

# RESISTANCE TRAINING FOR CHILDREN AND ADOLESCENTS: FROM A PHYSIOLOGICAL BASIS TO PRACTICAL APPLICATIONS

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## SUMMARY

Resistance training for children and adolescents, programmed according to individual needs and abilities and adequately implemented, is recommended by leading professional associations in the field of sports medicine, sport sciences and pediatrics. The most commonly used loads during training, with the aim of developing strength and power, are free weights and resistance exercise equipment that can be of standard sizes, but also specially designed for younger age groups, body weight exercises, and exercises with medicine balls and elastic bands. In addition to the positive influence on muscle strength and endurance, as well as a potential increase in the performance of certain motor tasks, regular resistance training can also result in improving body composition, increasing bone mineral density, improvement of cardio-respiratory endurance, as well as have a positive impact on the psycho-social status of children and adolescents. Due to the lack of clear evidence to suggest muscle hypertrophy in children, an increase in muscle strength is mainly attributed to neurological adaptations, including improved coordination, speed and the number of activated motor units. In designing a resistance training program for children and adolescents, one should respect the basic principles of training, pertaining to adults as well, but it must be borne in mind that neither children nor adolescents are "little adults", and that one should not simply copy the training of adults or athletes.

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Regular and clear instructions with constant supervision in resistance training for children and adolescents can have a positive impact on overall health, and can lead to the creation of positive habit acquisition to regularly perform training, and a healthy lifestyle. Current results and findings obtained from well-organized and monitored investigations, on a sample of children or adolescents, indicated a very low risk of injury when one meets all the training recommendations for a particular age group.

**Keywords:** resistance training, muscle strength, children and adolescents.

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## INTRODUCTION

It is logical to expect that weight training will help young athletes to achieve better results and that, thanks to their strength and power, they will gain a certain advantage over their peers. Improved success in performing certain motor tasks after weight training was noted in numerous studies whose samples of participants included young athletes. However, progress in muscle force and power will not always and inevitably lead an improvement in the performance of the desired motor tasks (Ignjatovic, Markovic, & Radovanovic, 2012). In order to realize a desired goal, that is, to achieve the successful performance of a motor task, training meant to develop force and power should adhere to the principle of specificity, that is, include precisely those movements and means of muscle contraction which are most similar to those generated when performing the desired motor task (Radovanović & Ignjatović, 2013).

## PHYSIOLOGICAL ADAPTATIONS FOR WEIGHT TRAINING

A properly designed weight training program for adults, in addition to developing muscle force, power, and endurance, usually leads to morphological adaptations to muscle hypertrophy and changes in the composition of muscle fibers. However, unlike in the case of adults, these adaptations cannot always be expected to the same extent among children and adolescents. Even though weight training among the young has proven itself to be effective in increasing muscle force and power, these increases did not accompany an increase in muscle mass to the same extent. Possible small increases in muscle mass are very difficult to measure precisely, especially among children. Due to a lack of strong and clear evidence which would indicate muscle hypertrophy among children, the increase in muscle force and power is mostly attributed to neurological adaptations. Neurological adaptations include improved coordination, speed, and the number of activated motor units (Radovanović & Ignjatović, 2013). These neurological

adaptations are very rarely measured directly, but are frequently ascribed to cases when an increase in force and power is significantly greater than any morphological changes. Research which has attempted to directly measure neurological adaptations following weight training among young participants, by using modern electromyographic techniques, has recorded an increase in neuromuscular activity, but these increases were smaller compared to the increases in force and power (Faigenbaum, Lloyd, & Myer, 2013).

## **ACCOMPANYING POSITIVE EFFECTS OF WEIGHT TRAINING**

In addition to the positive effects on muscle force, power and endurance, as well as the potential increase in the successful performance of certain motor tasks, regular weight training could also influence some other aspects of an individual's health status. Primarily, regular weight training can result in an improvement in body composition, increase bone mineral density, improve cardio-respiratory status, as well as influence an individual's psychological state. One of the most obvious benefits of weight training is the improvement in body composition, that is, a reduction in the percentage of body fat. Training has a positive effect on body composition by increasing energy consumption during exercise, but partly during recovery as well. This kind of influence is most noticeable among obese children and adolescents following weight training, as well as children with long-term chronic conditions (Smith, Eather, Morgan, Plotnikoff, Faigenbaum, & Lubans, 2014). The positive influence on bodily composition, body mass, level of fat in the blood, sensitivity to insulin, as well as blood pressure, can have an indirectly positive effect on the cardio-respiratory system. However, all these positive influences have not yet satisfactorily been confirmed on samples of healthy young athletes, even though current findings indicate the positive effects on the cardiorespiratory system. In the research carried out by Ignjatovic, Radovanovic, Stankovic, Markovic, & Kocic (2011) which included active young athletes involved in active training, weight training had a positive effect on numerous parameters of muscle force and power, while it had no statistically significant influence on the parameters of cardiorespiratory endurance. Weight training can have positive effects on bone growth and mineralization, as well as lead to a decrease in the risk of fractures caused by osteoporosis. However, there is need for further research which could, with more precision, determine optimum load during weight training with the aim of achieving a positive effect on bone structure. The positive sides of weight training that should be emphasized is also the effect it has on psychological aspects. It was determined that the level of socialization and mental discipline among young individuals taking part in organized weight training at a level similar to that of their peers who are involved in collective sports activities (Radovanović, 2017).

