

Integrating Resistance Training into High-School Curriculum

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Abstract

Resistance training for youth athletes is becoming increasingly common. Integrating a periodized resistance training program into school curriculum can help develop athleticism for all youth. This article aims to provide an overview of a resistance training program used in a New Zealand secondary school. Provided is an insight into the levels of planning for an effective athletic development program. Properly sequenced training blocks are essential in achieving long-term success. Additionally, coaches must be sufficiently certified and qualified to work with youth, which includes tailoring approaches to varying levels of skill and providing effective feedback.

Keywords: long-term athletic development; youth; resistance training; weightlifting; strength; power

Introduction

Resistance training in youth, which includes children and adolescents (age 11-18), can provide many physical (49) and social and emotional benefits (82) and refers to activities used to improve health, fitness and performance using body weight, machines, free weights, elastic bands and medicine balls (15). Globally, declines in neuromuscular fitness (63, 79), fundamental movement skills (29) and physical activity (13) likely contribute to the high rate of sport related injury in youth (61). Furthermore, the National Strength and Conditioning Association's (NSCA) position statement on long-term athletic development suggests all youth, not only athletes, should participate in long-term exercise programs that promote physical development to prevent injury and maintain a healthy lifestyle (50). An

increasingly common and effective method for improving youth physical development involves the use of resistance training in school curriculum (42). This requires a coordinated, periodized approach that goes beyond simply planning for a single school term and meets the World Health Organization's recommendations on physical activity for health that suggest children aged 5-17 years should engage in vigorous intensity activities that strengthen muscle and bone two to three times per week. Embedding resistance training that stimulates positive muscle and bone adaptation into school curriculum would help achieve this recommendation as previous research has found higher rates of bone development in youth weightlifters and gymnasts (10, 37).

An early position statement from the American Academy of Pediatrics (1) cautioned against the use of resistance training and weightlifting in pre-adolescents due to a high injury rate. However, resistance training is now recognized internationally as a safe and effective training mode for children and adolescents (51). Faigenbaum and Myer (18) suggest that resistance training injuries are often accidental and can be prevented with qualified instruction. Surveys conducted by Hamill (28) also suggest that injuries related to resistance training are much lower than other common team sports, such as soccer, rugby and basketball. Additionally, in academy and school boy rugby training, injury incidence from weight training was below that for all types of rugby-specific training activities, as well as endurance training (70).

Although resistance training often refers to traditional strength training (common gym movements such as squat, lunges, bench press performed at a moderate velocity with low to high volume and intensity depending on training goal), other forms of resistance training such as plyometrics and weightlifting training (snatch, clean and jerk and their derivatives) have also been shown as effective means of improving physical performance of youth (7, 8). A meta-analysis by Lesinski, Prieske and Granacher (49) demonstrated moderate effects of resistance training on strength and jump performance and small effects on linear sprint, agility and sport-specific performance in youth, highlighting the notion that resistance training effectively improves multiple fitness components. Furthermore, a recent meta-analysis by Behm et al. (3) highlighted the specificity of resistance training effects on athletic

performance in youth, showing greater gains in jump performance with power training (plyometrics) and greater strength gains from traditional strength training (external resistance or bodyweight). Finally, findings from Channell and Barfield (7) and Chaouachi, Hammami, Kaabi, Chamari, Drinkwater and Behm (8) indicate that weightlifting provides greater improvements in vertical jump height after 6 and 10-week interventions in post-PHV (age 15.9 ± 1.2 years) and prepubescent athletes (age 10-12 years), respectively. Therefore, a mixed methods approach to strength and power development for youth is most beneficial, though the adaptations are likely specific to the type of training performed.

