

The effect of dumbbell treatment exercise on appetite regulation hormone, lipolytic hormone and body composition in obese adolescents

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Abstract

Background/Objectives: The obesity for growing adolescents is not only an inducing factor to cause various adult diseases, but also is an obstruction factor to prevent the growth. Many studies verified that the exercise is the clearest, safest, and healthiest method in controlling the obesity. This study implemented dumbbell exercise for 10 weeks subjecting on 11 obesity male middle school students in order to define the effect of resistance exercise on appetite control related hormones, lipolysis related factors, and body components.

Methods/Statistical analysis: A dumbbell treatment exercise was conducted for 11 obesity male middle students participating in the health care program. Appetite control hormone (leptin, ghrelin), lipolysis factors (GH, insulin, cortisol), and body composition (%fat, muscle mass) were measured and analyzed during 10 weeks of dumbbell treatment exercise. All data were verified through error-test to maintain the accuracy of data analysis, and the difference in the average values of the relevant variables between and within the group was t-tested.

Findings: After participating to dumbbell exercise, of body composition, muscle mass and %fat showed significant change, leptin and ghrelin levels of appetite control related hormones showed significant change, and growth hormone, cortisol, and insulin levels of lipolysis related factors showed significant change, respectively. Considering such results, dumbbell exercise increases muscle mass while influences a positive effect on appetite control and lipolysis to improve the obesity

Improvements/Applications: In conclusion, resistance exercise of dumbbell exercise can easily control the exercise intensity and because of relatively easy delivery and low price, it can be a useful means as an exercise tool for maintaining and improving the health of obesity or physically weak people.

Keywords: Obesity, Dumbbell exercise, Appetite hormone, Lipolysis factors, Body composition

1. Introduction

One of diseases which Modern people who suffer from various diseases should prevent is the obesity. As obesity would become a cause of various adult diseases and in addition, it is difficult for those who are in obesity to lose their weights. World Health Organization (WHO) appointed that the obesity is a disease requiring a long-term medical care and is an emerging infectious disease in 21st century and also stated that it requires a positive health care. In addition, Organization for Economic Cooperation and Development (OECD) expected that the population with severe obesity in Korea will continue to increase and reach up to 9% of total population in 2030, which is a double of current ratio. In particular, it is indicated that obesity rate in boys and male adolescents was somewhat higher than the average of OECD (25%) and therefore, OECD expressed the concern that after 10 years when the above boys and male adolescents become adults, social and economic problems caused from the obesity will be even worse [1].

The obesity for growing adolescents is not only an inducing factor to cause various adult diseases, but also is an obstruction factor to prevent the growth. Further, the obesity in adolescents has even 30% of possibility to lead to adult obesity. Therefore, it increases the risk to various diseases more and more and has high possibility to lower the learning, inducing the fatigue easily due to psychological disorder such as depression, anxiety, and social phobia and deterioration in physical fitness [2].

For healthy body, you should reduce body fat and increase muscle mass, practicing consistent exercises and

dietary regulation. According to Youth Health Behavior Survey in 2019 by Ministry of Health and Welfare, however, it is indicated that the rate of students who practiced physical activities (more than 60 minutes a day) for more than five days per week was 14.7% (male: 21.5%, female: 7.3%) of the whole students and physical activity of the most students is short. In particular, 33% (male: 25.2%, female: 41.6%) of the whole students has ever exerted the efforts to lose their weights but the rate of trying inappropriate weight losing methods continues to increase causing to various health problems. Therefore, the concern for this is required [1].

The obesity is caused by complex interactions such as genetic and environmental factors and behavior pattern but it is closely related even with appetite control, lipolysis, and body composition. Therefore, the concern to obesity related factors is increasing. In particular, it is reported that appetite control hormones like leptin and ghrelin, lipolysis related hormones like growth hormone, cortisol, and insulin, and body compositions like muscle mass and body fat volume are closely related with the exercise and act positively on the obesity. The increase of energy consumption by exercise brings appetite control and the change of lipolysis to recover the energy balance [3].

