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Best standard model-based swimming to lose weight influence study

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ABSTRACT

With China economic rapidly development, people's living standard has been further improved, obesity problem is getting worse and worse, and obesity group in our country population also occupies more and more proportions. Study on our country population obesity and health has important significances in promoting our country people physical health development. Firstly, the paper starts from our country obesity problems, it studies obesity group development status, and obesity triggers a series of diseases, proposes that sports is a simple and most obvious effects lose weight way. Secondly, utilize variance analysis to study different sports to weight influential significances, it gets swimming has most remarkable influential effects on weight among jogging, sports dance, ball kinds of sports, swimming and other sports. On this basis, for swimming, it applies discriminant analysis to make further study, define best swimming time standard to adapt to lose weight and propose that best swimming time is 30~60min/ day, its losing weight effect is obvious, has bigger impacts on weight, waist circumference and other body shape, is one of most proper losing weight sports.

Key words: lose weight, swimming, variance analysis, discriminant analysis

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INTRODUCTION

In recent years, our country has become world power, gross national product is increasing, people's living quality is constantly improving, and many families have already advanced towards fairly well-off. But accompanying is not only living quality improvement [1]; physical health problem has become a problem that troubles our country people in new era [2]. Obesity problem is one of most optimal presented and prominent problems in recent years, is also one of headache difficulties for people [3, 4].

Li Xiao-Xi in the article " Female college students obesity prevention behavior psychological influence factors and intervention study", took female college students as main research objects, by analyzing female college students' most concerned obesity problem, she further researched psychological factors to propel to female college students weight losing and losing weight effective ways [5-7]. The thesis proposed that affected by sense of beauty, weight was a problem of female college students' great concerns; therefore it should encourage female college students to positive participate in physical exercises, so that avoided obesity occurring [8-10]. Zhan Xiao-Mei in the article "Obesity teenager heart to sports weight losing adaptation and mechanism study", it further studied losing weight mechanism by analyzing teenager obesity patients' physical quality. The thesis referenced lots of documents, utilized questionnaire survey form, collected teenager physical quality data, and made data processing, so that put forward: sports was most simple and feasible way in multiple weight losing ways, and effects were obvious, on the basis of researching on teenager heart level, designed most proper weight losing's sports mechanism [11-13]. Guo Juan-Juan in the article "Interesting aerobics to fat pupils physical health effect", she put forward sports that were beneficial to pupil obesity patients physical health. The thesis took pupils as research objects, referenced previous research results, and analyzed pupils' physical quality, finally it got: obesity y problem was one of key problems that contemporary pupils confronted, interesting aerobics is most proper way for pupils avoiding obesity, aerobics not only could strengthen body energy consumption, steatolysis, and could strengthen pupils physical quality, so that propelled to

pupils' health development [2, 14]. Liang Yi-Xiao in the article "sports dance to middle-aged and old women overweight and obesity patient fitness efficiency study" took middle-aged and old women as research objects, proposed sports dance impacts on their obesity. The thesis carried out data analysis by mathematical method, so that got conclusion: obesity and overweight were reflection of unhealthy, sports dance was one kind of sports that was fit for middle-aged and old women physical exercises, and had very important impacts on their body building. To promote middle-aged and old women health, it should encourage them to positive participate in sports dance [15].

The paper utilizes variance analysis and discriminant analysis methods to analyze our country obesity population status and obesity triggered multiple kinds of diseases, puts forward that exercises is the most proper losing weight method, and studies on swimming, so that gets most proper weight losing swimming time.

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

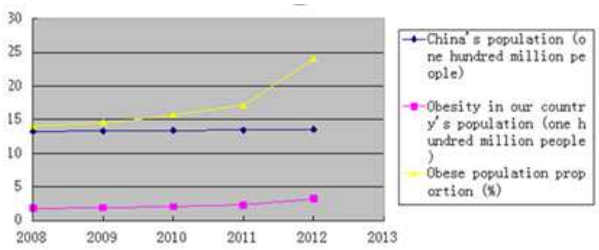

Figure 1: Obese population change

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:

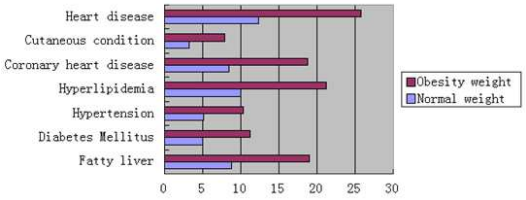

Figure 2: The disease rate of normal weight and obese weight

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 ± 45.5	97.11 ± 22.71	96.68 ± 18.25	97.11 ± 19.35	97.01 ± 20.14	95.21 ± 18.79	96.43 ± 20.46
Women	21.00 ± 7.19	85.02 ± 17.47	84.22 ± 16.41	85.10 ± 16.65	85.22 ± 17.01	83.11 ± 15.44	84.15 ± 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 $A_1, A_2, \cdots, A_r$, B takes s levels $B_1, B_2, \cdots, B_s$, under level combination（A_i, B_j）, totality x_{ij} conforms to normal distribution $N(\mu_{ij}, \delta^2), i = 1, \cdots, r, j = 1, \cdots, s$.And under A_i, B_j, it makes t experiments, result is recorded as x_{ijk}, x_{ijk} conforms to $N(\mu_{ij}, \delta^2), i = 1, \cdots, r, j = 1, \cdots, s, k = 1, \cdots, t$, and mutually independent. So that it can get following Table 4:

Table 4: Variance analysis data table

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

Decompose x_{ijk} into:

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

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

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

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

Among them, μ is total average value, α_i is level A_i to indicator effect, β_i is level B_i to indicator effect, γ_{ij} is level A_i and level B_i to indicator interactive effect. Model table is:

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

Null hypothesis is:

$$H_{01} : \alpha_i = 0 (i = 1, \cdots, r)$$
$$H_{02} : \beta_j = 0 (j = 1, \cdots, s)$$
$$H_{03} : \gamma_{ij} = 0 (i = 1, \cdots, r, j = 1, \cdots, s)$$

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

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

Now, model can be written into:

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

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:

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

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

$$= S_E + S_A + S_B$$

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

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

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: $$F_B = \frac{\frac{S_B}{r-1}}{\frac{S_E}{(r-1)(s-1)}} \sim F(s-1,(r-1)(s-1))$$

Test rule is:

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

When $F_B < F_{1-a}(s-1,(r-1)(s-1))$, 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:

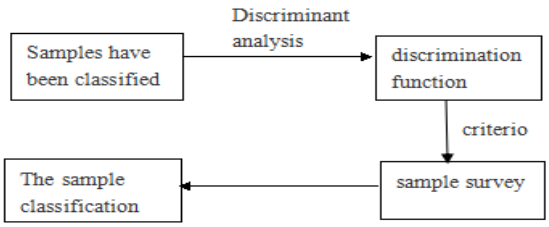

Figure 3: Discriminant analysis step

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:

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

That is to establish regarding observed indicators and observed objects linear function equations, every equation corresponds to a class discriminant criterion, from which $c_{0j}, c_{1j}, \cdots, c_{pj}, j = 1,2,\cdots,n$ 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	-.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:

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

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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