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100m Performance and long jump technical level playing linear regression analysis based on MATLAB

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ABSTRACT

In athletics events, long jump gives human race run and jump comprehensive combination wonderful exhibition, its influence factors mainly are technique, psychology, physical quality, competition environment and so on, while technical aspect factor accounts for large proportions, from which 100m performance has an important effect on athlete speed and legs strength so that affects long jump performance, therefore improve long jumpers' 100m performance and final 10s speed as well as soaring speed is the key to improve long jump run-up accuracy. In order to research 100m performance exact effects on long jump, this paper adopts unary linear regression analysis to research on 100m performance and corresponding long jump performance. Utilize multiple linear regression models to make research on final 10 seconds speed and soaring speed two great key factors, it gets good conclusions that provides references for long jump teaching and training.

KEYWORDS

Long jump performance;
Soaring speed;
Linear regression;
Influence factor.

INTRODUCTION

Long jump as one of relative influential events in athletics arouses public affection and attention. Having entered into 21st century, though long jump performance level has achieved substantial development, it still cannot break through world record; during 20th century, lots of excellent athletes broke through previous world records once and again, such as one athlete exhibited outstanding talent in sprint, Jesse Owens broke world record with 8.13m result in Ann Arbor held university students sports meeting in 1935[1-4]; however, such was broken through after 25 years, in Mexico Olympic Games after 8 years, one athlete jumped out 8.90 world record with the help of local thin and sparse air as well as low latitude advantageous conditions[5-7]. According to international association of athletics federations' records, by far men long jump world record holder is 20th century Tokyo sports meeting American Mike Powell who jumped only 8.95m at 0.3 m/s of local wind speed, but no one breaks through it until now, record holder holds the longest time, is a world record that need to be broken through in 21st century[8-10].

With human race food nutrition improvement and scientific training, no one would doubt that human race can jump out more than 9m distance in long jump event with their own strength. For present competitive sports such as long jump, the indispensible factors to get good results are utilizing scientific theory seriously follow training law and scientific training process[11-13]. For long jump the concrete sport event, though it has common training process and law as other competitive sports, it has its unique features. Therefore, find out training process and law that meets the special feature from multiple factors, then constant carry out researching and exploring that is a process of long jump gradually to succeed[14].

For the demands of long jump further development, find out such precious and regular things, propel long jump training and talents selection, so that form into perfect system provide basis, let training and selection become more scientific, reduce gap and improve training orientation and focus. The research result will not only be of important theoretical guiding significance, but also of very important practical significance and extraordinary practical value.

UNARY LINEAR REGRESSION MODEL APPLICATIONS IN LONG JUMP PERFORMANCE INFLUENCE FACTOR ANALYSIS

Unary linear regression model:

$$\mathbf{y} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_i \mathbf{x} + \boldsymbol{\varepsilon} \tag{1}$$

In formula (1), β_0, β_1 is regression coefficients, ε is random error item, always assume that $\varepsilon \sim N(0, \sigma^2)$, then random variable $y \sim N(\beta_0 + \beta_1 x, \sigma^2)$.

If makes n times of independent observation on y and x respectively, it gets as following n pairs of observation values $(y_i, x_i), i = 1, 2, \cdots, n$

The n pairs of observation values relationships conform to model $y_i = \beta_0 + \beta_1 x + \varepsilon_i, i = 1, 2, \cdots, n$

x_i is independent variable value when makes the i time observation, it is a non random variable and has no measurement error. Correspond to x_i, y_i is a random variable, its randomness is caused by $\varepsilon_i . \varepsilon_i \sim N(0, \sigma^2)$, for different observation, when $i \neq j$, ε_i and ε_j are mutual independent from each other.

