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110m hurdle performance influence factors spss significance test and application based on multiple linear regressions

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ABSTRACT

To take China men's 110m hurdle to the next level, it is very necessary to make analysis and research on hurdlers' 110 hurdles race performance. To define influence factor significance to total performance, it applies multiple linear regression, analyzing hurdlers' 110m hurdle total performance significance with starting to the first hurdle, hurdle step flight, three steps stride between hurdles, final spurt, utilize SPSS making unknown parameters estimation and significance test. To define four influence factors and total performance relationships, it establishes grey correlation degree model. At last, respectively horizontally and vertically analyze hurdlers' performance and stability, applies mathematical statistical knowledge comprehensively comparing hurdler Liu Xiang and Johnson, Olijars striding time and speed average value, standard deviation. Research shows that hurdlers' performance improvement direction is keeping final spurt advantage, improving hurdle step flight and three steps striding between hurdles speed. It suggests to effective control gravity when hurdling, increase maximum speed between hurdles and keep fast speed capacity, and speed up stride between hurdles' rhythm so as to ensure effective raise speed. © 2014 Trade Science Inc. - INDIA

KEYWORDS

110m hurdle;
Regression analysis;
Grey correlation degree;
Influence factor.

INTRODUCTION

Hurdles race has a long history, its original basis is human race gradually formed life technology as overcoming obstacles in fast running during fighting process with nature and animals to achieve survival resources. 100m hurdles race was firstly appeared in Britain in 1830; In 1864, it started 109.72m hurdles race; in 1888, Frenchman made supplement by adding 28 cm let it become 110m hurdles race. In 1896 Olympic Games, it has already had 110m hurdles race event, but due to hurdle techniques not perfect at that time,

performance is only 17.6s that is not ideal. Since the second Olympic Games, it started 110m hurdles race, which was introduced to China around 1900 and listed as formal competition event in national game in 1910.

For hurdle researches, Shandong normal college's Huang Jing-Hua published "China women's 100m hurdle status analysis and measurements research" in 2007, it mainly researched on women hurdle development history and performance improvement process. In October, 2012 Hong Xiang-Shun, Xu Wan-Fei published in Sports world "China 110 hurdle history review and development research summary", it mainly

made simple statement on recent China 110m hurdle history and proposed our country's 110m hurdle development fundamental causes.

This paper, on the basis of previous people, it makes further refinement, targeted makes research on hurdlers' 110m hurdle. Apply multiple linear regression analyzing hurdlers' 110m hurdle total performance significant relations with starting to the first hurdle, hurdle step flight, three steps striding between hurdles, final spurt such four stages, use grey correlation degree analysis analyzing hurdlers each stage performance merits, utilize mathematical analysis analyzing hurdler and American athletes Johnson, Olijars striding time and speed average value, standard deviation. Finally, it makes comprehensive analysis and makes reasonable suggestions.

REGRESSION ANALYSIS ALGORITHM

Multiple linear regression model^[1]

Given dependent variable y and independent variable x_1, x_2, x_3, x_4 have relationships:

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \varepsilon \tag{1}$$

Among them, y is observable quantity,

b_0, b_1, b_2, b_3, b_4 are unknown numbers, ε is error, meet

$$E_\varepsilon = 0, D(\varepsilon) = \sigma^2 \text{ (} \sigma^2 \text{ unknown).}$$

For data $(x_{1j}, x_{2j}, x_{3j}, x_{4j}) (j = 1, 2, \dots, n)$, input it into formula (1), it gets fitting relationship:

$$\begin{cases} y_1 = b_0 + b_1x_{11} + b_2x_{21} + b_3x_{31} + b_4x_{41} + \varepsilon_1 \\ \vdots \\ y_n = b_0 + b_1x_{1n} + b_2x_{2n} + b_3x_{3n} + b_4x_{4n} + \varepsilon_n \end{cases} \tag{2}$$

Above formula can use matrix to express as:

$$Y = \begin{bmatrix} y_1 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} b_0 & b_1 & b_2 & b_3 & b_4 \\ \vdots & x_{11} & x_{21} & x_{31} & x_{41} \\ \vdots & x_{1n} & x_{2n} & x_{3n} & x_{4n} \end{bmatrix} \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

$$Y = XB$$

Unknown parameters estimation

According to least square regression algorithm, by

tween hurdles x_3 , final spurt x_4 , their Sig are respectively 0.55300.00000.00100.928, their corresponding Sig is t value practical significance level that is p value, if given $\alpha = 0.01$,

$t_1 = 0.553 > \alpha$ then accept H_0 , it is thought regression coefficient is not significant.