The long-term structured approach needed for athletic development is supported by the NSCA position statement (50), several meta-analyses (4, 49) and athletic development models (2, 21, 52) and a commentary on multiyear planning for the high school athlete (38). Furthermore, Faigenbaum and Meadors (17) suggest structured training programs delivered by qualified coaches are needed to promote physically literate youth. Physical literacy is an increasingly popular term that refers to the ability to move with competence and confidence in a variety of physical activities in multiple environments that benefit the holistic development of a person (55). Youth are less likely to become physically literate if they are not afforded the opportunity to learn and perform movements in an increasingly challenging environment. Younger children engage in larger amounts of deliberate play, which may occur in a relatively unstructured manner (11) and although unstructured play is important in the wider context of the overall physical activity experience, children typically begin to shift from high levels of deliberate play to deliberate practice around the age they enter high school (11). Cumulatively, these concepts support the need for youth to follow a periodized plan (22) aimed to promote both physical literacy and athletic development. Several meta-analyses have demonstrated a positive relationship between intervention duration and resistance training effects (31), showing that longer training periods are more effective in realising gains in muscular strength (4, 49) and power (60). Additionally, Lesinski, Prieske and Granacher (49) concluded that improving strength for youth using resistance is most effective when programs lasted for at least 23 weeks. However, Meylan et al. (60) reported that the number of sessions, as opposed to intervention length, demonstrated a clearer difference in program effectiveness and should also be considered in program design. In a series of

long-term studies, 2 years of resistance training resulted in improvements in speed (80) and change of direction performance (41). Most impressive, however, were the large gains in back squat strength (100-300%) following exposure to a similar, 2-year training intervention compared to the control groups (20-60%) (40). Thus, youth have the capacity to make large gains in strength and athleticism when they ascribe to long-term, systematic training.

Resistance training for youth is becoming more prevalent in high schools as the safety and benefits of this type of training are gaining acceptance (42). However, there is a clear lack of specific guidance on programming for youth (57). A survey showed that high school physical education teachers and sport coaches, as well as university physical education students, may lack the required knowledge and experience to design, implement and supervise youth resistance training programs (57). Therefore, the purpose of this article is to provide coaches and educators an example of how resistance training can be effectively implemented into secondary-school curriculum, as well as highlight some of the challenges faced by coaches operating in the high school setting.

Periodization models

The need for long-term resistance training programs corresponds to a need for periodization of training. Periodization refers to a planning paradigm in which training interventions are structured to maximize athletic development in accordance with the person's needs (24) and reduces the likelihood of overtraining or monotony in youth (22). Several forms of periodization exist: traditional (classic or linear), block and undulating (daily or weekly). Traditional periodization organizes training into a multi-year plan, annual plan, macrocycle, mesocycle (medium-sized training cycles; typically 2-6 weeks), microcycle (small-sized training cycles; typically 1 week), training day, training session and training unit (34). It also typically involves a gradual increase in intensity with a decrease in volume. Linear periodization includes training several fitness components simultaneously and is ideal for a single-peak within a year. Block periodization, on the other hand, is organized into accumulation, transmutation and realization mesocycle-blocks and is more common in high-level athletes that require several yearly peaks (35). These blocks utilize highly concentrated loads for a limited amount of fitness components as opposed to training several simultaneously. Lastly, daily (DUP) and weekly (WUP) undulating

periodization models are based on variations of volume and intensity and are thought to provide better performance gains through a more varied training stimulus (72).

Research suggests both block and daily undulating periodization (DUP) are effective in improving strength and power in both adults (32) and adolescents (30). However, a study by Painter et al. (69) comparing a 10-week traditional versus DUP intervention in collegiate track and field athletes showed that both groups achieved similar gains in performance but the block periodization group completed less volume overall, suggesting traditional periodization is more efficient. Additionally, the use of repetition maximum (RM) ranges to prescribe intensity, as often seen in a DUP approach, may not be suitable for youth with a low training age trying to maintain technical competency. Lastly, a traditional approach may be superior to a block approach for young athletes wanting to develop a variety of fitness components simultaneously. Above all, proper vertical integration – how training factors interact with each other within a given period – and horizontal sequencing – how each factor is sequenced over time - is essential to achieving desired training outcomes (23, 24).