Parameter estimation

In formula (1), parameter β_0, β_1 still use least square method to estimate that should select estimation value $\hat{\beta}_j$, let $\hat{\beta}_j = \beta_j$ when $j = 0,1$, error squares sum refer to formula (2):

$$\mathbf{Q} = \sum_{i=1}^{m} \boldsymbol{\varepsilon}_i^2 = \sum_{i=1}^{m} (\mathbf{y}_i - \boldsymbol{\beta}_0 - \boldsymbol{\beta}_1 \mathbf{x}_{i1})^2 \tag{2}$$

Formula (2) arrives at minimum. So that, let $\frac{\partial Q}{\partial \beta_j} = 0, j = 0, 1, 2, \cdots, n)$, it gets formula (3):

$$\begin{cases} \dfrac{\partial \mathbf{Q}}{\partial \boldsymbol{\beta}_0} = -2\sum_{i=1}^{m} (\mathbf{y}_i - \boldsymbol{\beta}_0 - \boldsymbol{\beta}_1 \mathbf{x}_1) = 0 \\ \dfrac{\partial \mathbf{Q}}{\partial \boldsymbol{\beta}_j} = -2\sum_{i=1}^{m} (\mathbf{y}_i - \boldsymbol{\beta}_0 - \boldsymbol{\beta}_1 \mathbf{x}_1) = 0,\ j = 0,1 \end{cases} \tag{3}$$

By sorting, it converts into following regular equations formula (4):

$$\begin{cases} \boldsymbol{\beta}_0 \mathbf{n} + \boldsymbol{\beta}_1 \sum_{i=1}^{n} \mathbf{x}_{i1} + \boldsymbol{\beta}_2 \sum_{i=1}^{n} \mathbf{x}_{i2} + \cdots \boldsymbol{\beta}_m \sum_{i=1}^{n} \mathbf{x}_{im}) = \sum_{i=1}^{n} \mathbf{y}_i \\ \boldsymbol{\beta}_0 \sum_{i=1}^{n} \mathbf{x}_{i1} + \boldsymbol{\beta}_1 \sum_{i=1}^{n} \mathbf{x}^2{}_{i1} + \boldsymbol{\beta}_2 \sum_{i=1}^{n} \mathbf{x}_{i1}\mathbf{x}_{i2} + \cdots \boldsymbol{\beta}_m \sum_{i=1}^{n} \mathbf{x}_{i1}\mathbf{x}_{im}) = \sum_{i=1}^{n} \mathbf{x}_{i1}\mathbf{y}_i, \mathbf{m} = 0,1 \\ \boldsymbol{\beta}_0 \sum_{i=1}^{n} \mathbf{x}_{im} + \boldsymbol{\beta}_1 \sum_{i=1}^{n} \mathbf{x}_{im}\mathbf{x}_{i1} + \boldsymbol{\beta}_2 \sum_{i=1}^{n} \mathbf{x}_{im}\mathbf{x}_{i2} + \cdots \boldsymbol{\beta}_m \sum_{i=1}^{n} \mathbf{x}^2{}_{im}) = \sum_{i=1}^{n} \mathbf{x}_{im}\mathbf{y}_i \end{cases} \tag{4}$$

Regular equations matrix form is formula (5):

$$\mathbf{X}^T \mathbf{X} \boldsymbol{\beta} = \mathbf{X}^T \mathbf{Y} \tag{5}$$

When matrix X column in full rank, $X^T X$ is invertible square matrix, it gets formula (6):

$$\hat{\beta} = (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{Y} \tag{6}$$

When $\hat{\beta}$ substitutes back original model, it gets y estimated value and gets formula (7):

$$\hat{\mathbf{y}} = \hat{\beta}_0 + \hat{\beta}_1 \mathbf{x} \tag{7}$$

While the group of data fitting value is $\hat{Y} = X \hat{\beta}$, fitting error $e = Y - \hat{Y}$ is called residual, which can be used for random error ε, estimation:

$$\mathbf{Q} = \sum_{i=1}^{n} \mathbf{e}_i^2 = \sum_{i=1}^{n} (\mathbf{y}_i - \hat{\mathbf{y}}_i)^2 \tag{8}$$

Formula (8) is residual squares sum (or surplus squares sum), that is $Q(\beta)$.