$t_2 = 0.000 < \alpha$ then refuse H_0 , it is thought x_2 regression coefficient is significant.

Step three, calculate correlation coefficient, taking resolution coefficient $\rho = 0.2$, and then computational formula is:

$$\frac{2 \times 0.053024 \times 0.0114988}{a \times 0.0106048} \tag{8}$$

And then respectively calculate others absolute differences. The whole result is as TABLE 5 show. Find out maximum value and minimum value from them as:

$$a_{\max} = 0.053024 \quad a_{\min} = 0.000894$$

When number is 1

$$(1) \frac{0.0114988}{0.014346 \times 0.0106048} = 0.460859$$

$$(1) \frac{0.0114988}{0.004735 \times 0.0106048} = 0.749588$$

$$(1) \frac{0.0114988}{0.003403 \times 0.0106048} = 0.820864$$

$$(1) \frac{0.0114988}{0.030395 \times 0.0106048} = 0.280460$$

Use same method respectively calculating other each correlation coefficient; calculation result can refer to TABLE 6.

Step four, calculate correlation degree. Use Table 6, respectively solves every sequence every time correlation coefficient average value that can get correlation degree:

$$\frac{0.180716 + 0.705972 + 0.413677 + 0.631404}{4} = 0.549856$$

$$= - \frac{222428}{0.99991} + \frac{0.33646}{0.191728} = 0.476609$$

$$= - \frac{381115}{0.614831} + \frac{0.43868}{0.304757} = 0.546950$$

$$= - \frac{869487}{0.584941} + \frac{0.696106}{0.392121} = 0.567528$$

Step five, rank correlation degree

From correlation values, it is clear that, now,

$r_{04} > r_{01} > r_{03} > r_{02}$ it shows four kinds of comparison sequence to 110m hurdle total time correlation degree ranking orders are final spurt, starting to the first hurdle time, three steps striding between hurdles time, hurdle flight time. In 110m hurdle total time, it is the final spurt takes the leading effects, while starting to the first hurdle time, three steps striding between hurdles time, hurdle flight time take the secondary effects.

Carry out comprehensive evaluation by grey correlation degree analysis method

Given it has n pieces of evaluated objects; every evaluated object has p pieces of evaluation indicator. In this way, the i evaluated object can be described

as: $i = \{ i_{i1}, i_{i2}, \dots, i_{ip} \}, i = 1, 2, \dots, n$

(1) Define reference sequence

According to evaluation indicator economic meaning, select each indicator optimal value composed of

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$$ij \frac{a(\min) \quad a(\max)}{a_{ij} \quad a(\max)}$$

Calculate the i evaluated object and optimal reference sequence correlation degree.

(5) Comparison and rank

Due to r_i reflects the i evaluated object and evaluation standard sequence x_0 mutual correlated degree, if $E_i > E_j$, then it shows the i sample is better than the j sample. Therefore, according to $\{E_i\}$, it can rank and make comparison on evaluated objects.

MATHEMATICAL STATISTICS^[1]

Statistics: Assume there is a sample with capacity of n (that is a group of data), record as $x = (x_1, x_2, \dots, x_n)$, it needs to make certain processing on it then can ex-

time, hurdle flight reflects athlete hurdle technique merits, hurdler should targeted strengthen hurdle flight technique training so as to get better performance in future competition.

From TABLE 8, it can solve^[6] hurdler, Johnson, Olijars three people striding speed average value from first hurdle to tenth hurdle that are respectively 9.01444m/s, 9.04222m/s, 9.02444m/s, standard deviation are respectively 0.150342, 0.158964, 0.216108. Result shows: in spurt stage, hurdler has fastest speed, but the speed average value from first hurdle to tenth hurdle is slightly slower than Johnson, Olijars, and his standard deviation is the minimum one; to get better performance in future competition, hurdlers should on the basis of keeping speed stability, speed up hurdle

speed, especially for speed from third hurdle to fifth hurdle.

