

# Male College Students Calculate the Density of the Body's Preferred Model Study

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**Abstract.** Height, weight indicators and targets to which they derived from variable to the density of male college students physical indicators for the dependent variable, using scientific methods to establish multiple regression model. Application of statistical regression model parameters on a comparative analysis, the forecast selection of male college students physical density of the best regression model. Body mass index models to predict the value and the actual measurements showed no difference,  $P > 0.95$  level.

**Key words:** Male college students, density of the body; regression model, optimization

## 1. Introduction

Human density ( $\text{g}/\text{cm}^3$ ) refers to the human body in the air in the ratio of weight and size. There are individual differences in human density, the size of its value, the evaluation of the extent of human obesity, nutritional status, physical health status and competitive sports have an important theoretical reference. At present, the body density measurement methods commonly used method of underwater weighing, bioelectrical impedance. However, their experimental conditions and test equipment costs higher. CNKI network by the access-related literature, research in this area is reflected in the results of measuring instruments for the comparative study of accuracy, as well as skinfold thickness using the density of the projection methods to improve human research. Measuring instruments based on this study by the University of access to male F%, the use of  $D = 4.57 / ((F\% / 100) + 4.142)$  calculation model to obtain its data on the human body density. Indicators based on the body density data and physical evaluation index system in the higher part of the relevance of indicators, the establishment of a regression model and multiple regression calculation. Regression model based on the estimated value of human density and F indicators data analysis, optimization of the  $P > 0.95$  level of the regression model as the basis for calculating the body density of male college students of the computing model. The purpose is designed to provide simple, accurate calculation of the density of male college students approach the human body, in order to improve the physical fitness evaluation of university students to provide scientific and theoretical basis.

## 2. Subjects and methods

### 2.1. Study

Randomly selected male college students in school 349, aged 18-21 years old, a total of 349.

### 2.2. Research Methods

**2.2.1. Literature** information available related literature, analysis of relevant research results of this study was to find a "breach" provide a theoretical basis.

#### 2.2.2. Index System test

##### 2.2.2.1. The body composition and method of detection of targets

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The use of human body composition InBody3.0 analyzer (Biospace, Korea), test instrumentation prior to correction. Detection of indicators, including body water content, protein content, fat content, salt content of the four component indicators. Pre-test requirements of subjects within 24 hours to avoid strenuous exercise and a large amount of water. Testing subjects dressed in light clothing, paper towels prior to use saline to clean their hands and feet in order to increase the electrical conductivity of skin.

### 2.2.2.2. Indicators and methods of physical testing

The use of the promulgation of a national body to monitor the use of detection equipment and related equipment. Detection of indicators, including body shape, physical function, physical quality index system. The indicator system shown in Table 1.

Table 1 :the study of male college students a list of indicators of physical testing

Height	Weight	weight * 100 / height	Body volume	Body surface area	BMI	Vital capacity
Pulse	Diastolic blood pressure	Systolic blood pressure	Pulse pressure	100 meters	200m obstacle	1000 meters
5000 meters	Shot Put	Pull-up	Jump	Climbing	Direct response	Indirect response

### 2.2.3. The establishment of a database

Components will be tested in human and physical testing of indicators of computer data entry, the establishment of the relevant series of studies database.

### 2.2.4. Mathematical statistics

Micro Excel2000 and sports use of scientific data processing system software, the database of statistical data processing and analysis.

### 2.2.5. Optimization

Established based on a regression (linear and nonlinear) and multiple regression model, male college students compared to the human body to calculate the relative density of the accuracy of male college students preferred the human body suitable for the calculation of the density model.

## 3. Results and Analysis

### 3.1. The difference between the current formula analysis

Formula for calculating density based on the human body:  $Db_1 = 1.0913 - 0.00116x$  (upper arm skinfold skinfold + scapula) and  $Db_2 = 1.0863 - 0.00176x$  (abdominal skinfold), of 225 randomly selected male college students in the school, measured upper arm and scapula and abdominal skinfold thickness, calculated by the program in table 2.

