Journal of Human Kinetics volume 11, 2004, 53-58

Trainability of Muscular Strength

by

Adam Bielecki[1], Jan Szopa[2]

The main objective of this research project was the evaluation of trainability of different components of muscular strength in boys aged 16-17 during an annual experiment. The research included 60 subjects divided into two groups of 30 boys each. The experimental group was submitted to 5 hours of physical education classes weekly, including 2 strength training sessions. It was concluded that strength abilities and especially strength endurance are highly trainable. Boys between the age of 16 and 17 show great sensitivity to strength training and the effects are strictly related to the type of stimulus applied.
Keywords: *trainability, muscular strength*

1 M. Sc., High Pedagogical School, Jaroslaw, Poland
[2] Prof. dr hab., Univer. School of Phys. Educ., Katowice, Poland

Introduction

Trainability understood as a range of response to training stimuli is influenced by different factors of which the most important include (Bouchard et al 1997): genetic control of particular abilities, genotype of the subject, and structure of training loads and initial level of the ability. There is a lack of experimental data in this area, with most of the existing ones concentrated on maximal oxygen uptake (Bouchard 1992, Lortie et al 1982, Simoneau et al 1986).

Only one paper dedicated to the "training-detraining-retraining" phenomena (Szopa and Prus 1998) allowed to state that strength abilities are very sensitive to directed training and the adaptive changes are strictly related to the type of stimulus applied.

This paper is directed at the evaluation of effects of a directed 9 month strength training program in 16-17 year old boys during puberty, theoretically the most sensitive period for this ability.

Material and methods

The research material included 60 boys aged 16 (x= 16.10 years), divided into two even groups of 30 subjects each. The boys were randomly assigned into a control or an experimental group. The experimental group conducted additional 2 hours of physical education classes which included exercises directed at the development of strength. The control group realized the traditional physical education program that included 3 hours of classes weekly. The strength sessions were conducted in a circuit manner with exercises directed at the development of arm and hip extensors, shoulder girdle, chest, trunk and abdominal muscles. In exercises with the barbell, the load was set at 60%max, 6 to 8 repetitions were performed in 3 sets. The amount of sets and repetitions of sit-ups and pull-ups was individualized. The authors indicate that boys chose most often exercises with 30%, 50% and 20% volume, preferentially training chest muscles and shoulders.

The measurements were conducted twice: at the beginning of the experiment (September 2002) and at the end of it (June 2003). They included basic somatic traits and tests directed at the evaluation of most important components of strength abilities:

- Underhand and overhand grip pull-ups (relative strength).
- Barbell bench pressing with a load of 40kg until failure (arm and shoulder strength endurance).

- Barbell squats with a load of 40kg until failure (strength endurance of lower limbs).
- Sit-ups performed on a 30° bench until failure (strength endurance of abdominal muscles).
- The tests were performed under identical conditions on, all in one day, approximately 3 hours after a meal.
- The following statistical methods were used:
- Average values (x) and standard deviations (SD) were calculated.
- The significance of differences was evaluated by the Students t-test.
- The intergroup differences were expressed in normalized values Z, treating them as objective measurements of training effects (E and C group difference as a percentile of SD for group E)

As one can observe, the tested subjects are evaluated during puberty, thus their increments in body mass and height are typical for polish youth from urban centers (Przeweda and Dobosz 2003). The boys from the experimental group showed slightly higher values of all evaluated variables during initial testing, what was caused by approval of participating in the strength training program.

Table 1. Pre and post experimental values of basic somatic traits and strength tests applied

Trait (test)	Term	Experimental Group			Control Group			Z (E - P) SD_E
		x	SD	d_1	x	SD	d_2	
Body height (cm)	september 1)	177,1	6,3	1,5	176,5	6,0	1,4	
	june 2)	178,6	6,1		177,9	6,1		
Body mass (kg)	September	67,1	7,9	4,5	66,9	7,6	4,5	
	June	71,6	7,8		71,4	7,7		
Pull-ups overhand grip (amount of rep.)	September	3,6	2,38	2,5 x)	2,7	1,46	0,7	0,56
	June	6,1	4,05		3,4	1,47		
Pull-ups underhand grip (amount of rep.)	September	5,0	2,46	3,2 x)	4,2	1,76	0,5	0,87
	June	8,2	3,69		4,7	1,64		
Bench press (amount of rep.)	September	12,8	5,08	8,5x)	9,4	3,46	0,8	1,30
	June	21,3	6,97		10,2	3,13		
Barbell squat (amount of rep.)	September	13,2	4,74	8,8x)	11,2	2,28	1,7x)	1,30
	June	22,0	6,67		12,9	2,01		
Sit-ups (amount of rep.)	September	12,9	4,39	4,6x)	12,3	3,34	1,5	0,63
	June	17,5	5,48		13,8	3,32		

