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Effect of 6-Month Athletic Training on Motor Abilities in Seven-Year-Old Schoolgirls

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A B S T R A C T

The effects of six-month athletic training on improving motor abilities in 7-year-old schoolgirls were assessed. Analysis of the results of 12 motor tests showed significant improvement in the study group (n=38) in comparison with control group (n=140) subjected to conventional physical education classes only. The improvement referred to the variables of aerobic endurance (3-min run), flexibility (forward bow), explosive strength (ball throwing and 20-m run), keeping balance (bench standing), static strength (bent arm hang), and repetitive strength (sit-ups). These are probably adaptive changes brought up by discriminant functions. The varimax factor and discriminative function correlations indicated that all four factors of changes contributed significantly to the explanation of discriminative function. An almost equally high correlation of varimax factors and discriminative function was obtained on the basis of differences in the third factor responsible for changes in the frequency of movements and in the explosive strength of the jump type; in the second factor responsible for changes in coordination with changes in the repetitive strength of the body; and in the fourth factor responsible for changes in the explosive strength of the throw and sprint types with changes and endurance.

Introduction

Previous investigations have confirmed the effect of enhanced physical activity on the anthropologic status in young children[1–3]. The use of physical activity during the period of growth significantly improves anaerobic strength and aerobic capacity[4,5]. Exercise has a beneficial impact on the development of oxygen consumption[6] as well as on aerobic and muscular strength, aerobic capacity, coordination and muscular endurance[7,8]. Physical activities should be organized so as to en-

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hance the effects of physical training. The teachers, however, lack the competence to design programs for developing complex psychomotor fitness. Identification of effects attainable with the use of an expanded physical education program containing mainly athletic training but based on the existing 3-hour-a-week schedule, on developing essential motor fitness of first-grade school children is thus highly important.

The objective of the study was to establish whether it was possible to achieve favorable changes in anthropologic status by use of various athletic training modalities. Such an athletic training-based physical education program has been adopted for the following reasons:

– athletic training can be introduced even in schools with inadequate facilities;
– elements of athletic training represent a natural form of movement which enables children to adopt them quickly, thus promoting morphologic and motor changes;
– the acquired experience is a good basis for further motor development, thus improving the anthropologic status of the child.

Prospective benefits arising from possible implementation of such a program in elementary schools prompted us to undertake the study. The aim of this study was to assess the effect of programmed physical education including various elements of athletic training on motor abilities in 7-year-old girls.

Subjects and Methods

The study included 178 first-grade female students aged 7 years, representing the population of elementary school children. The girls were divided into two groups: control group of 140 girls who attended physical and health education classes according to the conventional program, study group of 38 girls attending classes of advanced intensified physical education. Study group girls were mostly trained by engagement in relay and elementary games, various athletic exercises (running with changing direction, speed and tempo; jumping over rope, hurdles, broad and vertical jumps, throwing, etc.). The advanced program was designed by taking into account the morphologic and motor status of children[9–11].

The training conducted during regular classes consisted of various units, the proportions between endurance and strength speed elements being approximately 30:70. Each week corresponded to one microcycle of high work load, followed by a microcycle of low work load.

Children from both groups were subjected to a set of 12 motor tests twice, six months apart. Motor abilities were assessed by use of 12 standard motor tests[2,12]: side-steps (s), polygon backwards (s), bench standing (s), forwards bow (cm), hand tapping (taps/min), foot tapping (taps/min), standing jump (cm), ball throwing (m), 20-m run (s), sit-ups (per min), bent arm hang (s), and 3-min run (m). Quantitative changes were evaluated by use of SSDIFF algorithm[13] based on discriminant[14] and factor analysis[15].