## POTENTIAL RISKS DURING WEIGHT TRAINING

Weight training like most other physical activities carries with it a certain risk of injury. Still, this risk is not greater than the risk involved in other sports or recreational activities in which children regularly participate (Radovanović & Ignjatović, 2015). Sprains, strains and fractures have been noted, but not the conditions under which they occurred, and which could have led to injury. These injuries are not common, and it is assumed that they could to a great extent be prevented by using proper training techniques, avoiding excessive load and poor and low-quality equipment. Of course, exercise in the presence and with the help of a qualified adult would drastically reduce the possibility of injury. Current knowledge from well-organized and monitored research including children or adolescents indicates the very small possibility of injury if the training recommendations for the given age group are adhered to (Lloyd, Faigenbaum, & Stone, 2014).

## DIFFERENT MODALITIES OF WEIGHT TRAINING

Usually, during weight training meant to develop force and power, free weights are used along with exercise machines which could be of standard size, but also specially designed for younger age groups. Quite often training programs consist of exercises which rely on the exerciser's own mass as load, exercises with a medicine ball and expanders, or elastic bands (Ignjatović, Stanković, Radovanović, Marković, & Cvečka, 2009). An increasing number of studies support the use of plyometric training among children and young athletes. Plyometric exercises use the suitability of the stretch-shortening cycle – SSC in the muscles for developing explosive power. If plyometric exercises are carried out properly with the appropriate dosing and a gradual increase in the load, there is no reason not to include them in programs meant for young athletes, including children. Lately, training programs which include exercises for the improvement of balance and coordination have been gaining in popularity. The potential benefit of such training is reflected in the decreased risk of injury. Also, another advantage of training on unstable surfaces is that greater activation of the muscle fibers without using greater load in weight training (Behringer, Vom Heede, Yue, & Mestrer, 2010).

## GUIDELINES FOR WEIGHT TRAINING PROGRAMS

Designing a weight training program for children and adolescents must adhere to the same basic principles of training, as in the case of adults, but must also not lose sight of the fact that children or adolescents are not “little adults”,

and programs meant for adults or athletes cannot just be copied and used for these age groups. Even in cases when children or young athletes manifest similar or even greater muscle abilities than adults, we should bear in mind that they are not yet fully anatomically, physiologically and psychologically mature. Through proper and clear instructions with constant professional supervision, weight training for the development of muscle force and power could have a positive effect on the overall health status, and could lead to new positive habits toward regular weight training, but also a healthy way of life (Radovanović, 2017).

When implementing weight training for children and adolescents, the following guidelines need to be adhered to (Radovanović & Ignjatović, 2013):

- Prior to the beginning of organized forms of exercise, it is necessary for the athlete to undergo a detailed physical examination by a specialist of sports medicine in order to determine whether there is a medical problem or musculoskeletal disorder which could be worsened by training, but also determine whether the child or young athlete is physically or psychologically prepared for organized weight training.
- Prior to the beginning of the training program, the level of muscle force and power should be determined, with the aim of designing training volume and intensity, as well as the desired goals, in accordance with the needs and abilities of young athletes.
- The guidelines and advice which refer to the exercise technique must be clear and precise.
- Prior to the beginning of the training program, a professional, familiar with all the specificities of training young athletes, should be selected to monitor the sessions.
- The rules of behavior in the gym and the protocol for spotting procedures must be followed to the letter.
- The conditions for exercise must be completely safe.
- In cases when maximum security is needed, the presence of adult spotters is required.
- Young exercisers must be familiar with the positive effects of weight training, as well as the possible risks. In addition, their expectations of the effects of training must be realistic.
- Prior to every training session, adequate warm-up is required.
- The extent and intensity during training should be overcome by a young athlete without exposure to extreme exertion.
- The volume and intensity of training should increase gradually in accordance with the increase in muscle force and power.

- The focus should be on training larger muscle groups, as well as strengthening the abdominal and back musculature.
- The final part of the training session should consist of lower intensity exercises or exercises meant to stretch the musculature.
- For optimum progress, an adequate diet and hydration is required, along with sufficient time to rest and recover (primarily a full night's sleep).
- The training program must not be boring and monotonous. Constant changes, the introduction of new and more demanding exercises will motivate young athletes who eagerly await every new training session.
- Support and encouragement on the part of the parents and coaches helps to create a more positive attitude toward training.

