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Suitability of resistance training and strength trainability in young people

Michael Chia

INTRODUCTION

The benefits of resistance training for strength trainability in adults are well established and not in dispute (Blimkie and Bar-Or 1996). However, the situation in young people is less secure. For instance, questions have been raised by parents and coaches about the benefits, risks and effectiveness of resistance training in the pre-pubertal (or prior to sexual maturity¹) and post-pubertal years (after sexual maturity). Physical education (PE) teachers in secondary schools are often faced with doubts about the appropriateness of assessing the maximum strength of young boys and girls using weight-training equipment. Many PE teachers are instructed at the pre-service level about adult principles of strength training, with little attention paid to the appropriateness and applicability of such adult training principles to the paediatric population. The problem is exacerbated by weight training textbooks and journals targeted for adult consumption or by body-building literature that propagate information that may be inappropriate or harmful when applied indiscriminately to young people.

Strength may simply be explained as the ability to generate maximum force at a particular speed over a specific range of motion, while power is the ability to generate strength very quickly. Resistance training usually takes the form of weight training, where free weights or weight training machines are used to bring about improvements in strength and muscular endurance. Both strength and muscular endurance are necessary in daily activities such as running up a flight of stairs or carrying a knapsack filled with school books. Strength and muscular endurance are also essential ingredients for success in various sports and are among the key fitness components assessed in annual school fitness tests.

¹ Sexual maturity for boys is defined as the attainment of first ejaculation. Sexual maturity for girls is defined as the attainment of menarche.

EFFICACY OF RESISTANCE TRAINING IN YOUNG PEOPLE

Strength gains with training during preadolescence

Most studies have involved only boys, with a paucity of studies on girls. Earlier studies on boys contributed to the view that resistance training during pre-pubertal years is ineffective and does not result in gains in strength (Ainsworth 1970; Virjens 1978). It was suggested that strength gains were not possible with training until circulating testosterone levels increased substantially during mid to late puberty (Blimkie & Bar-Or 1996). However, studies that involved moderate to high training loads and controlled for the effects of growth and motor skill acquisition, demonstrated significant and substantial strength gains during pre-adolescence (Blimkie 1992; Ozmun, Mikesky & Surburg 1994). In concordance with adult studies, the magnitude of strength gains in this group of young people with training is dependent on the interplay of the volume (amount) of training, the training intensity (how strenuous) and, to a lesser extent, the duration of the training.

The use of one-repetition maximum (1RM) effort (i.e. the maximum amount of weight that a pupil can lift or move in a single action) in strength testing in this group of young people is contentious. In a 20-week study, touted as the longest and most strenuous ever reported (Blimkie & Bar-Or 1996), Ramsay, Blimkie, Smith, Garner, MacDougall & Sale (1990), trained a group of normo-active, healthy pre-pubertal boys (aged 9-11 years) using resistance training at 75-85% of 1RM of elbow flexion and leg extensions. At the end of the training, improvements of between 21-37% were documented in a series of 1RM performances over the pre-training values. Evidently, the cited study represents cogent evidence that strength gains following specific training in young boys are possible. Notwithstanding the above-cited results, as mentioned earlier, the use of 1RM to determine exercise intensity in young people is contentious. The practice of using 1RM to determine exercise intensity and to formulate training prescriptions is a spill over from adult training principles. Its direct application to young people, is in my opinion questionable.

Prudence dictates that pupils must not attempt to perform a 1RM effort. This is to prevent the occurrence of growth plate injuries, often resulting in stunted growth (Micheli 1996) if not more serious injuries. A safer approach to determining exercise intensity is to assess 5RM (if strength is the training focus), 10-12RM (if strength and muscular endurance are the training foci) or 15-20RM (if muscular endurance is

the training focus). Working at between 50% to 80% of the respective RMs, in a progressive manner would be appropriate (Blimkie & Bar-Or 1996). 1RM efforts are more strenuous and are more inclined to induce delayed onset of muscle soreness, something that young people, especially girls may find off-putting. The use of 1RM to determine training intensity has greater acceptance when applied to adult populations.

Physical education teachers interested in developing strength in young people must be mindful that young people have shorter attention spans than adults and are less likely to adhere to repetitive exercise for long periods of time. Exercise training for strength or muscular endurance must therefore be made fun. Allowing young people to exercise to their favourite pieces of music and incorporating variety into the training programme by using different forms of specific training (e.g. different forms of circuit resistance training) can help sustain young people's interest in the training programme.

The optimal combination of mode (type) of training, the training volume, training intensity and training duration for maximum strength gains in pre-adolescent young people have yet to be determined and remains a fertile area for research attention. The issue of whether girls demonstrate similar patterns of strength development as boys with training also needs to be addressed.

