ISSN : 0974 - 7435 Volume 10 Issue 9

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(9), 2014 [4109-4119]

The Chinese elite female shot put athletes performance regression research based on MLR and GRA

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ABSTRACT

In this paper, we chosen seven factors which picked up based on former study or the interview result from the coaches and athletes, and we used MLR method built regression equation to predict the performance. Further more, we also try to used GRA method to calculate and sort the correlation degrees of the factors.

KEYWORDS

Shot put; MLR; GRA; Female; Correlation.

INTRODUCTION

Shot putting is a great and long history sport event which is full embody human being's beauty, strength and wisdom. Though the world and Chinese shot putting's phylogeny, the technical exploration was the eternal topic and the research emphasis[1].

Technical training is very important for daily training, especially to the top athletes. Lots of cases shows that when physical and mental factors were closely, the higher technical level, the better performance gained. In some specific situation, the great technique even can make up the short of strength.

In 2004, Li Jia-ying, Wang Xiao-gang published "Research on Technique of Back Slide Step of Our Elite Female Shot Putter", putting their attention on the velocity structure of back slide step and the body velocity change which effect the velocity structure[2]. In 2013, Doctor Yuan Ting-gang and his research group used 3-D video system to analysis Chinese top8 women's shot put athletes' key sport technique parameters in 11th National Games[3]. And at the same year, Doctor Deng Fu-qiang with his group put their focus on the key sport technique parameters of Backward Glide of Shot Put of Gong Li-jiao who was one of the best Chinese female Shot Put athlete.[4]

In this paper, Based on the former studies and the interview results from the Chinese first class coaches and researches, we chose seven factors, as the TABLE 1 shows.

TABLE 1 : Independent variables

Independent	Description	Abbreviation
X1	the shot's height on the moment of right foot step on the ground	Height
X2	the shot's height on the moment of hand left	Putting-Height
X3	the shot's resultant velocity on the moment of right foot left the ground	R.V.
X4	the shot's resultant velocity on the moment of left foot step on the ground	L.V.
X5	the shot's initial velocity on the moment of hand left	Inti.V.
X6	the shot's angle on the moment of hand left	Angel
X7	the last time of throwing	L.T.

We hope, we can find out which factor (s) can be used for predicting the performance though MLR method, sort the seven factors based on GRA theory and finally our research can provide a useful reference for scientific training.

EXPERIMENTAL

Data measurement method

For measure all the original data, we used two JVC-9800 digital video (the height was 125cm, the frame rate was 50fps) on two spot: one was the right side of the putting circle, the camera lens was facing the limit-line; the other one was behind the putting circle and facing the putting-direction. The two taking-directions were made 90 degree angle.

For measure the integrated data, the two cameras were taken the whole putting process, including the three-dimensional radiation framework which was placed in the putting-circle.

At last, we used APAS motion video analysis system for recording the athletes' technical parameters.

RESULT AND DISCUSSION

Explore the regression equation with MLR

MLR analysis is a reliable statistical method when analyzing the linear relationship between one variable and multiple observable variables. The MLR method could guiding us to build a regression equation which can help us to predict the independent and find out the correlationship between dependent and independent (s). Now MLR has been widely applied to natural science, social sciences and economics[5].

Though the MLR theory, given independent Y and dependents $X_1, X_2, X_3, \ldots, X_n$ meet:

$$Y = B_0 + B_1X_1 + \cdots + BnXn + \varepsilon \quad \textbf{(1)}$$

Y is observable random variable, X_n are observable independent variables, b_0 is intercept which is undetermined, B_n are undetermined parameters, ε is unobservable random error. Plug n groups independent sample date (y_i, x_{i1}, ..., x_{i4}, i=1,2, …, n) into formula (1), we get such formulas:

$$\begin{cases} Y_1 = b_0 + b_1x_{11} + \cdots + b_nx_{1n} + e_1; \\ Y_2 = b_0 + b_1x_{21} + \cdots + b_nx_{2n} + e_2; \\ \vdots \\ Y_i = b_0 + b_1x_{i1} + \cdots + b_nx_{in} + e_i; \end{cases} (i = 1, 2, ..., n) \quad \textbf{(2)}$$