Applying theory to practice: an applied working example from the New Zealand high-school system

Within a school setting, the structure of the training program must accommodate for academic events, holidays and daily timetable requirements. Therefore, the academic calendar may dictate the length of mesocycles based on school holidays or breaks. Fortunately, evidence shows even short training periods can be effective in promoting athleticism in youth (7, 77), but the accumulation of research shows longer programs (4, 49, 80) with more sessions (60) are most effective. Nevertheless, an academic year, which may last between 35-40 weeks, should provide a sufficient period to stimulate meaningful adaptations for strength, power, speed and aerobic capacity in both children and adolescents.

The example annual plan (Figure 1) was developed using a traditional periodization approach for high school students in New Zealand and delivered during curriculum time by a Certified Strength and Conditioning Specialist within the school. The program aimed to improve athletic motor skill

competencies to help prevent youth experiencing a proficiency barrier (83), where a lack of strength and skill may prevent youth from engaging in physical activity. This inherently requires some level of coaching and structure. The program was designed for students who have participated in sport and developed some level of competency of FMS (locomotion, balance and stability) but have little to no training age with regards to resistance training. Anecdotally, this is a common scenario within the high school setting. It is worth noting that because a child takes part in sport does not mean that they have competent athletic motor skills. For example, Parsonage et al. (71) found that regional academy rugby players had relatively low movement competency, which may hinder their progression to more advanced training methods. This supports the idea that all youth, irrespective of their involvement in sport, will benefit from resistance training. Within a multi-year plan, this annual plan could serve as the first or second year, depending on a child's capabilities. Given the levels of hierarchal planning needed for long-term periodized programs, this example provides a general overview at the macrocycle level before progressing to an in-depth example of an individual training session.

Macrocycle

The macrocycle can last several months to a year, but is often considered in terms of a season (22). However, in a school setting, it is not necessarily always feasible to align the macrocycle with sporting seasons, but rather adopt an approach where the academic year represents an entire macrocycle. Additionally, given the philosophies of long-term athletic development, the focus on overall athletic development - as opposed to sport-specific programming - allows for a more generalized macrocycle approach. When the annual plan contains a single macrocycle, the two terms are often used interchangeably (22). Figure 1 shows an annual plan (inclusive of 1 macrocycle) for a student being introduced to resistance training.

****Insert figure 1 near here****

Figure 1. A sample macrocycle for New Zealand and Australian school systems. COD = change of direction.

This plan includes 2 mesocycles, or medium-sized training periods, each school term, for a total of eight across the academic year. The training emphasis for each school term is delivered over 2, 4-5 week mesocycles. Emphasizing certain training qualities over 2 separate mesocycles each term allows for some variation in intensity, volume and exercise selection which may help reduce training monotony. For example, an early focus during term 1 on athletic motor skill competency (AMSC) provides low load and requires minimal equipment but can be developed using different exercises each mesocycle. As training age and technical competency increase throughout the year, more complex movements and greater intensities (>80% 1RM) can be used in order to promote ongoing adaptations in muscular strength and power (49). The example plan accounts for sessions on 2 non-consecutive days per week, in accordance with the school's curriculum and training frequency and recovery recommendations (15, 19). Long-term youth training programs should aim to develop all athletic qualities, so using resistance training combined with other training stimuli to promote athletic development is suggested (21, 52). Therefore, each session provides weight room-based exercises and field or court-based speed and agility exercises. These are done within the same session to deliver more frequent exposures to several stimuli, as opposed to only once per week.