Table 2: male college students a list of human body density calculation

Name	Height	Weight	Arm skinfold	Scapular skinfold	Abdominal skinfold	Human density ( $D_{b1}$ )	Human density ( $D_{b2}$ )
WangMingYu	173.5	59	9.5	11	9.5	1.0675	1.0696
LiZhiHong	167	58.5	8	14	15	1.0658	1.0599
WangWei	167	54	12.5	8.5	11	1.0669	1.0669
MaLiFan	159.5	50.7	15	13	28	1.0588	1.0370
ZhuDong	166	58.5	5.5	6	6.5	1.0780	1.0749
KongHuaBo	163.5	60.4	16	16.5	19	1.0536	1.0529
HuYongSheng	176	59	10.5	11	17	1.0664	1.0564
WuZhiRong	160.5	54	9.5	10.5	10	1.0681	1.0687
HuangLiChao	169.5	50.5	4.5	6	8	1.0791	1.0722
GaoChong	168.5	51.5	5	7	6	1.0774	1.0757
.....	.....	.....	.....	.....	.....	.....	.....

Based on Table 2 and  $Db_2$  in  $Db_1$  results, use Microsoft Office Excel software, analysis of variance of its terms, a Table 3.

Table 3: Db<sub>1</sub> and list the results of the analysis of variance Db<sub>2</sub>

Differences in the source	SS	df	MS	F	F crit	p
Groups	0.002487	1	0.002487	16.66272	10.97183	0.001
Group	0.066858	448	0.000149			
Total	0.069345	449				

Analysis from the Table 3 in,  $F = 16.66272 > F_{crit} = 10.97183$ ,  $p < 0.001$ . Db<sub>2</sub> between Db<sub>1</sub> with very significant difference. Therefore, the use of measurements in different parts of the body skinfold thickness, and density of the projection method the body can not be an accurate reflection of a more objective level of human density.

### 3.2. University of male density and body of human relevance of indicators

Based on body fat percentage (F%) =  $(4.57/D - 4.142) \times 100$  formula, the formula is derived for the density of a human:  $D = 4.57 / ((F\% / 100) + 4.142)$ . Based on body composition indicators of body fat percentage test data, by calculating the body density of male college students were indicators of the data. Database based on the body density of male college students with physical indicators of indicators data system data, the use of Micro Excel2000 software to calculate their relevance, their calculation results in table 4.

Table 4: University of male human body density and body mass index system of relevance (riy) List

Height	Weight	weight * 100 / height	Body volume	Body surface area	BMI	Vital capacity
0.1735	-0.5282	-0.6068	-0.5219	-0.4124	-0.6578	-0.0608
Pulse	Diastolic blood pressure	Systolic blood pressure	Pulse pressure	100 meters	200m obstacle	1000 meters
-0.0454	-0.0022	-0.059	-0.0757	-0.2376	-0.1004	-0.3031
5000 meters	Shot Put	Pull-up	Jump	Climbing	Direct response	Indirect response
-0.2382	-0.0056	0.2781	0.3181	-0.2036	0.0153	0.0015

Note:  $r_{(349-1),0.05}=0.105$ 、 $r_{(349-1),0.01}=0.137$ 、 $r_{(349-1),0.001}=0.175$

Table 4 Calculation based on the results of analysis: 1) male college students with physical indicators of human density correlation is very significant: body weight, (weight / height) \* 100, the body size, body surface area, body mass index, 100 m, 1000 m, 5000 m, pull-up, jump and climb the 10, the ri values are greater than  $r_{(349-1), 0.001} = 0.175$ ,  $p < 0.001$  level. So that, the body density of male college students and these indicators were highly correlated; 2) male college students with physical indicators of human density correlation is very significant: height, its ri value is greater than  $r_{(349-1), 0.01} = 0.137$ ,  $p < 0.01$  level; 3) the density of male college students with physical indicators of the human body was not the relevance of the indicators are: vital capacity, pulse, blood pressure, systolic blood pressure, pulse pressure, 200-meter steeplechase, shot put, direct response, indirect response, the ri are less than the value of  $r_{(349-1), 0.05} = 0.105$ ,  $p > 0.05$  level. So that, the body density of male college students with these indicators was not related to each other.

Comprehensive analysis of these results, the density of male college students with physical indicators of the body parts of the system indicators were highly correlated with some indicators were relevant and was not related to each other. So that the study of human male college students of the University of male density study to further improve the physical, has a certain practical value and theoretical significance.

### 3.3. Human male college students preferred density model

#### 3.3.1. To establish a regression model and optimization

Table 4 based on male college students in the human body density and body mass index system riy value of the size of the sort, select the top four in the correlation coefficient (weight / height) \* 100, body surface area, body mass index, body volume indicator variables, indicators of human density as the dependent variable, namely the establishment of a regression model.

