EFFECT OF RESISTANCE TRAINING IN CHILDREN WHO ARE OVERWEIGHT OR OBESE – PILOT STUDY

https://doi.org/10.5817/CZ.MUNI.P210-9631-2020-56

Kateřina Strašilová, Petr Vajda, Tomáš Hlinský

Faculty of sport studies, Masaryk University, Brno, Czech Republic

ABSTRACT

Overweight and obese children often suffer for many physiological and psychological issues. Resistance training allows them to excel over their peers due to strength ability which is related to their somatotype. The aim of this study was to examine the effect of an eight-week resistance training program on body composition in overweight and obese children. Study sample included 8 boys and 4 girls (age = 11.7 ± 1.54) who were involved in an eight-week strength specifically designed program consisted of two strength training unit per week. Resistance of exercise was set on 8–10 RM. Body composition were measured by InBody 720 two times before and after the training intervention. The Wilcoxon matched pairs test was used. Results showed increase in total body weight (2.7%), lean body mass (2.5%) and fat mass (3.7%). This effect indicates that used resistance training program is sufficient to lean body mass grow. Nevertheless, program proved to be inadequate to avoid an increase in fat mass. This could be caused by many factors which should be consider in further research (e.g. longer technique practice, diet, number of training units).

Keywords: Exercise; youth; obesity; strength training.

Introduction

Previous research has established that child obesity is a growing problem that is becoming global. According to Lobstein, Baur and Uauy (2004), there is an increase in childhood obesity annually by 0.5% in Brazil and the US, while in Europe, Canada, and Australia, this is up to 1% annually. This rapid increase in the incidence of childhood obesity in a relatively stable population, suggests that genetic predisposition will not be its primary cause. For instance, in Australia, 20-25% of children aged 2–18 are overweight or obese, and there are 22 million children with the same issue under the age of five worldwide Dias et al. (2015). Lobstein et al. (2004) maintain that it is not yet possible to estimate the extent of the burden on health services that the ever-increasing proportion of obese children will bring in the future. In addition to current problems, typical obese children are more prone to illnesses such as hyperinsulinemia, decreased glucose tolerance, increased risk of type 2 diabetes, hypertension, sleep apnoea, social exclusion, and depression. The increased incidence of childhood obesity will bring a significant increase in health problems to the future generation of adults. There is a risk of widespread heart disease, diabetes, some types of cancers, gallbladder disease, osteoarthritis, endocrine disorders, and other obesity-related conditions. Schonfeld-Warden & Warden (1997) states, that up to 80% of people with obesity in childhood are obese even in adulthood. In the industrialized countries, the most vulnerable group is children from low-income families, where the possibilities of physical activity and good eating habits are limited (Lobstein et al., 2004).

Children suffering from obesity are often encouraged to do aerobic activities. Commonly recommended activities for these children include; walking, jogging, skating, cycling, or dancing, 3-5 times a week with the medium to sub-maximum intensity and duration more than 1 hour (Daniels et al., 2005). However, the success of aerobic programs is very low. Overweight or obese children rarely achieve success compared to other ones, and exercise is often very difficult for them. As a combination of these two factors produce insufficient positive psychological or physiological effect of physical activity, they frequently lose interest in it (Schranz et al., 2013; Smith et al., 2014).

Resistance training seems to be an activity that gives these children a certain advantage over other children in terms of the possibility of success. Children who are overweight or obese have greater body weight and muscle mass and therefore greater strength. As a result, they can experience more success during exercise and perform better than other children (McGuigan et al., 2009).

The benefits of strength training for overweight and obese children include the development of muscle strength and endurance, and an increase in bone density and active muscle mass leading to positive change in body composition and improvements in blood lipid profile and a decrease in blood pressure (Kim, 2010; Lee et al., 2012; McGuigan et al., 2009; Shaibi et al., 2006). Resistance training positively affects the children's psyche and mental health of athletes, increases their self-confidence and self-efficacy and improves body image (Council on Sports Medicine and Fitness, 2008; McGuigan et al., 2009; Schranz et al., 2013).