Results and Discussion

Results presented in Table 1 show that the expanded physical education classes with a dominant athletic component had greatest effect on motor fitness variables that are susceptible to conditioning process and/or training (endurance, flexibility, strength), whereby those genetically more strongly conditioned (psychomotor speed and coordination) were less influenced. As expected, the most pronounced were between-group differences in aerobic endurance indices. Development of the oxygen transport sys-

TABLE 1
ANOVA OF MEASUREMENT 1 TO MEASUREMENT 2 VARIABLE DIFFERENCES BETWEEN CONTROL (C) AND STUDY (S) GROUPS OF GIRLS

Variable	C (N=140)	S (N=38)	F	p
	$X^2 - X^1$	$X^2 - X^1$		
Side steps (s)	– 1.59	– 1.80	0.43	0.52
Polygon backwards (s)	– 6.66	– 7.04	0.11	0.74
Bench standing (s)	0.09	1.01	29.66	0.00
Forward bow (cm)	1.76	8.38	64.85	0.00
Hand tapping (taps/min)	1.68	2.25	2.26	0.13
Foot tapping (taps/min)	1.47	1.52	0.03	0.87
Standing jump (cm)	13.23	16.63	2.19	0.14
Ball throwing (m)	0.31	2.11	43.89	0.00
20-m run (s)	– 0.22	– 0.54	39.65	0.00
Sit-ups (per min)	2.72	6.00	11.29	0.00
Bent arm hang (s)	1.57	8.23	25.83	0.00
3-min run (m)	20.05	89.98	115.33	0.00

$X^2 - X^1$ = means for measurement 2 – measurement 1

tem enhances the development of the whole chain of abilities to be improved. Increased physical activity affects growth and maturation, and physical training significantly improves anaerobic strength and aerobic capacity. When the training of an adequate intensity and volume induces positive adaptive changes, all kinds of movements are expected to improve, especially those under the excitatory control of the nervous system, which is manifested mostly in the frequency and explosive type of movements.

Discriminant function of variables of changes for the entire sample indicated that significant changes occurred in the variables for assessment of co-ordination, explosive strength (jumps and running), frequency of movement, endurance, and repetitive strength of trunk (Table 2). Changes had a significant contribution to this kind of discriminant function structure in the study group, where they were more pronounced than in the control group (results of the analysis of variance shown in Table 1). Athletic treatment especially influenced changes in aerobic endurance, flexibility, explosive strength, and balance.

Comparison of these results with those reported from a previous study[2] revealed the athletic treatment to produce more significant changes in flexibility and balance, and less significant changes in co-ordination (agility), frequency of movements (with arms), static strength, and endurance. However, in our previous study different kinesiologic treatments were employed, thus explaining the discrepancy between the results.

Varimax rotation of the main components of the difference correlation matrix yielded four factors, i. e. patterns in which changes induced by the treatment as well as by the growth and general development manifested in the total sample of girls (Table 2).

Through the first varimax factor, the treatment of athletics in the frame of physical education manifested in the first place by the development of motor abilities of balance and flexibility, which esti-

TABLE 2
VARIMAX FACTORS OF DIFFERENCES (V), STRUCTURE OF DISCRIMINANT FUNCTION (DF) AND CORRELATIONS OF DISCRIMINANT FUNCTION WITH VARIMAX FACTORS (C) (N = 178)

Variable	V1	V2	V3	V4	DF
Side steps (s)	0.00	0.75	0.18	0.02	–0.45
Polygon backwards (s)	0.40	0.44	–0.13	–0.38	–0.53
Bench standing (s)	0.72	–0.01	0.05	0.15	0.15
Forward bow (cm)	0.66	–0.19	–0.20	0.16	0.31
Hand tapping (taps/min)	–0.05	0.08	–0.71	0.15	0.43
Foot tapping (taps/min)	0.37	–0.16	–0.58	–0.09	0.43
Standing jump (cm)	–0.01	–0.04	–0.65	0.13	0.55
Ball throwing (m)	0.09	–0.04	–0.11	0.73	0.21
20–m run (s)	–0.09	0.06	0.10	–0.66	–0.46
Sit-ups (per min)	0.26	–0.73	0.05	0.08	0.31
Bent arm hang (s)	0.41	–0.03	0.10	0.39	0.20
3-min run (m)	0.41	–0.09	–0.16	0.59	0.39
C	0.34	–0.68	–0.72	0.63	

mate the dimension of homeostatic regulation and regulation of muscle tension, accompanying parallel development of aerobic endurance, static strength of arms, frequency of leg movements, and repetitive strength of the body. The development of these abilities is opposed by the development of the ability of solving complex motor problems (cortical regulation of movement). It can be supposed that the endurance in particular, and static force of the arms are in this case an essential basis for efficient materialization of the tasks of balance and flexibility.