Statistical analysis

(i) $\hat{\beta}$ is the linear

unbiased minimum variance estimation of β. It means that $\hat{\beta}$ is y linear function; expectation is equal to; in linear unbiased estimation, variance is the minimum one.

(ii) $\hat{\beta}$ Conforms to normal distribution:

$$\hat{\beta} \sim N(\beta, \sigma^2 (X^T X)^{-1}) \quad (9)$$

(iii) For residual squares sum Q, $EQ = (n - m - 1)\sigma^2$, and:

$$\frac{Q}{\sigma^2} \sim \chi^2 (N - M - 1) \quad (10)$$

Then it gets σ unbiased estimation formula (11):

$$S^2 = \frac{Q}{n - m - 1} = \sigma^2 \quad (11)$$

S^2 is residual variance(variance of residual), S is called residual standard deviation.

(iv) Make resolution on total squares sum $SST = \sum_{i=1}^{n} (y_i - \bar{y}_i)^2$, it has formula (12):

$$SST = Q + U, \quad U = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 \quad (12)$$

Among them, Q is residual sum of squares, U is called regression sum of squares. Above resolution applies regular equations.

Regression model hypothesis test

Whether dependent variable and y independent variable $x_1, \cdots x_m$ exist linear relationships as model (1) shows needs to be tested. Obviously, if all $|\hat{\beta}_j|$ $(j = 1, \cdots m)$ are quite small, y and $x_1, \cdots x_m$ linear relationship would not be remarkable, so can let original hypothesis to be $H_0 : \beta_J = 0 (j = 1, , m)$. When H_0 is true, U, Q defined from resolution formula meet formula (13).

$$F = \frac{U / m}{Q / (n - m - 1)} \sim F(m, n - m - 1) \quad (13)$$

Under significance level α, it has upper α quantile $F_\alpha(m, n - m - 1)$, if $F < F_\alpha(m, n - m - 1)$, accept H_0; otherwise, refuse H_0.

Unary linear regression model 100m performance influences on long jump

In order to research 100m performance and long jump performance relationship, we collect one session Olympic Games partial 100m performance and long jump performance athletes data as following TABLE 1.

TABLE 1 : 100m performance and long jump performance data

Athlete	One	Two	Three	Four	Five	Six	Seven	Eight
100m performance (s)1/x	10.31	9.86	10.36	10.01	10.14	10.70	10.90	10.64
Long jump performance (m) y	8.91	8.90	8.86	8.74	8.18	8.26	8.14	8.95

X takes reciprocal of 100m performance, y takes long jump performance; use MATLAB drawing out x and y scatter diagram, refer to Figure 1.

It is clear that x and y are in linear relationships; establish unary linear model $y = \beta_1 x + \beta_0$, by data handling it gets TABLE 2.

Use MATLAB, it solves $y = -0.8255x + 17.1736$.

Significance test $P = 0.0106 < 0.05$, $R^2 = 0.6094$, $F = 13.3815 > F_{0.05} = 3.65$, it is known that the unary linear model is at work. Better 100m performance is, the corresponding long jump performance would be, if given athlete 100m performance, it can predict its

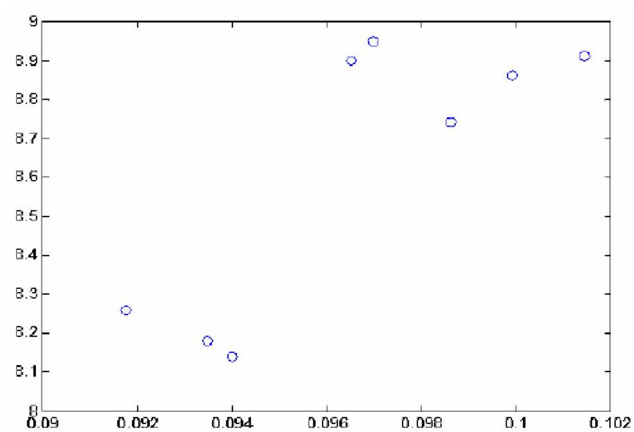

Figure 1 : 100m performance and long jump performance scatter diagram

TABLE 2 : Regression analysis

	Regression coefficient	Confidence Interval
B0	17.1736	[11.4474 22.8999]
B1	-0.8255	[-1.3777 -0.2733]

