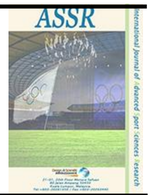

Strength Training Programme to Prevent Lower Limb Injuries in Young Sports

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ABSTRACT

There is a paucity of evidence regarding the use of injury prevention programmes for preadolescents participating in sports. However, effective injury prevention methods are needed to reduce the incidence o exercises f knee and ankle injuries in young people participating in sports. The aim of this study was to determine the effectiveness of training program for young sports. Seventy-nine young male sports (aged 14-16 years), were randomly assigned to either an intervention (n=39) or a control group (n=40). The training program is a 45-min program consisting of exercises includes the free weights, bicycles, an athlete's own body weight. The EXP group followed the training programme 3 days per week, for 6 weeks. Prior to, and after the intervention, both EXP and CON groups performed a battery of specific physical tests. Performance tests included, vertical jump test, sprint running and agility test. Eleven lower extremity injuries occurred in the intervention group and 29 occurred in the control group, per 1000 player hours. The incidence of knee and ankle injuries among young sports can be reduced by strength exercises programme.

Keywords: Injury, Exercises, Sports, Lower extremity, Incidence, Intervention.

1. Introduction

Almost all physical activities incorporate elements of force, quickness, duration, and range of motion. Exercises to overcome resistance are strength exercises. Speed exercises maximize quickness and high frequency. Exercises of long distance or duration, or many repetitions are endurance exercises. Maximum range of motion results in a flexibility movement. Exercises with complex movements are known as coordination exercises. Athletes vary in their talent to perform certain exercises. Talent is mostly genetic. Inherited strength, speed, and endurance play an important role in reaching high levels of performance and are called dominant motor or biomotor abilities. Motor refers to movement; the prefix bio- illustrates the biological importance of these abilities.

Multiple studies have shown that strength training, with proper technique and strict supervision can increase strength in preadolescents and adolescents. Frequency, mode (type of resistance), intensity, and duration all contribute to a properly structured program. Increases in strength occur with virtually all modes of strength training of at least 8 weeks' duration and can occur with training as little as once a week, although training twice a week may be more beneficial. Appropriately supervised programs emphasizing strengthening of the core (focusing on the trunk muscles, eg, the abdominal, low back, and gluteal muscles) are also appropriate for children and theoretically benefit sports-specific skill acquisition and postural control. Unfortunately, gains in strength, muscle size, or power are lost - 6 weeks after resistance training is discontinued.

Some coaches and trainers, especially in track and field and certain team sports, believe that power training should be performed from day one of training through the major championship. They theorize that if power is the dominant ability, it has to be trained throughout the year except during the transition phase (off-season). They use exercises such as bounding and implements such as medicine balls and the shot. Certainly, athletic fitness does improve through the year. The key element, however, is the athlete's rate of improvement throughout the year, especially from year to year, not just whether the athlete improves. Strength training has been shown to lead to far better results than power training.

Especially when Periodization of Strength is used. Power is a function of maximum strength. To improve power, one must improve maximum strength. Under these conditions, power improvement is faster and reaches higher levels. Strength, speed and endurance are the important abilities for successful performance. The dominant ability is the one from which the sport requires a higher contribution (for instance. endurance is the dominant ability in long-distance running). Most sports require peak performance in at least two abilities. The relationships among strength, speed and endurance create crucial physical athletic qualities. A better understanding of these relationships will help you understand power and muscular endurance and help you plan sport -specific strength training.

Combining strength and endurance creates muscular endurance, the ability to perform many repetitions against a given resistance for a prolonged period. Power, the ability to perform an explosive movement in the shortest time possible. Results from the integration of maximum strength and speed. The combination of endurance and speed is called speed-endurance. Agility is the product of a complex combination of speed, coordination, flexibility and power as demonstrated in gymnastics, wrestling, football, soccer, volleyball, baseball, boxing, diving, and figure skating. When agility and flexibility combine, the result is mobility, the ability to cover a playing area quickly with good timing and coordination.