In order to treat the obesity, the first prerequisite is a reduction of body fat. The controlling methods include diet-therapy, kinesitherapy, parallel therapy mixing diet-therapy with kinesitherapy, behavior modification therapy, pharmacotherapy, and surgical therapy. Generally, for kinesitherapy for treating and preventing the obesity by reducing body fat, aerobic exercise type has been widely recommended but recently, it is also reported that resistance exercise is even effective in the control of metabolic syndrome as well as the reduction of body fat. In such context, as it is reported that dumbbell exercise using 1 to 2 kg of dumbbells was effective for adolescents, chronically ill patients, and the elderly with weak physical fitness level, more and more people participate in the resistance type of dumbbell exercise [4].

Therefore, this study was aimed at examine the effect of dumbbell exercise with resistance type to lipolysis factors (growth hormone, cortisol, insulin), appetite control hormone (leptin, ghrelin), and body composition (%fat, muscle mass) of obese male middle school students.

2. Materials and Methods

2.1. Subjects

The study targets 13 obese (%fat of 30% or higher) male middle school students who agreed to voluntary participation by sympathizing to the intent of the study of health care program applicants from W university. In order to enable all subjects to understand and practice the behavior patterns which can impact on the result during this test period, we educated them and received test agreements from them. Also, the subjects who have not faithfully implemented the exercise program during 10-weeks of test period were removed from this test and final test subjects 11 participants (15.8±0.61yrs, 163.07±2.57cm, 75.25±3.89kg, 30%fat) were enrolled.

2.2. Experimental procedure & exercise program

Dependent variables are appetite control hormone (leptin, ghrelin), lipolytic factors (growth hormone, cortisol, insulin) and body composition variables (%fat, muscle mass) and measurements were total 2 times such as before & after 10-weeks from resistance exercise. In order to adapt to the movements of the dumbbell exercise, the main exercise was carried out for 10 weeks after a week of preliminary exercise. The exercise program was resistance exercise which consists of 12 components (push-up arm, bend both arms down, knee bending-flexion, waist turning, pushing up-breast-up, raising both arms, arm bending lift, raise arms, elbow pull-lift, straightening behind arm, pushing over the head, lie down and broaden both arms) using 1 ~ 2kg dumbbell. The dumbbell exercise was performed as follows; From the first week to 5th week for using 1kg dumbbell, 6th to 10th week for using 2kgs, repeated 1 item about 15 to 20 times and 30-40 minutes exercise a day was performed three times (Mon, Wed, Fri) a week according to the recommendations of Suzuki [4]. The break between next movements was 30 seconds, and exercise intensity

was set up with use of PRE (perceived rate of exercise) that the subjects felt comfortable based on precedent studies of Suzuki [4]. That is, the subjects exercised with the degree of 11~12 that they didn't feel uncomfortable and painful from 1st to 5th week, and in the degree of 13~14 from to 6th to 10th weeks.

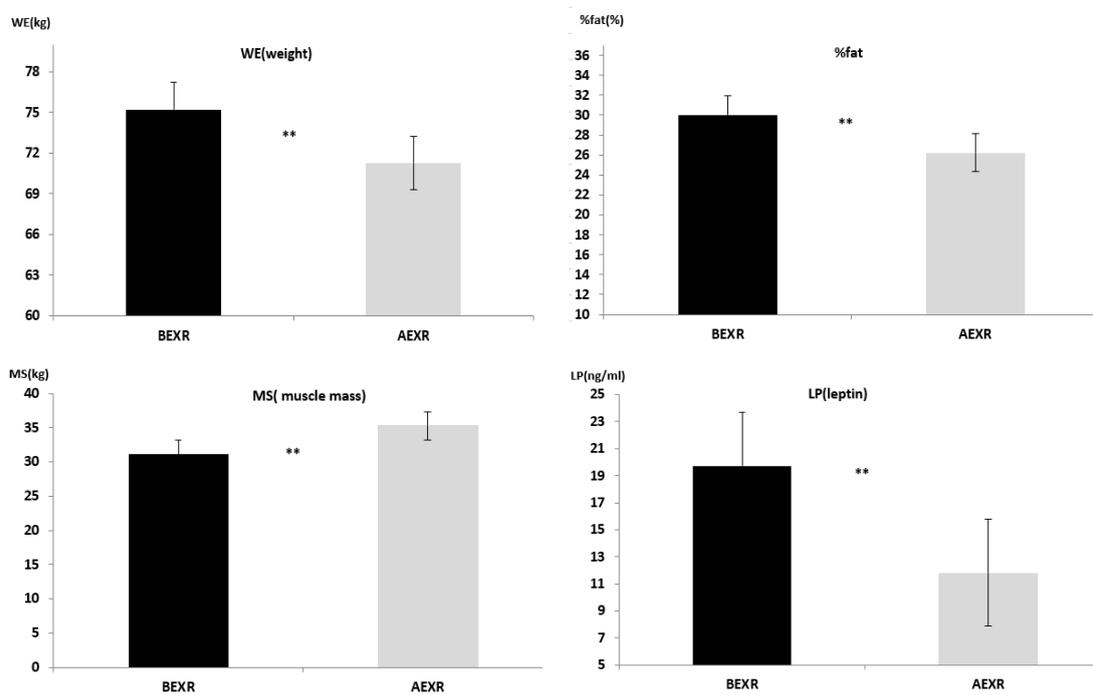
Appetite control related hormone were estimated by measure of leptin and ghrelin, and lipolytic related factors evaluated by growth hormone, cortisol and insulin. After fasting for 8 hours, blood collection for analysis was conducted in the morning with the help of experts, and after collecting blood, it was sent to the clinical center for analysis. In addition, body composition components were measured in body fat rate and muscle mass.

