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ABSTRACT

Twenty female gymnasts between the ages of twelve and fourteen were tested to determine possible difference in strength and flexibility before and after the development of an active menstrual cycle. Results indicate that females participating in gymnastics on a seriously competitive level tend to be short and light for their ages, as well as to develop the physical characteristics of adolescence later than females who do not compete on that high level. No relative changes in strength and flexibility were found. (LH)

STRENGTH AND FLEXBILITY IN GYMNASTS BEFORE AND AFTER MENARCHE

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The dominant theme of motor development in childhood and adolescence in regard to many variables, such as strength or muscle endurance, has been that with physical growth comes an improvement in motor performance. An exception has been some measures of motor performance by adolescent girls after puberty. For example, the mean time for the 600 Yard Run in the AAHPER Youth Fitness Test (1976) rose after age 15 in both the 1965 and 1975 scores. Of course, these data have often included a cross-section of adolescent girls, many of whom are less active in later adolescence. More than ever before, adolescent girls are now maintaining vigorous training throughout adolescence. While we know that girls accumulate body fat at puberty, we have little data on the changes in strength and flexibility which may accompany physical changes around the time of menarche, especially in girls maintaining vigorous training.

The purpose of this study was to: first, compare the performance on strength and flexibility tasks of a group of gymnasts who have reached menarche with that of a group of gymnasts who have not, and second, to report the approximate age of menarche for girls seriously participating in gymnastics but not at the level of national competition.

Procedures

The subjects of this study were tested during a wekk-long gymnastics day camp at the University of Missouri--St. Louis in 1978 and again in 1979, but all were members of local gymnastics clubs and participated in the sport year-round. Twenty of the gymnasts between 12 and 14 years of age tested in 1978 returned to the camp in 1979. During the intervening year, 10 of the gymnasts reached menarche and 10 did not. The pre-menarche group averaged 14.2 years (SD = .4) in 1979 and an ability level of 4.4 on a 5-point scale. The post-menarche group averaged 14.4 years (SD = .4) in 1979 and 4.3 on the ability scale. Although the number of girls tested is small, this occurrence offered a unique opportunity to look at anthropometric, flexibility, and strength measures in these groups which were close in age and ability level. The post-menarche gymnasts reported that they trained an average of 7.8 hours/week while the pre-menarche gymnasts reported training 6.8 hours/week.

The anthropometric measures taken on the gymnasts were standing height, body weight, upper arm girth (midway between elbow and shoulder, flexed biceps), and waist girth. A tricep skinfold and subscapular skinfold measure were also taken with Lange calipers by the same experimenter in both years. Three measurements were made at each site and the average taken. Lean body mass and relative fat were estimated from the equation of Lohman, Boileau, and Massey (1975). Although there may be minor differences between the sexes before puberty, this equation has been shown effective when used with young girls (Rizzo, 1977). One may question whether any single equation is appropriate for measures both before and after menarche, so the lean body mass and percent body fat measures must be interpreted in this light.

Strength testing was performed in two categories: specific and general. The specific tests measured the pulling strength of the arms in three positions. The test, orginally described by Faulkner (1962), is a modification of the arm depressor exercise described by Councilman (1968). Measurements were made at 3 positions using a cable tensiometer apparatus with the subject in a kneeling position. The positions and angles at the elbow were (1) overhead 125°, (2) chest level 90°, and (3) waist level 135°. The best of 3 trials at each position was used to represent a given position.

General tests for muscle strength, power, and flexibility were given. Strength and power evaluation included evaluation of dominant and non-dominant grip strength, and vertical jump. The grip of a hand dynamometer was set for hand size with 3 trials given for each hand. Maximum readings were used. The vertical jump was performed as described by Mathews (1973) and the sit-ups and flexed arm hang as described in the AAHPER Youth Fitness Test (1976). Flexibility was determined for ankle, plantar-dorsiflexion, and shoulder hyperextension, and abduction as described by Munroe and Romance (1975). Trunk flexibility was evaluated as noted in Mathews (1973).

Results and Discussion

Four multivariate analyses of covariance were calculated to test for differences between the groups in 1979, using the 1978 scores as covariates. The four nalyses were conducted on the antrhopometric variables, the flexibility variables, the arm and shoulder strength variables, and on the remaining strength variables. As the summary statistics show (Table 1) there was no significant difference between the two groups in any case. It is possible that some differences were not detected because of the small number of gymnasts. Several differences in the mean scores of the groups (Tables 2-4) will be pointed out because they may warrant further examination with larger groups. The post-menarche gymnasts weighed more than the pre-menarche group both in 1978 and 1979. The "post" group also had larger arm and waist girths, but the difference in waist girth decreased over the year. It may be noted that the pre-menarche gymnasts "gained" on the "post" group in height, as expected, but the difference in weight actually increased. It may also be noted that the post-menarche gymnasts, heavier in weight than the pre-menarche gymnasts showed higher strength performance on the "lat" pull strength tests but weaker performance on the flexed arm hang, where the body weight must be supported.

