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## Based on the best standard model the influence of swimming exercise to lose weight

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### ABSTRACT

Along with our country economy fast development, people's living standards improve, the obesity problem more and more serious, obese people in our country also has more and more proportion of the population. Study population obesity and health in our country, to promote the development of our country people's physical health is of great significance. First of all, this article obtains from the obesity problem in our country, studied the development of obesity, and obesity induced a series of disease, put forward the sport is simple, and the effect of the most obvious way to lose weight. Secondly, analysis of variance was used to study the impact of different sports to weight of significance, it is concluded that in jogging, sports dance, ball games, swimming and so on, the swimming for the effect of the most significant weight. Against swimming in this foundation, using discriminant analysis further research, identify the best swimming time standards for weight loss, and put forward: the best time to swim for 30 ~ 60 min/day, obviously the effect reducing weight, had a greater influence on the body shape, such as body weight, waist circumference, is one of the most suitable sports to lose weight.

### KEYWORDS

Lose weight; Swimming; Variance analysis; Discriminant analysis.



## INTRODUCTION

In recent years, our country has become a world power, GDP is growing, increasing people's quality of life, many families have been on the path of a well-off. But the resulting is not only the better quality of life, physical health problems has become a new era of our people have a problem. Obesity is one of the optimal problem in recent years, is also one of the most headache problem.

Xiao-xi li in the female college students action research on psychological factors and intervention to prevent obesity, female college students as the main research object, through the analysis of the problem of female college students care about the most, and then the weight loss of female college students study prompted psychological factors as well as an effective way to lose weight. This paper puts forward that: under the influence of aesthetic feeling, the weight is the most concern of the female college students, for female college students should be encouraged to actively participate in physical training, so as to avoid the occurrence of obesity. ZhanXiaoMei in obese adolescents heart to exercise to lose weight adaptation and mechanism research, the article, through the analysis of the physical quality of adolescents obesity patients, and the mechanism of reducing weight. Paper refer to a large number of literature material, the use of the form of questionnaire, collecting the adolescent physical quality data, and data processing, thus put forward: exercise to lose weight in a variety of ways to lose weight is the most simple way, and obvious effect, on the basis of research on teenagers heart level, set the most suitable for weight loss mechanism of exercise for weight loss. Juan-juan guo in the interest of aerobic exercise on obese pupils physical health effect ", put forward to pupils obese patients physical health sports. Paper to elementary school students as the research object, the reference of the predecessors' research results, and analyze the elementary student's physical quality, and finally concluded that obesity is the one of the key issues facing the contemporary students, interesting aerobics is the most suitable for primary school students to avoid obesity, aerobic exercise can not only strengthen the decomposition of energy consumption and fat, also can enhance students physical quality, so as to promote the healthy development of the pupils. Liang Yixiao in the sports dance in middle-aged and old women are overweight and obese people fitness effect research, with older women as the research object, put forward the influence of sports dance on the obesity. Paper, by using the method of mathematics for data analysis, thus draw the conclusion: overweight and obesity are unhealthy performance, sports dance is a kind of sports, suitable for middle-aged and old women exercise, and have a very important impact on their fitness. In order to promote a healthy, older women should be encouraged to take an active part in sports dance movement.

This paper, by using analysis of variance and discriminant analysis method to analyze the status of the obese population and cause a variety of diseases of obesity, exercise for weight loss is the most suitable method reducing weight is put forward, and swimming, and it is concluded that the most suitable for swimming time of losing weight.

## OBESITY POPULATION STATUS

Food is the first thing for people; food plays very important roles in everybody physical and psychological health development. However, due to living standard improvement, food becomes more and more rich, obesity has become topic at dinner parties, is also main problem that troubles our country lots of people, obesity group proportion is constantly increasing. Research on our country population obesity and health problem is also very important for promoting our country people physical and psychological health development.

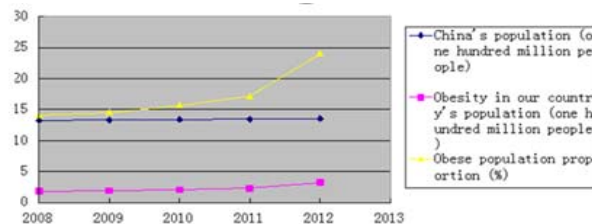
### **Obesity population proportion occupies total population**

By far, due to people immoderate excessive diet, obesity has become headache problems for many people; our country's obesity population has also become more and more. Below Table is our

country population growth and obesity population growth status from 2008 to 2012, data is from Chinese statistical yearbook.