Despite the growing popularity of strength training and the increasing number of studies recommending this type of training for overweight and obese children, only a few of them deal with the effect of strength training on body composition (several studies investigated combination of strength training with aerobic intervention or diet modification ((Dietz et al., 2012; Schranz et al., 2013)). The purpose of this study is to determine the efficacy of an 8-week resistance training program using multiple-joint exercises on body composition in children who were overweight and obese.

Methods

Twelve overweight and obese children (4 girls and 8 boys) in age on pre-measurement day = 11.7 ± 1.54 years were involved in this study. Anthropometric values were recorded during the initial measurement (mean body weight = 68.1 ± 20.7, mean body height = 156.0 ± 12.2 and mean BMI index = 27.5 ± 5.5). There were no limitations in physical activity for health reasons for any of the children. The influence of eight-week strength training was evaluated in this study. Strength training took place two times per week (always the second and fourth day of the week) at the same time in the afternoon. Each training session consisted of 10 minutes general warm-up, 3 sets of 8RM (excepted abdominal muscles exercise) and 10 minutes of cool down and final evaluation. The exercise training program was in circuit style and included squat, bench press, sit-up, pull-down, leg press and exercises for core strength and stability. One training session lasted 60 minutes.
Introductory training preceded resistance training for four weeks (two sessions per week). During this time, all subjects were taught the proper technique and maximum strength testing. (maximum strength testing were according 1-RM protocol excepted bench press and leg press. There were used testing on level 5-RM according to the same protocol and 1-RM were determined by calculation for safety reasons). Anthropometric and body composition measures (InBody 720) were done before and after the eight-week strength session. There were two measures for one week in the same time period. Mean values were used for results interpretation.

Maximum strength testing

All subjects completed 4 weeks of proper technique training. Maximum strength was tested according to the 1-RM protocol, where the correct technique is a necessary prerequisite for carrying out the test. The 1-RM value was recorded the resistance where children could be able to do throughout the full range of motion and with the correct technique just once. They started with 10 minutes of general warm-up, followed two series with 10 repetitions with 50% of the expected maximum. Finally, a series of single repetitions with increasing loads were done. In case that weight was lifted with proper technique, in full range of motion and disruption of tempo the weight was increased by approximately 0.5–2.3 kg followed by 2 minutes of rest. This was followed by another series of single repetition until the child was no longer able to meet all the criteria. Strength testing was supervised by a specialist instructor, with the instructor to subject ratio 1:1. Communication was positive, and the resistance was added based on the individual feeling of the children without external pressure. The children themselves determined whether they were able to increase the resistance (Faigenbaum, Milliken, & Westcott, 2003).

Statistical Analyses

Statistical analyses were performed using SPSS software (IBM SPSS Statistics 25 for Windows; SPSS, Inc., Chicago, IL). Data did not come from a normal distribution. The Wilcoxon Signed Ranks Test was used for evaluating the effects of the intervention. The criterion alpha level for significance was set at $p \leq 0.05$. Pre and post values were evaluated also by percentage evaluation and graphical method due to the small number of cases.

