



ANALYSIS OF THE METABOLIC REGULARITY OF BODY IMPORTANT INDEX OF OBESE ADOLESCENTS FROM THE ANGLES OF SPORTS AND NUTRITIONAL INTERVENTION

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ABSTRACT

This paper has compared the results of various indicators before and after experiments of implementing three different intervention programs of simple exercise, simple nutrition and combination of both for ten weeks among overweight and obese adolescents. It has been found out that different programs have different influence on the body composition, circumference, physiological function, physical quality and partial metabolic indicators of overweight/adolescents by observing the differences in physique and metabolism between overweight/obese adolescents and non-overweight/obese adolescents aging from 12 to 16.

1. Introduction

In recent years, with the changing of people's way of life, the detection rate of overweight and obese children is increasingly rapidly year by year, coming with the decreasing of physiological function and physical quality of children as well as the increasing of metabolic diseases such as hypertension, diabetes, dyslipidemia and metabolism syndrome etc. Children obesity not only has influence on their social adaption and psychology, for the obesity during childhood, the relative risk of obesity after grown up is obviously higher than those who have normal weight during childhood, which has increased the morbidity rate and mortality rate of adult chronic disease and cardiovascular diseases. Therefore, it is very important for the current and future health of obese adolescents to seek for effective and safe intervention means to improve physical quality and decrease the happening of metabolic related diseases.

Numerous researches have shown that suitable decrease of weight can improve body composition, strengthen physical quality and change metabolic characteristics etc. Till today, a lot of scholars both at home and abroad have adopted sports, nutrition, psychology, medicine and operations etc. (Mallinson et al. 2013). To decrease the weight of obese children, while sports and nutritional intervention are means adopted most at present. There is still controversy in the selection of suitable sports intensity, design for sports program as well as strategy and means of nutritional intervention etc. for reducing the weight of children (Kleiner, 2003). Study and compare the effects of simple sports, simple nutrition as well as the combination of two for reducing the weight of obese children and for reducing the fat content. In the process of reducing weight, the research on physical quality and metabolic characteristics is not adequate (Naidoo et al. 2009); especially the research results of effects of sports and nutritional intervention on related indicators of

fat and glucose metabolism are not exactly the same. Considering about the individual differences existed in physical quality and metabolic disorder of obese children, further research needs to be made on how to adopt suitable intervention means and design suitable individual program based on different physical and metabolic disorders.

This research has taken middle school students in urban area aged between 12 and 16 who are in critical period of weight growth as research objects, made intervention of simple nutrition, simple sports as well as combination of both for ten weeks through making aerobic exercise program and nutritional intervention program and observed the changes of body composition, physiological function, physical quality, blood lipid and blood glucose and other metabolic indicators before and after intervention and tried to discuss the following problems:

(1) Influence of sports and nutritional intervention on physique of overweight and obese adolescents;

(2) Influence of sports and nutritional intervention on partial indicators of fat and glucose metabolism of overweight and obese adolescents. Decrease the degree of obesity of overweight and obese adolescents through research on above two aspects; discuss the differences in the influences of sports, nutrition and combination of sports and nutrition on their body composition, physiological function, physical quality and metabolic influence, and then provide theory and practical material for the design of individualized intervention program to enhance physical fitness and improve metabolism of overweight and obese adolescents.

2. Materials and methods

Physique refers to the quality of human body, which is the human form structure expressed on the basis of hereditary and acquisition. The comprehensive characteristics of physiological function and physical quality are the material basis of human production and life. The

physique mainly includes the following five aspects: body shape development, physiological function level, physical quality level, psychological balance state and adaptability. The physique of students is always the focus of education and sports department. It has been pointed out in the national physical fitness monitoring report that compared with 1995, at present, the physical fitness of our students is decreasing, which is mainly presented in speed, endurance, flexibility, explosive force and strength etc, while the obese students are increasing obviously, which has great influence on the decreasing of the overall quality of adolescents. At present, improving the physique especially the physique of obese students has drawn the attention of all social circles.