e_i meet $Nor(0,\sigma^2)$, and $\sum(e_i)^2$ = min. According to least square method, finally, we get formula (3):

$$Y = XB \quad \textbf{(3)}$$

To build the equation, we used IBM SPSS Statistics 20 under the environment of 64-bit Windows 7 ultimate edition service pack 1. Typing the source data into the software and using the method of "enter", we got the multiple regression equation:

$$y = -10.918 - 3.873x_1 + 1.055x_2 - 0.03x_3 + 0.317x_4 + 2.333x_5 + 0.021x_6 - 0.273x_7 \quad \textbf{(4)}$$

The significance testing result ($\alpha = 0.05$) shows on TABLE 2.

TABLE 2 : ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	78.839	7	11.263	258.924	.000[b]
	Residual	1.740	40	.043		
	Total	80.579	47			

a. Dependent Variable: Perf.; b. Predictors: (Constant), L.T., L.V., Putting-Height, R.V., Angle, Inti.V., Height

In this case, we can see the Sig. <0.001 $<\alpha$. And the regression equation is significant.

And the T-test of all regression coefficients ($\alpha = 0.05$) result shows on TABLE 3

According to TABLE 3, Height's t-statistics is -2.791, Putting-Height's t-statistics is 2.675, R.V.'s t-statistics is -0.167, L.V.'s t-statistics is 1.151, Inti.V.'s t-statistics is 10.83, Angel's t-statistics is 1.274, L.T.'s t-statistics is -0.276, and according to our significance level $\alpha = 0.05$, we can find out:
Sig.1=0.008 $<\alpha$, it means the independent variable Height regression coefficient is significant;
Sig.2=0.011 $<\alpha$, it means he independent variable Putting-Height regression coefficient is significant;
Sig.3=0.868 $>\alpha$, it means he independent variable R.V. regression coefficient is not significant;
Sig.4=0.256 $>\alpha$, it means he independent variable L.V. regression coefficient is not significant;
Sig.5<0.001$<\alpha$, it means he independent variable Inti.V. regression coefficient is significant;
Sig.6=0.210 $>\alpha$, it means he independent variable Angle regression coefficient is not significant;

Sig.7=0.784 > α , it means he independent variable L.V. regression coefficient is not significant;

TABLE 3 : Regression coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-10.918	4.484		-2.435	0.019
	Height	-3.873	1.388	-0.217	-2.791	0.008
	Putting-Height	1.055	0.394	0.069	2.675	0.011
	R.V.	-0.03	0.18	-0.005	-0.167	0.868
	L.V.	0.317	0.276	0.034	1.151	0.256
	Inti.V.	2.333	0.215	0.806	10.830	0.000
	Angle	0.021	0.017	0.034	1.274	0.210
	L.T.	-0.273	0.988	-0.007	-0.276	0.784

a. Dependent variable: Perf.

Depend on the significance testing result, we remove X3, X4, X6 and X7 from the regression equation, and use SPSS software to do the MLR progress again, the finally multiple regression equation is:

$$y = -9.56 - 3.634x_1 + 0.958x_2 + 2.346x_5 \tag{5}$$

The F-test result is shown as TABLE 4 and the Sig. < α . The equation is significant.

TABLE 4 : ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	78.727	3	26.242	623.216	0.000[a]
	Residual	1.853	44	0.042		
	Total	80.579	47			

a. Predictors: (Constant), Inti.V., Putting-Height, Height; b. Dependent variable: Perf.

The T-test result is shown as TABLE 5 which shows us that all coefficients are significant.

TABLE 5 : Regression coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-9.56	4.218		-2.266	0.028
	Height	-3.634	1.252	-0.203	-2.902	0.006
	Putting-Height	0.958	0.369	0.063	2.592	0.013
	Inti.V.	2.347	0.207	0.811	11.359	0

a. Dependent variable: Perf.

