teaching the movement of weight lifting is to have a standard for the movement of the barbell with relationship to the body dimensions and the weight (Worobiew, 1977; Nawrat, 1983; Roman, 1986; Wolkow, 1987). The parameters of the barbell's track can be thought of as the basic criterion of the level of the weight lifting technique of an individual. The course of the barbell's track* is very individual and dependent on many different factors. One of the most important factors is the anthropometric body dimensions of the athlete. By using a special device, which is called a Pantograph, the general parameters of the barbell's track can be defined. At the present time a special simulator is being constructed which enables us to simulate the individual track of the barbell according to input data of the individual. The system is controlled by computer.

The main goal of this research is to find the relationship between the anthropometric body dimensions of the subjects and the basic parameters of the barbell's track of snatch technique. We expect that the individual's parameters will be the input data for the simulation of the optimum barbell's track.

METHODS

The research was provided by a group of 29 top weight-lifting athletes (body weight = 64.06 ± 13.32 kg, body height = 168.46 ± 9.18 cm). Eight anthropometric data (length parameters) and 7 derived anthropometric values from previous data were the input data for the statistical analysis (see Table 1).

Table 1. Measured and computed body dimension variables

Body height	BH	W,	TRL / BH
Trunk length	TRL	W_2	LLL / BH
Upper limb length	ULL	W_3	ULL / BH
Forearm length	FL	W_4	FL / ULL
Arm length	AL	W_5	AL / ULL
Lower limb length	LLL	W_6	THL / LLL
Thigh length	THL	W,	SHL / LLL
Shank length	SHL		

By using a device of our own construction (Pantograph), the track of the barbell for each individual was measured. The general model of the barbell's track was expressed by 7 different measured characteristics (see Figure 1): H_{max} - maximum height of the lifted bar, H_1 - the height at which the bar is closest to the body in the first phase, H_2 - the height at which the bar is farthest away from the body in the second phase, X_1 - the horizontal distance to the farthest point in the first phase, X_2 - the horizontal distance to the farthest point in the second phase, X_3 - the horizontal distance to the highest point of the bar, and X_4 - the horizontal distance to the lowest point of the bar.

The best competition attempts were selected for the research. The basis for the statistical evaluation of measured data was the method of correlation and multiple regression analysis. By using these statistical methods, the relationship was examined between all anthropometric dimensions and all parameters of the barbell's track
(7 variables).

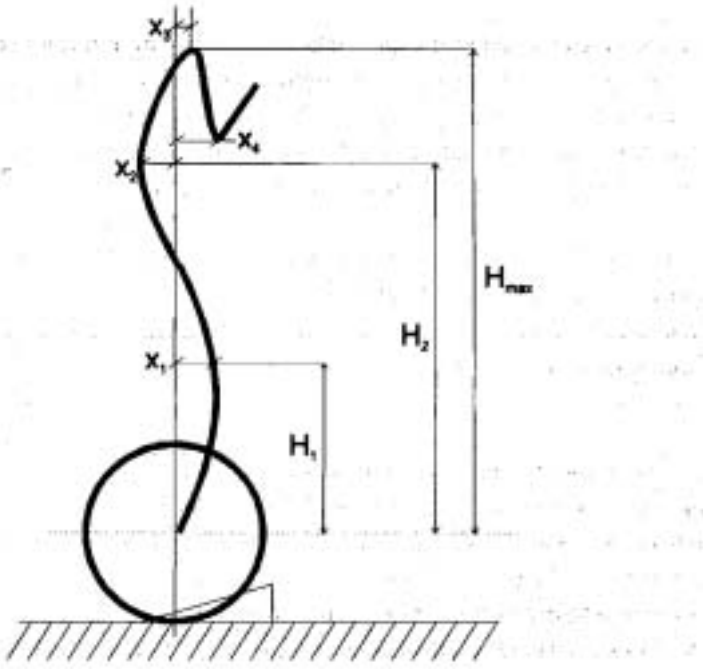

Figure 1. Parameters of the barbell's track

RESULTS

In Table 2 only the regression equations expressing the statistically significant relationships between measured anthropometric dimensions and variables of the barbell's track and the multiple correlation coefficients are included.

The range of the magnitude of correlation coefficients has been found to be from r = .935 to .456 ($p < .01$) which expressed a different level of the relationships between anthropometric dimensions and the parameters of the barbell's track.

Two groups of variables of the barbell's track were selected based on the magnitude of the correlation coefficients. The variables H_{max}, H_1, H_2, and X_3 have a higher level of relationship ($r \geq .70$) to the body dimensions in comparison with the variables X,, X_2, and X_4 ($r < .70$). This means that the vertical parameters of the barbell's track depend on the body dimensions more than the variables expressing the horizontal declinations of the barbell's movement. The predictive value of the anthropometric variables is higher for the vertical parameters of the barbell's track in comparison with the horizontal parameters. Only 10 anthropometric variables from the total sum

of 15 are the important input data for computing a model of the barbell's track for an individual (5 measured - ULL, THL, AL, LLL, TRL, and 5 computed - $W_1, W_2, W_3, W_4, W_5, W_7$). An individual model of the barbell's track can be computed based on the derived multiple regression equations. Table 3 gives examples of computed parameters of the barbell's track.

Table 2. The relationship between anthropometric variables and the parameters of the barbell's track

Multiple regression equation	Coefficient of multiple correlation
$H_{max} = 1.74E\text{-}02 \cdot ULL - 2.10 \cdot W3 + 0.73$	.935
$H_1 = 1.35E\text{-}02 \cdot ULL - 3.91 \cdot W3 + 1.82 \cdot W7 + 0.13$	.808 H_2
$= 6.12E\text{-}02 \cdot AL - 2.41E\text{-}02 \cdot THL - 5.25 \cdot W3 - 4.43 \cdot W5 + 4.22$	.712
$X_1 = 0.16 \cdot LLL - 7.27E\text{-}02$	.456
$X_2 = 3.42E\text{-}02 \cdot ULL - 6.39E\text{-}02 \cdot AL - 1.16$	.635
$X_3 = 4.02E\text{-}02 \cdot ULL - 8.49E\text{-}02 \cdot AL + 6.08 \cdot W5 - 0.60 \cdot W1 - 2.22$	.718
$X_4 = 5.72E\text{-}02 \cdot TRL - 0.67 \cdot WL - 1.54 \cdot W4 + 0.37$	.656

Table 3. Parameters of the barbell's track

Parameters of the barbell's track	Measured set of athletics n=29	Two individuals A	B
BH	64.04± 13.23	54.2	71.5
BW	168.46± 9.18	151.0	175.0
Hmax	108.15 ± 8.24	92.16	126.97
H1	49.78 ± 7.62	38.24	67.97
H2	87.00 ± 9.71	79.26	101.75
X1	6.93 ± 2.88	3.40	7.17
X2	-0.37 ± 2.67	0.00	0.00
X3	5.26 ± 3.68	1.31	10.97
X4	13.22 ± 4.64	5.26	21.30

BH - body height
BW - body weight

CONCLUSIONS

- Statistically significant relationships between some anthropometric variables and the parameters of the barbell's track were found.
- The computation of an individual model of the barbell's track is based on the multiple regression equations and 10 measured and computed anthropometric variables.
- The individual model of the barbell's track is the starting point for the experimental approach to the problem of learning and teaching a weight lifting technique.

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