

Physical and sexual development of 10-year-old girls in rhythmic gymnastics and acrobatics

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Authors' Contribution:

A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: The purpose of the research is to study influence of regular trainings in rhythmic gymnastics and sports acrobatics on physical and sexual development of girls.

Material: 10-year-old girls (n=102) participated in research. One part of them was engaged in rhythmic gymnastics (n=36), other part was engaged in acrobatics (n=15). Sexual development was evaluated on secondary sexual characteristics. Physical development was evaluated according 31 absolute and 28 relative anthropometrical parameters.

Results: Physical development of gymnasts and acrobats does not meet age standard. Gymnasts and acrobats are retarded of equal in age girls according 32 of 59 parameters. It shows that there is a presence of more asthenic somatotype. Gymnasts have more decreased parameters of physical development, than in acrobats. It is explained by early start of trainings (on 1,21 year) and more strict selection. Development of secondary sexual characteristics in gymnasts and acrobats are within age norm.

Conclusions: rhythmic gymnastics and acrobatics cause delay of physical and sexual development in girls. It is not favorable for reproductive health.

Keywords: physical development, sexual development, health, girls, gymnastics, acrobatics.

Introduction

Rhythmic gymnastics and sports acrobatics belong to kinds of sport with early specialization. Selection is carried out from preschool and primary school age. It is considered specific and genetically stipulated coordination skills and flexibility [1]. Nowadays majority of world-class results are set up by young athletes. That's why trainings start from 4-5 years [2]. Child's body growths during all sport career [3].

In recent years there are no special researches devoted to health and physical development of girls engaged in rhythmic gymnastics and sports acrobatics. According to Sobolev D.V. et al. [4] only small amount of works are devoted to reproductive problems of girls and teens in female sport for the last 30 years. Such works are devoted to the following problems: reproductive health of teenage girls and young professional athletes [5]; formation of reproductive system' function in teenage girls who are regularly going in for sports [6]; formations of characteristics stipulated by gender in girls and teenage girls engaged in sports activities [7]; influences of considerable physical activity on reproductive function of women athletes [8]; management of women' athletic training process [9]; influence of sport on reproductive health of women [10].

Information concerning influence of physical culture and sport on reproductive health of girls is important in practical application. It allows to answer the following questions: what sport is preferable on physical education classes at school; what age is the best for start trainings; what physical activity will be optimal [11].

Majority of researchers consider that rhythmic gymnastics' trainings and other sports led to later menarche [12]; disorder of menstrual function [13]; delayed puberty [14] and sexual development [15]. Thus the frequency of delayed puberty in teenage girls and young athletes exceeds the same in female population in 3-4 times [7]. It is revealed in 62,5% athletes, in 23,2% volleyball players, in 16,7% basketball players [1]. In the research of Georgopoulos N.A. et al. [16] gymnasts shown later age of menarche in comparison with control group ($15,6 \pm 1,6$ vs $12,7 \pm 1,7$ years; $P < 0,001$) and high level of menstrual disorder (64%). It was investigated that menarche was observed only in 26% athletes engaged in artistic gymnastics (middle age was 13,2 years) [17].

Researchers associate delay of athletes' puberty with increase in level of androgens [18]. It is also revealed that hyperandrogenism is formed on the base of vegetative dysfunction [19] in 78,8% teenagers (14-18 years). A lot of researchers consider that it is caused by girls' asthenic somatotype [20]. Delayed puberty is consequence of such selection [4]. Asthenization and retardation of physical development could be genetically stipulated [21].

Also asthenization is caused by considerable physical and emotional loads [20], dietary restriction (including fats) [22]. Asthenization of gymnasts' physical development is confirmed by number of researches [23]. Thus, gymnasts have smaller weight (-8,5%, $P < 0,001$), index of body weight (-11,7%, $P < 0,001$), percentage of fat in body mass (-43%, $P < 0,001$) in comparison with non-athletes. They have higher muscle bulk (6,3%, $P < 0,001$) and height (+2,8 cm, $P < 0,001$) [24].

Comparison of artistic gymnastics athletes with

rhythmic gymnastics athletes produced the following results: artistic gymnastics athletes are higher than rhythmic gymnastics athletes (their height exceeds norm) and they have lower percentage of fat and index of body weight. Height of rhythmic gymnastics athletes is lower than 50th percentile [23]. Weight and height parameters increased considerably within 4-5 years in research of artistic gymnastics athletes. It is characteristic after age of the expected maximum height rate. It witnesses of delayed puberty [17].

