ON THE INFLUENCE OF AIR RESISTANCE DURING LONG JUMP

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INTRODUCTION: The long jump consists of four phases: approach run, takeoff, flight and landing. The tasks to perform during the last five steps of the approach are contradictory – to increase velocity but to attain the optimum position for takeoff. During the flight the long jumper must compensate the big forward angular momentum about the transverse axis, generated during the approach and the takeoff (Hay, 1993). The basic flight techniques using are: "sail" (tucked position), "hang" (raising arms and extending legs), "hitchkick" (running in the air). The aim of the study is to evaluate the influence of air resistance on the flight phase.

METHODS: Usually the effect of air resistance is neglected, so the body mass may be concentrated in the body mass centre. For this elementary kinematic problem the equation of the trajectory in a frame OXY is:

$$y = tg\alpha_0 x - \frac{g}{2v_0^2\cos^2\alpha_0}x^2 \qquad (1)$$

where *y* is the height of the initial trajectory point; v_0 is the initial velocity; α_0 is the acute angle of v_0 related to axe OX; *x* is the horizontal distance. Equation (1) is certainly not an adequate model of the human body long jump. If the air resistance is taken into account the problem is not so simple. The air resistance $R = M f(v)$ is function of the velocity *v* and the body mass *M*. If $f(v) = kv^2$ we can obtain approximately:

$$y = tg\alpha_0 x - \frac{g}{2v_0\cos^2\alpha_0}x^2 - \frac{gk}{3v_0\cos^2\alpha_0}x^3 - ... \qquad (2)$$

where: $k=C\rho S_{eff}$; *C* is the aerodynamic coefficient; $\rho\,[kg.s^2/m^4]$ is the air density; $S_{eff}[m^2]$ is the effective surface of body resistance.

RESULTS: To evaluate the influence of air resistance 16 young long jumpers are investigated. For every jumper nine body parameters are measured and using the heuristic method described by Toshev and Monchaud (1997) the individual coefficients *k* are calculated (both for Hang and Hitchkick techniques) and equation (2) is resolved. Every jumper performed 10 jumps (5 Hang and 5 Hitchkick). The results are shown in Table 1.

Table 1 Preliminary average results for 16 young long jumper

	Theoretically without resistance	Theoretically with resistance	Real result HANG	Real result HITCHKICK
LONG JUMP [m]	6.25±0.38	6.01±0.32	5.90±0.30	5.95±0.28

CONCLUSION: The preliminary results show that the theoretical model taking into account the air resistance predicts the real results in better agreement with the experimental data. The influence of air resistance on the long jump is up to 4%.

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