At last, We used the Durbin-Watson statistic to check out all residuals are mutual independence or not. When the Durbin-Watson statistic = 2 or close to 2, means all residuals are mutual independence[5]. In this case, The Durbin-Watson statistic is 1.68, means all residuals are mutual independence.

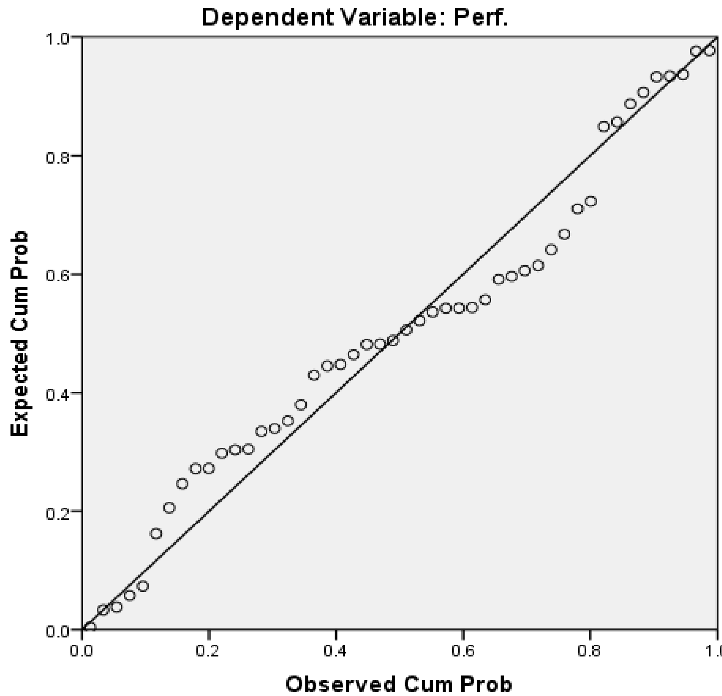

Figure 1 : Normal P-P plot of regression standardized residual

From the Figure 1 we can find out that most of the scatter points close to diagonal line which means the regression standardized residual is conforming to normal distribution.

By the conclusion of the multiple linear regression, we known that the X1(Height), X2(Putting-Height) and X5(Inti.V.) can be used for predict the performance of Chinese elite female Shot putting.

Using GRA method to sort the factors by correlation degree

In 1979, the Chinese professor Deng Ju-Long proposed Grey system theory, and in 1982, professor Deng published the first paper about Grey system theory "The Control Problems of Grey System" in System & Control Letter[5]. Through several years' development, the theory has been widely applied in economics, military, sports, and other fields[6]. Grey theory adaptation range is "small sample", "poor data information", "undefined" system, and it fits many aspects in sports research[7].

In this case, we using Grey relevancy analysis to explore which factor dominates shot put performance.

Step 1: Define reference contract series

In this case, we regard Y (performance) as reference series, and represented by X0, regard X1(Height), X2(Putting-Height), X3(R.V.), X4 (L.V.), X5(Inti.V.), X6(Angel) and X7(L.T.) as contract series. The detail is shown in TABLE 6.

Step 2: process the original data

Calculate each series' average values:

X0(t)=19.30104 X1(t)=1.06833 X2(t)=2.00958 X3(t)=2.55958
X4(t)=2.95625 X5(t)=13.13104 X6(t)=37.20833 X7(t)=0.21688

And then use average values to divide original data series, refer to TABLE 7:

