

The Promise of Youth Resistance Training

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SUMMARY

Global health reports indicate that a vast majority of children and adolescents are not accumulating the recommended amount of moderate to vigorous physical activity (MVPA) daily. This decline in MVPA has coincided with troubling temporal trends in muscular fitness in modern day youth. Since a prerequisite level of muscular strength is needed to move proficiently, developmentally appropriate interventions that target neuromuscular deficits are needed to prepare girls and boys for ongoing participation in active play, exercise and sport activities. Instead of focusing exclusively on aerobic activities, the promotion of youth physical activity should recognize the shared importance of strength,

skill and aerobic activities for all youth regardless of body size or physical prowess. In addition to enhancing muscular fitness and improving motor skill performance, regular participation in resistance training has been found to have a favorable influence on musculoskeletal strength, cardiometabolic function, body composition, and mental health in children and adolescents. A new mindset that recognizes the critical importance of strength-building activities early in life is needed before this generation of girls and boys becomes resistant to exercise interventions later in life.

ZUSAMMENFASSUNG

Globale Gesundheitsberichte deuten darauf hin, dass die große Mehrheit der Jugend nicht die empfohlene Menge an moderater bis intensiver körperlicher Aktivität täglich erreicht. Dieser Rückgang an Aktivität stimmt mit den beunruhigenden Entwicklungen der muskulären Fitness der heutigen Jugend überein. Da ein bestimmtes Maß an Muskelkraft erforderlich ist, um sich effizient bewegen zu können, sind entwicklungsgerechte Interventionen erforderlich, die auf neuromuskuläre Defizite abzielen, um Mädchen und Jungen auf eine kontinuierliche Teilnahme an aktiven Spiel-, Bewegungs- und Sportaktivitäten vorzubereiten. Anstatt sich ausschließlich auf aerobe Aktivitäten zu konzentrieren, sollte die Förderung der körperlichen Aktivität von Kindern und Jugendlichen die gemeinsame Bedeutung von Kraft-, Geschicklichkeits- und aeroben Aktivitäten für alle anerkennen, unabhängig von Körpergröße und körperlichen Fähigkeiten. Neben der Steigerung der muskulären Fitness und der Verbesserung der motorischen Leistungsfähigkeit hat die regelmäßige Teilnahme am Krafttraining auch einen positiven Einfluss auf die Körperzusammensetzung und die psychische Gesundheit von Kindern und Jugendlichen. Eine neue Denkweise, die die kritische Bedeutung von kraftbildenden Aktivitäten in jungen Jahren anerkennt, ist notwendig, bevor diese Generation von Mädchen und Jungen später im Leben resistent gegen Bewegungsinterventionen wird.

WHAT IS ALREADY KNOWN?

- Youth resistance training can be a safe, effective and worthwhile activity for children and adolescents provided that the program is well-designed and supervised by qualified professionals. In addition to enhancing muscular fitness,

regular participation in a youth resistance training program can improve health outcomes and prepare young athletes for sport.

WHAT IS NEW?

- Low levels of muscular fitness seem to drive physical inactivity in modern day youth who are weaker than previous generations. Integrative exercise interventions that target strength deficits are needed to activate this generation of children and adolescents. There is a need to recognize dynapenia in modern day youth and value the unique benefits of resistance training. An understanding of the multifaceted nature of youth physical activity and the importance of strength building activities early in life may be needed to activate this generation of girls and boys.

Over the past 30 years a compelling body of evidence has found that youth resistance training can be a safe, effective and worthwhile method of conditioning for children and adolescents [8], [19]. In addition to observable gains in muscular strength, muscular power and local muscular endurance, regular participation in a well-designed resistance training program can enhance the health and fitness of girls and boys while preparing aspiring young athletes for the demands of sport practice and competition [13], [16], [19]. Despite outdated concerns associated with lifting weights during the growing years, the qualified acceptance of youth resistance training by medical and fitness organizations is becoming universal [3], [19], [27]. Notably, the 2020 World Health Organization guidelines on physical activity for children and adolescents include recommendations for performing muscle strengthening activities at least 3 days per week [29].