##### 3.3.1.1. (Weight / height) \* 100 indicators and optimization of regression model

Students based on measurements (weight / height) \* 100 and human density data, the use of Micro

Excel2000 data analysis software, by calculating the five kinds of the regression model shown in figure 1.

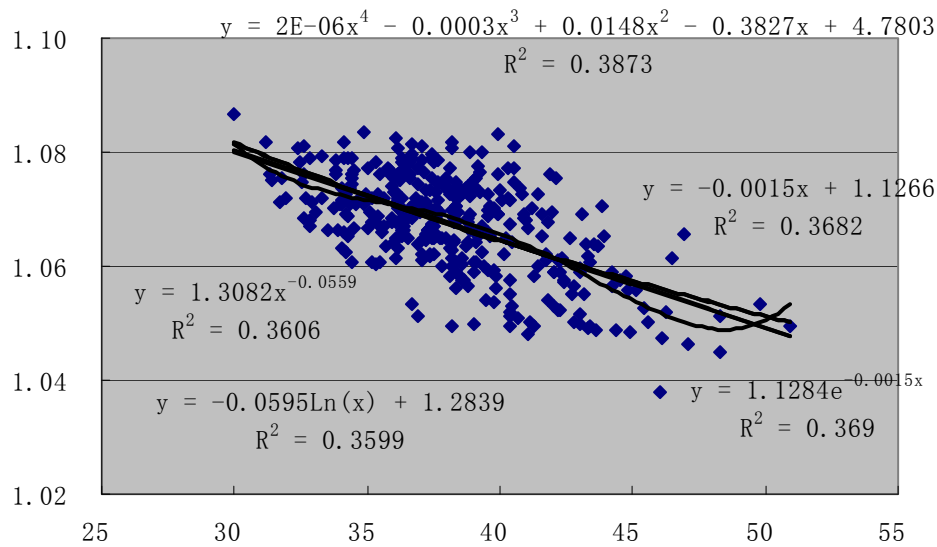


Figure 1

Figure 1 was based finishing 5

Table 5 :(weight / height) \* 100 indicators for the results of regression model with a list of preferred

Model	Formula	R <sup>2</sup>	Selection Sort
Linear equations	$\hat{y} = -0.0015x + 1.1266$	0.3682	3
Logarithmic equation	$\hat{y} = -0.0595Ln(x) + 1.2839$	0.3599	5
By the power equation	$\hat{y} = 1.3082x^{-0.0559}$	0.3606	4
Index equation	$\hat{y} = 1.1284e^{-0.0015x}$	0.3690	2
Polynomial equation	$\hat{y} = 2E - 06x^4 - 0.0003x^3 + 0.0148x^2 - 0.3827x + 4.7803$	0.3873	1

Based on Table 5 in the multiple correlation coefficient (R<sup>2</sup>) value of the size of the evaluation model can be calculated density of the human male college students relative accuracy of the calculation. So that, in the five kinds of regression model, the relative predictive value of its accuracy are: polynomial equations, exponential equations, linear equations, by the power equation and logarithmic equations, polynomial equations for the optimum.

### 3.3.1.2 Indicators of body surface area with the preferred regression model

Students based on measurement of body surface area and human density data, the use of Micro Excel2000 data analysis software, by calculating the five kinds of the regression model shown in Figure 2.

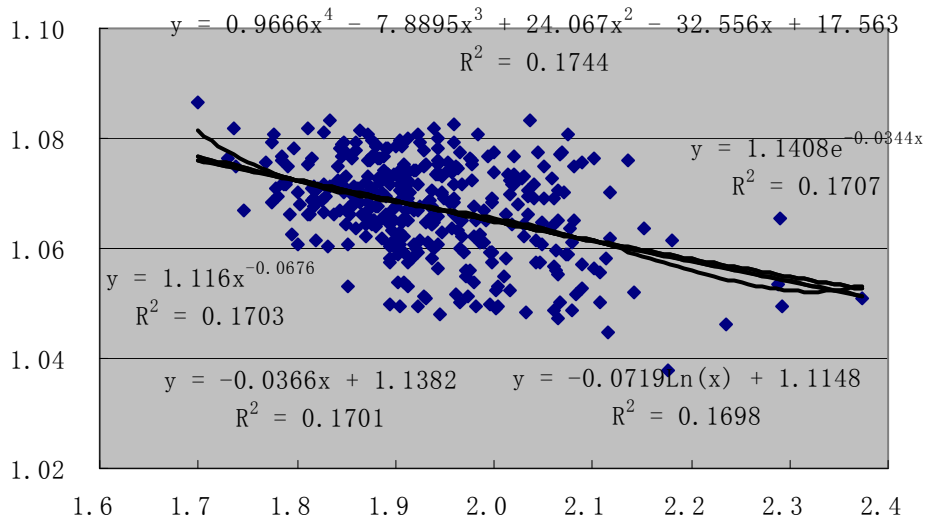


Figure 2

Figure 2 was based on finishing Table 6

Table 6: Indicators of body surface area, the results of regression model with a list of preferred