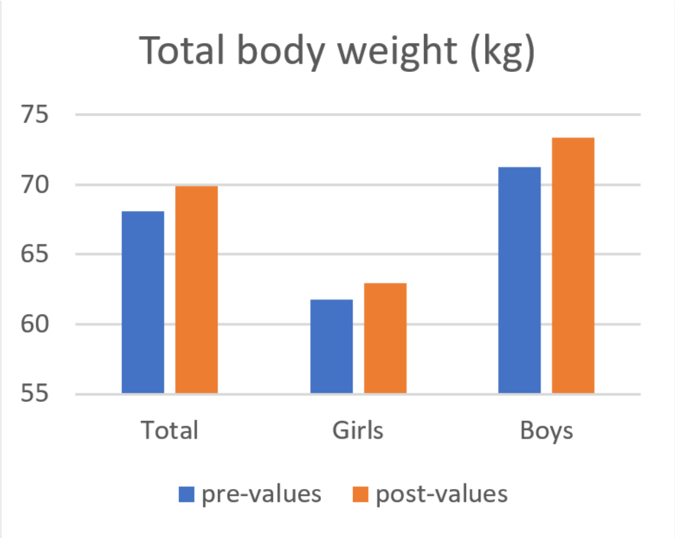
Results

12 overweight and obese children (4 girls and 8 boys) were involved in eight weeks of strength training sessions. Anthropometric values and body composition by InBody 720 were measured two times before (pre-value) and after (post-value) intervention. The mean values from both measurements are in table 1, for the whole sample, girls and boys separately.

Table 1 *Pre and post intervention means ±SD*

Mean ± SD	Age	Height (cm)		Weight (kg)		Lean body mass (kg)		Fat mass (kg)		BMI	
	pre	pre	post	pre	post	pre	post	pre	post	pre	post
Total (n=12)	11.7 ± 1.6	156.0 ± 12.2	156.3 ± 12.1	68.1 ± 20.7	69.9 ± 21.9	21.8 ± 5.7	22.4 ± 6.1	27.8 ± 12.4	28.8 ± 12.9	27.5 ± 5.5	28.2 ± 6.7
Girls (n=4)	10.3 ± 1.4	148.3 ± 11.8	148.5 ± 11.4	61.8 ± 16.9	62.9 ± 4.1	18.6 ± 4.1	18.8 ± 4.1	27.5 ± 10.7	28.2 ± 10.6	27.7 ± 5.4	28.3 ± 5.2
Boys (n=8)	12.5 ± 1.2	159.9 ± 11.1	160.3 ± 11.1	71.3 ± 22.8	21.9 ± 5.1	23.5 ± 5.9	24.3 ± 6.3	28.0 ± 13.9	29.0 ± 14.6	27.4 ± 5.9	28.1 ± 6.2

There was an increase for the whole sample for body weight 2.7 % ($p = 0.005$), for lean body mass 2.5% ($p = 0.004$) but also for body fat 3.7% ($p = 0.013$) and for BMI 2.5% ($p = 0.005$). If the girls and boys were explored separately the trend remained the same but its power was different. More obvious changes were observed in boys. Body weight increased about 2.9 % ($p = 0.017$), lean body mass about 3.2% ($p = 0.012$) but also there was enhancement of bodyfat about 4.3% ($p=0.05$) and BMI about 2.7% ($p = 0.017$). An increase in girls was found by 2.0%, $p = 0.15$; 2.1%, $p = 0.19$; 2.6%, $p = 0.19$ and 2.0%, $p = 0.14$ for body weight, lean body mass, body fat and BMI, respectively. The changes in the body proportion components are visible in figure 1–4.