Despite this knowledge, global declines in measures of moderate to vigorous physical activity (MVPA) in modern day youth have coincided with temporal declines in measures of muscular fitness [11], [15], [25]. That is to say, this generation of physically inactive girls and boys is weaker than previous generations and, consequently, at greater risk for adverse health outcomes associated with physical inactivity and muscle disuse [10], [22]. Since a prerequisite level of muscular strength is needed to jump, kick, throw and run proficiently [20], concerted efforts are needed to “activate” this generation of boys and girls with developmentally appropriate interventions that target neuromuscular deficits before youth become resistant to exercise and sport programs.

Although the term dynapenia has traditionally been associated with the loss of muscular strength and power often seen in older adults [5], the inevitable consequences of muscular weakness and neuromuscular dysfunction are also observable in physically inactive youth [10]. The construct of pediatric dynapenia can be used to capture an identifiable and treatable condition in children and adolescents characterized by low levels of muscular strength and power and consequent functional limitations not caused by neurologic or muscular disease [10]. It is time to recognize the foundational importance of muscular fitness in order to understand the multifactorial nature of physical inactivity in youth and design interventions that are most appropriate for this generation of girls and boys [9]. The aim of this article is to highlight the unique benefits of resistance training in youth as a primary agent for change. For ease of discussion, the term youth refers to children (6 to 12 years of age) and adolescents (13 to 18

years of age) and the term muscular fitness represents muscular strength, muscular power and local muscular endurance.

Contemporary Corollaries of Pediatric Dynapenia

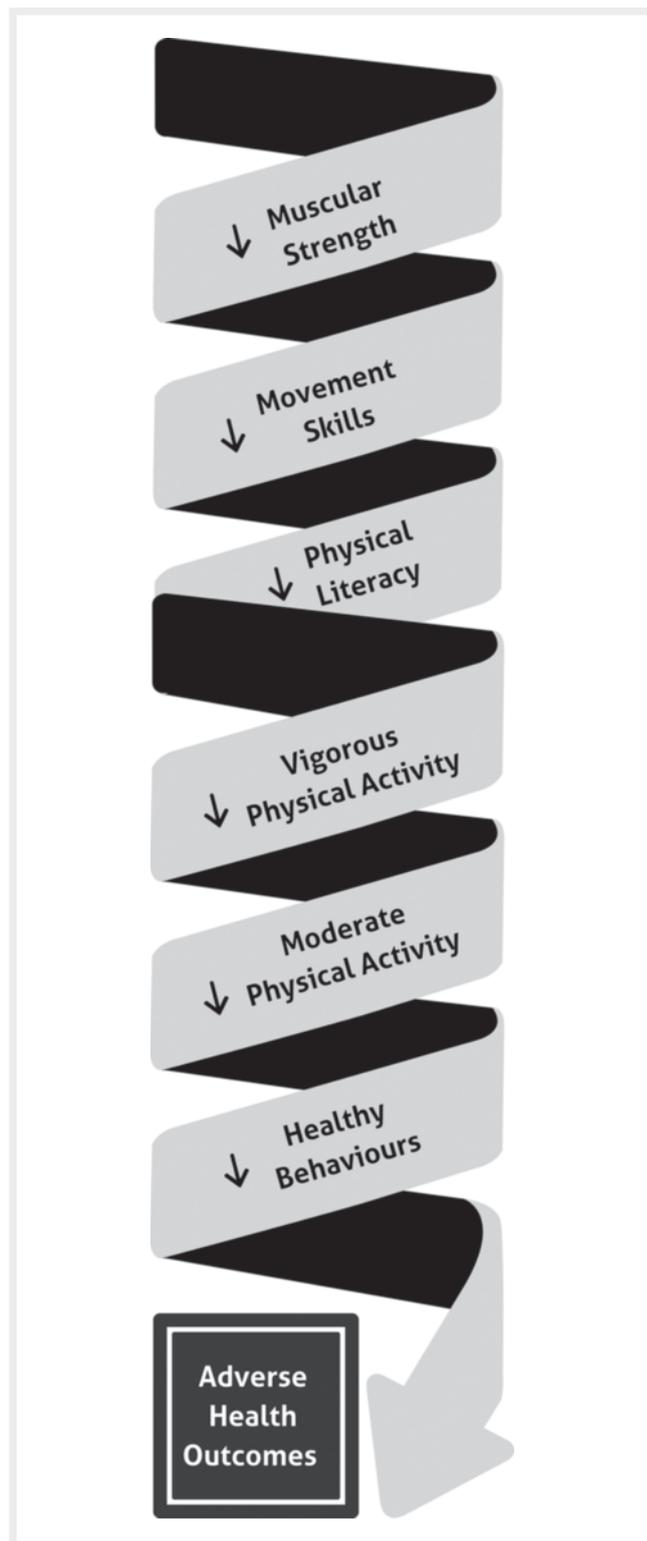
Technological advances and social media usage have decreased the need to move. About 80 % of German youth spend more than two hours per day sedentary, watching TV or using other screen devices [7]. Without regular participation in a variety of physical activities including those that enhance muscular fitness, girls and boys will not be prepared for the demands of active play, exercise and sport activities. Since muscular strength underpins many of the biomotor qualities that are needed to perform movement skills proficiently [28], reduced levels of muscular fitness may inevitably lead to a decrease in MVPA and an increase in physical illiteracy [10], [30].