The body composition of obese children has the characteristics of large weight and high percentage of body fat etc. Feng Ning and others determined the body composition for 356 children of 7 years old with normal weight and overweight with adoption of double energy X-ray absorption method; results have shown that compared with the children with normal weight with the same age the gender, the obese children have the characteristics of high fat-free mass index (FFMI), high fat mass index (FMI), high BMI and high body fat percentage). The body fat percentage of obese children is between 30% and 45%, while the percentage of children with normal weight is between 10% and 30%. The FMI and BMI of obese children present high degree of positive correlation and the correlation coefficient is bigger than that of children with normal weight; FFMI and BMI of obese children present moderate positive correlation. Compared with children with normal weight, the obese children present different degrees of decrease in body shape, physiological quality and physical quality. In the aspect of cardio-pulmonary function, the obese children have the characteristics of low VO_2max , big quiet pulse and high systolic pressure etc. Nianhong Yang and others have made investigation on obesity as well as related influencing factors among 56, 150

students from middle and primary schools in 11 big and medium-sized cities; investigation results have shown that there is no significant difference in the weight of the two groups of children, but the weight, bust, pulse, blood pressure and vital capacity of obese group are obviously higher than that of the group with normal weight; vital capacity index is obviously lower than non-overweight obesity group and the differences have significant meaning. McGavock and others have studied the obese children aging from 5 to 19 and the research results have shown that the systolic pressure (SBP) of obese children is obviously higher than children with normal weight (Łagowska, 2014). The tracking survey from 2004 to 2006 has shown that in these two years, the increased SBP value of people with the most BMI increase is 4.5 times of that with the minimum BMI increase; SBP will increase by 0.77mmHg with the increasing of weight by 1kg. Research made by Zhengzhen Wang and others has shown that the cardiac and pulmonary function of overweight and obese adolescents aging between 12 and 14 is obvious lower than children of normal weight at the same age. People with hypertension account for 32.92%, however, the correlation between increased blood pressure and change of body composition is not obvious;

The vital capacity index of obese adolescents has decreased obviously, the vital capacity index of obese male is in moderate negative correlation with body fat percentage (Chen, 2015); the relative maximum oxygen intake of obese adolescents decreases obviously. Research made by Rizzo and others has shown that the fat weight of children body is in negative correlation with cardiac and pulmonary function; the physical activity level of girls is in negative correlation with metabolic risk factors (HDL, TG, FBG and others are higher than the mean plus

standard deviation of people with normal weight). The author suggests that the correlation of CPF and metabolic risk factors is bigger than the correlation degree of CPF and physical activity level. In addition, in the correlation of CPF and metabolic risk factors, the body fat weight plays a negative role.

Children obesity can be divided into simple obesity and secondary obesity. Secondary obesity refers to obesity with clear cause. However, the simple obesity is closely related to way of life with characteristics of excessive eating, less physical activity and behavioral biases and it's a chronic disease of hyperplasia of body adipose tissue. At present, two main methods of defining children obesity at home and abroad are weight for height and body mass index. In 1997, International Obesity Task Force (IOTF) suggests to adopt body mass index (BMI) to reflect the body fat index of school age children and adolescents as well as the parameter of estimated incidence of obesity. At present, two BMI classification standards made by National Center for Health Statistics (NCHS) and IOTF recommended by World Health Organization (WHO) are widely applied international. In Nov. 2003, working group on obesity in China (WGOC) of International Society for Life Science has made defined standards for overweight and obese children aging between seven to eighteen suitable for our children; the definition for obese children in domestic generally adopts this standard.

3. Results and discussions

This research takes the students from the first and second grade of one middle school in Xicheng district of Beijing city as research objects. Inclusion standards and exclusion standards of research objects are as Table 1.