TABLE 6 : Original data series

NO.	X_0	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	15.7	1.19	2.17	2.31	3.06	11.88	37	0.24
2	16.4	1.18	2.06	2.36	3.02	12.28	36	0.23
3	17.05	1.18	1.96	2.37	2.98	12.52	35	0.23
4	17.87	1.17	2.1	2.39	3.01	12.51	37	0.28
5	17.88	1.16	1.87	2.48	3.11	12.74	34	0.17
6	17.91	1.16	1.9	2.38	2.99	12.55	39	0.29
7	17.91	1.15	1.98	2.37	3.01	12.71	39	0.24
8	17.96	1.15	1.98	2.39	3.03	12.77	36	0.23
9	18	1.15	1.91	2.4	3.03	12.78	36	0.3
10	18.27	1.14	2.16	2.43	3.01	12.72	38	0.26
11	18.44	1.14	2.02	2.33	3.09	12.74	37	0.25
12	18.46	1.14	2.27	2.39	2.96	12.78	36	0.22
13	18.46	1.13	2.09	2.57	3.23	12.72	37	0.17
14	18.52	1.13	2.03	2.46	2.83	12.86	38	0.26
15	18.63	1.12	1.92	2.49	3.05	12.91	38	0.24
16	18.7	1.13	1.99	2.39	2.89	12.93	39	0.25
17	18.78	1.12	1.9	2.5	3.07	12.9	44	0.24
18	18.79	1.11	2.07	2.88	3.31	12.86	36	0.12
19	18.94	1.11	1.97	2.78	2.97	13.05	35	0.19
20	18.94	1.11	2.13	2.47	2.86	13.03	37	0.19
21	19.01	1.1	2.09	2.45	2.87	13.15	36	0.2
22	19.16	1.1	2.24	2.51	3.08	12.92	34	0.16
23	19.22	1.08	1.9	2.48	3.12	13.15	33	0.18
24	19.29	1.07	2.05	2.38	2.72	13.25	37	0.18
25	19.35	1.06	2.08	2.56	2.61	13.02	39	0.2
26	19.4	1.06	2.02	2.79	2.85	13.16	40	0.22
27	19.46	1.05	1.98	2.82	2.99	13.17	35	0.16
28	19.66	1.04	1.94	2.85	2.99	13.28	37	0.22
29	19.69	1.03	1.97	2.84	2.89	13.3	38	0.22
30	19.76	1.03	1.98	2.63	2.88	13.27	37	0.22
31	19.87	1.02	1.94	2.86	2.91	13.38	36	0.23
32	19.98	1.02	2.04	2.79	2.87	13.16	35	0.2
33	20.02	1.02	1.91	2.83	2.97	13.43	40	0.22
34	20.08	1.01	1.95	2.38	2.79	13.45	39	0.21
35	20.24	1	2.06	2.36	2.59	13.4	38	0.16
36	20.25	1	2	1.98	2.79	13.41	34	0.16
37	20.29	0.99	2	2.87	2.92	13.48	41	0.21
38	20.3	0.98	2	2.87	2.92	13.51	39	0.22
39	20.43	0.98	1.91	2.58	2.91	13.52	39	0.22
40	20.45	0.99	1.96	2.63	2.96	13.51	37	0.23
41	20.54	0.98	2.02	2.65	2.97	13.53	37	0.23
42	20.58	0.98	1.98	2.65	2.99	13.55	36	0.22
43	20.62	0.98	2	2.42	2.77	13.54	40	0.21
44	20.76	0.98	2.02	2.37	2.76	13.58	38	0.24
45	21.49	0.96	1.97	2.83	3.04	13.92	36	0.25
46	21.52	0.97	2.02	2.43	3.07	13.98	37	0.2
47	21.66	0.97	2	2.95	3.1	13.95	39	0.22
48	21.76	0.96	1.95	2.96	3.06	14.08	35	0.22

