

STATE CHANGES IN POSTURE AND ARCH OF THE FOOT IN CHILDREN AGED 4 - 6 YEARS WITH HYPERMOBILITY OF THE JOINTS UNDER THE INFLUENCE OF REHABILITATION ACTIVITIES IN SCHOOLS

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Annotation. The effect of the rehabilitation activities in educational institutions on the dynamics of changes in the state and posture of the foot arch in children. The study involved 446 children aged from 4 to 6 years. The rehabilitation program lasted 10 weeks and consisted of 3 periods. Found that 35.88% of healthy children had impaired posture in the sagittal plane. Flatfoot detected in 64.46% of children with joint hypermobility. After the implementation of the rehabilitation program the value of the brachial arch indicators declined in children 3 major groups, respectively, 32.85 cm, 33.24 cm and 33.92 cm in all major groups established downward trend in the proportion of children with kyphotic posture and flat feet. The positive dynamics of changes in the values of posture in the sagittal plane was observed among children of all 3 major groups: shoulder width increased respectively by 1.55%, 3.09%, 4.77%.

Keywords: children, incorrect posture, flat feet, hypermobility joint.

Introduction

It is known that 4-6 six years age is an important stage in formation of child's personality, motion abilities, creating of normal conditions for biological development. As on to-day, one of main tasks of education in educational establishment is strengthening of children's health [1,2]. However the fact, that among rising generation there is observed high rate of increasing of supporting motor system's (SMS) disease can not but troubles.

Close connection of SMS with human health was proved by numerous researches and one of main reasons of children's SMS negative changes is non differentiated dysplasia of connective tissues (NDCT) that is manifests as destabilizing of connective tissue's structure at systemic level [3, 4].

Children of 4-6 years old are a special group of risk of SMS pathological changes, as far as exactly in this period of time intensive reconstruction of bone-muscular system starts against the background of age related "jump". Hyper-mobility of joints (HMJ), which is accompanied by weakness of joint-sinew system and increasing of movements in one or several joints, belongs to main sign of NDCT from SMS side. It was observed at 50-72.2% of children population [4,5]. At early stages of children HMJ kyphotic posture and flat-footedness are observed, which in future can progress in scoliosis and local symptoms [6].

In clinical practice greater attention is paid to treatment and rehabilitation of obvious pathological abnormalities (osteochondrosis, rheumatic diseases, scoliosis with dysplasia, etc.), while functional changes of SMS against the background of joints hyper-mobility, as independent sign of orthopedic lesions, in most cases remain without diagnosis (D.S. Kyseliova, 2011; V.N. Gorbunov, 2012; Bushby K. J., 2011).

Most of specialists point at high effectiveness of physio-therapeutic rehabilitation methods in case of children's HMJ in conditions of specialized establishments [6, 7]. Though, significant prevalence of posture abnormalities and flat-footedness against the background of HMJ in children population requires application of broader spectrum of physio-therapeutic rehabilitation measures in conditions of educational establishments.

The present work has been fulfilled as per plan of scientific & research works for 2007-2012 of sport medicine and valeology department of physical culture Institute of Sumy state pedagogical university, named after A.S. Makarenko, as per subject: "Physiological-hygienic and psychological-pedagogic foundation of health related activity in educational establishments" (state registration No. 0109U004945).

Purpose, tasks of the work, material and methods

The purpose of the research: appraisal of posture and foot arch changes of 4-6 years old children with joints hyper-mobility under influence of physio-rehabilitating measures in conditions of educational establishments.

Materials and methods of the research. 446 children in age from four to six years old (43.60±2.81% of boys and 56.40±2.80% of girls) participated in the research. The plan of the research included: 1) copying of complex medical examinations' data; 2) determination of joints' hyper-mobility presence and degree with method of Carter-Wilkinson-Beighon (passive bending of both little fingers, passive bending of both thumbs, bending-re-bending of elbows, knees, forward torso bending with determination of distance to floor) [11]; 3) examination of children for posture abnormalities in sagittal plane, that was determined by shoulder index's (SI) deviation from standard by formula:

$$SI = (SW/SA) \cdot 100\%$$

Where, *SW (cm)*- is width of shoulder (measured with the help of centimeter tape from left acromion process of blade to the right one at front of the body); *SA (cm)* – shoulder arch(measured with the help of centimeter tape from left acromion process of blade to the right one at back of the body); *SI* evaluation was

carried out considering certain values, videlicet: up to 89.9% - kyphotic posture, from 90 to 100% -correct posture in sagittal plane [9]; 4) characteristics of children's with HMJ feet were determined with podometry method of M.O. Fridland [9], which is based on determination of foot arch height and foot length with further calculation of foot arch index by formula:

$$FAI = (h/l) \cdot 100\%$$

Where *FAI* – index of foot arch, *h* (cm) – foot arch height (distance from the bearing area to low edge of ossis navicularis, *l* (cm)– foot length; 5) mathematical and statistical processing was carried out with the help of program STATISTICA 6.0 [10].