$P = 0.0106 < 0.05$ $R^2 = 0.6904$ $F = 13.3815 > F_{0.05} = 3.65$

roughly long jump performance, it provides more reliable reference basis for national long jumpers selection and training.

MULTIPLE LINEAR REGRESSIONS' 100M PERFORMANCE AND SOARING SPEED ASPECTS INFLUENCES ON LONG JUMP

According to lots of scientific research and long jump practice, it indicates that good final 10m run-up speed and soaring speed can get good long jump performance. Scientists researches through continuously efforts indicate that speed is closely related to long jump performance, the two correlation coefficient is 0.948; relative scholars make researches and find that final 10m run-up speed and soaring speed are main factors that affect long jump; in competition, long jump performance largely is up to final 10m run-up speed and soaring speed correlation coefficient $x=0.83\sim0.96$; to verify its accuracy, we collect following data, refer to TABLE 3.

Use MATLAB drawing out TABLE 3x1-y, x2-y scatter Figure 2 and Figure 3.

From scatter Figure 2 and Figure 3, it is clear that final 10m run-up speed, soaring speed are respectively in linear distribution with long jump performance. Establish multiple linear models $y = \beta_2 x_2 + \beta_1 x_1 + \beta_0$, by data handling, it gets TABLE 4.

Use MATLAB, it solves out $y = 1.1521x_2 + 0.0396x_1 - 2.6502$.

Significance test $P = 0.0159 < 0.05$, $R^2 = 0.9369$, $F = 22.2532 > F_{0.05} = 3.65$, it is clear that the unary linear model is at work. The better final 10m run-up speed and soaring speed are, the corresponding better long jump performance would be, it provides more reliable reference basis for national long jumpers selection and training.

TABLE 3 : Long jump performance, final 10m run-up speed and soaring speed

Athlete	Long jump performance y(m)	Final 10m run-up speed x1 (m/s)	Soaring speedx2 (m/s)
Rank first	8.9500	10.7900	9.7000
Rank second	8.9000	10.7000	9.6000
Rank third	8.7900	11.4000	9.5500
Rank fourth	8.4200	10.6000	9.4200
Rank fifth	8.1800	10.3500	9.1000
Rank sixth	8.0500	10.1000	8.9000