Global reports indicate that a vast majority of children and adolescents are not accumulating the recommended minimum of 60 minutes of MVPA daily [1], [14]. Data from 298 school-based surveys from 146 countries found that 81 % of students aged 11 to 17 years were insufficiently physically active [14]. These findings are consistent with data from the 2018 German Report Card on Physical Activity for Youth which found that only about 20 % of girls and boys accumulate at least 60 minutes of MVPA daily and less than 25 % of German youth play actively for several hours per day [7]. Despite the well-established benefits of regular MVPA [8], participation in active play and recreational exercise remains persistently low and temporal measures of muscular fitness (e. g., push-up, sit-up, and standing long jump) among modern day youth are troubling [10].

From a public health perspective, children and adolescents with low strength reserves (i. e., below average levels of muscular strength) may be less able (and less willing) to overcome unexpected stressors during daily life or physical challenges while engaged in exercise or sport activities. Indeed, evidence supports an association between muscular fitness and physical activity early in life, with the strongest link for vigorous physical activity and organized sports [26]. When looked at collectively, the evidence indicates that pediatric dynapenia is prevalent in modern day youth and that expected gains in muscular fitness in a growing number of children and adolescents are not optimal [10]. Consequently, the divergence in performance between weaker and stronger youth will likely widen over developmental time since youth with persistently low levels of muscular fitness are at increased risk of maintaining low muscular fitness levels into adulthood [12].

The health-related consequences of low muscle strength have been known for decades, but only recently have the life changing consequences of pediatric dynapenia begun to emerge. Muscular weakness early in life has been found to be associated with metabolic dysfunction [22], cardiovascular risk [4] and major causes of premature death [23]. It appears that low levels of muscular strength and fundamental movement skills early in life can interact synergistically over time to predispose youth to associated changes in physical activity, body composition and related co-

morbidities. ► **Abb. 1** illustrates the downward cascade of dynapenic-driven events and inter-related factors that may lead to physical inactivity and poor health outcomes.



► **Abb. 1** The cascade of adverse outcomes resulting from poor muscular strength.

Potential Benefits of Youth Resistance Training

In order to alter the current trajectory towards physical inactivity and health-related comorbidities, a population wide approach for preventing and treating pediatric dynapenia is needed. Interventions that enhance muscular fitness can provide an opportunity for weaker youth to catch up with their stronger peers. Without a prerequisite level of muscular strength, weaker youth may be unable to break through a “strength barrier” that would allow them to perform fundamental movement skills proficiently and, subsequently, make observable gains in other important components of health and fitness as they move and play. Although most youth will develop a minimal level of muscular strength with activities of daily life, both unstructured (e. g., active outdoor play), semi-structured (e. g., school recess) and structured (e. g., youth fitness class) physical activities are needed to optimize gains in muscular fitness throughout childhood and adolescence.