Model	Formula	R <sup>2</sup>	Selection Sort
Linear equations	$\hat{y} = -0.0366x + 1.1382$	0.1701	4
Logarithmic equation	$\hat{y} = -0.0719\text{Ln}(x) + 1.1148$	0.1698	5
By the power equation	$\hat{y} = 1.116x^{-0.0676}$	0.1703	3
Index equation	$\hat{y} = 1.1408e^{-0.0344x}$	0.1707	2
Polynomial equation	$\hat{y} = 0.9666x^4 - 7.8895x^3 + 24.067x^2 - 32.556x + 17.563$	0.1744	1

Table 6 based on the multiple correlation coefficient (R<sup>2</sup>) value of the size of that in the five kinds of regression model, the relative predictive value of its accuracy are: polynomial equations, exponential equations, by the power equation, linear equations and logarithmic equations, polynomial equations for the optimum.

**3.3.1.3 .Indicators of BMI regression model with the optimization**

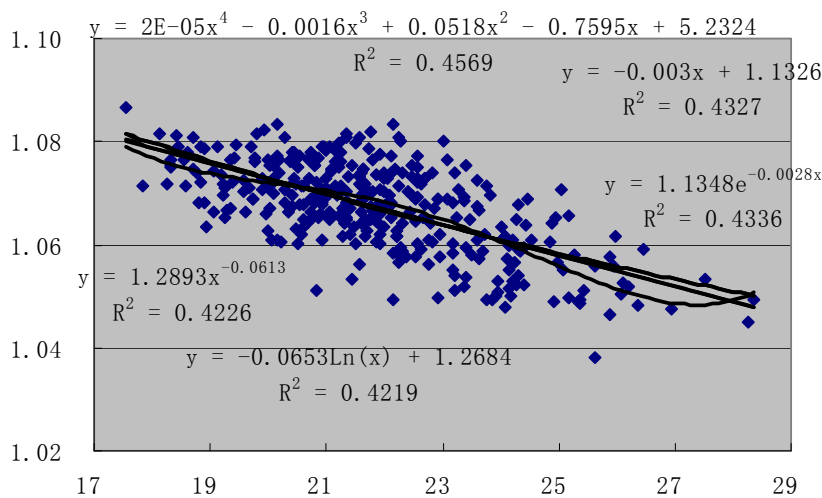


Figure 3

Students based on measurement of body mass index and human density data, the use of Micro Excel2000 data analysis software, the five kinds of calculated regression model see Figure 3.

Figure 3 was based on finishing Table 7

Table 7: Indicators of body mass index regression model with the results of a list of preferred

Model	Formula	R <sup>2</sup>	Selection Sort
Linear equations	$\hat{y} = -0.003x + 1.1326$	0.4327	3
Logarithmic equation	$\hat{y} = -0.0653Ln(x) + 1.2684$	0.4219	5
By the power equation	$\hat{y} = 1.2893x^{-0.0613}$	0.4226	4
Index equation	$\hat{y} = 1.1348e^{-0.0028x}$	0.4336	2
Polynomial equation	$\hat{y} = 2E - 05x^4 - 0.0016x^3 + 0.0518x^2 - 0.7595x + 5.2324$	0.4569	1

Based on Table 7 in the multiple correlation coefficient (R<sup>2</sup>) value of the size of that in the five kinds of regression model, the relative predictive value of its accuracy are: polynomial equations, exponential equations, linear equations, by power equations and logarithmic equations, polynomial equations for the optimum.

**3.3.1.4. Indicators of body volume and the preferred regression model**

Students based on measurement of human body volume and density data, the use of Micro Excel2000 data analysis software, by calculating the five kinds of the regression model shown in Figure 4.