Several times a year, students complete various tests to assess motor skill performance and monitor growth rates. Coaches can use this data to evaluate the effectiveness of the program and modify exercise volume or complexity during periods of rapid growth, as youth are more prone to overuse injuries in this time (58). Additionally, using a combination of a weekly questionnaire to determine training load and a daily wellbeing questionnaire to assess readiness to train, as suggested by Read et al. (76), may help coaches manipulate training load to reduce the risk of non-functional overreaching and overtraining (81). For example, reducing volume, load or exercise selection during the season may help the athlete cope with the cumulative stressors of life in sport. Any performance tests used should be specific to the training and may assess qualities such as movement competency, strength, power, speed and aerobic fitness. Monitoring growth rates or maturation can be achieved using the Mirwald et al. (62) or Khamis and Roche (43) equations. Evaluating progress of athletic motor skills and maturation is advocated by the NSCA (50) and International Olympic Committee youth athletic development

position statements (5) and coaches typically assess five fitness components and occur three to four times per year (14). The example plan supports these suggestions as the training is designed to improve movement competency, strength, speed, power and aerobic fitness and assessments are implemented on three occasions throughout the year – at the start, midpoint and end of the year.

Mesocycle

A mesocycle provides more detailed planning for each training block and generally last between 2-6 weeks (24). The most common mesocycle setup is a traditional 3:1 (3 loading:1 unloading) microcycle loading structure. Haff (22) provides several other loading structures (3:1, 3:2, 4:1, 4:2) that are dependent on an athlete's training age and ability to recover from training. In a high school setting, mesocycle length and structure may also depend on breaks or holidays. Figure 2 shows example content from the first term (mesocycle 1 and 2) of the example annual plan.

****Insert figure 2 near here****

Figure 2. The first two mesocycles from the annual plan showing training variable guidelines. COD = change of direction.

The first two mesocycles are primarily focused on using bodyweight or light resistance for the development of AMSCs, as described by Moody, Naclerio, Green and Lloyd (64). The AMSCs include 8 components: lower body unilateral; lower body bilateral; upper body pushing; upper body pulling; anti-rotation and core bracing; jumping, landing, and rebounding mechanics; throwing, catching, and grasping; acceleration, deceleration, and reacceleration. The example plan addresses most of these skills using 1-3 sets of 5-12 reps of bodyweight and light resistance movements aimed to improve technical competency in common resistance training movements and basic plyometric exercises. Due to the relatively low load used during this training period and the generally low training age of most students, an unload week to allow athlete recovery is not needed at the end of the each mesocycle. However, the volume is typically lower during the first week of each mesocycle to allow for explanation of new exercises and coaching cues.

After three school terms inclusive of six to seven sequential mesocycles of training, technically competent students may be able to (and need to) perform high force movements (e.g. loaded back squats) and high velocity movements (e.g. jumps and sprints) to promote ongoing adaptations. Figure 4 shows example content from term 4 (mesocycles 7 and 8) from the example annual plan.

****Insert figure 3 near here****

Figure 3. The last two mesocycles from the annual plan.

Research has shown that a combination of high force and high velocity exercises is superior to one or the other exclusively (33) and can successfully be performed within the same training sessions to develop a range of fitness qualities (53, 75). The range of exercise intensities and velocities in mesocycles 7 and 8 reinforces this mixed method (high-force and high-velocity movements) approach advocated by Haff and Nimphius (25); 1-5 sets of 2-8 reps was used to allow for higher loading and more intersets recovery. However, if a student is lacking proper movement, coaches should continue to prescribe less complex exercises until a student demonstrates competency.

Microcycle

A microcycle typically lasts 5-10 days, with a week being the most common length. Figure 3 shows an example microcycle from the annual plan that includes 2 resistance training sessions a week, which has been shown to be sufficient in eliciting improvements in young males (16). However, though session frequency and duration would depend on a particular school's timetable, these variables may not change over the course of a year and would not depend on technical competency or training age like other variables may. The microcycle content, however, may differ depending on a student's technical competency, whether or not they are in a sport season, academic pressures (e.g. exam periods) and their overall workload.

****Insert figure 4 near here****

Figure 4. Example microcycle with school curriculum athletic development sessions, as well as extracurricular sport training and competition.