The program of children's rehabilitation in conditions of educational establishment lasted ten weeks and included three periods: preparatory, training-correcting, and stabilizing. The program of measures included therapeutic gymnastics, self massage, psycho-emotional relaxation, observation of orthopedic regime, correcting component, owing to varying part of health related physical culture work during day at pre-school educational establishment.

Application of the offered complex program of physical rehabilitation of children with HMJ and further determination of its effectiveness in conditions of educational establishments was carried out with dividing of children contingent into groups, depending on degree of joints' pathologies.

The first main group (MG1, *n*=41) and first control group (CG1, *n*=42) included children with light degree of HMJ. The second main group (MG2, *n*=42) and second control group (CG2, *n*=39) included children with HMJ of middle degree. The third main group (MG3, *n*=40) and control (CG3, *n*=37) included children with HMJ of high degree.

Rehabilitation measures as per specially developed programs were applied to all children of main groups, while children of control groups were trained as per standard health related sections of basic program of pre-school age children development "I am in the world". [8].

Results of the researches

As per posture indices and standards of foot characteristics among 84.56% of healthy children (as per the data of complex medical examinations) we found 35.88% of children with posture abnormalities in sagittal plane and 64.46% of children with flat-footedness against the background of HMJ.

As per the results of repeated examination of children, fulfilled after passing of physical rehabilitation program we observed positive dynamics of morphological changes of posture in sagittal plane.

Changes of posture indicators were happen with children of all main groups in comparison with control groups. We stated the trend to increasing of shoulder width's indicator of children of groups MG1, MG2 and MG3 (32.04±7.28 cm, 31.98±7.19 cm, 32.02±7.37 cm, correspondingly) in comparison with groups CG1, CG2 and CG3 (31.71±7.18 cm, 31.14±7.41 cm, 30.67±7.58 cm, correspondingly). Shoulder width of MG1 group's children increased by 1.55%, while in CG 1 – only by 0.12% (*p*<0.05), in group MG2 – by 3.09±2.67% and in CG2 – by 0.16±0.64% (*p*<0.05). The same changes took place in groups of children with HMJ of high level – MG3 and CG3 (4.77% and 0.45% accordingly) *p*<0.05) (see table 1).

In the process of analysis of shoulder arch indicators it was established that after implementation of rehabilitation program, their value reduced, concerning children of main groups, MG1, MG2 and MG3 by 32.85±7.33 cm, 33.24±7.26 cm and 33.92±7.48 cm accordingly. Difference of indicators at beginning and after the end of pedagogic experiment of MG1 children was 2.37±2.34%, MG2 – 2.52±2.41% and at MG3 – 2.31±2.37%, while, concerning children of CG1– 0.29±0.82%, CG2- 0.08±0.43% and CG3 – 0.31±0.91% (*p*<0.05) (see table 1).

Table 1

Dynamics of changes in posture characteristics of children from different groups, with comparing in sagittal plane (abs. fig.)

Value	Groups	Posture characteristics	
		Shoulder width (cm)	Shoulder arch (cm)
Initial indicators	MG1, <i>n</i> =41	31.55±7,25	33.65±7,37
	CG 1, <i>n</i> =42	31.67±7,17	33.59±7,28
	MG 2, <i>n</i> =42	31.02±7,13	34.10±7,31
	CG 2, <i>n</i> =39	31.09±7,41	34.02±7,58
	MG 3, <i>n</i> =40	30.56±7,28	34.72±7,52
	CG 3, <i>n</i> =37	30.53±7,57	34.54±7,81
Final indicators	MG 1, <i>n</i> =41	32.04±7,28	32.85±7,33
	CG 1, <i>n</i> =42	31.71±7,18	33.49±7,28
	MG 2, <i>n</i> =42	31.98±7,19	33.24±7,26
	CG 2, <i>n</i> =39	31.14±7,41	34.05±7,58
	MG 3, <i>n</i> =40	32.02±7,37	33.92±7,48