Comparison of gymnasts' physical development with accepted standards points at contradictory data. In the research of Silva M.R. et al. [25] is revealed that body weight and the index of gymnasts' body weight is lower than age norm; normal height or even a little higher than norm. In work of Camargo C.T. et al. [17] was found that indexes of body weight and height in gymnasts of all age are lower than norm. In work of Georgopoulos N.A. et al. [23] was found that body height is lower than norm. We have not found the similar researches devoted to acrobatic athletes. We have not found complex researches in one work. Also we have not found the solution of problems of physical and sexual development of young athletes in one work. Also we have not revealed researches devoted to comparison of gymnasts athletes and acrobatic athletes, their physical and sexual development. All above mentioned is basis of suggestion a hypothesis and research purpose.

Hypothesis: gymnastics and acrobatics activity have negative influence on physical and sexual development of athletes.

The purpose of the research is to study influence of regular rhythmic gymnastics' and sports acrobatics' trainings on physical and sexual development of 10-year-old girls.

Material and methods

Participants. 10-year-old girls (n=102) participated in research. One part of them was engaged in rhythmic gymnastics (n=36), other part was engaged in acrobatics (n=15). All participants (and their parents) gave informed consent to participation in research. The control group consisted of non-athletes of equal in age from comprehensive schools of Kirov (Russia). The experience of sports was $3,94 \pm 0,24$ years in gymnasts, $2,73 \pm 0,52$ years in acrobats. Week load was $10,14 \pm 0,49$ hours in gymnasts, $15,97 \pm 1,39$ in acrobats.

Organization of research. The research is conducted on the basis of sports schools of Olympic reserve for children and young people № 1, 3 and 8 of Kirov (Russia). Sexual development was evaluated by standard method [26], i.e. by determination of secondary sexual characteristics – development of mammary glands (Ma), pubic (P) and axillary (Ax) pilosis, menstrual function (Me) and total point of sexual development. Physical development was evaluated according to 31 absolute and 28 relative anthropometrical parameters [27]. Researches were conducted regularly in the morning in medical rooms.

Statistical analysis. Results of research are subject of

statistical analysis by methods of parametrical statistics. It was calculated: arithmetic middling (M) and standard error of mean (m). These data are shown in the text and tables in the form of $M \pm m$. Differences were evaluated upon criterion Student-t for independent selections and upon criterion chi-square (considered reliable at $p < 0,05$).

Results

Physical development. We found that statistically significant differences according 32 of 59 studied parameters (Tab. 1). 21 parameters among them are decreased in acrobats and in gymnasts: height; hand length; interdigital size; wrist, waist and hips circumferences; interacromial, interpectineal and intertrochanteric size; external conjugate; body weight; weight-height index; body fat mass and skinfold thickness on eight parts of the body.

Ten parameters are decreased only in gymnasts: leg length; chest volume and diameter; neck, hip and calf circumferences; interspinal size. One parameter is decreased only in acrobats – head circumference.

Sexual development. It was revealed statistically significant differences according 4 of 5 parameters: two are decreased in acrobats and in gymnasts (Ma and total point of sexual development); two are decreased only in gymnasts (P and Ax).

Discussion

Physical development. Earlier we investigated physical development of non-athletes school pupil [28] and preschool age children [29]. We could confirm that physical development of non-athletes in this research corresponds to parameters of physical development of 10-year-old girls from Kirov (Russia) [30] and neighbor regions of Russia: Ufa [31], St. Petersburg [32], Nizhny Novgorod [33].

In our research athletes have lower body weight (in comparison with non-athletes), weight and height index, body fat mass and skinfold thickness. It can be caused by influence of considerable physical and emotional loads [22], restriction in food [20], girls' selection in these sports with more asthenic somatotype [14].

Lower values of anthropometrical parameters of athletes demonstrate decrease in height processes and asthenic somatotype. It confirms idea of retarded influence of such kinds of sport. Data concerning lower values of pelvis size in athletes (including external conjugate) confirm other researches [6].

