Resistance Training in Youth Improves Athletic Performance: A Systematic Review

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ABSTRACT

Purpose: To perform a systematic review of the highest level of evidence to determine the effect of resistance training interventions on athletic performance in the youth population.

Methods: A systematic search of five electronic databases (PubMed, CINAHL, Cochrane, Web of Science, and SPORTDiscus) was conducted in November 2015. All English language, peer-reviewed, randomized control trial journal articles published between 2003 and 2015 that provided a resistance training intervention to a group of typically developing, healthy youth that measured an outcome of athletic performance were included for further review. A review team of three certified professionals independently read blinded articles that met the inclusion criteria and rated them using the Physiotherapy Evidence Database (PEDro) scale. Articles of the highest quality were included for review.

Results: From a total of 496 articles found, 21 studies were included for review based on inclusion criteria and methodological quality. The variables of strength (13 studies), power (12 studies), running speed (7 studies), sport-specific skill (6 studies), endurance (5 studies), and change-of-direction agility (2 studies) were observed in this review.

Conclusions: Supervised resistance training significantly increases power, strength, endurance, running speed, and sport-specific skill within the youth population when compared to a lack of resistance training and/or sport-specific training alone. [Athletic Training & Sports Health Care. 2017;9(4):184-192.]

It is estimated that more than half of youth aged 8 to 16 years participate in at least one organized sport each year, with this figure remaining consistent during the past decade. Consequently, approximately 35 million children and adolescents are participating in organized sports each year. Despite the fact that the musculoskeletal system of prepubescent children and adolescents has a greater capacity than that of adults to adapt to additional stress, injuries are a common occurrence. Annually, youth account for 28 million visits in U.S. emergency departments, with “sports” reported to be the leading cause of injury in the age group of 6 to 12 years. Sports-related injuries sustained in youth are predominantly musculoskeletal in nature (eg, sprains, strains, and fractures), with this population accounting for the highest percentage of all musculoskeletal injuries treated in the emergency department. These injuries are commonly reported to occur from overuse, with some reports finding overuse to be the mechanism approximately 50% of the time. The quantity and severity of these injuries are a burden to both patients and the health care system. Therefore, investigation on injury prevention in youth is imperative.

Adding resistance to skeletal muscle tends to lead to positive and predictable adaptations that will allow the muscles, tendons, and bones of the body to withstand increasing amounts of stress, thereby potentially lowering the risk of subsequent injury. Current evidence in adults advocates that resistance training may help avoid, or potentially absorb, both overuse and
traumatic sports-related injury, and the benefits of resistance training far outweigh the risks.\textsuperscript{18-20} Therefore, it stands to reason that there is potential for the same effect in the adolescent population.

Although research exists on the ability of resistance training to improve athletic performance in children and adolescents, there has been no systematic review based on methodological quality in this domain to date. Therefore, the purpose of this study was to perform a systematic review of the highest quality of evidence to determine whether resistance training interventions are effective in improving athletic performance in the youth population.

LITERATURE REVIEW

A systematic search of five electronic databases (PubMed, CINAHL, Cochrane, Web of Science, and SPORTDiscus) was conducted between September and November 2015. Unique search strategies were developed for each electronic database (Table A, available in the online version of this article). All English language, peer-reviewed journal articles published between 2003 and 2015 were included for review. Inclusion criteria were randomized control trials that provided a resistance training intervention to a group of typically developing, healthy youth and adolescents (age range: 8 to 16 years) with at least one standardized measure for a variable of athletic performance (sport-specific skill or fitness measure). Reasons for exclusion were as follows: (1) not a randomized control trial study design, (2) not available in English, (3) not peer reviewed, (4) resistance training was not the independent variable, (5) lack of a resistance training intervention, (6) participants not within the age range of 8 to 16 years, (7) no outcome measure for athletic performance, (8) included atypically developing or unhealthy participants, and (9) average Physiotherapy Evidence Database (PEDro) score less than 5.

Initially, all articles were included or excluded by the primary author (ASV) based on the title and abstract. Next, a review team analyzed blinded, full-text articles for inclusion based on methodological quality. The reference list of the included articles was then analyzed for additional relevant articles that met the listed inclusion criteria. The described search strategy is outlined in Figure 1.