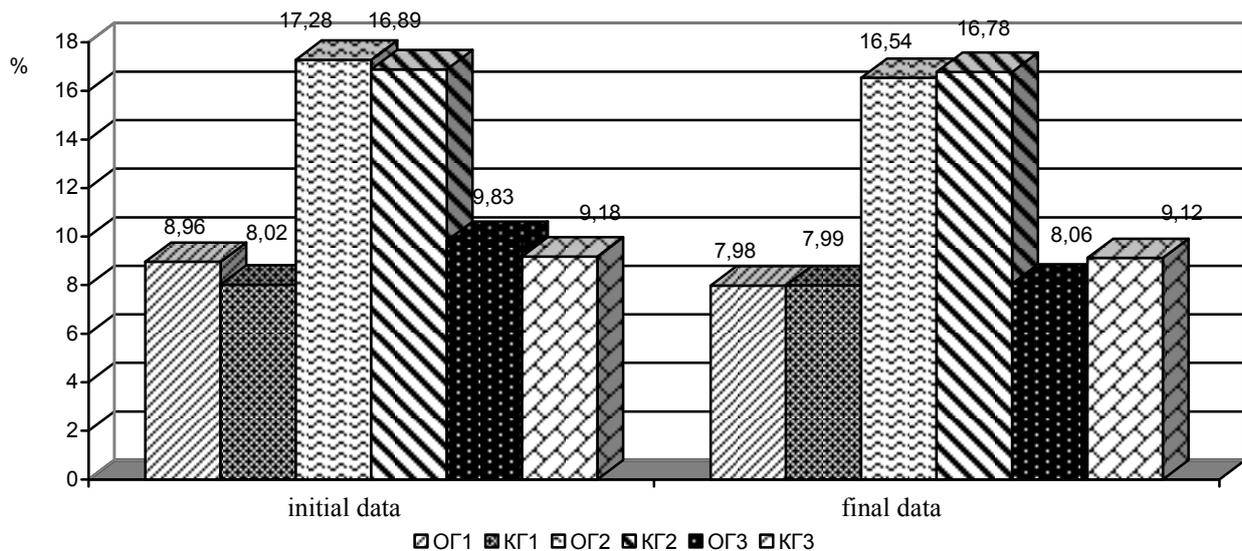
	CG 3, n=37	30.67±7,58	34.43±7,81
Δx_1	MG 1	+1.55±1,90	-2.37±2,34
	CG 1	+0.12±0,53	-0.29±0,82
Δx_2	MG 2	+3.09±2,67	-2.52±2,41**
	CG 2	+0.16±0,64	-0.08±0,43** <i>t</i> =2,03
Δx_3	MG 3	+4.77±3,36*	-2.31±2,37
	CG3	+0.45±1,01* <i>t</i> =2,00	-0.31±0,91

Notes:

* confident difference of increment of shoulder width values between children of MG3 and CG3 ($p < 0.05$);

** confident difference of increment of shoulder arch values between children of MG2 and CG2 ($p < 0.05$);

As a result of repeated using of method of index evaluation (IE) in order to determine specific weight with maximal changes of posture in sagittal plane, we found a trend to reduction of specific weight of children with kyphotic posture in main groups. In main group MG1 specific weight of children reduced from 8.96±4.46% to 7.98±4.23%, while in CG1 group – from 8.02±4.19% to 7.99±4.19% accordingly. It should be noted that in groups MG2 and CG2 there appeared the same trend to reduction of children's, with posture abnormalities in sagittal plane, specific weight. Among children with high degree of HMJ we determined the following changes of posture: in group MG3 before rehabilitation measures, specific weight of children with kyphotic posture was 9.83±4.71%, and after them – 8.06±4.31%, in group CG3 - 9.18±4.74% and 9.12±4.73% correspondingly (see fig.1). Thus, we can note that the offered physio-rehabilitation measures influence positively not only on separate morphological indicators of children with joints abnormalities, but also on posture in sagittal plane.



OG1=MG1; KG1=CG1; OG2= MG2; KG2=CG2; OG3=MG3; KG3=CG3

Fig.1. Specific weight of children with kyphotic posture before and after rehabilitation course, in the observed groups (%)

In the period of pedagogical experiment we registered increment of children's foot arch height indicators that witnesses about increasing of tone of foot muscular system and about improvement of its spring function. In main groups MG2 and MG3 increment of right foot arch height was +8.54±4.31% and +8.92±4.51%, while in control groups CG1, CG2 and CG3 it was +0.93±1.53% and +1.01±1.64% ($p < 0.05$). The same changes were found concerning average value of left foot arch height. Similar to previous indicators, indicators of main groups dominated in comparison with control ones ($p < 0.05$) (see table).

Table 2

Dynamics of foot arch height characteristics of children from different groups (abs. fig.)