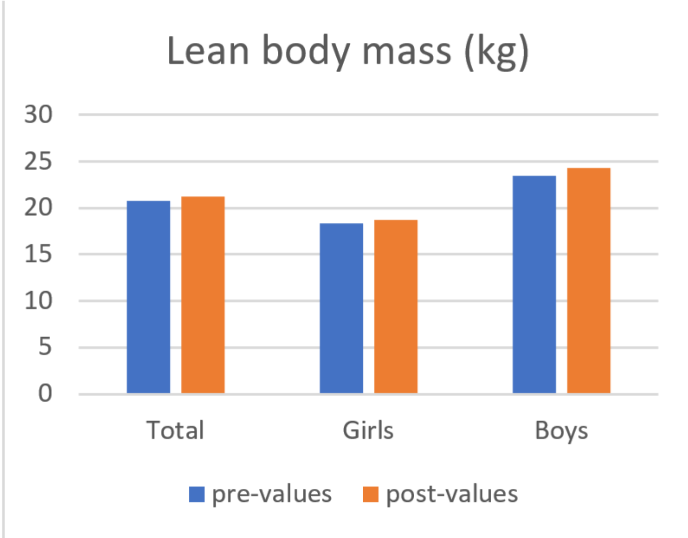
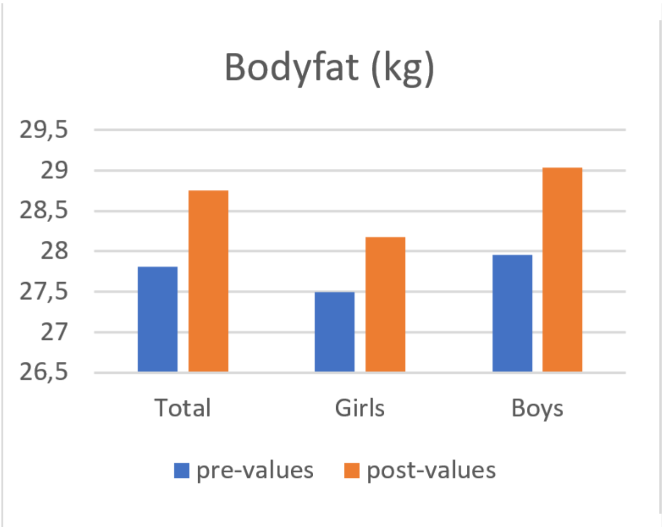


Figure 1 *Changes in total body weight*

Figure 2 *Changes in lean body mass*



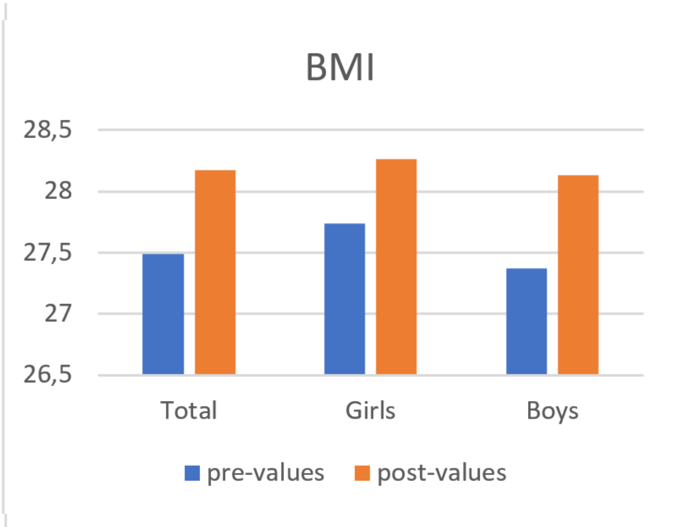


Figure 3 *Changes in bodyfat*

Figure 4 *Changes in BMI*

Discussion

The results suggest that strength training can significantly affect muscle mass in overweight and obese children. The positive effect was detected in both girls and boys, but more significantly in boys. This difference corroborates with earlier findings which showed that the effect is smaller in samples consist of girls only or children of prepubescent age (Shaibi et al., 2006). There was an increase of 2.5% for the whole group and 3.2% and 2.1% for boys and girls in our study. These results correspond to a previous study which showed an increase of 2.4% in mixed group (Yu et al., 2005). Active muscle mass growth can be beneficial for children who are overweight and obese due to increased basal metabolism affecting all-day energy expenditure.

Along with the increase in muscle mass, an increase in muscle strength is often described (Faigenbaum et al., 2003). In many cases it is not associated with muscle hypertrophy (lack of circulating androgens in pre-pubertal children), but with neuromuscular adaptation (especially increased motor unit activation, improved motor skills, and development of intra-muscular and inter-muscular coordination). According to Guy and Micheli (2001), the increase in strength due to these aspects is described in children up to several tens of percent after 8–10 weeks of strength training. We assume, that because of the great improvement in strength caused by neuromuscular adaptation, insufficient stimulation may occur during the intervention. The resistance was set to 8RM in our study. The 1RM was tested for each child and 8 training units (60 min) focused on the development of correct technique preceded resistance training. Despite that, most children have to increase their resistance after 3–4 weeks of research to meet 8RM. The average of such an increase ranged from 15–25% depending on the exercise (more distinctly for lower limbs). The validity and reliability of the 1RM test in this group of children may also be a possible cause. Although the Test-retest reliability after six weeks for the group of 32 girls and 64 boys between 6.2 and 12.3 years reached 0.93–0.98 (Faigenbaum et al., 2003). But it is possible that children who are overweight or obese may have a reduced degree of frustration tolerance because of their lack of experience with physical activity. This may affect the ability of children to perform the test to the maximum.