**TABLE 1 : Obesity population proportion**

Years (year)	2008	2009	2010	2011	2012
China's total population (one hundred million people)	13.2802	13.3450	13.4091	13.4735	13.5404
Obesity in Our country's population (one hundred million people)	1.86	1.94	2.10	2.31	3.25
Obese population proportion (%)	14.01	14.54	15.66	17.14	24.00



**Figure 1 : Obese population change**

Above statistical Figure 1 indicates: obesity population amount and its proportion in our country total population have been constantly increased, growth is relative slower from 2008 to 2011, and its change speeds up since 2011. It has very important connections with our country economic rapidly development and people's living standard constantly improvements. Thereupon, it should pay attention to our country residents' diet habits, avoid occurrence of obesity, let more people to live a health life on the condition of good living standards.

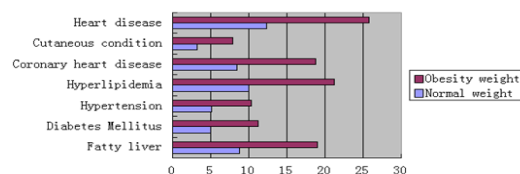
**Obesity triggered diseases**

Obesity is the chief culprits that trigger every kinds of cardiovascular diseases, skin diseases, and kidney kinds of diseases. In general, incidence of obesity group's hypertension, hyperlipidemia, coronary heart disease, fatty liver, diabetes mellitus, joint coetaneous condition, heart disease and other diseases tends to be higher than people with normal weight. Patient that overweight 10%, their incidence is twice the normal-weight person; while patient that overweight 10%~20%, their incidence is five times the normal-weight person; while patient that overweight 30%~50%, their incidence is seven times the normal-weight person. It is clear that obesity has great impacts on our physical and psychological health.

**TABLE 2 : Normal-weight person and obesity person incidence comparison**

Incidence%	Fatty liver	Diabetes mellitus	Hypertension	Hyperlipidemia	Coronary heart disease	Cutaneous condition	Heart disease
Normal weight	8.75	4.98	5.10	10.01	8.42	3.21	12.35
Obesity weight	19.01	11.23	10.32	21.24	18.75	7.92	25.77

Above TABLE 2 is our country each kind of disease normal weight and obesity weight incidence comparison, data is from internet relative investigation report, draw them into following figure, and make analysis:



**Figure 2 : The disease rate of normal weight and obese weight**

From above statistical Figure 2, it is clear obesity weight incidence tends to be twice to third times higher than normal weight's. Obesity group hypertension, hyperlipidemia, coronary heart disease, heart disease and others curing is also a problem in medical field. Therefore, in order to avoid these diseases occurrence and keep more healthy body, it should positive participate in physical exercises, so that strengthen physical quality, and let living quality to be higher.

**VARIANCE ANALYSIS-BASED SPORTS TO WEIGHT IMPACT SIGNIFICANCE ANALYSIS**

Sports have very important impacts on strengthen body energy consumption, steatolysis, and avoiding occurrence of obesity, is simple and feasible choice in losing weight actions. Generally, sports activities' selection, amount of exercise, exercise duration and others are factors that should be considered in sports weight losing process. Variance analysis data TABLE 3 is as following.

**TABLE 3 : Variance analysis data table  $X \pm SD$**

	Age (Years old)	Weight before exercising (kg)	Jogging	Skating type	Sports dance type	Swimming	Ball type exercising
Men	18.45 $\pm$ 45.5	97.11 $\pm$ 22.71	96.68 $\pm$ 18.25	97.11 $\pm$ 19.35	97.01 $\pm$ 20.14	95.21 $\pm$ 18.79	96.43 $\pm$ 20.46
Women	21.00 $\pm$ 7.19	85.02 $\pm$ 17.47	84.22 $\pm$ 16.41	85.10 $\pm$ 16.65	85.22 $\pm$ 17.01	83.11 $\pm$ 15.44	84.15 $\pm$ 16.21

**Variance analysis guiding thought**

Variance analysis is considering factor to indicator impact size. Research object experiment result is indicator, control variable and conditions are factors. When research objects influence factors have two ones, it should consider two factors analysis of variance.