For the purpose of this article, the terms “child” and “children” refer to boys and girls who have not yet developed secondary sex characteristics (up to ap-
proximately age 10 years in girls and 12 years in boys: Tanner stages one and two of sexual maturation). The term “adolescent” refers to the period between childhood and adulthood (up to approximately 18 years of age for both genders: Tanner stages three and four of sexual maturation). The term “youth” is broadly defined to include both children and adolescents. In addition, “resistance training” is defined as exercise that incorporates external resistance, whereas “sportspecific skill” is defined as a movement or action that is unique to the requirements of a specific sport (ie, tennis serve accuracy).

Pediatric research in this domain uses chronological age and/or sexual maturation as measurements of participants’ physical development. Despite our preference to classify participants based on sexual maturation, because age is often a poor indicator of physiological maturity in youth, the inclusion criterion of chronological ages 8 to 16 years was chosen to include as much of the available literature as possible and to incorporate both pre-adolescents and early-stage adolescents.

Methodological Quality Evaluation

The PEDro scale has been determined to be a reliable measure in rating the methodological quality of randomized control trials.\(^{21,22}\) This scale scores 11 items to evaluate methodological quality of intervention studies, 10 of which are evaluated on a yes (1) or no (0) basis. A score of 6 or greater has been established to signify a high quality study design.\(^ {22}\)

To maintain consistency and limit bias, a review team of certified professionals familiar with qualifying evidence-based literature reviewed all included articles. This team consisted of three different professionals currently practicing in their chosen field: an athletic trainer (KAW), a physical therapist (MS), and a youth strength and conditioning specialist (LNM). Each met with the lead author (ASV) to ensure he or she knew how to use the PEDro scale. The review team was then given a test article of a different subject matter to determine their competency at using the scale and to help ensure consistency. Their results were gathered and then disseminated to the review team with additional feedback to ensure complete understanding of the scale and to promote inter-rater consistency.

The three professionals independently read and rated all articles that met the inclusion criterion. All titles, journal names, and author names were removed from the articles to help prevent bias. A score of 6 or greater has been validated for the PEDro scale. However, due to the challenge inherent in blinding treatment groups for resistance training, the authors chose to eliminate this criterion on the PEDro scale. Thus, articles were deemed acceptable with a score of 5 or greater. When at least two of the three raters gave an article a score of 5 or greater, the article was included. Conversely, when at least two of the three raters gave an article a score of less than 5, the article was excluded. Average PEDro scores are reported in Figure 2.

### RESULTS

A total of 496 articles were found through the described search. After exclusion criteria were applied and methodological quality was assessed, 21 studies were included in the review (Figure 1). Each study included fitness outcomes as measures of athletic performance. Of those, 6 studies incorporated an outcome measure for a sport-specific skill.\(^ {23-28}\) A greater number of studies evaluated males alone (8 studies) compared to females alone (3 studies). Four studies included both sexes, whereas six studies did not disclose participant sex. The following modes of resistance training were performed among the included studies: free weights, medicine balls, resistive bands, sport-specific equipment, and pulley/weight machines. The following fitness measures were examined: strength (13 studies), power (12 studies), running speed (7 studies), sport-specific skill (6 studies), endurance (5 studies), and change-of-direction agility (2 studies). The length of intervention ranged from 4 weeks to 2 years (duration: < 8 weeks [5 studies], 8 to 12 weeks [11 studies], 13 weeks to 6 months [3 studies], and 2 years [2 studies]). The most common frequency and duration pairing was two sessions per week for 8 or 12 weeks. Most studies indicated that supervised resistance training significantly increased power, strength, endurance, running speed, and sport-specific skills in youth when compared with a lack of resistance training and/or sport-specific training alone. Individual study findings are reported in Table B (available in the online version of this article). Due to heterogeneity of intervention and outcomes, pooling of data for meta-analysis was not possible.