2.3. Statistics

The measured value obtained from this study calculates average and standard deviation to each measuring item using SPSS Package Ver.20.0 Statistical Processing Program. All data maintained the accuracy of data analysis by implementing error validation. After the dumbbell movement, the difference in the average values of the relevant variables between and within the group was t-tested. All statistical significance levels are set to .05.

3. Results and Discussion

As shown in Fig. 1 and Fig. 2, after participating in the dumbbell exercise, appetite control related hormone, lipolytic related hormone and body composition variables showed positive changes for each. That is, after 10 weeks of dumbbell treatment exercise in obese students, leptin($p<.01$) and insulin($p<.05$) decreased significantly, respectively. In addition, ghrelin, GH and cortisol each showed a significant increase ($p<.05$).



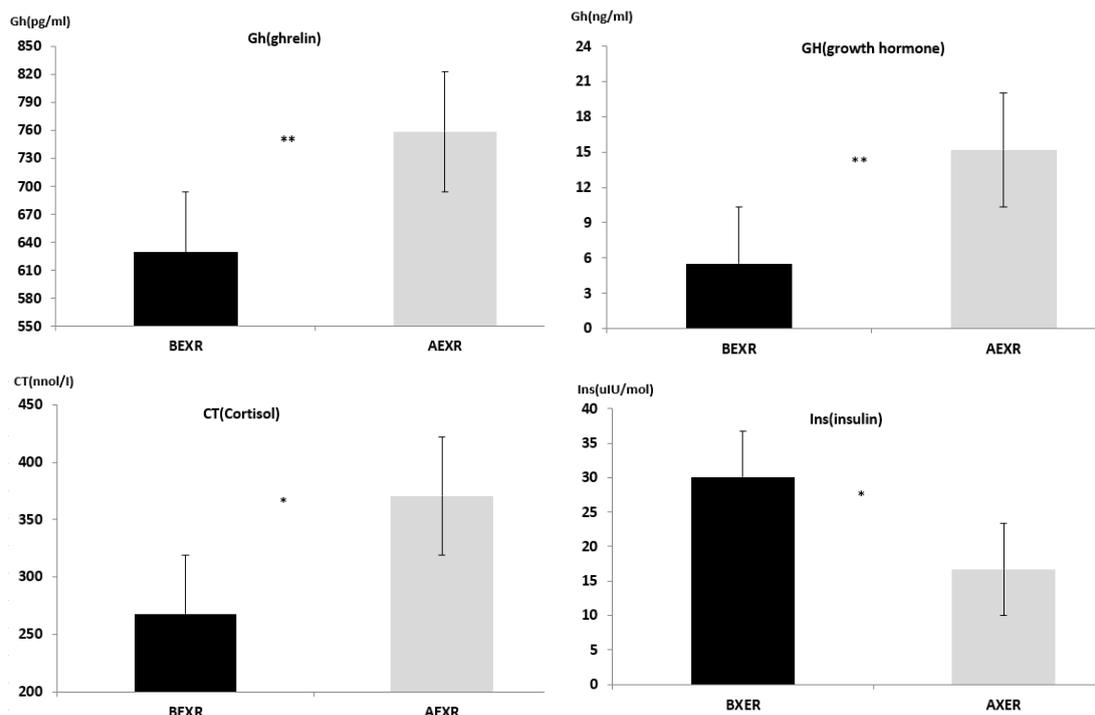
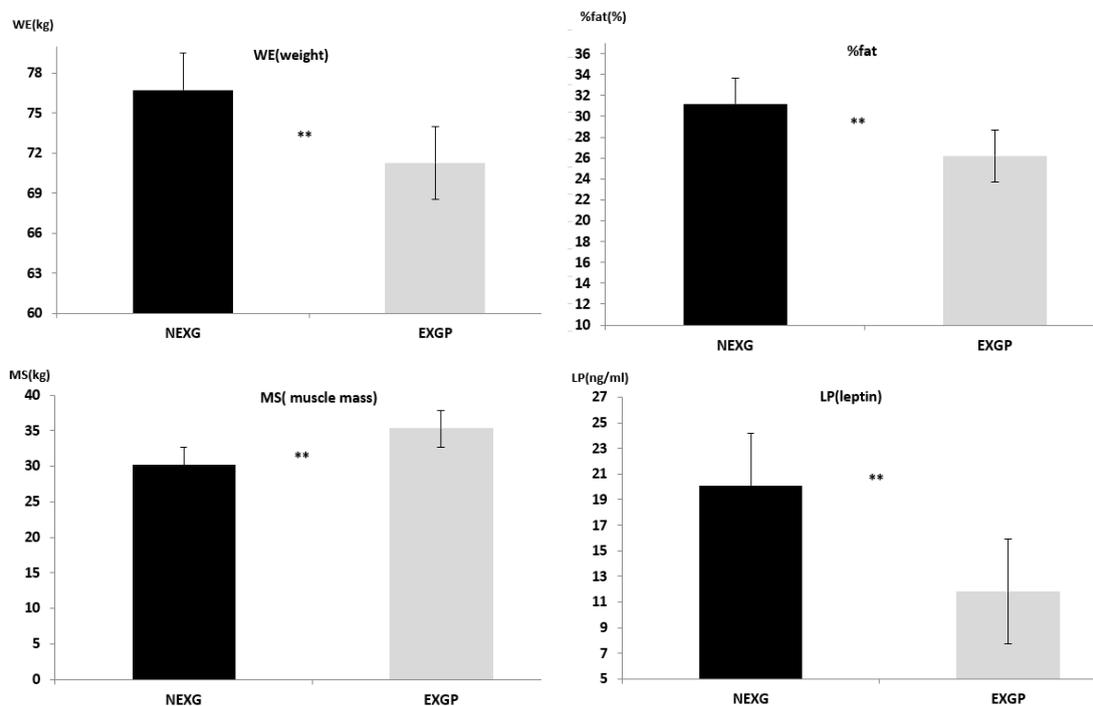


Figure 1. Change of dependent variables according to dumbbell treatment in exercise group
 Values are means ± SEM. *, **Significant different after exercise ($p < 0.05$, $p < 0.01$), BEXR; before exercise, AEXR; after exercise