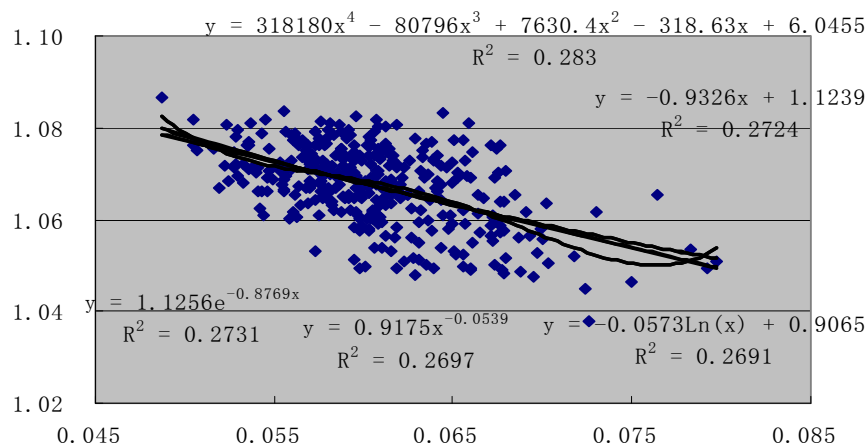


Figure 4

Figure 4 was based on finishing Table 8

Table 8: Indicators of the body size of the results of regression model with a list of preferred

Model	Formula	R <sup>2</sup>	Selection Sort
Linear equations	$\hat{y} = -0.9326x + 1.1239$	0.2724	3
Logarithmic equation	$\hat{y} = -0.0573Ln(x) + 0.9065$	0.2691	5
By the power equation	$\hat{y} = 0.9175x^{-0.0539}$	0.2697	4
Index equation	$\hat{y} = 1.1256e^{-0.8769x}$	0.2731	2
Polynomial equation	$\hat{y} = 318180x^4 - 80796x^3 + 7630.4x^2 - 318.63x + 6.0455$	0.2830	1

Table 8 based on the multiple correlation coefficient ( $R^2$ ) value of the size of that in the five kinds of regression model, the relative predictive value of its accuracy are: polynomial equations, exponential equations, linear equations, by power equations and logarithmic equations, exponential equations and linear equations for the optimum.

**3.3.2 .The establishment of multiple regression models and optimization**

Selected based on the body density of male college students with riy indicator value for the former four variables, indicators of human density as the dependent variable, multiple regression to establish the calculation model. Based on the independent variables and the dependent variable indicator data, the use of sports science data processing system software, by the statistical processing, the results in table 9.

Table 9: the density of male college students of the human body a list of multivariate statistical parameters

Indicators	Regression coefficient $b_i$	Standard regression coefficient $B_i'$	Partial regression sum of squares $P_i$	F test $F_i$
$b_0$	1.187469			
$b_1$	0.007582	2.9709	0.000005	0.1149
$b_2$	-0.04403	-0.4966	0.000004	0.0893
$b_3$	-0.01223	-2.6946	0.000014	0.3282
$b_4$	-0.94896	-0.5311	0.000001	0.0125

Note:  $R^2 = 0.6722$   $Sy = 0.0065$   $F=71.31$  ( $P<0.01$ )

Table 9 based on the regression coefficient, the establishment of the body density of male college students multiple regression model:

$$= 1.187469 + 0.007582 \times (\text{weight} / \text{height}) \times 100 - 0.04403 \times (\text{Body surface area}) - 0.01223 \times (\text{Body mass index}) - 0.94896 \times (\text{Body volume})$$

**3.3.3 Preferred regression model**

Based on (weight / height) \* 100, body surface area, body mass index, body volume targets established by a regression model to establish the optimal model and the multivariate regression model and the data related to relevant indicators, the use of data software Micro Excel2000 analysis of male college students by the program calculating the value of human density, the calculation results in table 10.