TABLE 7 : Processed original data

X_0	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1.22937	0.89776	0.92608	1.10804	0.96609	1.10531	1.00563	0.90365
1.17689	0.90537	0.97553	1.08457	0.97889	1.06930	1.03356	0.94293
1.13203	0.90537	1.02530	1.07999	0.99203	1.04881	1.06310	0.94293
1.08008	0.91311	0.95694	1.07096	0.98214	1.04964	1.00563	0.77455
1.07948	0.92098	1.07464	1.03209	0.95056	1.03069	1.09436	1.27574
1.07767	0.92098	1.05768	1.07546	0.98871	1.04630	0.95406	0.74784
1.07767	0.92899	1.01494	1.07999	0.98214	1.03313	0.95406	0.90365
1.07467	0.92899	1.01494	1.07096	0.97566	1.02827	1.03356	0.94293
1.07228	0.92899	1.05214	1.06649	0.97566	1.02747	1.03356	0.72292
1.05643	0.93713	0.93036	1.05333	0.98214	1.03231	0.97917	0.83413
1.04669	0.93713	0.99484	1.09853	0.95672	1.03069	1.00563	0.86750
1.04556	0.93713	0.88528	1.07096	0.99873	1.02747	1.03356	0.98580
1.04556	0.94543	0.96152	0.99595	0.91525	1.03231	1.00563	1.27574
1.04217	0.94543	0.98994	1.04048	1.04461	1.02108	0.97917	0.83413
1.03602	0.95387	1.04666	1.02795	0.96926	1.01712	0.97917	0.90365
1.03214	0.94543	1.00984	1.07096	1.02292	1.01555	0.95406	0.86750
1.02774	0.95387	1.05768	1.02383	0.96295	1.01791	0.84564	0.90365
1.02720	0.96246	0.97081	0.88874	0.89313	1.02108	1.03356	1.80729
1.01906	0.96246	1.02009	0.92071	0.99537	1.00621	1.06310	1.14145
1.01906	0.96246	0.94347	1.03627	1.03365	1.00775	1.00563	1.14145
1.01531	0.97121	0.96152	1.04473	1.03005	0.99856	1.03356	1.08438
1.00736	0.97121	0.89714	1.01975	0.95982	1.01633	1.09436	1.35547
1.00422	0.98920	1.05768	1.03209	0.94752	0.99856	1.12753	1.20486
1.00057	0.99844	0.98028	1.07546	1.08686	0.99102	1.00563	1.20486
0.99747	1.00786	0.96615	0.99984	1.13266	1.00853	0.95406	1.08438
0.99490	1.00786	0.99484	0.91741	1.03728	0.99780	0.93021	0.98580
0.99183	1.01746	1.01494	0.90765	0.98871	0.99704	1.06310	1.35547
0.98174	1.02724	1.03587	0.89810	0.98871	0.98878	1.00563	0.98580
0.98025	1.03722	1.02009	0.90126	1.02292	0.98730	0.97917	0.98580
0.97677	1.03722	1.01494	0.97323	1.02648	0.98953	1.00563	0.98580
0.97137	1.04739	1.03587	0.89496	1.01589	0.98139	1.03356	0.94293
0.96602	1.04739	0.98509	0.91741	1.03005	0.99780	1.06310	1.08438
0.96409	1.04739	1.05214	0.90445	0.99537	0.97774	0.93021	0.98580
0.96121	1.05776	1.03056	1.07546	1.05959	0.97629	0.95406	1.03274
0.95361	1.06833	0.97553	1.08457	1.14141	0.97993	0.97917	1.35547
0.95314	1.06833	1.00479	1.29272	1.05959	0.97920	1.09436	1.35547
0.95126	1.07912	1.00479	0.89184	1.01241	0.97411	0.90752	1.03274
0.95079	1.09014	1.00479	0.89184	1.01241	0.97195	0.95406	0.98580
0.94474	1.09014	1.05214	0.99209	1.01589	0.97123	0.95406	0.98580
0.94382	1.07912	1.02530	0.97323	0.99873	0.97195	1.00563	0.94293
0.93968	1.09014	0.99484	0.96588	0.99537	0.97051	1.00563	0.94293
0.93785	1.09014	1.01494	0.96588	0.98871	0.96908	1.03356	0.98580
0.93603	1.09014	1.00479	1.05768	1.06724	0.96980	0.93021	1.03274
0.92972	1.09014	0.99484	1.07999	1.07111	0.96694	0.97917	0.90365
0.89814	1.11285	1.02009	0.90445	0.97245	0.94332	1.03356	0.86750
0.89689	1.10137	0.99484	1.05333	0.96295	0.93927	1.00563	1.08438
0.89109	1.10137	1.00479	0.86766	0.95363	0.94129	0.95406	0.98580
0.88700	1.11285	1.03056	0.86472	0.96609	0.93260	1.06310	0.98580