Its mathematical model is: Set  $A$  takes  $r$  levels  $A_1, A_2, \dots, A_r$ ,  $B$  takes  $s$  levels  $B_1, B_2, \dots, B_s$ , under level combination  $(A_i, B_j)$ , totality  $x_{ij}$  conforms to normal distribution  $N(\mu_{ij}, \delta^2), i=1, \dots, r, j=1, \dots, s$ . And under  $A_i, B_j$ , it makes  $t$  experiments, result is recorded as  $x_{ijk}$ ,  $x_{ijk}$  conforms to  $N(\mu_{ij}, \delta^2), i=1, \dots, r, j=1, \dots, s, k=1, \dots, t$ , and mutually independent. So that it can get following TABLE 4:

**TABLE 4: Variance analysis data table**

	$B_1$	$B_2$	...	$B_s$
$A_1$	$x_{111} \dots x_{11t}$	$x_{121} \dots x_{12t}$	...	$x_{1s1} \dots x_{1st}$
$A_2$	$x_{211} \dots x_{21t}$	$x_{221} \dots x_{22t}$	...	$x_{2s1} \dots x_{2st}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
$A_r$	$x_{r11} \dots x_{r1t}$	$x_{r21} \dots x_{r2t}$	...	$x_{rs1} \dots x_{rst}$

Decompose  $x_{ijk}$  into:

$$x_{ijk} = \mu_{ij} + \varepsilon_{ijk}, i=1, \dots, r, j=1, \dots, s, k=1, \dots, t$$

Among them,  $\varepsilon_{ijk} \sim N(\mu_{ij}, \delta^2)$ , and is mutual independent, record:

$$\mu = \frac{1}{rs} \sum_{i=1}^r \sum_{j=1}^s \mu_{ij}, \mu_{i\bullet} = \frac{1}{s} \sum_{j=1}^s \mu_{ij}, \alpha_i = \mu_{i\bullet} - \mu$$

$$\mu_{i\bullet} = \frac{1}{r} \sum_{i=1}^r \mu_{ij}, \beta_i = \mu_{\bullet j} - \mu, \gamma_{ij} = \mu_{ij} - \mu - \alpha_i - \beta_i$$

Among them,  $\mu$  is total average value,  $\alpha_i$  is level  $A_i$  to indicator effect,  $\beta_i$  is level  $B_i$  to indicator effect,  $\gamma_{ij}$  is level  $A_i$  and level  $B_i$  to indicator interactive effect. Model table is:

$$\begin{cases} x_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \varepsilon_{ijk} \\ \sum_{i=1}^r \alpha_i = 0, \sum_{j=1}^s \beta_j = 0, \sum_{i=1}^r \gamma_{ij} = \sum_{j=1}^s \gamma_{ij} = 0, \\ \varepsilon_{ijk} \sim N(0, \delta^2), i = 1, \dots, r, j = 1, \dots, s, k = 1, \dots, t \end{cases}$$

Null hypothesis is:

$$H_{01} : \alpha_i = 0 (i = 1, \dots, r)$$

$$H_{02} : \beta_j = 0 (j = 1, \dots, s)$$

$$H_{03} : \gamma_{ij} = 0 (i = 1, \dots, r, j = 1, \dots, s)$$

If there is no interactive impact between two factors, let  $t = 1$ , process can be simplified, assume  $\gamma_{ij} = 0$ , and then:

$$\mu_{ij} = \mu + \alpha_i + \beta_j, i = 1, \dots, r, j = 1, \dots, s$$

Now, model can be written into:

$$\begin{cases} x_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \\ \sum_{i=1}^r \alpha_i = 0, \sum_{j=1}^s \beta_j = 0 \\ \varepsilon_{ijk} \sim N(0, \delta^2), i = 1, \dots, r, j = 1, \dots, s \end{cases}$$

Below is test statistics:

$$\bar{x} = \frac{1}{rs} \sum_{i=1}^r \sum_{j=1}^s x_{ij}, x_{i\bullet} = \frac{1}{s} \sum_{j=1}^s x_{ij}, x_{\bullet j} = \frac{1}{r} \sum_{i=1}^r x_{ij}$$

$$S_T = \sum_{i=1}^r \sum_{j=1}^s (x_{ij} - \bar{x})^2$$

Among them,  $S_T$  is all test data total variation, is called total squares sum, make decomposition on it:

$$\begin{aligned}
 S_T &= \sum_{i=1}^r \sum_{j=1}^s (x_{ij} - \bar{x})^2 \\
 &= \sum_{i=1}^r \sum_{j=1}^s (x_{ij} - \bar{x}_{i\bullet} - \bar{x}_{\bullet j} + \bar{x})^2 + s \sum_{i=1}^r (x_{i\bullet} - \bar{x})^2 + r \sum_{j=1}^s (x_{\bullet j} - \bar{x})^2 \\
 &= S_E + S_A + S_B
 \end{aligned}$$