Hurdler 110m hurdle annual average performance and stability analysis

At first, according to hurdler 110 hurdle yearly average performance TABLE 9, draw out performance stability Figure 2 and average performance Figure 3, so as to easier analyzing.

From hurdler 110m hurdle annual average performance Figure 2, it is clear that though hurdlers' performance have some fluctuations, it entirely is in the constant increasing trend, performance stability Figure 3 changes show hurdlers' performances gradually tend to stable in fluctuation.

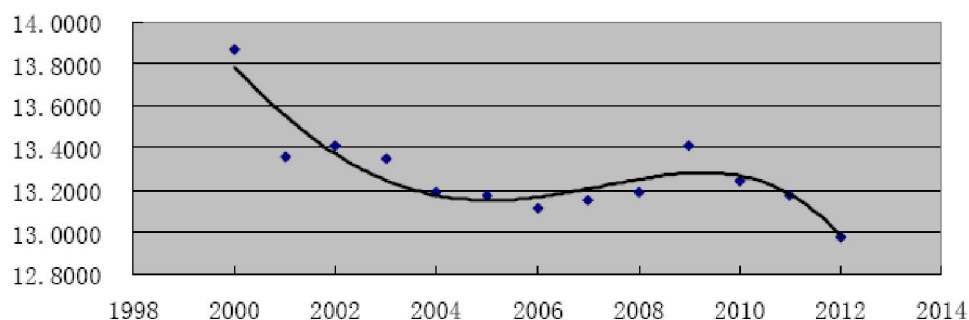


Figure 2 : Liu Xiang 110m hurdle annual average performance

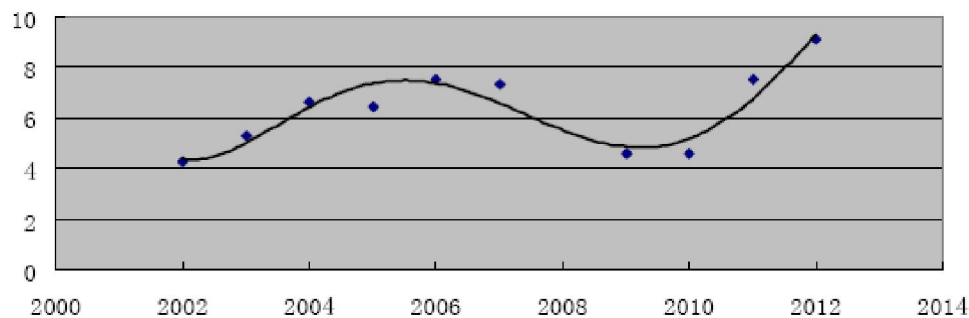


Figure 3 : Liu Xiang yearly performance stability standard deviation analysis

CONCLUSIONS

By regression analysis, 110m hurdle performance has significance relations with hurdle step flight, three steps striding between hurdles; grey correlation degree analysis gets that final spurt takes leading effects on 110m hurdle performance. Integrate the two researches, it is clear that performance significant correlated hurdle step flight, three steps striding between hurdles are not the items that hurdlers do best, so hurdlers performance improvement direction is keeping final spurt advantage,

improving hurdle step flight and three steps striding between hurdles speed. It suggests to effective control gravity when hurdling, increase maximum speed between hurdles and keep fast speed capacity, and speed up stride between hurdles' rhythm so as to ensure effective raise speed.

By Chinese excellent hurdlers yearly performance analysis and researching, total performance can be already regarded as excellent, but striding speed is slight not so good, if they want to move to the next level on this basis, then they need to keep stable speed and spurt advantage, meanwhile strengthen flight hurdle and three

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steps striding between hurdles speed. It suggests that in training, it should strengthen hurdle training, improve hurdle speed and keep fast hurdling capacity. Know yourself and know your enemy, you will win every war, only get overall and objective recognition of your own status, it can know where is the gap between you and world high level and how many the gap is, so that can look for breakthrough and catch up with it. Scientific analysis the competition performance is to the benefit of positioning, and helpful for making reasonable training plan to avoid blindness.

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