Training Session

In the applied example, the training session lasts one class period and consists of several training units, such as the warm-up, weight-room and field or court-based portion. Due to time constraints, sessions typically last between 45-60 minutes in the school setting (14), which are still in accordance with youth resistance training recommendations (51). Logistics must consider transition time to get students changed into appropriate training gear and perform a thorough warm-up. The warm-up provides a unique opportunity to introduce exercises and games that help promote movement competency in a fun, less structured way. In fact, the warm-up itself can provide a physical stimulus that challenges movement competency and strength (89) and may be beneficial in other scenarios when a full session is not possible.

To manage relatively large class sizes, coaches with an appreciation of movement competency can choose a progressive or regressive task that provides a suitable challenge for each student, or group of students, based on technical proficiency, time of year or maturation status. Tasks can be manipulated using a variety of categories to create more or less challenging versions of the same task: task complexity (simple to complex), nature of exercise stimulus (pre-planned to reactive), motor skills per exercise (single to multiple), direction of movement (linear to multidirectional), repetition velocity (slow to fast), resistance (unloaded to loaded), movement type (static to dynamic), structure of program (exploratory to highly structured). These task manipulation categories can apply to all types of training. For example, students with low competency for a horizontal push pattern may perform a band-assisted push-up; students with average competency may perform a standard push-up; while students with high competency may perform a weighted push-up or an alternative progression (e.g. feet raised, a narrower

hand position or an explosive push-up with hands leaving the ground). Additionally, in a sprinting task, less competent students may focus on technical drills using submaximal intensity while more competent students may perform maximal sprints with external resistance.

Shown below in Figure 5 is an example session that accounts for different levels of movement competency using a bronze, silver and gold approach, similar to a study by Meylan, Cronin, Oliver, Hopkins and Contreras (59) in age 11-15 year old males. Since competency might vary between movement patterns, programming methods should allow students to perform each exercise at the appropriate competency level. For example, if a student is competent on a squat pattern, but not a horizontal push, he or she may perform the gold level squat but bronze level horizontal push.

****Insert figure 5 here****

Figure 5. Sample session adaptable for athletes of varying competency levels. DB = dumbbell; SL = single-leg.

There are measurement tools to formally assess basic bodyweight movements (44-47) and resistance training competency of students (54, 66). However, the ‘art’ of assessing movement and hopefully correcting potential movement limitations in real-time is a critical skill set of successful coaches. Examples of poor movement competency is usually characterized by excessive spinal flexion or extension, instability, uncontrolled tempo and/or patterns associated with injury risk (such as knee valgus) (66). In contrast, students displaying technical competency often use a controlled tempo with stability displayed throughout the motion and joints tracking in the correct direction. These deficiencies in movement competency could be due to neuromuscular, strength and/or mobility limitations (66), so coaches must first identify the cause for the limitation before implementing strategies for improvement. Additionally, there may be situations where a coach may want to temporarily regress a movement after a long school holiday, or more importantly, when kids are going through a growth spurt and may experience adolescent awkwardness.

Delivering the program

Equally important to the content is the delivery of the training program to the students, as suggested by pillar ten of the NSCA position statement on long-term athletic development (50). Furthermore, Faigenbaum and Meadors (17) highlight the importance of coaches understanding the process of development, fostering creativity and being patient in order to maximize youth development. School administrators should ensure that coaches or teachers have an awareness of pediatric exercise science and are properly qualified and certified to work with youth in an athletic development setting. Qualified coaches can then use their knowledge to provide feedback techniques that elicit gains in skill acquisition and subsequently, athletic performance. Additionally, qualified teachers or coaches can help an athlete navigate athletic development during the transitional high school years by taking an athlete-centered approach and being aware of symptoms associated with overtraining.