Table 1

MANOVA SUMMARY STATISTICS, "GROUP" MAIN EFFECT

Dependent Variable Group	Wilk's Criterion	F	df	p
Anthropometric	.03	5.08	6,1	.32
Flexibility	.80	0.43	4,7	.80
Arm, Shoulder Strength	.86	0.28	4,7	.88
Other Strength	.71	0.73	4,7	.60

Table 2

MEAN STRENGTH SCORES

YEAR	GROUP	VERTICAL JUMP(cm)	DOMINANT HANDGRIP (kg)	NONDOM HANDGRIP (kg)	SIT-UPS	FLEXED ARM HANG	OVERHEAD LAT PULL (kg)	CHEST LAT PULL	WAIST LAT PULL
1978	PRE-MENARCHE	40.7	25.5	24.8	43.2	19.7	101.9	32.1	63.9
	POST-MENARCHE	39.9	26.2	25.9	42.3	18.3	105.0	37.6	72.7
	DIFFERENCE	.8	.7	1.1	.9	1.4	3.1	5.5	8.8
1979	PRE-MENARCHE	43.5	28.0	28.6	46.5	22.7	106.8	31.5	79.4
	POST-MENARCHE	42.6	28.6	28.1	42.9	18.9	125.8	38.0	87.3
	DIFFERENCE	.9	.6	.5	3.6	3.8	19.0	6.5	7.9

Table 3

MEAN FLEXIBILITY SCORES

YEAR	GROUP	ANKLE FLEXIBILITY (deg)	TRUNK FLEXIBILITY (cm)	SHOULDER HYPEREX-TENSION (deg)	SHOULDER ABDUCTION (deg)
1978	PRE-MENARCHE	74.0	64.0	53.8	209.1
	POST-MENARCHE	73.3	67.5	55.4	207.3
	DIFFERENCE	.7	3.5	1.6	1.8
1979	PRE-MENARCHE	68.7	65.3	37.4	204.9
	POST-MENARCHE	66.5	69.8	46.5	200.3
	DIFFERENCE	2.2	4.5	9.1	4.6

Table 4

MEAN ANTHROPOMETRIC SCORES

YEAR	GROUP	HEIGHT (cm)	WEIGHT (kg)	ARM GIRTH (cm)	WAIST GIRTH (cm)	LEAN BODY MASS	PERCENT BODY FAT
1978	PRE-MENARCHE	149.8	38.6	22.7	59.3	30.8	20.3
	POST-MENARCHE	153.2	42.9	23.8	62.7	33.4	22.1
	DIFFERENCE	3.4	4.3	1.1	3.4	2.6	1.8
1979	PRE-MENARCHE	155.3	42.9	23.5	61.2	33.5	21.8
	POST-MENARCHE	156.9	47.9	42.9	62.5	36.1	24.5
	DIFFERENCE	1.6	5.0	1.4	1.3	2.6	2.7

The small stature and light weight of skilled gymnasts has been noted in the literature, as well as their tendency to reach menarche later than average. Malina et al (1979) recencly noted that gymnasts participating in the Montreal Olympic games were 14.5 years of age, on the average, at menarche. The gymnasts in the present study appear to confirm these trends, even though they are not at the skill level of National or Olympic athletes. In 1979 the present gymnasts as a group were at the 25th percentile of their age group for stature. The "post" group was at the 35th percentile for weight and the "pre" group at the 18th percentile. On the average, the "post" group reached menarche between 13.4 and 14.4 years of age, while of course, none of the "pre" group had reached menarche by an average of 14.2 years.

Frisch and McArthur (174) have determined that the minimal weight for a particular height for onset of menstrual cycles is indicated by the 10th percentile of fractional body water at menarche. If the 1978 weight-for-height values for the present two groups of gymnasts are calculated, it can be seen that the group mean of the "pre" group is slightly above the 10th percentile line while the "post" group is above the 25th percentile.

In summary, adolescent girls of this sample seriously participating in gymnastics but not at national or international skill level tend to be short and light for their age and tend to be late maturers. No evidence has been found that gymnasts in training decline in their performance on strength and flexibility tasks after menarche compared to pre-menarche gymnasts of similar age. While we typically search for differences between groups, it is interesting to note that strength and flexibility performance was not different for those girls who had reached this very significant maturational landmark but maintained training in gymnastics.

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