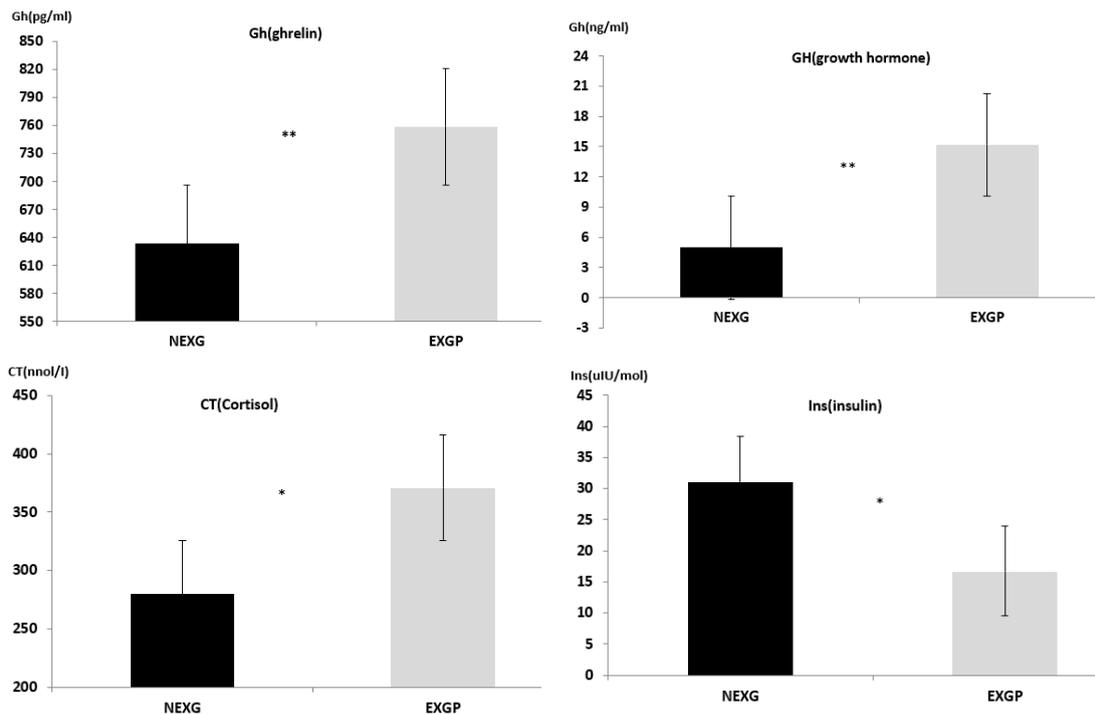


Figure 2. Change in intergroup related variables after dumbbell exercise

Values are means ± SEM. *, **Significant differences between groups ($p < 0.05$, $p < 0.01$), NEXG; non exercise group, EXGP; exercise group

The obesity which is rapidly spread to the world like infectious disease is a chronic disease defined by WHO. As prevalence rate of obesity in ages of 19 or higher in Korea shows a rapid increase for last 20 years from 26% in 1998 to 34.7% in 2018, the practice of healthy life is being emphasized more. For adolescents, the obesity ratio is 11% (male: 13.8%, female: 8.1%) and is steadily increasing since 2011. In particular, prevalence rate of obesity of children and adolescents has globally increasing trend like that of adult, WHO classified child obesity as a global disease and stated that this should be positively controlled [1, 2].

Many studies verified that the exercise is the clearest, safest, and healthiest method in controlling the obesity. Resistance exercise triggers the growth of myocyte and the development of muscular strength as it can mobilize many motor units. Also, it stimulates the secretion of hormones involved in appetite control and lipolysis as well as the change of body composition. Recently, dumbbell resistance exercise using dumbbell of resistance exercises develops the whole body evenly and trains muscles. As the muscle is the largest tissue to burn fat, if increasing the muscle, basal metabolism is raised, the fat is easily oxidized to energy source, and the energy consumption increases. In particular, Suzuki [4] reported that dumbbell gymnastics can be recommended as an obesity healing exercise. In particular, to children in growing period, physically weak persons, and the elderly with lack of muscle strength, dumbbell gymnastics with 1 to 2 kg of light dumbbells can be recommended rather than weight-bearing exercise giving heavy load [5].

Muscle mass of body composition dominates the most area, is closely related with energy metabolism, osteoporosis, and fracture, and is significantly reduced for age increase and obesity [6]. In particular, the reduction of muscle mass according to the reduction of physical activity which is highly related with obesity reduces the functional capacities such as muscle strength, walking speed, and balance, which leads to muscular dystrophy and physiological reserve capacity degradation. Finally, daily lives are much disrupted. In this study, it showed the reduction of %fat and the increase of muscle mass after participating to dumbbell exercise for 10 weeks. It is regarded that dumbbell exercise develops the muscles of whole body evenly to bring muscular hypertrophy. In addition, it is regarded that such muscular hypertrophy has raised basal metabolism and has positively acted on body composition as the fat is easily oxidized to energy source and energy consumption increases.

Growth hormone is a hormone secreted to anterior pituitary and is known that it influences functionally on all cells and in particular, promotes lipolysis. Some reports indicate that the exercise increases GH concentration but some other reports indicate that it does not. Common opinions, however, report that exercise intensity and duration time are critical to the secretion of growth hormone [7]. It is also reported that the secretion of GH according to resistance exercise may differ depending on exercise type and intensity & method of training. In this study, it significantly increased after 10 weeks of exercise, which showed similar trend with the result of previous study [8]. As such, it is regarded that GH increase due to resistance exercise is because lipid metabolism, the increase of protein synthesis capacity, and factors related to anaerobic energy metabolism as well as the improvement of aerobic metabolism capacity in skeletal muscle by training stimulate GH secretion.