Qualification

Several position statements (50, 51) recommend hiring qualified strength and conditioning coaches with appropriate certifications (e.g. CSCS or USAW) for the high school setting. These recommendations are supported by a study by Coutts, Murphy and Dascombe (12) that found that 12 weeks of resistance training under a strength and conditioning coach improved training adherence and total body strength more than an unsupervised training group. Research has also revealed that most resistance training injuries in youth are due to accidents (67) and unsupervised training (20). Thus, qualified professionals can elicit improvements in performance and decrease the risk of resistance training related injury and should therefore be present in all high school weight rooms.

Pedagogical considerations for the high school setting

There are several factors that may help with the integration of strength and conditioning into high school curriculum. For instance, a constraints-led approach can be used to manipulate environmental, task and individual constraints to better facilitate skill development (85). Environmental constraints refer to the physical and social factors contributing to movement skill acquisition and are important in creating a motivational climate that students enjoy. Enjoyment of physical activity depends on the student's

perception of the motivational climate (36). In a survey of year 9 Finnish students (n = 4397), a task-oriented environment, relatedness and autonomy were positively related to enjoyment of PE classes. Furthermore, Halperin, Wulf, Vigotsky, Schoenfeld and Behm (27) suggest that giving autonomy to athletes by letting them make choices regarding training variables can increase motivation and performance. Another survey of high school athletes (n=128) indicated that athletes that perceived a high caring and task-involving climate in their strength and conditioning program reported high effort, enjoyment, competence, intrinsic motivation and commitment (6) which demonstrates the importance of creating a beneficial training environment. Chamberlin, Fry and Iwasaki (6) offers tips for creating a caring and task-involving climate, such as praising athlete's for their high effort and improvement, fostering cooperation among athletes, emphasizing that mistakes are part of the learning process, highlighting an athlete's role within a team and encouraging athletes to treat other with kindness and respect. Lastly, evidence has shown that a year-long intervention aimed to change motivational climate to more task-involving and less ego involving can positively affect high school students attitudes towards exercise and sport participation (9). Together, these studies suggest that environment is an important but modifiable constraint that is integral to implementing resistance training successfully.

Qualified coaches should be able to modify activities to ensure skill can be developed in variety of contexts across different age and ability levels. Practitioners can impose task constraints to help students learn movements by solving problems in an exploratory manner. Task constraints refer to the goal of the task, rules of the activity and implements used during the skill acquisition process and are one of the most common types of constraints used. Task constraints are easily implementable and can include the simple addition of a bean-bag placed on top of the head during a squat will keep a student's head and torso more upright; placing a foam-roller or stick behind an athlete to reach their hips back on a hinge pattern; or performing a squat facing a box or wall to keep the heels from coming off the floor (48). Research by Verhoeff (84) showed that adding task constraints can improve power clean bar path, which may improve 1RM performance.

Performer, or individual, constraints refer to the physical, physiological, cognitive and emotional make-up of the learner. Although mostly unchangeable, coaches should be cognizant of individual constraints as they may influence what a child can do or how they do it. For example, an athlete with longer legs may utilize a wider squat stance. Physical constraints may be somewhat determined by genetics but a coach can help improve certain physiological factors such as strength, power and movement skill with a periodized training program.

Providing valuable feedback

Different methods of providing feedback can be beneficial in positively altering movement mechanics. Jeraj, Veit, Heinen and Raab (39) reported that methodological knowledge (details and approaches that constitute the steps for performing a specific movement) and visual perspective (where a coach is viewing the movement in relation to where an athlete is performing it) were two of the most important feedback factors that might influence the error-correction process. Therefore, a coach must know what common errors he or she is looking for in a movement, and view movements from different perspectives to get a clear picture of what is happening. For example, in order to observe technical deficiencies in a squat pattern (e.g. forward trunk lean, knee valgus), coaches should view movements from multiple planes of motion (e.g. sagittal and frontal). Additionally, visual experience (accumulation of specific observations and spectatorships of a movement) was listed as the most frequently used factor for providing feedback (39), suggesting that accuracy in error detection and correction may improve with increased experience.