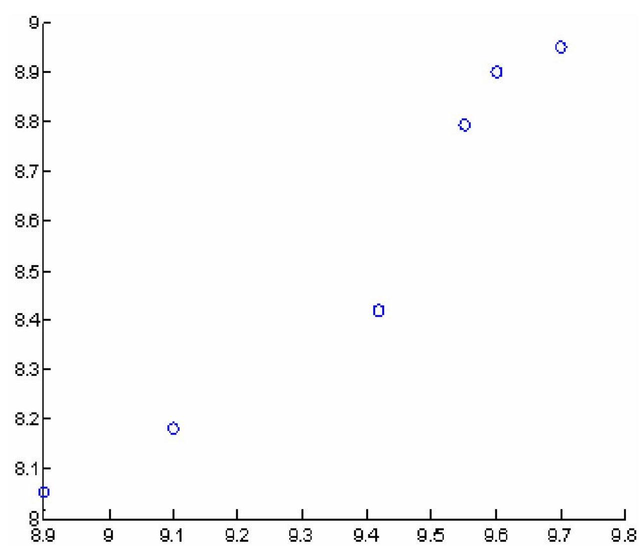

Figure 2 : x1-y scatter diagram

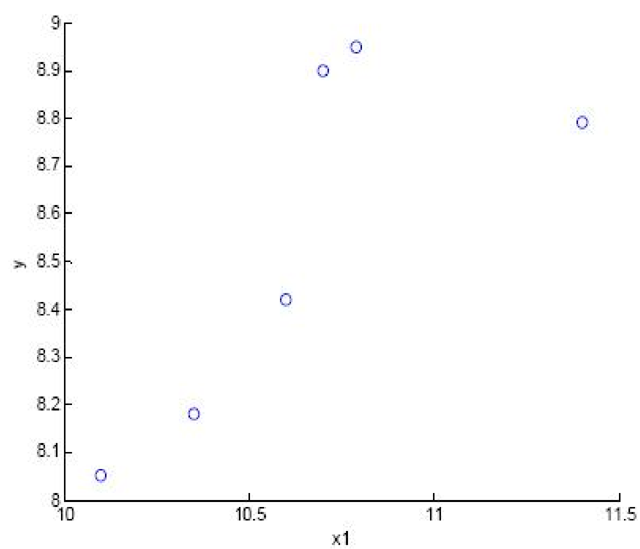

Figure 3 : x2-y scatter diagram

TABLE 4 : Regression analysis table

	Regression coefficient	Confidence Interval
B0	-2.6502	[-7.9977 2.6973]
B1	0.0369	[-0.5869 0.6608]
B2	1.1521	[0.2703 2.0339]

CONCLUSIONS

Modern long jump speed development tendency asks for quicker, higher athlete 100m performance, final 10s speed and soaring initial speed. From above two models research, it gets that 100m performance, final 10s speed and soaring initial speed respectively have a positive correlation with long jump performance. If it gets better 100m performance, it will get better long jump performance, as well as the better final 10m run-up speed and soaring speed are, the corresponding better long jump performance would be. In order to select and train good athletes, expect for considering other factors, it should regard 100m performance, final 10s speed and soaring speed as one of important parts from them and list into long jump training and selection plans.

REFERENCES

[1] He Zhijin, Xaing Jiajun, Liu Liming, Xu Bo; Journal of Chongqing Three-gorges University, **3**, 151-154 **(2013)**.

[2] Li Jian-ying; Liu Ya; China Sport Science and Technology, **42(4)**, 100-102 **(2006)**.

[3] Li Lin, Fan Yong, Hong Chang Qing; Journal of Wuhan Institute of Physical Education, **35(5)**, 102-104 **(2001)**.

[4] Jia Yi, Liu Zhan-Feng, Yan Bo-Tao, Liu Ya; Journal of Xi'an Institute of Physical Education, **28(5)**, 620-624 **(2011)**.

[5] Ma Yong Zhan, Fang Ai Lian; China Sport Science and Technology, **37(2)**, 22-24 **(2001)**.

[6] Sun Pu, Liu Sheng-jie; China Sport Science and Technology, **42(1)**, 31-33 **(2006)**.

[7] Wang Ling-Fei; Journal of Beijing Sport University, **31(8)**, **(2008)**.

[8] Liu Sheng-Jie, Wang Guo-xiang; Journal of Physical Education, **18(2)**, 106-111 **(2011)**.

[9] Xu Guan Zhong, Wang Wen Hao, Ding Hai Yong; Journal of Shanghai Physical Education Institute, **27(1)**, 46-48 **(2003)**.

[10] Xiaomin Zhang; Journal of Chemical and Pharmaceutical Research, **5(12)**, 8-14 **(2013)**.

[11] Wang Bo, Zhao Yulin; Journal of Chemical and Pharmaceutical Research, **5(12)**, 21-26 **(2013)**.

[12] Mingming Guo; Journal of Chemical and Pharmaceutical Research, **5(12)**, 64-69 **(2013)**.

[13] Bing Zhang, S.Zhang, G.Lu; Journal of Chemical and Pharmaceutical Research, **5(9)**, 256-262 **(2013)**.

[14] Bing Zhang; Journal of Chemical and Pharmaceutical Research, **5(2)**, 649-659 **(2014)**.