Step 3: calculate correlation coefficient

The correlation coefficient formula is:

$$\xi_i(k) = \frac{\min_s \min_t |x_0(t) - x_s(t)| + \rho \max_s \max_t |x_0(t) - x_s(t)|}{|x_0(k) - x_i(k)| + \rho \max_s \max_t |x_0(t) - x_s(t)|} \quad (6)$$

Among them, ρ is called resolution coefficient, and usually $\rho \in (0,1)$. ρ is used for waken the correlation coefficient distortion influence from the oversize $\max_s \max_t |x_0(t) - x_s(t)|$, so the value of ρ is depended on $\max_s \max_t |x_0(t) - x_s(t)|$ and assigned by the researcher. In common situation, ρ is often assigned closely to 0.5.[5] In our case, ρ = 0.5.

TABLE 8 is the values of $|x_0(t) - x_s(t)|$:

And:

$\min_s \min_t |x_0(t) - x_s(t)| = 0.78009$

$\max_s \max_t |x_0(t) - x_s(t)| = 0.00006$

$$\xi_i(k) = \frac{\min_s \min_t |x_0(t) - x_s(t)| + \rho \max_s \max_t |x_0(t) - x_s(t)|}{|x_0(k) - x_i(k)| + \rho \max_s \max_t |x_0(t) - x_s(t)|} = \frac{0.001866 + 0.5 \times 0.329530}{|x_0(k) - x_i(k)| + 0.5 \times 0.329530} = \frac{0.166631}{x_{ij} + 0.164765} \quad (7)$$

Now we can calculate the $\xi_i(k)$, the result are as the TABLE 9 shows.

Step 4: calculate correlation degree.

According to the GRA theory, the correlation degree computational formula is:

$$\gamma_i = \frac{1}{48} \sum_{1}^{48} \xi_i(k) \quad (8)$$

The result of the GRA correlation degree was shows in TABLE 10:

Obviously, $\gamma_5 > \gamma_3 > \gamma_6 > \gamma_2 > \gamma_4 > \gamma_1 > \gamma_7$, it means the first factor is X_5(Inti.V.), and the last factor is X7(L.T.).