Another important factor when providing feedback is whether the focus of attention is directed *internally* towards bodily movements or functions, or *externally* towards the movement outcome or an external object (56). Several studies have demonstrated greater performance in isometric mid-thigh pull (26), standing long-jump (73), and sprint (74) performance with an externally focused compared to an internally focused attention. Recently, a review from Winkelman (88) highlighted three characteristics of external cues (i.e. distance, direction and description) that should be considered when providing feedback to individuals. *Distance* refers to a focus of attention distal or proximal in relation to a fixed

point; *direction* refers to a location that is towards or away from a fixed point; *description* can be conveyed through the use of action terms or analogies (88). Some examples of using direction as an external cue includes telling an athlete to jump as close as possible to a cone just out of reach or having them jump vertically to reach a target (towards a fixed point). Description as an external cue can include a coach describing a squat pattern as “sitting on a chair” to get an athlete to reach their hips back as they descend (analogy) or telling an athlete to “punch” instead of “push” (action term), as it implies an explosive movement. Creativity of the coach is the only limiting factor in the use of external cues; however, external focus of attention can improve performance in strength and power exercises, as well as correcting technical errors.

Coaches often use a combination of verbal and video feedback to help identify and correct movement. Indeed, Rucci and Tomporowski (78) showed that a combination of verbal and video feedback provided better improvements in the hang power clean technique than video feedback only. Additionally, several studies demonstrate the effectiveness of video modelling and video feedback on weightlifting movement kinematics (65, 68). In a group setting, highlighting a student with good technique in a given exercise (e.g. snatch) may improve confidence and act as a more relatable model than an elite level competitive athlete (e.g. Olympic weightlifter). Furthermore, research has shown that improvements in kinematic variables due to combined feedback methods result in improved kinetic variables such as force and power in the power snatch (87) and power clean (86). Therefore, although video feedback may help a coach provide feedback, a coach must have the methodological knowledge of movement and be able to explain it to a young athlete in everyday terms.

What next?

Ideally, after a year of training, the students would continue to participate in athletic development during curriculum throughout secondary school. A new annual plan that progresses athletic development beyond the previous year should be implemented. Following the long summer holidays, coaches will likely need a general preparation phase to reinforce movements and fitness qualities mastered the previous year. More complex movements may be introduced throughout the year, as well as higher

intensities and greater volume. After children have gone through their pubertal growth spurt, a focus on hypertrophy may be emphasized during certain training stages (52). Training sessions may also become more structured as youth mature and are able to respond to more instruction. Additionally, as training and sport intensity increases, monitoring of workload and athletic performance remains an integral key to reducing injury and improving performance. For reference to a multi-year high school plan, see the review from Jeffreys (38).

Practical Applications

The annual plan presented in this manuscript provides the reader with an applied, real-world example of how strength and conditioning provision has been implemented within the physical education curriculum in a high school in New Zealand. Specifically, it has demonstrated how principles of periodization can be applied to the high school setting and highlighted how the resistance training programs can be delivered to young high school students with a limited training age. Using a classic (or linear) approach to periodization will allow for the development of multiple fitness components simultaneously, while still allowing for emphasis to shift based on the goal of each mesocycle. To truly target overall athletic development, training should initially aim to improve technical competency in a broad range of physical qualities (e.g. resistance training, linear speed, change-of-direction). However, once a robust level of competency is reached, practitioners should sensibly manipulate training in order to satisfy the principle of progressive overload. It should be noted that training intensity should never be increased at the expense of technical competency. Providing valuable feedback using external cues, even video analysis where possible, and adopting a constraint-led approach to skill development all within a motivationally-oriented climate should help students realise improvements in athleticism in a variety of contexts. Students should aim to build upon their physical training foundation in subsequent high school years, which may lead to a lifelong active and healthy lifestyle.

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