### Strength

Thirteen of the included studies assessed strength.\(^ {23,27,29-39}\) Regardless of the equipment used, all
<table>
<thead>
<tr>
<th>Study</th>
<th>Average Peak</th>
<th>Subjects</th>
<th>Groups</th>
<th>Intervention Duration</th>
<th>Strength Measures</th>
<th>Power Measures</th>
<th>Running Speed Measures</th>
<th>Sport-Specific Skill Measures</th>
<th>Endurance Measures</th>
<th>Agility Measures</th>
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<tr>
<td>Christou et al (19)</td>
<td>5</td>
<td>N=26 (Boys)</td>
<td>RT &amp; SP; N=9 SP; N=9 CON; N=8</td>
<td>2 x Week; 20 Weeks</td>
<td>Log Press 1RM, Bench Press 1RM</td>
<td>Sprint Jump Height, CM Jump Height</td>
<td>10m Sprint Time, 30m Sprint Time</td>
<td>Soccer Technique Test</td>
<td>10m x 3 5m Shuttle Run Time</td>
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<td>Escamilla et al (15)</td>
<td>6</td>
<td>N=34 (Unknown)</td>
<td>RT; N=17 CON; N=17</td>
<td>3 x Week; 4 Weeks</td>
<td>Heavy Ball Throwing Velocity, Light Ball Throwing Velocity</td>
<td>85% of 1RM and 1RM on Polley</td>
<td>Baseball Throwing Velocity</td>
<td></td>
<td></td>
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<tr>
<td>Ezema et al (16)</td>
<td>6</td>
<td>N=13 (Girls)</td>
<td>RT; N=7 THR; N=6</td>
<td>3 x Week; 8 Weeks</td>
<td>Heavy Ball Throwing Velocity, Light Ball Throwing Velocity</td>
<td>85% of 1RM and 1RM on Polley</td>
<td>Javelin Throwing Velocity</td>
<td></td>
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<td>Fulgenzi and et al (29)</td>
<td>4</td>
<td>N=24 (7 G, 9 D)</td>
<td>RT (Low Reps); N=12 RT (High Reps); N=12 CON; N=12</td>
<td>2 x Week; 6 Weeks</td>
<td>Chest Press 1RM</td>
<td>Vertical Jump Height</td>
<td>Standing Long Jump Distance</td>
<td>Leg Press 1RM</td>
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<td>Varela et al (22)</td>
<td>6</td>
<td>N=20 (Boys)</td>
<td>RT &amp; SP; N=15 SP; N=15</td>
<td>3 x Week; 6 Weeks</td>
<td>Tricep Serve Velocity</td>
<td>Serve Accuracy</td>
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<td>RT &amp; SP; N=6 END; SP; N=11</td>
<td>2 x Week; 11 Weeks</td>
<td>CM Jump Height with Various Loads</td>
<td>3m Sprint Time</td>
<td>Staged Sub-Max Tensile Test (blood lactate)</td>
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<td>Ignatjev et al (27)</td>
<td>4</td>
<td>N=21 (Girls)</td>
<td>RT &amp; SP; N=11 SP; N=10</td>
<td>2 x Week; 12 Weeks</td>
<td>Bench Press 1RM, Shoulder Press 1RM</td>
<td>1kg Med Ball Thrown Distance</td>
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<td>Ingle et al (28)</td>
<td>5</td>
<td>N=54 (Boys)</td>
<td>RT; N=33 CON; N=21</td>
<td>3 x Week; 12 Weeks</td>
<td>10 RM of Exercises</td>
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<td>2 x Week; 2 Years</td>
<td>Back Squat 1RM</td>
<td>Front Squat 1RM</td>
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<td>COD Sprint Test</td>
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<td>4</td>
<td>N=35 (Boys)</td>
<td>RT; N=11 RT &amp; RUN; N=12 CON; N=12</td>
<td>2 x Week; 9 Weeks</td>
<td>Back Squat 1RM Single Leg Step Up 1RM Leg Curl 1RM</td>
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<td>30m Sprint Test</td>
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<td>N=27 (Girls)</td>
<td>RT; N=13 Plyo; N=14</td>
<td>3 x Week; 4 Weeks</td>
<td>Knee Flexion Torque, Knee Extension Torque, Hip Abduction Torque</td>
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<td>N=37 (Unknown)</td>
<td>RT &amp; SP; N=19 SP; N=18</td>
<td>2 x Week; 16 Weeks</td>
<td>CM Jump Height, CM Jump Height with Lateral Squat Speed &amp; Lead</td>
<td>30m Sprint Time</td>
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<td>N=108 (B &amp; G)</td>
<td>RT Elastics; N=41 RT Weights; N=37 CON; N=30</td>
<td>2 x Week; 8 Weeks</td>
<td>Sumo Bench Press 1RM Inclined Leg Press 1RM</td>
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<td>30m Sprint Time</td>
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<td>6</td>
<td>N=42 (Boys)</td>
<td>RT; N=15 RT &amp; END; N=15 CON; N=12</td>
<td>2 x Week; 6 Weeks</td>
<td>1kg Med Ball OH Thrown Distance, 3kg Med Ball OH Thrown Distance, CM Vertical Jump Height, CM Horizontal Jump Height</td>
<td>30m Sprint Time</td>
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<td>4</td>
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<td>RT &amp; SP; N=15 SP; N=10</td>
<td>2 x Week; 10 Weeks</td>
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<td>Fadhe et al (50)</td>
<td>3</td>
<td>N=17 (Boys)</td>
<td>RT; N=9 SMJ; N=8</td>
<td>3 x Week; 6 Weeks</td>
<td>Max Voluntary Contraction</td>
<td>Squat Jump Height, CM Jump Height, Deep Jump Height</td>
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<td>Van Den Tillaar et al (54)</td>
<td>5</td>
<td>N=63 (39 G, 24 B)</td>
<td>RT; N=22 VTC; N=21 COMBO; N=21</td>
<td>2 x Week; 6 Weeks</td>
<td>1kg Med Ball OH Thrown Velocity, 3kg Med Ball OH Thrown Velocity</td>
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<td>6</td>
<td>N=18 (11 G, 7 B)</td>
<td>RT &amp; SP; N=9 END; SP; N=9</td>
<td>3 x Week; 12 Weeks</td>
<td>Bench Press 1RM, Seated Row 1RM, Shoulder Press 1RM</td>
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<td>Vaz et al (57)</td>
<td>4</td>
<td>N=28 (G &amp; B)</td>
<td>RT; N=17 CON; N=11</td>
<td>3 x Week; 12 Weeks</td>
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<td>Average</td>
<td>3.2</td>
<td>N=50</td>
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<td></td>
<td>Mean: 23.5 x Week; 18.5 Weeks</td>
<td>Median: 2 x Week; 18 Weeks</td>
<td>Mode: 2 x Week</td>
<td>8 &amp; 12 Weeks</td>
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</table>