Table 1. Basic information of each group subjects

	The overweight /obese group	Sports group	Fewer ten patients experienced septic	Sport + and fewer ten patients experienced septic complications	Obesity in the control group
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			complications		
age	13.26	12.95	13.26	13.69	13.48
height	161.23	166.23	165.21	163.54	163.47
weight	52.12	71.58	78.02	74.25	75.21
BMI	19.25	25.12	27.25	26.32	27.95

3.1. Exclusion standards

Patients of secondary obesity, patients diagnosed with diabetes, patients with severe organic diseases of heart, brain, lung, kidney and motion system etc, patients with hepatic dysfunction, progressive fatal disease, patients with a history of alcoholism or drug abuse, patients with chronic disease and taking drugs, patients unwilling to sign informed consent (Malayil, 2014).

Based on entrance examination data and basic testing results of students, finally 124 students have been selected for this research, in which there are 94 overweight/obese people and 30 non-overweight/obese people. On the voluntary basis of participants, divide the overweight and obese students into five groups. There is no statistical difference in BMI of overweight/obesity groups, details as shown in Table 2.

Table 2. The stages of exercise group and exercise + and fewer ten patients experienced septic complications exercise intensity and its corresponding heart rate

	Sports group	Sports+nutrient group
40% VO2max(ml/kg/min)	14.25	15.65
Corresponding to the heart rate	128.25	128.54
50% VO2max(ml/kg/min)	18.54	18.84
Corresponding to the heart rate	140.36	141.25
60% VO2max(ml/kg/min)	22.52	22.84
Corresponding to the heart rate	154.23	156.32
70% VO2max(ml/kg/min)	25.85	26.51
Corresponding to the heart rate	167.25	167.45

3.2. Research Methods

Research procedures and technical routes are as shown in Figure 1 and the research methods

adopted in this research mainly include literature review, questionnaire and experiment method.

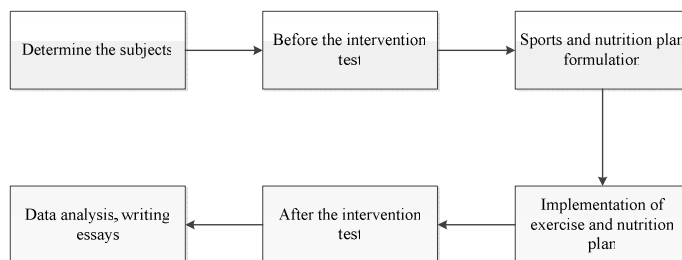


Figure 1: The research steps and technical route

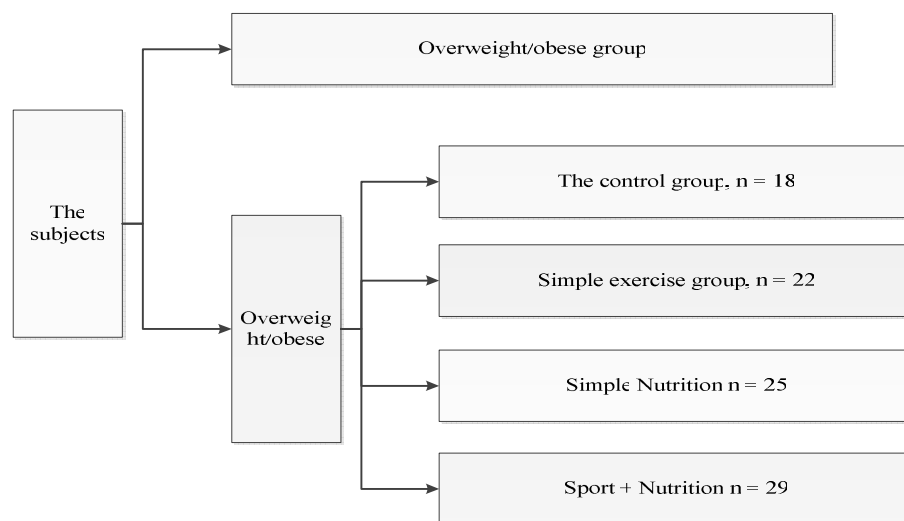


Figure 2. The experimental group

3.3. Experimental grouping

There are totally five groups in this research, which include non-overweight/obese control group, overweight/obese control group, sports group, nutrition group and sports + nutrition group, see details in Figure 2.