Table 10 Regression model of the human body density of male college students a list of statistical results

Name	The actual measurement and calculation of the value of							Predictive value of human density regression				
	H	W	(W/H)*100	BSA	BMI	BV	BD	(W/H)*100	BSA	BMI	BV	Multi - Return
	cm	kg	kg/cm	m <sup>2</sup>	kg/m <sup>2</sup>	m <sup>3</sup>	g/cm <sup>3</sup>					
OuYangChao	172	66.8	38.837	1.913	22.580	0.06044	1.069	1.068	1.071	1.066	1.069	1.064
ShiRenJie	177	65.6	37.062	1.932	20.939	0.05964	1.061	1.070	1.070	1.071	1.069	1.071
WangJing	180	65.7	36.500	1.955	20.278	0.05978	1.068	1.070	1.070	1.072	1.069	1.073
LeiJianBo	170	68.7	40.412	1.924	23.772	0.06183	1.049	1.065	1.071	1.062	1.067	1.060
ZhouYu	177	75.6	42.712	2.065	24.131	0.06720	1.055	1.060	1.066	1.060	1.061	1.061
HuangYe	180	78	43.333	2.118	24.074	0.06908	1.062	1.058	1.064	1.060	1.058	1.063
YeJianFeng	170	63	37.059	1.848	21.799	0.05752	1.070	1.070	1.073	1.069	1.070	1.066
XuJie	179	75.6	42.235	2.079	23.595	0.06725	1.061	1.061	1.066	1.062	1.061	1.064
ChenQiHui	171	74.1	43.333	2.003	25.341	0.06594	1.049	1.058	1.069	1.054	1.063	1.055
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Table 10 based on the body density of male college students in the actual measured values and predicted values, using the Micro Excel2000 data analysis software, by analysis of variance statistics, the results shown in table 11.

Based on statistical results of Table 11, the actual value with the model prediction in the choice of the level of 0.95, based on the analysis of the value of F values and Fcrit know: body mass index regression models to predict the value of  $F = 4.9645E-05 < F_{crit} = 0.00393496$ ; multiple regression model predictive value of  $F = 0.01627136 > F_{crit} = 0.00393496$ ; (weight / height) \* 100 regression models to predict the value of  $F = 0.02665568 > F_{crit} = 0.00393496$ ; human size models to predict the value of  $F = 0.39434327 > F_{crit} =$

0.00393496; regression models to predict the body surface area value of  $F = 34.0801813 > F_{crit} = 0.00393496$ ,  $p > 0.95$ . So that: in the choice of  $P > 0.95$  level, body mass index of the predictive value of regression model,  $p > 0.95$ , showed no differences, and multiple regression prediction model, (weight / height) \* 100 regression model predictions value, the body size of the predictive value of regression model, body surface area of the predictive value of regression model,  $p < 0.95$ , there were differences. So that, in the five kinds of forecasting models, body mass index prediction model for the optimal forecasting model.

Table 11: Regression model of male college students and the actual value of the human body density measurements analysis of variance results list

Actual values and model prediction	Differences in the source	SS	df	MS	F	F crit	Level	p	Sort
And (weight / height) * 100 predictive value	Groups	1.3911E-06	1	1.3911E-06	0.02665568	0.00393496	0.95	<0.95	
	Group	0.03653222	700	5.2189E-05					3
	Total	0.03653361	701						
And Predictive value of body surface area	Groups	0.00147379	1	0.00147379	34.0801813	0.00393496	0.95	<0.95	
	Group	0.03027133	700	4.3245E-05					5
	Total	0.03174512	701						
And Predictive value of body mass index	Groups	2.7306E-09	1	2.7306E-09	4.9645E-05	0.00393496	0.95	>0.95	
	Group	0.03850233	700	5.5003E-05					1
	Total	0.03850234	701						
And Predictive value of body volume	Groups	1.9051E-05	1	1.9051E-05	0.39434327	0.00393496	0.95	<0.95	
	Group	0.03381804	700	4.8311E-05					4
	Total	0.03383709	701						
And Predictive value of multiple regression	Groups	8.9139E-07	1	8.9139E-07	0.01627136	0.00393496	0.95	<0.95	
	Group	0.03834805	700	5.4783E-05					2
	Total	0.03834895	701						

## 4. Conclusion

4.1. Skinfold thickness in accordance with the existing calculation method of the human body density (formula), the reasonableness of calculated results to be further argued.

4.2. University of male density and physical form of the human body, bodily functions and physical, some indicators were relevant and highly relevant. Thus, male college students on indicators of human density is the study of male college students to further improve the physical fitness and supplement, and has a certain practical value and theoretical significance.

4.3. To height, weight measurement data and by the indicators of height, weight indicator data indicators derived from the variable data to the human body density of male college students as the dependent variable indicators, the establishment of multiple regression model, the application of statistics to compare with the optimization parameters, body mass index prediction model for the optimal calculation model.

4.4. In the absence of human density test conditions, only male college students to test height, weight indicators, the use of optimal body mass index calculation model can calculate the body density of male college students.

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