Instead of focusing exclusively on aerobic activities such as running, bicycling and swimming, the promotion of youth physical activity should recognize the shared importance of strength, skill and aerobic activities for all youth regardless of body size or physical prowess [9]. Regular participation in strength-building activities has been found to have a favorable influence on musculoskeletal strength, cardiometabolic function, body composition, and mental health in children and adolescents [13], [19], [27]. Moreover, youth resistance training programs can have a positive impact on sprinting, jumping, throwing and agility performance in youth [6], [16] which, in turn, may increase participation in MVPA including sports [26]. As girls and boys get stronger and build their strength reserves, they may be better prepared for the ongoing demands of sports participation and less likely to suffer an activity-related injury [17], [18], [21]. The multifaceted anatomical, physiological and psychological benefits of youth resistance training are shown in ► **Abb. 2**.

The health-enhancing and performance-improving benefits of youth resistance training should not be overlooked by health care providers, physical education teachers or youth fitness specialists. Different combinations of sets, repetitions and exercises can be used to enhance muscular fitness, reinforce desired movement patterns, and spark an ongoing interest in a form of exercise that can be performed throughout the life course [8], [19], [27]. Although there is no minimum age requirement for participation in a supervised and well-designed youth resistance training program, all participants should have the emotional maturity to accept and follow instructions. Most girls and boys are ready for some type of sport participation around 5 to 7 years of age, and this may be a suitable time for participation in a resistance training program that is consistent with each participant’s needs and abilities [27].

With developmentally appropriate teaching strategies, children can learn how to perform strength-building animal movements with their body weight (e. g., bear crawls and bunny jumps) as well as resistance exercises with external loads (e. g., dumbbell squats and medicine ball chest passes). Since the early years of life are characterized by rapid changes in brain development and associated neuroplasticity, childhood may be an ideal



► **Abb. 2** Potential benefits of youth resistance training.

time for girls and boys to improve their resistance training skill competency as they learn how to perform more complex exercises that require a higher degree of technical skill [21]. As resistance training skill competency improves, youth may progress to more complex movements with heavier loads to optimize training-induced adaptations [17], [19]. General youth resistance training guidelines are outlined in the table.

GENERAL YOUTH RESISTANCE TRAINING GUIDELINES

- Seek instruction from qualified fitness professionals
- Begin with 1 to 2 sets of 8 to 12 repetitions using a light load
- Start with basic upper body, lower body and core exercises
- Increase the load as resistance training skill competency improves
- Gradually increase sets and training load while decreasing repetitions
- Incorporate complex multi-joint exercises into the program
- Resistance trained youth may periodically use heavier loads
- Vary the program to keep the stimulus effective
- Incorporate corrective exercises into the program as needed
- Start with a dynamic warm-up and cool-down with stretching activities

Since engaging in moderate amounts of muscular strengthening activities is associated with lower all-cause mortality, independent from MVPA, it seems prudent to participate in integrative exercise programs that include some form of resistance training throughout the life course [24]. In light of declining trends in muscular fitness in modern day youth, strength building activities should take a more prominent position in public health physical activity recommendations for youth [9]. It is

unlikely that the current focus on accumulating at least 60 minutes of MVPA across the week will help inactive girls and boys develop attitudes and behaviors that support ongoing participation in a variety of exercise and sport activities.

Concerted efforts are needed to inform youth, parents, community leaders and school officials about the adverse consequences of pediatric dynapenia and importance of participating in strength building activities. In addition, educating fitness professionals about the potential health and fitness benefits of well-designed youth resistance training programs may be helpful. Without developmentally appropriate interventions that target strength deficits and build strength reserves, this generation of girls and boys may be more likely to experience functional deficits, activity related injuries and adverse health outcomes than previous generations.

New insights into the design of physical activity programs for youth have highlighted the importance of initiating interventions early in life, integrating strength and skill building exercises into the program, and developing competence and confidence in a variety of exercise and sport activities [8]. Yet findings from the first-ever European survey of fitness trends for 2020 found that “children and exercise” ranked 19th (between wearable technology and Yoga) whereas “fitness programs for older adults” ranked 11th [2]. A new mindset that recognizes the critical importance of enhancing muscular fitness early in life is desperately needed before this generation of girls and boys becomes resistant to our exercise interventions later in life.

Conflict of interest

The authors declare no conflicts of interest and do not have any financial disclosures.