(1) Non-overweight/obese control group: only participate in the test and health education seminars before research; educate them the means and methods of preventing obesity and improving physical quality (Deibert et al. 2007).

(2) Overweight/obese control group: the subjects participate in all tests before and after research voluntarily, but are reluctant to participate in any interventions. But before the research, they also participate in health education seminars, which focus on educating them the harms of obesity, common methods for weight loss and fat loss and suggestions for weight loss and fat loss.

(3) Sports group: subjects participate in sports intervention program focusing on aerobic exercise within ten weeks; they only participate in health education seminars before intervention and are not offered with nutritional guidance and recipes.

(4) Nutrition group: implement nutritional intervention of ten weeks based on nutrition intervention program, participate in health

education seminars before intervention and do not participate in the exercise of the research organization.

(5) Sports + nutrition group: offer nutrition intervention program, at the same time, participate in ten weeks' exercise class organized by this research, make health education before intervention.

3.4. The preparation and implementation of sports program

The selection of modes of exercise focuses on aerobic exercise, including brisk walking, jogging, walking up and down the stairs, meanwhile, combining strength, flexibility and agility exercise and inserting with sports games, in which strength exercise adopts the method of overcoming its own weight (such as push-up and sit-up etc.) and trying to avoid static exercise. In addition, adding one aerobic exercise per week from the sixth week to increase the difficulty and interest of aerobic exercise (Duncan et al. 2012).

The setting of exercise intensity takes the maximum oxygen uptake attained from exercise load test as the basis, takes decreasing the fat weight and improving cardiac and pulmonary function and physical quality of subjects as purpose and selects 50%-60%V02max as the main intensity range of ten weeks' aerobic

exercise intervention (Andrade et al. 2014). Moreover, divide the implementation of this exercise program into three stages based on the characteristics of physical quality of obese children compared with that of normal children:

First stage: the exercise intensity before two weeks of implementation of exercise program is 40%-50% VO₂max;

Second stage: increase to 50%-60% VO₂max after two weeks;

Third stage: insert exercise with great intensity in short time (60%-70% VO₂max) in

the exercise intensity of 50%-60% VO₂max after six weeks.

Use the heart rate corresponding to the above intensity to monitor the intensity during exercise; the exercise intensity and heart rate corresponding to this intensity in three stages of sports group and sports + nutrition group are as shown in Table 3; there is no obvious difference in the item values of these two groups.

Table 3. Ten patients experienced septic complications and sport + energy and fewer ten patients experienced septic complications recipes key nutrients

	Sports group	Sports+nutrient group
The total energy	1982.36	2015.23
protein	82.36	85.42
fat	60.23	61.45
carbohydrates	274.56	281.69
The total energy	254.26	16.32
protein	17.26	27.23
fat	27.85	55.26
carbohydrates	55.62	55.21

3.5. Content of nutrition program

Nutrition intervention program mainly includes nutrition recipe and nutrition guidance. Calculate the daily energy requirement of normal children based on the recommended value (moderate physical activity) of energy of Chinese children and adolescents RNI (recommended intake standard). Based on the differences between overweight and obesity, offer 80% and 70% of the daily total energy of children with ideal weight respectively and for ideal weight, please refer to “standard height and weight for normal male and female”(Hansen et al. 2014). Make daily diet recipes for simple nutrition group and exercise + nutrition group in this research. In the total daily energy, the protein accounts for 10%-20%, fat accounts for 25%-30% and sugar accounts for 50%-60%. The details of daily total energy and main nutrient conditions of nutrition group and exercise + nutrition group are as shown in Table 4. There is

no obvious difference in each indicator between these two groups.