Cortisol responding for maintaining homeostasis to exercise or stress stimulation affects much on lipolysis process like growth hormone. Generally, the cortisol secreted during the exercise accelerates mobilization and use of fat for energy production while it reduces the synthesis of fat at liver [7]. The results which cortisol concentration after continuous exercise has no increase, reduction, and change are reported. In particular, it is also reported that cortisol concentration is much influenced by emotional factor rather than physical activity. In addition, between trained players and untrained players, conflicting results which trained players show significantly higher concentration than untrained players and trained players show rather lesser concentration are reported [8]. In this study, cortisol has significantly increased after 10 weeks of exercise, it is regarded that the increase of cortisol concentration after resistance exercise like the above is because mobilization and use of fat to energy production as well as the increase of gluconeogenesis were actively made.

Exercise influences on insulin secretion while stimulating beta-cell of pancreas. Lowering of insulin secretion according to exercise causes the reduction of body fat by promoting the mobilization of free fatty acid from fat tissue and increasing the mobilization of muscle glycogen. Generally, insulin reduction phenomenon is remarkably indicated in long-term low intensity exercise. In addition, it is reported that when stabilizing at exercise group, insulin concentration was low and when exercising, insulin was reduced. In this study, it has significantly increased after 10 weeks of exercise to show similar trend with the results of previous studies [9]. It is regarded that such results are because the sensitivity of sympathetic nerve was reduced by resistance exercise and the use of insulin was reduced due to the reduction of body fat.

Appetite control hormones, *in vivo* protein recently found as a material affecting on ingestion and energy metabolism include leptin and ghrelin. Of these, leptin plays a role to control the obesity by inhibiting the ingestion and increasing energy consumption by acting on hypothalamus. It is reported that leptin has associations with percentage of body fat, muscle mass, insulin concentration, growth hormone, adrenal hormone, and blood lipid. In particular, it is reported that the conflicting results which it showed high figure showing leptin resistance and there was no reduction and change after one-time exercise but it is known that it is reduced after endurance training. In this study, it is indicated that it is significantly reduced after 10 weeks of dumbbell exercise to show a trend matching with the results of previous studies [10]. As it is reported that leptin concentration shows interrelationship with much influence on the changes of body fat volume, weight, percentage of body fat, insulin, and growth hormone, this study also regards that such factors influence each other due to the exercise in above reduction.

Also, ghrelin is known as appetite increasing material rather than various *in vivo* materials found until now and is called as appetite promotion or starvation hormone. It plays a significant role in transduction of signal to ingestion and *in vivo* nutrient status into hypothalamus, shows low blood mass for people in obesity, is inversely proportional to insulin and body mass index, and shows high relevance with waist measurement, hip circumference, abdominal visceral region, and abdominal subcutaneous fat. Therefore, it has close relevance with weight loss. It is reported that regular and continuous exercise increase the figure of ghrelin but there is no change after one-time exercise. In this study, it shows similar results of previous studies [11] as ghrelin concentration was significantly increased after 10 weeks of exercise. It is regarded that the increase of ghrelin concentration after exercise is because expression of

ghrelin raised when weight or body fat is reduced during long-term exercise, endurance ghrelin signal is rapidly blocked in short-term by appetite inhibition and weight loss after exercise due to exercise, and ghrelin level was raised according to the losing degree when losing weight by exercise without limiting the ingestion.

4. Conclusion

After participating to dumbbell exercise, muscle mass and %fat of body components showed the significant changes, respectively. In addition, of appetite control related hormones, leptin level showed a significant increase and ghrelin level showed a significant reduction. Of lipolysis related factors, growth hormone, cortisol, insulin levels showed significant increase and reduction, respectively. Considering such results, dumbbell exercise increases muscle mass while influences a positive effect on appetite control and lipolysis to improve the obesity. Therefore, resistance exercise of dumbbell exercise can easily control the exercise intensity and because of relatively easy delivery and low price, it can be a useful means as an exercise tool for maintaining and improving the health of obesity of obesity or physically weak people. Further study, however, may provide more accurate information if change trend depending on comparative analysis with aerobic type exercise, sex, intensity of exercise, and change of exercise period is made.

5. Acknowledgment

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