1Study re-examined outcome after an additional period of time to measure effects of detraining; G; Girls; B; Boys; RT, Resistance Training group; SP, Sport group; CON, Control group; THR, Throwing group; COD, Change of Direction; RUN, Running group; PLYO, Plyometric group; END, Endurance group; PRO, Professional; SMJ, Sensory Motor Training group; VTR, Velocity Training group; COMBO+, Combination group; OH, Overhead; Max, Maximum; CM, Countermovement.

Figure 2. Characteristics, methodological quality, and program design of studies included in systematic review.
studies that included this outcome demonstrated a significant increase in muscular strength in the trained extremity when compared to a non-resistance training control group.

Five of the included studies compared a group that performed resistance training and sport-specific training to a group that completed only sport-specific training. Twenty-three, thirty, thirty-two, thirty-six Two of these five studies included a third group that did not perform sports or resistance training activities to control for natural development. Twenty-three, thirty-two The results of these studies indicate that both sport-specific training alone and the addition of resistance training resulted in significantly greater strength gains than sport-specific training alone. Twenty-three, thirty-two

**Power**

Twelve of the included studies assessed power. Twenty-five, twenty-seven, thirty, thirty-three, thirty-seven, forty, forty-three Nine studies measured lower extremity power, whereas five studies measured upper extremity power. Lower extremity power was most commonly measured by vertical or horizontal jump height, and upper extremity power was most commonly measured by throwing velocity. Regardless of the extremity tested, eleven of the twelve studies demonstrated a significant increase in muscular power when compared to a non-resistance training control group. Twenty-five, twenty-seven, twenty-eight, thirty, thirty-three, thirty-seven, forty, forty-three

Four of the twelve studies compared a group that performed resistance training and sport-specific training to a group that completed only sport-specific training. Twenty-three, thirty, forty-one, forty-three All four of these studies found that resistance training significantly improved power outcomes compared to sport-specific training alone. The effect of sport-specific training alone on power is unclear because the sport-specific training group’s performance on post-test power outcomes varied between studies.