Make nutrition education to subjects through “nutrition guidance”. Eat based on the principles of “having more meals a day but less food at each”, “fixed time and fixed amount” and “adding meals without adding amount” etc. In addition, teach the subjects and parents to exchange the food and adjusting the diet flexibly based on keeping the same total energy intake.

The above nutritional intervention program is prepared and accomplished by department of nutrition in Beijing Hospital led by Ministry of Health.

Table 4. The overweight/obese and overweight/obese compared the basic situation and body composition

	Sports group	Sports+nutrient group
age	13.62	13.36
height	161.52	164.52

weight	50.23	75.45
BMI	19.54	26.35
Fat mass	10.23	44.52
Lean body mass	40.26	46.32
Body fat percentage	19.23	37.25

3.6. Research results

Before the experiment, there is no obvious difference in the age and height between non-overweight/obese group and overweight/obese group. However, the weight, BMI, fat weight, lean body weight and body fat percentage of overweight/obese group are higher than that of non-overweight/obese group and with obvious difference ($P<0.01$), see details in table 5.

The SBp and DBp of overweight/obese girl group is obviously higher than that of non-overweight/obese group ($p<0.01$, $P<0.05$). The vital capacity of overweight/obese girl group is obviously higher than that of non-overweight/obese group ($P<0.01$). The vital capacity index of both overweight/obese girl group and overweight/obese boy group is obviously lower than that of non-overweight/obese group with the same gender ($P<0.01$, $P<0.01$). The maximum oxygen uptake of overweight/obese boy group is obviously lower than that of non-overweight/obese boy group ($P<0.05$).

Table 5: Not overweight/obese and overweight/obese male and female physiology

	The overweight/obese group Male	Overweight/obese Male	The overweight/obese group Female	Overweight/obese Female
Quiet pulse	77.22	82.62	84.52	85.41
Systolic blood pressure	110.23	113.25	99.52	110.23
Diastolic blood pressure	68.25	69.25	65.48	75.23
Lung capacity	3215.23	3125.23	2635.23	1985.23
Vital capacity index	62.35	44.85	52.12	41.23
Vo2 Max	48.21	40.26	36.52	23.36
Reaction time	0.40	0.42	0.45	0.45

4. Conclusions

This paper has compared the results of various indicators before and after experiments of implementing three different intervention programs of simple exercise, simple nutrition and combination of both for ten weeks among overweight and obese adolescents. It has been found out that different programs have different influence on the body composition, circumference, physiological function, physical quality and partial metabolic indicators of overweight/adolescents by observing the differences in physique and metabolism between overweight/obese adolescents and non-

overweight/obese adolescents aging from 12 to 16. Conclusions are as following:

(1) The cardiac and pulmonary function as well as physical quality of overweight/obese adolescents in this research is weaker than that of normal adolescents. Ten weeks of interventions of exercise, nutrition as well as combination of both can reduce the obesity degree of overweight/obese adolescents effectively. Exercise and combination of exercise and nutrition intervention can improve the cardiac

and pulmonary function of overweight/obese adolescents. Exercise combined with nutrition intervention is with the best effect in decreasing visceral fat and improving physical quality.

(2) The blood lipid, glucose, insulin and other metabolic indicators of overweight/obese adolescents in this research are within the normal range, but its regulation role for fat and glucose metabolism is obviously lower than non-overweight/obese.

(3) Ten weeks of exercise combined with nutrition has the best effect on improving blood lipid metabolism. Nutrition intervention has good effect on improving the regulation of blood glucose. Exercise and exercise combined with nutritional intervention can improve the secretion function of insulin cell of overweight/obese adolescents effectively. However, these three intervention programs do not have obvious effect on regulating the role of insulin resistance.

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