TABLE 8 : The absolute difference value

X_1	X_2	X_3	X_4	X_5	X_6	X_7
0.33161	0.30329	0.12132	0.26327	0.12406	0.22374	0.32572
0.27153	0.20137	0.09232	0.19800	0.10759	0.14333	0.23396
0.22666	0.10673	0.05203	0.14000	0.08322	0.06893	0.18909
0.16698	0.12314	0.00913	0.09794	0.03044	0.07445	0.30553
0.15850	0.00483	0.04739	0.12891	0.04878	0.01489	0.19626
0.15669	0.01999	0.00221	0.08896	0.03137	0.12361	0.32982
0.14868	0.06273	0.00232	0.09553	0.04454	0.12361	0.17402
0.14568	0.05973	0.00371	0.09901	0.04640	0.04110	0.13173
0.14329	0.02014	0.00579	0.09662	0.04481	0.03872	0.34936
0.11930	0.12607	0.00311	0.07429	0.02412	0.07727	0.22230
0.10956	0.05185	0.05184	0.08998	0.01600	0.04106	0.17919
0.10843	0.16028	0.02540	0.04683	0.01809	0.01200	0.05976
0.10013	0.08404	0.04961	0.13031	0.01325	0.03993	0.23018
0.09675	0.05223	0.00169	0.00244	0.02110	0.06301	0.20804
0.08215	0.01064	0.00807	0.06676	0.01890	0.05685	0.13237
0.08671	0.02230	0.03881	0.00922	0.01659	0.07808	0.16464
0.07388	0.02993	0.00391	0.06480	0.00983	0.18210	0.12410
0.06474	0.05638	0.13845	0.13407	0.00612	0.00637	0.78009
0.05660	0.00103	0.09835	0.02369	0.01285	0.04403	0.12238
0.05660	0.07560	0.01721	0.01459	0.01131	0.01343	0.12238
0.04410	0.05379	0.02942	0.01474	0.01675	0.01825	0.06907
0.03615	0.11023	0.01239	0.04754	0.00897	0.08700	0.34811
0.01502	0.05346	0.02787	0.05670	0.00566	0.12331	0.20064
0.00213	0.02029	0.07488	0.08628	0.00955	0.00506	0.20429
0.01039	0.03132	0.00237	0.13519	0.01106	0.04341	0.08691
0.01296	0.00006	0.07749	0.04238	0.00290	0.06469	0.00910
0.02563	0.02311	0.08418	0.00312	0.00521	0.07126	0.36364
0.04550	0.05413	0.08364	0.00697	0.00704	0.02389	0.00405
0.05697	0.03985	0.07898	0.04268	0.00705	0.00108	0.00555
0.06044	0.03817	0.00355	0.04970	0.01276	0.02886	0.00902
0.07602	0.06450	0.07641	0.04453	0.01003	0.06220	0.02843
0.08137	0.01907	0.04860	0.06403	0.03178	0.09708	0.11836
0.08330	0.08805	0.05964	0.03128	0.01365	0.03388	0.02171
0.09655	0.06935	0.11425	0.09838	0.01508	0.00715	0.07153
0.11472	0.02192	0.13096	0.18780	0.02632	0.02556	0.40186
0.11520	0.05165	0.33958	0.10645	0.02606	0.14122	0.40233
0.12787	0.05353	0.05942	0.06116	0.02285	0.04374	0.08148
0.13935	0.05400	0.05895	0.06162	0.02116	0.00327	0.03501
0.14540	0.10740	0.04735	0.07115	0.02649	0.00932	0.04106
0.13531	0.08148	0.02941	0.05492	0.02813	0.06181	0.00088
0.15046	0.05516	0.02620	0.05569	0.03083	0.06595	0.00325
0.15228	0.07709	0.02803	0.05086	0.03123	0.09571	0.04794
0.15410	0.06876	0.12164	0.13120	0.03376	0.00583	0.09670
0.16041	0.06512	0.15027	0.14138	0.03722	0.04944	0.02608
0.21471	0.12195	0.00631	0.07431	0.04518	0.13542	0.03064
0.20449	0.09795	0.15644	0.06606	0.04238	0.10874	0.18749
0.21028	0.11370	0.02344	0.06254	0.05020	0.06297	0.09470
0.22585	0.14356	0.02227	0.07910	0.04561	0.17610	0.09880