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## ТРЕНИНГ СА ОПТЕРЕЋЕЊЕМ ЗА ДЕЦУ И АДОЛЕСЦЕНТЕ: ОД ФИЗИОЛОШКИХ ОСНОВА ДО ПРАКТИЧНЕ ПРИМЕНЕ

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### САЖЕТАК

Тренинг са оптерећењем за децу и адолесцените програмиран у складу са индивидуалним потребама и могућностима, и адекватно спроведен, препоручен је од стране водећих професионалних удружења у области спортске медицине, наука о спорту и педијатрије. Најчешће се као оптерећење приликом тренинга за развој силе и снаге користе тегови и справе за вежбање које могу бити стандардних димензија, али и специјално дизајниране за млађе узрасте, вежбе током којих се користи сопствена маса вежбача као оптерећење, те вежбе са медицинкама и еластичним тракама. Поред повећања мишићне силе, снаге и издржљивости, као и потенцијалног повећања успешности извођења одређених моторичких задатака, редован тренинг са оптерећењем може резултовати побољшањем телесног састава, повећаном минералном густином костију, повећањем кардиореспираторне издржљивости, као и позитивним утицајем на психосоцијални статус деце и адолесцената. Због недостатка јасних доказа који би указивали на мишићну хипертрофију код деце, повећања мишићне силе и снаге се углавном приписују неуролошким адаптацијама, које укључују повећани број, брзину и координацију активираних моторних јединица. При састављању програма тренинга са оптерећењем за децу и адолесцените треба поштовати основне принципе тренинга, као за одрасле особе, али се при томе мора имати на уму да деца или адолесценти нису „мали људи“ и не сме се једноставно прекопирати тренинг за одрасле особе или спортисте. Правилним и јасним инструкцијама, уз стални стручни надзор, тренинг са оптерећењем за децу и адолесцените може имати позитиван утицај на целокупно здравствено стање и довести до стварања позитивних навика према редовном тренингу и здравом начину живота. Тренутна сазнања из добро организованих и праћених истраживања на узорку деце или адолесцената указују на веома малу могућност повређивања током тренинга са оптерећењем, уколико се испоштују све препоруке за дати узраст.

**Кључне речи:** тренинг са оптерећењем, мишићна снага, деца и адолесценти.

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## ТРЕНИРОВКИ С ОТЯГОЩЕНИЕМ ДЛЯ ДЕТЕЙ И ПОДРОСТКОВ: ОТ ФИЗИОЛОГИИ К ПРАКТИКЕ

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### АННОТАЦИЯ

Тренировки с отягощением для детей и подростков, разработанные с учетом нужд и способностей каждого и адекватного их применения рекомендованы ведущими профессиональными ассоциациями в области спортивной медицины, наук о спорте и педиатрии. В качестве груза для развития выносливости и силы во время физических тренировок используются свободные веса (штанги и гантели) и оборудование, как стандартных размеров, так и специально разработанное для представителей младшего возраста, предназначенное для упражнений с сопротивлением, упражнений для переноса тяжести тела, упражнения с медицинскими мячами и эластичными лентами. Помимо того, что регулярная тренировка с отягощением положительно влияет на мышечную силу и выносливость, она также увеличивает потенциал выполнения определенных двигательных задач, приводит к улучшению массы тела, увеличивает минеральную плотность костной ткани, улучшает кардио-дыхательную выносливость и оказывает положительное влияние на психосоциальный статус детей и подростков. Отсутствуют явные доказательства того, что подобного рода тренировки приводят к гипертрофии мышц у детей. Увеличение мышечной силы, улучшение координации движения, увеличение скорости и задействование большого числа активных нейро-моторных единиц обусловлено, главным образом, неврологической адаптацией. При разработке программы тренировки с сопротивлением для детей и подростков следует иметь в виду, что, ни дети, ни подростки не являются "маленькими мужчинами" и что нельзя просто "переносить на них" тренировки взрослых людей или спортсменов. При регулярном и четком выполнении инструкций и постоянно наблюдая за детьми и подростками в ходе тренировок с отягощением, можно улучшить их общее состояние здоровья, а также можно сформировать привычки к регулярным физкультурным занятиям и здоровому образу жизни. Выводы и результаты, полученные в ходе правильно организованных и контролируемых исследований, указывают на очень низкий риск получения травм детьми и подростками на тренировках при выполнении всех рекомендаций, предусматривающих специфику их возраста.

**Ключевые слова:** тренировки с отягощением, мышечная сила, дети и подростки.

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