Groups	Initial values (x_0)		Final values (x_i)		Δx_1 (%)	Δx_2 (%)
	Right foot arch height, mm (x_1)	Left foot arch height, mm (x_2)	Right foot arch height, mm (x_1)	Left foot arch height, mm (x_2)		
MG1 <i>n</i> =41	2.38±2.38	2.32±2.35	2.44±2.41	2.39±2.41	+2.45 ±2.41	+2.92 ±2.62

CG 1 n=42	2.29±2.31	2.31±2.31	2.31±2.31	2.32±2.32	+0.86 ±1.42	+0.43 ±1.01
MG 2 n=42	2.14±2.23	2.11±2.21	2.34±2.33	2.38±2.35	+8.54* ±4.31	+11.34● ±4.89
CG 2 n=39	2.12±2.31	2.13±2.31	2.14±2.31	2.15±2.32	+0.93* ±1.53	+0.97● ±1.54
MG 3 n=40	1.94±2.18	1.95±2.18	2.13±2.28	2.12±2.27	+8.92** ±4.51	+8.01▪ ±4.29
CG3 n=37	1.96±2.27	1.98±2.29	1.98±2.29	1.99±2.29	+1.01** ±1.64	+0.74▪ ±1.40

Notes: * confident difference of right foot arch height between children of MG2 and CG2 ($p<0.05$);

** confident difference of right foot arch height between children of MG3 and CG3 ($p<0.05$);

● confident difference of left foot arch height between children of MG2 and CG2 ($p<0.05$);

▪ confident difference of left foot arch height between children of MG3 and CG3 ($p<0.05$);

After pedagogical experiment we repeatedly used the method of index evaluation for determination of foot arch state of children from different groups. With the help of analysis of examinations' results we found the trend to reduction of specific weight of children with flat-footedness. In main groups MG1 and MG2 quantity of flat-footed children reduced from 12.43±5.15% and 14.24±5.39% to 10.02±4.68% and 12.99±5.18%, accordingly, while in control groups CG1 and CG2 – from 14.98±5.51% and 14.33±5.61% to 14.96±5.51% and 14.31±5.61% accordingly. Besides, it was stated that in main group MG3 specific weight of flat-footed children reduced by 1.56%; in CG3 group it remained unchanged after pedagogical experiment.

Thus, considering general positive changes in posture and foot arch of children with joints' abnormalities from different groups, we can affirm that the offered program of children's physical rehabilitation in conditions of pre-school educational establishment is an effective contribution in normalization of bone-muscular system's state and children's organism in general.

Summary

Among 84.56% of healthy children (as per the data of complex medical examinations) we found 35.88% of children with posture abnormalities in sagittal plane and 64.46% of children with flat-footedness against the background of HMJ.

Positive dynamics of posture indicators' changes in sagittal plane was observed among children with HMJ in all main groups in comparison with control groups: in MG1 shoulder width increased by 1.55% while in CG1 – only by 0.12% ($p<0.05$), in MG2 – by 3.09±2.67% and in CG2 – by 0.16±0.64% ($p<0.05$) and in groups of children with high degree of HMJ – MG3 and CG3 (4.77% and 0.45% accordingly, $p<0.05$).

After implementation of rehabilitation program the value of shoulder arch indicators reduced in main groups MG1, MG2 and MG3 by 32.85±7.33 cm, 33.24±7.26 cm and 33.92±7.48 cm accordingly.

In all main groups we stated the trend to reduction of specific weight of children with kyphotic posture. In group MG1 specific weight of such children reduced from 8.96±4.46% to 7.98±4.23%, while in CG1 group – from 8.02±4.19% to 7.99±4.19% correspondingly.

In main groups MG2 and MG3 increment of foot arch was 8.54±4.31% and +8.92±4.51%, while in control groups CG1, CG2 and CG3 it was +0.93±1.53% and +1.01±1.64% ($p<0.05$).

The quantity of flat-footed children reduced in main groups MG1 and MG2 from 12.43±5.15% and 14.24±5.39% to 10.02±4.68% and 12.99±5.18%, accordingly, while in control groups CG1 and CG2 – from 14.98±5.51% and 14.33±5.61% to 14.96±5.51% and 14.31±5.61% correspondingly.

After carrying out of rehabilitation measures children's postures in sagittal plane improved and specific weight of flat-footed children reduced that witness about efficiency of the implemented rehabilitation measures in conditions of educational establishment.

The prospects of further researches stipulate determination of characteristic for 4-6 years old children with HMJ phenotype dysplasia symptoms and influence of rehabilitation measures for them.

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