TABLE 9 : Correlation coefficient table

X_1	X_2	X_3	X_4	X_5	X_6	X_7
0.54057	0.56265	0.76286	0.59711	0.75880	0.63557	0.54501
0.58966	0.65961	0.80872	0.66338	0.78391	0.73139	0.62516
0.63256	0.78527	0.88243	0.73598	0.82428	0.84994	0.67359
0.70034	0.76016	0.97728	0.79942	0.92775	0.83984	0.56084
0.71116	0.98790	0.89180	0.75170	0.88896	0.96338	0.66536
0.71351	0.95138	0.99450	0.81441	0.92569	0.75946	0.54191
0.72412	0.86158	0.99422	0.80339	0.89764	0.75946	0.69159
0.72817	0.86733	0.99071	0.79767	0.89382	0.90480	0.74764
0.73143	0.95103	0.98552	0.80158	0.89708	0.90983	0.52759
0.76589	0.75584	0.99224	0.84013	0.94190	0.83478	0.63706
0.78082	0.88279	0.88281	0.81267	0.96073	0.90488	0.68530
0.78260	0.70885	0.93901	0.89294	0.95581	0.97030	0.86726
0.79584	0.82286	0.88728	0.74968	0.96729	0.90727	0.62897
0.80137	0.88203	0.99582	0.99393	0.94882	0.86105	0.65225
0.82614	0.97359	0.97986	0.85398	0.95393	0.87291	0.74672
0.81824	0.94605	0.90963	0.97705	0.95933	0.83332	0.70328
0.84088	0.92887	0.99021	0.85766	0.97555	0.68182	0.75874
0.85778	0.87382	0.73813	0.74430	0.98469	0.98408	0.33338
0.87340	0.99751	0.79874	0.94287	0.96824	0.89869	0.76128
0.87340	0.83777	0.95789	0.96408	0.97196	0.96685	0.76128
0.89855	0.87894	0.93000	0.96372	0.95896	0.95543	0.84969
0.91531	0.77978	0.96934	0.89149	0.97765	0.81774	0.52848
0.96306	0.87959	0.93344	0.87321	0.98584	0.75991	0.66042
0.99471	0.95069	0.83906	0.81897	0.97624	0.98734	0.65637
0.97419	0.92579	0.99411	0.74271	0.97257	0.89998	0.81791
0.96797	1.00000	0.83439	0.90212	0.99276	0.85786	0.97733
0.93848	0.94420	0.82261	0.99221	0.98696	0.84564	0.51759
0.89566	0.87827	0.82354	0.98258	0.98241	0.94242	0.98986
0.87268	0.90744	0.83172	0.90150	0.98239	0.99738	0.98611
0.86595	0.91100	0.99113	0.88710	0.96847	0.93125	0.97753
0.83701	0.85822	0.83632	0.89767	0.97508	0.86259	0.93219
0.82752	0.95352	0.88932	0.85910	0.92479	0.80083	0.76731
0.82414	0.81595	0.86750	0.92589	0.96632	0.92021	0.94742
0.80170	0.84917	0.77356	0.79869	0.96292	0.98215	0.84515
0.77283	0.94693	0.74875	0.67510	0.93692	0.93864	0.49261
0.77211	0.88318	0.53466	0.78571	0.93751	0.73428	0.49232
0.75322	0.87944	0.86793	0.86458	0.94479	0.89930	0.82732
0.73689	0.87851	0.86883	0.86369	0.94868	0.99183	0.91778
0.72856	0.78421	0.89188	0.84584	0.93654	0.97680	0.90490
0.74255	0.82732	0.93002	0.87671	0.93286	0.86332	0.99789
0.72174	0.87622	0.93719	0.87519	0.92688	0.85549	0.99187
0.71931	0.83510	0.93310	0.88478	0.92601	0.80308	0.89067
0.71691	0.85026	0.76238	0.74840	0.92047	0.98542	0.80144
0.70868	0.85705	0.72199	0.73406	0.91303	0.88762	0.93747
0.64506	0.76192	0.98423	0.84009	0.89632	0.74239	0.92730
0.65615	0.79939	0.71384	0.85529	0.90211	0.78210	0.67546
0.64981	0.77440	0.94346	0.86194	0.88610	0.86112	0.80475
0.63339	0.73107	0.94612	0.83152	0.89544	0.68905	0.79801

TABLE 10 : Correlation coefficient table

	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7
γ_i	0.78379	0.85863	0.88500	0.84112	0.93548	0.86752	0.75057
GRA Ranking	6	4	2	5	1	3	7

CONCLUSION

With the help of the MLR, three factors were picked up to composed the multiple linear regression equation which was showed as equation 5. There are four factors were not brought in, it does not means they were not important in daily training, but in the MLR section of this paper, we put our primary attention on predicting not the correlation.

For find out the importance of seven factors' correlation with performance, we used the Grey correlation degree method to calculate the correlation degree. Depend on the result, we sort the seven factors from large to small: X5(Inti.V.), X3(R.V.), X6(Angel), X2(Putting-Height), X4(L.V.), X1(Height), and X7(L.T.).

At last, we can find out that whether to predict or the correlation with performance, X5(Inti.V.) was the most important factor in Chinese elite female's shot put daily training. The coaches and athletes should put more attention on the shot's initial velocity on the moment of hand left (X5), at the same time, the result also remind us that in the technical training, suitable putting-angle (X6) and coherent movement (for improve the X3:R.V, and X4:L.V) are also useful to improve the performance.

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