BMI and body weight raised for both boys (BMI = 2.7%; BW = 2,7%) and girls (BMI = 2%; BW = 2%). Aside from the increase of muscle mass, the body fat grew too (the whole sample by 3.7%, boys by 4.3% and girls by 2.6%). This result is uncommon as the changes in BMI and body fat are usually described as small (e.g. Yu et al., 2005). Also, review results Schranz et al. (2013) show that strength training has a small effect on body composition and fat loss, but a high effect on muscle strength. In contrast, McGuigan et al. (2009) reported that due to an 8–week strength training with a resistance level of 10–15 RM, some children lost about 7% of their fat mass. Lee et al. (2012) describe the loss in mean body fat of 3.5% in 45 obese boys as a result of three months of resistance training (8–12RM). It could be explained by using design with 3 training units per week or the fact that we decided to include abdominal muscle and core exercise with the absence of external resistance. While the lean body mass in our developed in all children (range 2.7–4.7%) except for one girl, the body fat changes were more variable. Three children experienced a decrease of 3.6–0.5%, six children had an increase of 0.7–4.5% and three children had an increase of 7.0–15.5%. This discrepancy between studies could point to the insufficiency of two training units per week. What more McGuigan et al. (2009) tested 8 exercises in three series with resistance size 8–15RM.

Sufficiency of using BMI evaluation for the resistance training intervention is questionable. Changes in body components are often not reflected in the BMI (McGuigan et al., 2009). We use InBody 720 to better assess the changes in the ratio of the individual body components. Notwithstanding that the measurement of bioimpedance analysis was held at the same time of the day, the condition was not all the same as the children were not on an empty stomach. We reduced this limitation by the doubled measurement and using average. Despite this, some values could be affected by food intake before the test. McGuigan et al. (2009) believe that Dual-energy X-ray absorptiometry appears to be the most reliable and valid method for measuring body composition changes. Absence of the control group did not allow to fully separate the effect of the intervention from the ontogenic body development. An additional uncontrolled factor is increase in strength during the intervention due to concerns with maximal strength testing for free-weight exercises in this population.

Conclusion

At the practical application level, we can say that short-term resistance training can significantly improve lean body mass in children who are overweight and obese. This type of training is well accepted by children and it seems they enjoy it. Regarding the effectiveness of strength sessions for body fat loss, training two times per week appear to be inadequate. However, this is difficult to evaluate. There are not many studies that use strength training twice per week or compare the efficiency of a different number of training sessions per week. Also, maximum strength testing and exercise resistance estimating seems to be problematic in this group of children. Future research should focus on finding the most appropriate strength training design to reduce children's overweight and obesity.

References

Council on Sports Medicine and Fitness. (2008). Strength Training by Children and Adolescents. *PEDIATRICS*, *121*(4), 835–840. https://doi.org/10.1542/peds.2007-3790

Daniels, S. R., Arnett, D. K., Eckel, R. H., Gidding, S. S., Hayman, L. L., Kumanyika, S., Robinson, T. N., Scott, B. J., St. Jeor, S., & Williams, C. L. (2005). Overweight in Children and Adolescents: Pathophysiology, Consequences, Prevention, and Treatment. *Circulation*, *111*(15), 1999–2012. https://doi.org/10.1161/01.CIR.0000161369.71722.10