The results indicate high and statistically significant improvements in all evaluated components of strength abilities in the experimental group while minor, and in most cases insignificant changes in the control group. The only exception included squats with the barbell, what only confirms the natural growth trend for this stage of ontogenetically development (Szopa et al 1996). The margin of these differences is varied. Great differences in standard deviations make comparisons possible only after average values were normalized and the maturation trends were excluded.

The Z values presented in table 1 indicate that:

- The range of strength training effects is significant despite its low volume (0,63-1,30).
- Muscular endurance is more susceptible to training that relative strength, especially in case of large muscle groups.
- Lowest trainability was observed in case of abdominal strength endurance.

Discussion

The genetic control of strength abilities is rather low (Wolanski and Parizkova 1976, Kovar 1980, Szopa 1982, Bouchard et al. 1997), thus high trainability of these abilities is expected. The range of improvements was also expected since the age of the tested subjects is viewed by many authors as very sensitive to this type of stimuli (Malina and Bouchard 1984, Szopa 1983, Szopa and Prus 1998). It is no surprise that coaches and sports training experts suggest initiation of strength training between the age of 15 and 16. Significant differences in training volume and individualization of exercise programs make comparisons of these results and those regarding different stages of ontogenetic development difficult. Taking into consideration the small amount of other physical activities requiring muscular strength, group E showed large improvements in all analyzed components of strength, usually not registered in pre pubertal or post pubertal periods (Szopa and Prus 1998) nor during full adulthood (Malina and Bouchard 1984, Bouchard 1997).

The obtained results also indicate great sensitivity of strength abilities to the structure of training program (intensity and amount of repetitions) and motivation (the reluctance in performing abdominal exercises). This only confirms great liability of these abilities.

Conclusions

1. Strength abilities show significant trainability, especially strength endurance.
2. The ecosensitivity of muscular strength in males is very high between the ages of 16 and 17.
3. Strength abilities are very sensitive to even minor changes in the structure of training loads.

References

Bouchard C. 1992. Genetics determinants of endurance performance. (In:) Sheppard R.J., Astand P.O , eds. Encyclopaedia of sports medicine, Vol. 2, Endurance in sport. Oxford, Blacharell Sc.

Bouchard C., Malina R.M., Perusse L. 1997. Genetics of fitness and physical performance. Hum. Kin. Publ., Champaign, Illinois.

Kovar R. 1980. Human variation in motor abilities and its genetic analysis. Charles Univ., Praque.

Lortie G., Bouchard C., Leblanc C., Trenblay A., Simoneau J., A., Therrault G., Savoie J.P. 1982. Familial similarity in aerobic power. Hum. Biol. 54.

Malina R.M., Bouchard C. (Ed.) 1984. Sport and human genetics. Hum. Kin. Publ., Champaign. Illinois.

Przeweda R., Dobosz J. 2003. Kondycja fizyczna polskiej mlodziezy. Studia i Monografie. AWF Warszawa, nr 98 (in Polish).

Simoneau J.A., Lortie G., Boulay M.R., Marcottie M., Thibault M.C., Bouchard C. 1986. Inheritance of human skeletal muscle and anaerobic capacity adaptation to high – indensity intermitted training. Int. Journ. Sports Medic., Vol. 7.

Szopa J. 1982. Genetic determination of some manifestation of muscular strenth in Man. Genetica Polonica, Vol. 23.

Szopa J., Prus G. 1998. Trainability of motor abilities in 12-15 years – old boys: results of „training – detraining – retraining" experiment. Journ Hum. Kinet. (Antropomotoryka), Vol. 18.

Wolanski N., Parizkova J. 1976. Physical of fitness and development of Man. S.T., Warszawa (in Polish).