It can verify: in above square sums decomposition, all cross items are 0. Among them:

$$S_E = \sum_{i=1}^r \sum_{j=1}^s (x_{ij} - \bar{x}_{i\bullet} - \bar{x}_{\bullet j} + \bar{x})^2 \quad ; \quad S_A = s \sum_{i=1}^r (x_{i\bullet} - \bar{x})^2 \quad ; \quad S_B = r \sum_{j=1}^s (x_{\bullet j} - \bar{x})^2$$

When  $H_{01}$  is true: 
$$F_A = \frac{\frac{S_A}{r-1}}{\frac{S_E}{(r-1)(s-1)}} \sim F(r-1, (r-1)(s-1))$$

When  $H_{02}$  is true: 
$$F_B = \frac{\frac{S_B}{s-1}}{\frac{S_E}{(r-1)(s-1)}} \sim F(s-1, (r-1)(s-1))$$

Test rule is:

When  $F_A < F_{1-\alpha}(r-1, (r-1)(s-1))$ , accept  $H_{01}$ , otherwise refuse  $H_{01}$ ;

When  $F_B < F_{1-\alpha}(s-1, (r-1)(s-1))$ , accept  $H_{02}$ , otherwise refuse  $H_{02}$ .

**Variance analysis handling with data**

Utilize MATLAB software to analyze data, so that get following variance analysis data TABLE 5:

**TABLE 5 : Variance analysis result  $X \pm SD$**

	Jogging	Skating type	Sports dance type	Swimming	Ball type exercising
Men	96.78 ± 18.29	97.01 ± 19.25	97.11 ± 20.04	95.18 ± 18.79	96.46 ± 20.56
Women	84.32 ± 16.51	85.01 ± 16.79	85.02 ± 17.21	83.01 ± 15.24	84.05 ± 16.22

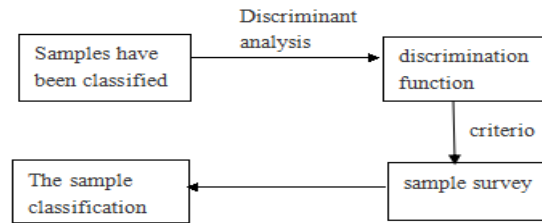
By above statistical TABLE 5, it can get conclusion: compare to jogging, skating, sports dance, ball type and other sports, swimming to weight impacts significant difference is the largest, such point has been reflected in men and women weight changes to some extent. Thereupon, in numerous sports, swimming has most obvious effects in losing weight and avoiding obesity, is one of best choices in exercising weight losing.

**BEST STANDARD MODEL-BASED SWIMMING TO LOSE WEIGHT INFLUENCE STUDY**

On the basis of above variance analysis, it is clear that swimming has best effects on losing weight. Therefore, utilize discriminant analysis method to analyze swimming, establish best swimming weight losing scheme’s optimization model, so that formulate swimming time that is most beneficial to exercise weight losing.

**Discriminant analysis guiding thought**

Discriminant analysis is a kind of multiple statistical analysis method, it refers to observe on known evaluation indicators and according to observed data to make classification on evaluation objects. Discriminant analysis general steps are as following Figure 3:



**Figure 3 : Discriminant analysis step**

Discriminant analysis refers to make discriminant analysis of historical data, and then establish discrimination function to makes classification on observed data. Here, it utilizes Bayes discriminant analysis to study on swimming time and body shape changes so that define most proper swimming time for losing weight. Below table is average swimming time per day and body shape change data TABLE 6.

**TABLE 6 : Discriminant analysis data table**

Observation No.	Average swimming time min/day	Weight change rate%	Waist circumference change rate %	Hip circumference change rate%	Abdomen change rate%
1	15	3.68	4.99	1.09	14.38
2	25	4.25	5.04	2.35	15.06
3	35	5.01	6.52	2.98	16.48
4	50	5.92	6.62	3.16	16.56

**Establish discriminant analysis model**

Bayes discriminant analysis is a kind of method that analyzes two classes or multiple classes data, here define most proper swimming time for losing weight should analyze according to one’s body shape, so use Bayes discriminant analysis is most suitable.

Under Bayes discriminant analysis discrimination criterion, established classification function form is:

$$\begin{cases}
 y_1 = c_{01} + c_{11}x_1 + c_{21}x_2 + c_{31}x_3 + \dots + c_{p1}x_p \\
 y_2 = c_{02} + c_{12}x_1 + c_{22}x_2 + c_{32}x_3 + \dots + c_{p2}x_p \\
 y_3 = c_{03} + c_{13}x_1 + c_{23}x_2 + c_{33}x_3 + \dots + c_{p3}x_p \\
 \dots \\
 y_n = c_{0n} + c_{1n}x_1 + c_{2n}x_2 + c_{3n}x_3 + \dots + c_{pn}x_p
 \end{cases}$$

That is to establish regarding observed indicators and observed objects linear function equations, every equation corresponds to a class discriminant criterion, from which  $c_{0j}, c_{1j}, \dots, c_{pj}, j = 1, 2, \dots, n$  is estimated parameter. After establishing discriminant functions, input one discriminant corresponding each parameter value into above discriminant parameter, then it can know which class the object belongs to.