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References

- [1] Aubert S, Barnes J, Abdeta C, Abi Nader P, Adeniyi A, Aguilar-Farias N, Andrade Tenesaca D, Bhawra J, Brazo-Sayavera J, Cardon G, Chang C, Delisle Nyström C, Demetriou Y, Draper C, Edwards L, Emeljanovas A, Gába A, Galaviz K, González S, Herrera-Cuenca M, Huang W, Ibrahim I, Jürimäe J, Kämppi K, Katapally T, Katewongsa P, Katzmarzyk P, Khan A, Korcz A, Kim Y, Lambert E, Lee E, Löf M, Loney T, López-Taylor J, Liu Y, Makaza D, Manyanga T, Mileva B, Morrison S, Mota J, Nyawornota V, Ocansey R, Reilly J, Roman-Viñas B, Silva D, Saonum P, Scriven J, Seghers J, Schranz N, Skovgaard T, Smith M, Standage M, Starc G, Stratton G, Subedi N, Takken T, Tammelin T, Tanaka C, Thivel D, Tladi D, Tyler R, Uddin R, Williams A, Wong S, Wu C, Zembura P, and Tremblay M. Global Matrix 3.0 Physical Activity Report Card Grades for Children and Youth: Results and Analysis From 49 Countries. *Journal of Physical Activity and Health* 15: S251–S273 2018