Dias, I., Farinatti, P., De Souza, M. D. G. C., Manhanini, D. P., Balthazar, E., Dantas, D. L. S., De Andrade Pinto, E. H., Bouskela, E., & Kraemer-Aguiar, L. G. (2015). Effects of Resistance Training on Obese Adolescents: *Medicine & Science in Sports & Exercise*, *47*(12), 2636–2644. https://doi.org/10.1249/MSS.0000000000000705

Dietz, P., Hoffmann, S., Lachtermann, E., & Simon, P. (2012). Influence of Exclusive Resistance Training on Body Composition and Cardiovascular Risk Factors in Overweight or Obese Children: A Systematic Review. *Obesity Facts*, *5*(4), 546–560. https://doi.org/10.1159/000341560

Faigenbaum, A. D., Milliken, L. A., & Westcott, W. L. (2003). Maximal Strength Testing in Healthy Children. *The Journal of Strength and Conditioning Research*, *17*(1), 162. https://doi.org/10.1519/1533-4287(2003)017<0162:MSTIHC>2.0.CO;2

Guy, J. A., & Micheli, L. J. (2001). *Strength Training for Children and Adolescents*. *9*(1), 29–36.

Kim, Y.-M. (2010). *Role of regular exercise in the treatment of abdominal obesity in adolescent boys*.

Lee, S., Bacha, F., Hannon, T., Kuk, J. L., Boesch, C., & Arslanian, S. (2012). Effects of Aerobic Versus Resistance Exercise Without Caloric Restriction on Abdominal Fat, Intrahepatic Lipid, and Insulin Sensitivity in Obese Adolescent Boys: A Randomized, Controlled Trial. *Diabetes*, *61*(11), 2787–2795. https://doi.org/10.2337/db12-0214

Lobstein, T., Baur, L., & Uauy, R. (2004). Obesity in children and young people: A crisis in public health. *Obesity Reviews*, *5*(s1), 4–85. https://doi.org/10.1111/j.1467-789X.2004.00133.x

McGuigan, M. R., Tatasciore, M., Newton, R. U., & Pettigrew, S. (2009). Eight Weeks of Resistance Training Can Significantly Alter Body Composition in Children Who Are Overweight or Obese: *Journal of Strength and Conditioning Research*, *23*(1), 80–85. https://doi.org/10.1519/JSC.0b013e3181876a56

Schonfeld-Warden, N., & Warden, C. H. (1997). PEDIATRIC OBESITY. *Pediatric Clinics of North America*, *44*(2), 339–361. https://doi.org/10.1016/S0031-3955(05)70480-6

Schranz, N., Tomkinson, G., & Olds, T. (2013). What is the Effect of Resistance Training on the Strength, Body Composition and Psychosocial Status of Overweight and Obese Children and Adolescents? A Systematic Review and Meta-Analysis. *Sports Medicine*, *43*(9), 893–907. https://doi.org/10.1007/s40279-013-0062-9

Shaibi, G. Q., Cruz, M. L., Ball, G. D. C., Weigensberg, M. J., Salem, G. J., Crespo, N. C., & Goran, M. I. (2006). Effects of Resistance Training on Insulin Sensitivity in Overweight Latino Adolescent Males: *Medicine & Science in Sports & Exercise*, *38*(7), 1208–1215. https://doi.org/10.1249/01.mss.0000227304.88406.0f

Smith, J. J., Eather, N., Morgan, P. J., Plotnikoff, R. C., Faigenbaum, A. D., & Lubans, D. R. (2014). The Health Benefits of Muscular Fitness for Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine*, *44*(9), 1209–1223. https://doi.org/10.1007/s40279-014-0196-4

Yu, C. C. W., Sung, R. Y. T., So, R. C. H., Lui, K.-C., Lau, W., Lam, P. K. W., & Lau, E. M. C. (2005). Effects of Strength Training on Body Composition and Bone Mineral Content in Children Who Are Obese. *The Journal of Strength and Conditioning Research*, *19*(3), 667. https://doi.org/10.1519/14994.1