In adults, the significant benefit of physical conditioning interventions in the prevention of injuries has been reported in several studies (Caraffa et al., 1996), particularly with respect to the reduction of Anterior Cruciate Ligament (ACL) injuries. Similarly, in younger adolescent male (Junge et al., 2002) and female football players (Heidt et al., 2000; Mandelbaum et al., 2005), and in other team sports (Emery et al., 2005; Hewett et al., 1999; Myklebust et al., 2003; Olsen et al., 2005), the usefulness of exercise-based conditioning programmes for injury prevention has been shown.

However, whilst it is clear that sport-specific strength training programmes that include a balance training component are effective in improving physical condition and reducing the risk of injury in mature athletes, little research has considered such strategies in relation to young (MacKay et al., 2004). Young is skeletally immature and when participating in sport, is susceptible to a range of hard- and soft-tissue injuries (Frank et al., 2007). Indeed, in a recent review (Spinks and McClure, 2007), the significant injury incidence in young participating in football (or soccer) was highlighted. In one study, the injury rate could be as high as 51.2 injuries per 100 player seasons for 11-14 year olds (Yde and Nielsen, 1990). To address this, Emery et al. (2005) recently highlighted the need to develop suitable injury prevention programmes for young and to determine their effectiveness using a scientific approach.

2. Methodology

2.1 Study Population

This study is based on data from a large randomised trial comparing the risk of injury between an intervention group receiving a training programme to prevent lower extremity injuries and a control group training as usual. The design, the intervention programme and the results of the study have been described in detail elsewhere. Young athletes' (aged 14-16 years) from three international schools (*n*=90) in the Malaysia were invited to take part in this study and (*n*=79) young athletes' accepted. Athletes' were randomly assigned to either an experimental (EXP, n = 39) or a control (CON, n = 40) group. Participant and parental informed consent was obtained prior to participation, and all participants completed a customised pre-exercise medical questionnaire.

Table 1.
Baseline data descriptive characteristics of the subjects, data are means (±SD)

Characteristics	EXP, n = 39	CON, n = 40
Age (years)	15.4 ± 0.4	15.5 ± 0.9
Height (m)	165.8 ± 5.6	166.2 ± 1.4
Weight (kg)	54.7 ± 4.8	55.9 ± 6.2
Body mass index, kg/cm^2	22.1 ± 2.8	21.8 ± 5.6

2.2 Strength Training Program (STP)

The strength training group (STP) participated in a 6-week training programme performing a variety of strength exercises designed for reduce the lower extremity injuries (Table 2), while the control group performing usual training programme. Prior to the study, procedures and guidelines were presented orally and in written form. Subjects agreeing to participate signed an institutionally approved consent form. The strength training group trained at the same time of day, three days a week, throughout the study. During the training, all subjects were under direct supervision and were instructed on how to perform each exercise.

Table 2.

Strength Training Programme (STP), 6-week Exercises Training Protocol

Strength Exercises	Sets X Reps	Training Intensity
➢ Push ups	2-3 X 8	Moderate
➢ Pull ups	2-3 X 8	Moderate
➢ Sit ups (crunches, bicycles, etc)	2-3 X 10	Low
➢ Back extensions	2-3 X 6	Moderate
➢ Body weight lunges or squats	2-3 X 8	Moderate
➢ Step-ups	2-3 X 8	Low
➢ Dips	2-3 X 10	Low

2.3 Statistical analysis

Descriptive data were calculated for all variables. Group differences at baseline were evaluated using independent sample *t*-tests. One way repeated measures ANOVA were performed to assess group differences for the variables of interest including vertical jump height, 20 m sprint and agility. When significant main effects and interactions were observed, post-hoc paired *t*-tests corrected for alpha inflation (Bonferroni correction) were utilized for identifying the specific differences. All analyses were carried out using SPSS version 20.0, and statistical significance was set at $p < 0.05$.