Gymnasts have lower parameters of physical development, than acrobats. It is explained with early start of trainings in gymnasts – on 1,21 year (Tab. 2). It is not leveled by lower training load (on 5,83 hours a week less, than in acrobats). Therefore, rhythmic gymnastics' trainings influenced more negatively (asthenic, retarded) on physical development in comparison with sports acrobatics.

Sexual development. Rate of sexual development (on total point of sexual development) of gymnasts and acrobats is delayed in comparison with non-athletes.

Table 1. Statistically significant differences of parameters (M±m) of 10-year-old athletes and non-athletes physical development

Parameter	Control group (n=36)	Women gymnasts (n=36)	Control group (n=15)	Women acrobats (n=15)
Height in the standing position, cm	139,79±1,03	135,93±0,93 p<0,010	141,37±1,29	136,80±1,59 p<0,050
Height in the sitting position, cm	73,25±0,55	71,54±0,66 p<0,050	73,90±0,63	70,03±0,94 p<0,010
Hand length, cm	60,43±0,57	57,71±0,48 p<0,001	61,77±0,77	57,50±0,74 p<0,010
Leg length, cm	74,86±0,80	71,82±0,63 p<0,010	75,53±1,15	72,83±1,29
Interdigital size, cm	142,24±1,20	137,71±1,10 p<0,010	143,40±1,90	137,37±1,56 p<0,050
Chest volume at rest, cm	66,56±1,04	62,83±0,55 p<0,010	67,80±1,84	65,00±0,95
Chest volume in max inspiration, cm	71,03±1,03	67,56±0,63 p<0,010	72,63±1,72	69,67±0,92
Chest volume in max expiration, cm	65,31±1,06	61,96±0,55 p<0,010	66,73±1,90	64,20±0,95
Head circumference, cm	52,77±0,23	52,18±0,22	53,55±0,38	52,28±0,27 p<0,050
Neck circumference, cm	29,26±0,25	28,19±0,26 p<0,010	29,53±0,45	28,40±0,35
Wrist circumference, cm	13,37±0,19	12,28±0,11 p<0,001	13,87±0,34	12,54±0,18 p<0,010
Waist circumference, cm	58,10±0,93	53,50±0,49 p<0,001	59,17±1,63	54,21±1,03 p<0,050
Hips circumference, cm	71,00±0,91	66,92±0,65 p<0,001	74,00±1,81	68,09±1,44 p<0,050
Hip circumference, cm	42,28±0,74	39,36±0,49 p<0,010	44,07±1,55	27,10±0,58
Calf circumference, cm	28,13±0,44	26,87±0,28 p<0,050	29,13±0,98	40,50±1,20
Transverse thoracic diameter, cm	20,19±0,27	19,31±0,19 p<0,010	20,20±0,46	19,70±0,19
Anterior-posterior thoracic diameter, cm	14,44±0,21	13,46±0,17 p<0,001	14,90±0,43	14,07±0,25
Interacromial size, cm	30,78±0,32	29,56±0,26 p<0,010	31,13±0,57	29,67±0,31 p<0,050
Intertrochanteric size, cm	23,26±0,30	22,22±0,20 p<0,010	24,03±0,53	22,33±0,35 p<0,050
Interspinal size, cm	19,42±0,22	18,47±0,21 p<0,010	19,67±0,49	18,53±0,36
Interpectineal size, cm	21,94±0,25	20,86±0,20 p<0,010	22,70±0,46	21,10±0,37 p<0,050
External conjugate, cm	14,96±0,16	13,33±0,14 p<0,001	15,37±0,32	13,83±0,26 p<0,010
Skinfold thickness below the shoulder blade, mm	8,63±0,64	4,63±0,16 p<0,001	9,89±1,27	5,34±0,53 p<0,010
Skinfold thickness of posterior surface of shoulder, mm	12,94±0,54	8,02±0,29 p<0,001	13,79±0,82	7,64±0,61 p<0,001
Skinfold thickness of anterior surface of shoulder, mm	7,14±0,49	4,03±0,22 p<0,001	7,80±0,76	4,68±0,92 p<0,050
Skinfold thickness of posterior surface of forearm, mm	6,84±0,35	4,64±0,18 p<0,001	7,55±0,65	4,61±0,61 p<0,010
Skinfold thickness of anterior surface of forearm, mm	6,66±0,39	3,67±0,16 p<0,001	7,48±0,59	3,93±0,51 p<0,001
Skinfold thickness of stomach, mm	13,16±0,93	5,86±0,44 p<0,001	14,64±1,40	6,91±1,03 p<0,001
Skinfold thickness of hip, mm	15,34±0,56	8,31±0,25 p<0,001	16,69±0,90	8,41±0,55 p<0,001
Skinfold thickness of calf, mm	12,30±0,40	7,62±0,28 p<0,001	13,14±0,71	7,53±0,50 p<0,001
Body weight, kg	32,24±1,03	29,25±0,60 p<0,050	35,04±1,84	29,77±1,14 p<0,050
Body fat mass, kg	7,15±0,43	3,77±0,15 p<0,001	8,51±0,83	4,04±0,45 p<0,001
Weight-height index, gr/cm	230,10±6,64	214,71±3,41 p<0,050	247,04±11,77	217,07±6,87 p<0,050