The second factor is determined by changes in co-ordination (more pronounced in agility and much less in resolving complex motor tasks) which are closely related with changes in the repetitive strength of the body. Thus, the tasks of coordination where the whole body is engaged (quick change of direction of movement – agility) are saturated by the repetitive strength of the body, as quick contractions of stomach muscles are necessary for their realization.

The third factor shows how athletic treatment in female students manifested in parallel changes in the ability, movement frequency, and explosive strength of the jump type. In these subjects, the manifestation of movement frequency was conditioned by the explosive strength of lower extremities.

The fourth varimax factor is defined by changes in the explosive strength of the throw and run types, which are accompanied by changes in aerobic endurance, static strength of arms, and ability of resolving complex motor problems. It can be supposed that aerobic endurance is the basis for materialization of those types of explosive strength in which the qualitative development of muscle tissue has a dominant role.

Correlation of varimax factors and discriminative function showed that all four factors of changes contributed significantly to the explanation of discriminative function. An almost equally high correlation of varimax factors and discriminative function was obtained on the basis of

differences in the third factor responsible for changes in the frequency of movements and in the explosive strength of the jump type; in the second factor responsible for changes in coordination with changes in the repetitive strength of the body; and in the fourth factor responsible for changes in the explosive strength of the throw and sprint types with changes in endurance. The first varimax factor, which is responsible for changes in balance and flexibility accompanying the changes in endurance and static strength of arms, showed a considerably lower correlation with discriminative function.

While these and other investigations have established mainly quantitative changes (e.g., in motor and functional skills) resulting from sports training, the results obtained in the present study applying discriminant functions to changes in variables suggest qualitative changes, i.e. changes in motor functions. The discriminant structure confirmed that six months of a kinesiologic treatment had a significant and complex impact on the development of motor skills in girls. This effect was especially pronounced in the indices of co-ordination, explosive strength (jumps and runs), frequency of movement, endurance, and repetitive strength of the body.

Such a structure of the discriminant function was undoubtedly attributable to proper design of athletic training, the control group being therefore handicapped in this regard. This points to the importance of classes of physical education, which should be on equal foot with other subjects taught at elementary school.

The mechanisms responsible for realization of complex movements, from balance and flexibility to co-ordination and frequency of movement as well as the mechanism of maximal energy mobilization were identified.

Two types of changes were specified in the study group: changes determining the fourth factor (explosive strength and aerobic endurance), and changes determining the first factor (balance and flexibility).

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UČINAK ŠESTOMJESEČNOG ATLETSKOG TRENINGA NA MOTORNE SPOSOBNOSTI SEDMOGODIŠNJIH DJEVOJČICA

S A Ž E T A K

U ovom radu istraživana je učinkovitost šestomjesečnog atletskog treninga na promjene motoričkih sposobnosti kod sedmogodišnjih djevojčica. Analizom rezultata 12 motoričkih testova, utvrđeno je da je došlo do značajnih kvantitativnih razlika u promjenama kod eksperimentalne skupine (N=38), koja je podvrgnuta posebno programiranoj nastavi tjelesnog odgoja uz primjenu sadržaja uglavnom iz atletike, i kontrolne skupinu (N=140) koja je provodila redoviti program nastave tjelesnog odgoja. Razlike su posebno izražene u aerobnoj izdržljivosti (trčanje 3 minute), fleksibilnosti (pretklon raznožno), eksplozivnoj snazi (bacanje lopte i trčanje 20 metara), ravnoteži (stajanje na klupici), statičkoj snazi (izdržaj u zgibu) i repetitivnoj snazi (podizanje trupa). Nastale promjene su vjerojatno posljedica adaptivnih procesa na trening atletike. Korelacije između varimax faktora i diskriminativne funkcije pokazuju da sva četiri faktora promjena značajno doprinose objašnjenju diskriminativne funkcije. Gotovo identično visoka korelacija varimax faktora sa diskriminativnom funkcijom uočena je u osnovi razlika trećeg faktora odgovornog za brzinu promjene frekvencije pokreta i eksplozivne snage tipa skokova; drugog faktora odgovornog za promjene u koordinaciji i repetitivnoj snazi, te četvrtog faktora odgovornog za promjene u eksplozivnoj snazi (tipa bacanja i trčanja) i izdržljivosti.