Strength gains with training during adolescence

The trainability of strength during adolescence is less contentious and, while the general patterns of strength development with training generally parallels that of adults, the magnitude of improvements may not necessarily be the same. Significant strength gains are documented for isometric training (generation of force without external motion), dynamic weight training and isokinetic training (generation of force at constant speed of motion) (Blimkie and Bar-Or 1996). With dynamic weight training, it appears that the strength gains are directly related to the frequency, intensity and duration of training (Gilliam 1981). Nevertheless, as with the pre-adolescent population, data on girls are notably sparse and the optimal training stimulus for maximum strength gains has not yet been determined.

Persistence of strength gains following training

There has been limited research in this area since strength loss following structured training may be off-set by concomitant strength gains due

to the normal processes of growth and maturation (Blimkie and Bar-Or 1996). In a single study on pre-adolescent boys, a single, once-a-week high intensity training session was insufficient to preserve prior-training-induced strength gains (Blimkie, Martin, Ramsay, Sale & MacDougall 1989). Based on this limited research, it appears that training-induced strength gains are impermanent and that a single high intensity training bout per week is insufficient to maintain training-induced strength gains. No firm guidelines can be drawn about the requirements for maintenance of strength during pre-adolescence or adolescence, implicating that further research into this area is necessary.

IMPLICATIONS FOR THE PE TEACHER

Developmental considerations in strength-training young people

It appears that there is an increased popularity of the use of dynamic resistance training to develop strength and muscular endurance in school children today. It is therefore prudent to pay attention to a number of developmental considerations, outlined as follows, of young people so as to derive optimal benefits from the training efforts.

- During the pre-adolescent period, especially, use resistance training as only one of a variety of normal recreational and sporting activities.
- When using resistance training, use a variety of different training forms, e.g. body weight, free weights and machines, while taking note of all safety precautions.
- Emphasize the importance of personal improvement and discourage inter-individual competition.
- Discourage very strenuous exercise, e.g. maximal or near-maximal lifts with weights or machines, especially during pre-adolescence. To determine exercise intensity for this group, work at 50-80% of 5RM load (strength) or 10-12 RM load (strength and endurance) or 15-20 RM load (endurance), respectively.
- Avoid *isolated* eccentric-type (force generation with muscle lengthening, e.g. lowering a weight that is too heavy as in a bicep-curl exercise) exercise until the latter stages of adolescence.
- Plan a circuit-type training programme and incorporate specific stretching exercises to derive other health-related benefits of fitness such as improved flexibility and aerobic fitness.

- Where possible, select weight-training machines and free weights that have been customized for young people rather than those designed for adults (ask the appropriate questions before purchasing expensive equipment).
- Ensure that there is always trained (adult) supervision during weight training.

Guidelines for resistance training for young people

Attention to the following guidelines will help ensure the safety, effectiveness and enjoyment of young people during strength training in a non-competitive sports or physical education programme.

- Preclude physical and medical problems (when in doubt, ask for a doctor's certification).
- Ensure that pupils are appropriately attired for the session (e.g. proper PE attire, and no watches or jewellery).
- Warm-up with a brisk walk or jog and proper stretches for a few minutes.
- Begin with exercises involving body weight (e.g. press-ups & crunches) before progressing onto free-weights and machines. Ensure that good posture is maintained (e.g. not locking joints).
- Start with exercises that involve multi-major muscle groups (e.g. back exercises) before moving to smaller muscle groups (arm exercises).
- Individualize the training load when using free weights and machines. Determine training intensity using 50% of 5RM, 10RM or 15RM. The use of an individualized exercise log card may be helpful.
- Train all major muscle groups, both extensors and flexors to provide for balanced development (e.g. working the muscles of the front of the thigh and then working the muscles of the back of the thigh).
- Exercise the muscles through their natural range of motion in a controlled manner.
- Breathe out on effort and in on the less strenuous part of the exercise. Do not allow any breath holding during any exercise.

- Alternate days of training with rest days. Train no more than three times a week. Eat a balanced diet with no need for any dietary supplements. Drink plenty of water throughout the training session.
- When using free weights and machines, progress gradually (e.g. after 5-6 sessions) from light loads, high repetitions (15), and few sets (1-2), to heavier loads, fewer repetitions (6-8) and moderate number of sets (3-4).
- Cool down after the workout with a slow jog or walk and with more stretching. Cooling down after the workout will help the body recover from the exercise and will minimize any muscle soreness.
- When selecting equipment, check for durability, stability, robustness and safety before usage.
- Educate pupils to regard sharp pain as a warning signal and to seek medical treatment and advice when necessary.

CONCLUSIONS

Research suggests that young people can benefit from a structured and properly supervised resistance-training programme. The benefits of weight training to the general health and well being of young people are many-fold. For example, one can expect increased muscular strength and endurance, enhanced enjoyment and improvement in sports performance, improved self-concept of young people, proactive prevention of osteoporosis in the advanced adult years (particularly for females) and possibly positive attitudes carried over into adulthood about resistance training as a life-long physical activity. Physical education teachers play a pivotal role in sowing the seeds, nurturing them and allowing their pupils to harvest some of the fruits of their resistance training efforts.

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