Table 2 Statistically significant differences of parameters (M±m) of 10-year-old athletes and non-athletes sexual development

Parameter	Control group (n=36)	Women gymnasts (n=36)	Control group (n=15)	Women acrobats (n=15)
Ma, points	0,83±0,15	0,07±0,05 p<0,001	1,04±0,23	0,16±0,11 p<0,010
P, points	0,08±0,03	0,00±0,00 p<0,010	0,06±0,04	0,00±0,00
Ax, points	0,09±0,04	0,00±0,00 p<0,05	0,11±0,06	0,00±0,00
Me, points	0,00±0,00	0,00±0,00	0,00±0,00	0,00±0,00
Total point of sexual development	1,01±0,19	0,07±0,05 p<0,001	1,21±0,27	0,16±0,11 p<0,010

It will be coordinated with other researches [14]. This regularity is explained by the same reasons, as lower body weight in athletes [4] (including selection of girls with the constitutional caused delayed puberty [10]). Decrease in body weight is serious risk factor of delayed puberty. Percentage of fats which is source of estrogen in organism decreases in this case. Menarche is possible only when girl achieves a certain body weight (44,0-47,0 kg) [12].

Degree of training load also influences on the change rate of sexual development. In literature it is noted that 5-7 hours of physical load in week in teenagers caused delayed puberty. Regular loads over 8 hours a week delayed release of follicular hormones. Increase in load to 10-15 hours cause delay and violation of sexual development [34]. Such load is observed in gymnasts and acrobats in our research. It is not considered as considerable load [12]. For gymnasts in the prepubertal and pubertal periods loads over 18 hours a week are considered training loads of high intensity [35]. Therefore, even loads, usual for training process (10-15 hours a week) delay puberty.

One of criteria of correct sexual development is strict sequence of development of secondary sexual characteristics. In a norm puberty starts with development of mammary glands (thelarche) [6]. It is observed in athletes in our research. They have low degree of thelarche, than in non-athletes. The age of thelarche in studied athletes is within the limits of physiological norm (8-11 years).

Degree of development of pubis pilosis and pilosis of axillary crease in athletes is not observed. It is within age norm of secondary sexual characteristics development [10].

Athletes have decreased values of sexual development parameters (thelarche, axillarche, pubarche). It is possible to assume that menarche will happen later, than in non-athletes. It is confirmed by data of authors who note higher age of menarche in gymnasts – 14,3-15,2 years (later on 1,2-1,3, than in non-athletes) [15].

Conclusions

1. It was determined the number of statistically significant differences of physical development of athletes (32 of 59 parameters) in comparison with equal in age athletes which witnesses about more asthenic somatotype.
2. Physical development of 10-year-old gymnasts and acrobats delays of age norm. It witnesses about asthenic influence of sport activities and is explained by early (on 1,21) start of gymnastic activities.
3. Rates of sexual development and development of mammary glands (in gymnasts and acrobats), rates of axillary and pubic pilosis (in gymnasts) delay in comparison with non-athletes. It witnesses about retarded influence of sport activities.
4. Athletes have correct sexual development, and development of secondary sexual characteristics in within age norm.
5. Rhythmic gymnastics and acrobatics trainings cause delay of physical development and sexual development in 10-year-old girls that is negative for reproductive health.

Conflict of interests

The authors declare that there is no conflict of interests.

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