3. Results and Discussion

Performance of "STP" resulted in significant changes in several of the physical performance abilities assessed. The largest improvement was observed for Vertical Jump Height (VJH) (EXP = 9.75 %; CON = 2.50 %, $p < 0.05$, Table 3). . However, it may also serve to reduce the risk of ankle, knee and other lower limb injuries (Chandy and Grana, 1985). Chandy and Grana (1985) showed that jump training programmes, incorporating plyometric exercises and weight lifting, both increased performance and decreased injury risk in competitive high school athletes (age: 15 ± 0.6 years). Also, positive effects of a six week training programme incorporating strength, power and agility training, alongside the development of correct and maximal jumping technique, are apparent in volleyball (Hewett et al., 1996). Hewett et al. (1996) found that such a programme improved technique and decreased peak impact forces by 22% when landing and reduced medial and lateral directed forces by 50%. The performance benefit was a 10% increase in vertical jump height, which was consistent that observed in the present study (9.75%, Table 3).

Table 3.
Pre- and Post-intervention Data, and Percent Changes, for all Measures in Both the Experimental and Control Group. Values are Mean (± SD)

Variable	EXP (n = 39)			CON (n = 40)			P value
	Pre	Post	Δ%	Pre	Post	Δ%	
Vertical Jump Height (m)	0.41 (1.18)	0.45 (1.22)	9.75	0.39 (2.24)	0.40 (1.36)	2.50	.031
20 m Sprint (sec)	3.45 (1.38)	3.17 (1.39)	-8.12	3.50 (1.78)	3.67 (2.65)	4.85	.026
Agility (sec)	13.71(2.21)	13.21 (1.12)	-3.65	14.32 (.93)	14.78 (1.23)	3.11	.014

Δ = change. P value reflects differences between the change scores for each group

Multiple studies have shown that strength training, with proper technique and strict supervision can increase strength in preadolescents and adolescents. Frequency, mode (type of resistance), intensity, and duration all contribute to a properly structured program. Increases in strength occur with virtually all modes of strength training of at least 8 weeks' duration and can occur with training as little as once a week, although training twice a week may be more beneficial. Appropriately supervised programs emphasizing strengthening of the core (focusing on the trunk muscles, eg, the abdominal, low back, and gluteal muscles) are also appropriate for children and theoretically benefit sports-specific skill acquisition and postural control.

In preadolescents, proper resistance training can enhance strength without concomitant muscle hypertrophy. Such gains in strength can be attributed to a neurologic mechanism whereby training increases the number of motor neurons that are "recruited" to fire with each muscle contraction. This mechanism accounts for the increase in strength in populations with low androgen concentrations, including female individuals and preadolescent boys. In contrast, strength training augments the muscle growth that normally occurs with puberty in boys and girls by actual muscle hypertrophy.

Appropriate strength-training programs have no apparent adverse effect on linear growth, growth plates, or the cardiovascular system although caution should be used for young athletes with preexisting hypertension, because they may require medical clearance to reduce the potential for additional elevation of blood pressure with strength training if they exhibit poorly controlled blood pressure. Youth who have received chemotherapy with anthracyclines may be at increased risk for cardiac problems because of the cardio toxic effects of the medications, and resistance training in this population should be approached with caution.

Specific anthracyclines that have been associated with acute congestive heart failure include doxorubicin, daunomycin /daunorubicin, idarubicin, and possibly mitoxantrone. Youth with other forms of cardiomyopathy (particularly hypertrophic cardiomyopathy), who are at risk for worsening ventricular hypertrophy and restrictive cardiomyopathy or hemodynamic decomposition secondary to an acute increase in pulmonary hypertension, should be counseled against weight training.

Individuals with moderate to severe pulmonary hypertension also should refrain from strenuous weight training, because they are at risk for acute decomposition with a sudden change in hemodynamics.31 Young people with Marfan syndrome with a dilated aortic root also are counseled against participation in strength-training programs. Young athletes with seizure disorders should be withheld from strength-training programs until clearance is obtained from a physician. Overweight children may appear to be strong because of their size but often are unconditioned with poor strength and would require the same strict supervision and guidance as is necessary with any resistance program.

4. Conclusion

Strength training programme has been shown to have a beneficial effect on several measurable health indices such as, prevent lower extremity injuries and physical activity. Preventive training should therefore be introduced as a natural part of youth sports training programmes in similar pivoting sports.

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