According to above data, make data processing, and establish Bayes discriminant analysis classification function equation set, so that define most proper swimming time for losing weight.

**Establish Bayes discriminant analysis classification function**

Processing data: Utilize SPSS software to analyze above data, and then it can get classification function about most proper weight losing swimming time:

**TABLE 7 : Coefficient table**

Model	Non-standardized coefficients		Standard coefficients
	B	Standard error	Trial version
(Constant)	-10.499	.000	-9.857
Weight change rate %	16.327	.000	1.061
Waist circumference change rate %	15.547	.000	0.975
Hip circumference change rat%	1.927	.000	.121
Abdomen change rate %	-2.551	.000	-0.184

**a. Dependent variable: Average swimming time min/day**

According to above coefficient TABLE 7, it can get most losing weight swimming time standard classification function:

$$y = 1.061x_1 + 0.975x_2 + 0.121x_3 - 0.184x_4 - 9.857$$

Among them,  $y$  is average swimming time per day,  $x_1$  is weight change rate,  $x_2$  is waist circumference change rate,  $x_3$  is hip circumference change rate,  $x_4$  is abdomen change rate.

**Improved Bayes discriminant analysis classification function**

In order to improve discrimination accuracy, firstly add one item as prior probability, it makes improvements on above Bayes discriminant analysis classification function equations. On the basis of prior probability, Bayes discriminant analysis classification function is converted into following form:

$$\begin{cases} y_1 = c_{01} + c_{11}x_1 + c_{21}x_2 + c_{31}x_3 + \dots + c_{p1}x_p + \ln(q(y_1)) \\ y_2 = c_{02} + c_{12}x_1 + c_{22}x_2 + c_{32}x_3 + \dots + c_{p2}x_p + \ln(q(y_2)) \\ y_3 = c_{03} + c_{13}x_1 + c_{23}x_2 + c_{33}x_3 + \dots + c_{p3}x_p + \ln(q(y_3)) \\ \dots \\ y_n = c_{0n} + c_{1n}x_1 + c_{2n}x_2 + c_{3n}x_3 + \dots + c_{pn}x_p + \ln(q(y_n)) \end{cases}$$

According to swimming time and body shape change data, it can define most proper losing weight swimming time standard prior probability is  $q(y) = 0.45$ .

On the basis of considering prior probabilities, it can further get relative most proper losing weight swimming time standard Bayes classification function is as following:

$$y = 1.061x_1 + 0.975x_2 + 0.121x_3 - 0.184x_4 - 9.857 + \ln(0.45)$$

That:  $y = 1.061x_1 + 0.975x_2 + 0.121x_3 - 0.184x_4 - 10.66$

Above is most proper losing weight swimming time's discriminant function.

**Define classification standard**

According to lots of documents, and above analysis process, now define that most proper losing weight swimming time standard as following:



- Losing weight effect is not obvious:  $y \in 10 \sim 20 \text{ min/day}$  ;
- Losing weight effect is general:  $y \in 20 \sim 30 \text{ min/day}$  ;
- Losing weight effect is obvious:  $y \in 30 \sim 40 \text{ min/day}$  ;
- Losing weight effect is very obvious:  $y \in 40 \sim 60 \text{ min/day}$  ;

According to above standard, it can get conclusion: most proper losing weight swimming time is 30~60min/day, keep swimming can get obvious weight losing effects.

## CONCLUSION

The paper firstly analyzes China obesity population status, by researching on recent five years our country obesity population proportions changes and obesity triggered a series of diseases, finally gets that obesity problem is key problem to be urgent solved in nowadays that economy is rapidly developed, is also the chief culprit that affects our country residents' physical health. And on this basis, utilize variance analysis method, propose that sports is best choice to lose weight, among jogging, sports dance, ball type exercises and swimming, swimming has most significant effects on weight.

Secondly, utilize discriminant analysis method, establish optimization model-based most proper losing weight swimming time discriminant function, and further analyze weight, waist circumference, hip circumference, and abdomen as well as other body shapes change rates under different swimming time, so that finally get best swimming time: every day keep swimming 30~60min is helpful for losing weight, building better body shape and can get very obvious effects.

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