**Running Speed**

Seven of the included studies assessed running speed. Twenty-three, twenty-seven, thirty-three, forty, forty-two Two studies compared a group of healthy boys who were unfamiliar with resistance training to a control group that completed no activity, and both studies found that resistance training significantly improved running speed. Twenty-seven, forty-two The other five studies were performed on soccer players who were divided into a resistance training group and a control group, with all participants concurrently participating in soccer. Twenty-three, thirty-three, thirty-six, forty, forty-one These studies indicated that soccer training alone did not increase running speed, but the addition of resistance training to soccer training did lead to significant gains in running speed in three of the five studies. Twenty-three, twenty-seven, thirty-three

**Sport-Specific Skill**

Six of the included studies assessed sport-specific skill. Twenty-three, twenty-eight Specifically, the skills included soccer technique testing, soccer overhead throw velocity, overhand baseball pitch velocity, javelin ball throwing velocity, tennis serve velocity, tennis serve accuracy, and basketball chest pass distance. Five studies found an increase in sport-specific skill, twenty-four, twenty-eight whereas one study found no significant difference in skill. Twenty-three Of the six studies, only two studies had players who were concurrently participating in sport. Twenty-three, twenty-six These results indicate that resistance training alone can improve sport-specific skills.

**Endurance**

Five studies assessed endurance. Twenty-nine, thirty-eight, forty, forty-two Of these, four studies had players concurrently participating in sport. Thirty-eight, forty, forty-two Endurance was measured using multiple outcomes across the studies. Three studies measured cardiovascular endurance: two studies used staged maximal aerobic running tests and one study measured blood lactate levels after a staged submaximal running test. Forty, forty-two Two studies measured localized muscular endurance: one study measured a 15-repetition maximum on a leg press and the other study calculated “fatigue index” for scapular protraction. Twenty-nine, thirty-eight Two studies found significant improvement in endurance outcomes, whereas three studies found no change or a decrease in endurance performance. The three studies that found no significant improvement in endurance outcomes were comparing resistance training to a running/endurance training control group. Thirty-eight, forty, forty-two The results of these studies showed that resistance training significantly improved both cardiovascular endurance performance in staged maximal aerobic running and localized muscular endurance, but did not significantly improve outcomes when compared to endurance training. Twenty-nine, forty-one, forty-two
Change-of-Direction Agility

Two of the included studies assessed change-of-direction agility.25,32 Both studies examined two groups that completed soccer training, with one group additionally performing resistance training. One of the studies included a third group that did not perform sports or resistance training activities to compare for natural growth.23 Change-of-direction agility was measured differently in each study: a shuttle run test versus a change-of-direction sprint test. In both studies, both groups significantly improved change-of-direction outcomes with no difference between groups. This indicated that soccer training alone could increase change-of-direction agility with no significant additional benefit from resistance training. More evidence is required to determine the effect of resistance training on change-of-direction agility.

Detraining

Two of the included studies reexamined outcomes after a 12-week period of detraining.27,42 Both studies asked participants to refrain from all physical activity beyond normal daily activities during this period. The results of both studies showed that ceasing all training led to regressing athletic performance gains back toward baseline in strength, power, and endurance. However, in both studies, most outcomes were still improved in the resistance-trained group compared to the control groups, indicating a slower rate of decay.27,42

Injury Reporting

Five of the included studies reported no participant injury or drop-out secondary to injury from participation in the study.25,27,29,31,35 None of the remaining articles reported participant injury or drop-out rates.

DISCUSSION

The results of this review suggest that adding a resistance training program to youth sports-related activities appears to lead to physiological improvements on virtually all measured outcomes. It is important to note that the act of resistance training alone does not guarantee optimal gains in fitness outcomes. Program design, intensity, effort, and qualified instruction are important variables that need to be incorporated appropriately to limit the risk of injury with participation and maximize the targeted improvement. Unfortunately, recommendations on program design prove to be difficult to extrapolate from the articles included in this review because the studies implemented varying program designs (ie, mode of resistance, parameters, and progression criteria). Multiple studies used more than one mode of resistance within their program, and some studies progressed participants based on their increasing ability, whereas others did not. Positive outcomes generally occurred across all studies reviewed despite large variances in program design, indicating that varying program designs can result in improved performance. Some studies have examined specific program design variables and made recommendations for parameters, but based on the variability of anthropometric characteristics during puberty in adolescents, it is clear that initial program intensity and progression should be determined based on individual physiological characteristics and abilities.16,44-47

To date, no evidence indicates that resistance training is any riskier than simply participating in youth sporting and recreational activities, and the studies that have measured or commented on the risk of resistance training in youth have placed resistance training at a significantly smaller risk than simply participating in organized sports.16,45,48,49 The minimal risk of resistance training paired with the positive results noted in this study urge youth to incorporate resistance training into their regular activity.