- [2] Batrakoulis A. European survey of fitness trends for 2020. *ACSMs Health and Fitness Journal* 23: 28–35, 2019
- [3] Bergeron M, Mountjoy M, Armstrong N, Chia M, Côté J, Emery C, Faigenbaum A, Hall G, Kriemler S, Léglise M, Malina R, Pensgaard A, Sanchez A, Soligard T, Sundgot-Borgen J, van Mechelen W, Weissensteiner J, and Engebretsen L. International Olympic Committee consensus statement on youth athletic development. *British Journal of Sports Medicine* 49: 843–851, 2015
- [4] Castro-Piñero J, Perez-Bey A, Cuenca-García M, Cabanas-Sanchez V, Gómez-Martínez S., Veiga O, Marcos A, Ruiz J, and UP&DOWN Study Group. Muscle fitness cut points for early assessment of cardiovascular risk in children and adolescents. *Journal of Pediatrics* e3: 134–141, 2019
- [5] Clark B and Manini T. What is dynapenia? *Nutrition* 28: 495–503, 2012
- [6] Collins H, Booth J, Duncan A, and Fawkner S. The effect of resistance training interventions on fundamental movement skills in youth: A meta-analysis. *Sports Medicine Open* 5: 17, 2019
- [7] Demetriou Y, Hebestreit A, Reimers A, Schlund A, Niessner C, Schmidt S, Finger J, Mutz M, Völker K, Vogt L, Woll A, and Jens Bucksch J. Results from Germany's 2018 report card on physical activity for children and youth. *Journal of Physical Activity and Health* 15: S363–S365, 2018
- [8] Faigenbaum A, Lloyd R, Oliver J, and American College of Sports Medicine. *Essentials of Youth Fitness*. Champaign, IL: Human Kinetics, 2020
- [9] Faigenbaum A, MacDonald J, Straccioli A, and Rial Bebullido T. Making a strong case for prioritizing muscular fitness in youth physical activity guidelines. *Current Sports Medicine Reports* 19: 530–536, 2020
- [10] Faigenbaum A, Rial Bebullido T, Pena J, and Chulvi-Medrano I. Resistance exercise for the prevention and treatment of pediatric dynapenia. *Journal of Science in Sport and Exercise* 1: 208–216, 2019
- [11] Fraser B, Blizzard L1, Tomkinson G, Lycett K, Wake M, Burgner D, Ranganathan S, Juonala M, Dwyer T, Venn A, Olds T, and Magnussen C. The great leap backward: Changes in the jumping performance of Australian children aged 11-12-years between 1985 and 2015. *Journal of Sports Science* 37: 748–754, 2019
- [12] Fraser B, Schmidt M, Huynh Q, Dwyer T, Venn A, and Magnussen C. Tracking of muscular strength and power from youth to young adulthood: Longitudinal findings from the Childhood Determinants of Adult Health Study. *Journal of Science and Medicine in Sport* 20: 927–931, 2017
- [13] García-Hermoso A, Ramírez-Campillo R, and Izquierdo M. Is muscular fitness associated with future health benefits in children and adolescents? A systematic review and meta-analysis of longitudinal studies. *Sports Medicine* 49: 1079–1094, 2019
- [14] Guthold R, Stevens G, Riley L, and Bull F. Global trends in insufficient physical activity among adolescents: A pooled analysis of 298 population-based surveys with 1.6 million participants. *Lancet Child and Adolescent Health* 4: 23–35, 2020
- [15] Kaster T, Dooley F, Fitzgerald J, Walch T, Annandale M, Ferrar K, Lang J, Smith J, and Tomkinson G. Temporal trends in the sit-ups performance of 9,939,289 children and adolescents between 1964 and 2017. *Journal of Sport Sciences* 38: 1913–1923, 2020
- [16] Lesinski M, Herz M, Schmelcher A, and Granacher U. Effects of resistance training on physical fitness in healthy children and adolescents: An umbrella review. *Sports Medicine* 50: 1901–1928, 2020
- [17] Lesinski M, Prieske O, and Granacher U. Effects and dose – response relationships of resistance training on physical performance in youth athletes: A systematic review and meta-analysis. *British Journal of Sports Medicine* 50: 781–795, 2016
- [18] Lloyd R, Cronin J, Faigenbaum A, Haff G, Howard R, Kraemer W, Micheli L, Myer G, and Oliver J. The National Strength and Conditioning Association position statement on long-term athletic development. *Journal of Strength and Conditioning Research* 30: 1491–1509, 2016
- [19] Lloyd R, Faigenbaum A, Stone M, Oliver J, Jeffreys I, Moody J, Brewer C, Pierce K, McCambridge T, Howard R, Herrington L, Hainline B, Micheli L, Jaques R, Kraemer W, McBride M, Best T, Chu D, Alvar B, and Myer G. Position statement on youth resistance training: The 2014 International Consensus. *British Journal of Sports Medicine* 48: 498–505, 2014
- [20] Malina R, Bouchard C, Bar-Or O. *Growth, Maturation and Physical Activity*. Champaign, IL: Human Kinetics, 2004
- [21] Myer G, Faigenbaum A, Edwards E, Clark J., Best T, and Sallis R. 60 minutes of what? A developing brain perspective for activation children with an integrative approach. *British Journal of Sports Medicine* 49: 1510–1516, 2015
- [22] Orsso C, Tibaes J, Oliveira C, Rubin D, Field C, Heymsfield S, Prado C, and Haqq A. Low muscle mass and strength in pediatrics patients: Why should we care? *Clinical Nutrition* 38: 2002–2015, 2019
- [23] Ortega F, Silventoinen K, Tynelius P, and Rasmussen F. Muscular strength in male adolescents and premature death: Cohort study of one million participants. *British Medical Journal* 345: e7279, 2012
- [24] Patel A, Hodge J, Rees-Punia E, Teras L, Campbell P, and Gapstur S. Relationship between muscle-strengthening activity and cause-specific mortality in a large US cohort. *Preventing Chronic Disease* 17: E78, 2020
- [25] Sandercock G and Cohen D. Temporal trends in muscular fitness of English 10-year-olds 1998-2014: An allometric approach. *Journal of Science and Medicine in Sport* 22: 201–205, 2019
- [26] Smith J, Eather N, Weaver R, Riley N, Beets M, and Lubans D. Behavioral correlates of muscular fitness in children and adolescents: A systematic review. *Sports Medicine* 49: 887–904, 2019
- [27] Stricker P, Faigenbaum A, McCambridge T, and Council on Sports Medicine and Fitness. Resistance training for children and adolescents. *Pediatrics* 145: e20201011, 2020
- [28] Suchomel T, Nimphius S, Bellon C, and Stone M. The importance of muscular strength: Training considerations. *Sports Medicine* 48: 765–785, 2018
- [29] World Health Organization. *WHO Guidelines on Physical Activity and Sedentary Behaviour*. Geneva, Switzerland: World Health Organization, 2020
- [30] Zwolski C, Quatman-Yates C, and Paterno M. Resistance training in youth: Laying the foundation for injury prevention and physical literacy. *Sports Health* 9: 436–443, 2017