Many established scientific pediatric and youth-focused research studies are recommending resistance training for both children and adolescents.16,46,48,50-52 Despite the numerous publications and position statements encouraging resistance training in this population, child and adolescent sports-related reported injuries are strikingly high. This suggests that barriers may exist in either the awareness or the implementation of resistance training programs in this population.

Resistance training has been found to have a positive effect on bone mineral density in adolescents,53-56 with improvements noted in as little as 4 weeks.56 Current observations suggest that childhood and adolescent years may be the opportune time for bone modeling and remodeling.45,46 Given that fractures are one of the leading injuries in youth, the ability of resistance training to increase bone density and tensile/compressive forces may potentially decrease bone injury rates and should be investigated in future research. In addition, there
has been no documented detrimental effect of appropriately designed resistance training programs on linear growth in children and adolescents.\textsuperscript{57,58}

A major limitation of nearly every study in this area is the lack of control for work endured by the participants (ie, workload) in both the experimental and control groups. Clearly, the evidence suggests that an increase in workload through resistance training results in an improvement in the previously identified performance outcomes. However, whether the cause of these improvements is due solely to the resistance training or the increase in workload by the participants cannot be determined. For example, Ettema et al.\textsuperscript{25} examined throwing velocity after an 8-week upper extremity pulley resistance training program and compared it to a throwing-only program of equal workload in elite handball players. The investigators controlled for workload by calculating the respective number of throws with the corresponding weights to determine a consistent force on the body (impulse). Their results yielded no significant difference between groups; however, each group significantly improved in upper extremity strength.

Moreover, van den Tillaar et al.\textsuperscript{28} examined throwing velocity of different weighted balls (soccer ball and 1-kg and 3-kg medicine balls) while varying throw counts with respect to ball weight to control for workload in three groups of high school students. These results mirrored Ettema et al.’s\textsuperscript{25} demonstrating significant improvements for the soccer and 3-kg medicine ball groups in throwing velocity. Interestingly, a secondary finding of van den Tillaar et al.’s\textsuperscript{28} study identified that the resistance training groups demonstrated significantly higher throwing velocity with the 1-kg medicine ball compared to the group that only trained with the soccer ball. Because the investigators controlled for workload, this finding suggests that either resistance training or some previously unexamined variable other than workload may result in this performance increase.

Regardless of the influence of workload on current research in this area, these results suggest that resistance training might be a more efficient way to train (performing 18 throws on a pulley versus 81 throws with a handball yielding statistically similar gains). Therefore, incorporating resistance training could create an opportunity for greater workload to be performed within a given training session.

CONCLUSION

Supervised resistance training significantly increases power, strength, endurance, running speed, and sport-specific skill within the youth population when compared to a lack of resistance training and/or sport-specific training alone. Although there is sound reasoning by multiple authors to support the correlation between resistance training and injury prevention, future research is needed to determine whether fitness gains actually affect injury rates in this population.

Although 21 studies met our minimum requirement of methodological quality, the average PEDro score among them was 5.2. This low average demonstrates a potential for improvement in study design among this series of studies. Future research should consider the following in regard to study design: account/control for total work performed between groups, classify participants by physiological maturity, initiate and progress training programs based on individual ability, include outcomes of athletic performance beyond fitness measures, use blind assessors measuring outcomes, and include reporting injury and drop-out rates. Future research should also aim to examine the following: outcomes in relation to body weight, the rate of detraining, and the effects of a retraining/maintenance program. This information will help to further validate and quantify the benefits of resistance training and to potentially support lower-cost maintenance resistance training programs.

Health care providers, strength and conditioning coaches, and personal trainers should feel confident recommending and leading resistance training exercises in children and adolescents for improvement in both fitness and sports performance. Program design, intensity, and exercise selection should be initially determined, and subsequently progressed, based on the capacity of the athlete and the physical demands of the sport.

REFERENCES

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Note: RSI = Reaction Speed Index; TQ = Time to Quality; CON = Control group; SP = Study group; RT = Resistance Training group; SM = Speed Training group; VFR = Velocity Training group; COMBO = Combination group; END = Endurance group; SMT = Soccer Motive Training group.