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Physical Fitness: Age Changes and Sex Differences Among the Jats of Delhi

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ABSTRACT A well co-ordinated physical fitness regime includes strength, cardio-respiratory endurance, flexibility, agility, speed and balance. Incorporating all these components into the exercise schedule makes the physical fitness program truly beneficial. Considering that physical fitness and health have a symbiotic relationship and that health of the children denotes Nation's prosperity, knowledge of physical fitness and its application is of paramount importance. Selecting a representative sample of 580 Jat school children of Delhi, their physical fitness was assessed by employing physical fitness tests, including AAHPER (American Alliance for Health, Physical Education and Recreation) tests. Both the components of Physical fitness, viz. health related and motor fitness were studied. Health related fitness increases with age in both Jat boys and girls. A clear developmental trend in motor fitness is lacking, as it is controlled by individual skills, practice, etc. Jat boys are stronger than the girls in static, explosive and functional strength. They also outdo girls in the tests of flexibility, shuttle run, fifty yard run, and softball throw. Girls, on the other hand, achieve higher scores in plate tapping and balance flamingo tests. Results of Analysis of variance (ANOVA) show statistically significant sex differences in most of the tests, as well as health related fitness, motor fitness, and total physical fitness, particularly after 12 years of age.

INTRODUCTION

Physical fitness is a highly complex phenomenon. It is the ability to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies (President's Council on Physical Fitness and Sports, 1971). The essential components of physical fitness are strength, cardio-respiratory endurance, flexibility, agility, speed and balance. A number of factors such as somatic, motor, cardio-respiratory and behavioural factors influence the state of physical fitness (Simons et al., 1990). Besides, developmental and socio-cultural approaches also provide useful information for a thorough understanding of physical fitness. Thus, it is proper to be aware of these components before carrying out any physical fitness program.

There is a need to understand the factors that affect the type, duration and intensity of children's physical activity behaviour because childhood physical activity has important health consequences during adulthood (Sallis et al., 1992). The training for attainment of optimum fitness level during the formative years is fundamental for achieving the same during adulthood. Also undertaking moderate activity from an early age is better than to restore fitness abruptly at a later stage in life, when years of inactivity has deteriorated it.

Physical fitness of children was assessed as and when there was a concern for individualised physical education in schools. Somatic and motor development of Belgian boys and girls was studied by previous investigators (Simons, et al., 1978, Ostyn et al., 1980 ; Renson et al., 1980). Age changes in motor fitness were studied on European children by the Council of Europe (Simons and Renson, 1982). Physical fitness of Canadian children was examined by Shephard and his colleagues (Shephard et al., 1986). Physical growth, maturation and performance in Flemish girls were studied in detail by various authors (Beunen et al., 1988; Claessens et al., 1990; Simons et al., 1990). Age changes and sex differences in physical fitness of Hungarian children were studied by Eiben and his colleagues (Eiben et al., 1991). Age changes and sex differences in motor skills during childhood and adolescence were also assessed by previous investigators (Merni et al., 1981; Branta et al., 1984; Kemper et al., 1985). Reference data thus obtained were used as a clinical tool in primary health care, endocrinology and in the formulation of National policy on growth and

development of children. These studies also motivated the youngsters to practice regular exercise for maintaining fit and healthy body.

AIMS AND OBJECTIVES

Keeping this in mind, the present study was designed to study physical fitness in Jat children and adolescents inhabiting the outskirts of Delhi. Jats are known for their good health and strong physique. Earlier they consumed plenty of milk and milk products and their diet was rich in protein and fat, though most of them were totally vegetarian. Regular exercise along with nutritious diet, helped them in maintaining healthy body. But gradually, with the modern living style, particularly in the members who have migrated to the urban areas, consumption of milk and its products has drastically decreased. Along with the change in the dietary habits, there is also a reduction in exercise. Consequently, the state of their physical fitness is deteriorating. Therefore, the basic objective of the present study, is to assess the physical fitness in Jats and highlight its importance in maintaining good health. The aims of the study are to

1) evaluate age changes and sex differences in physical fitness tests in Jat boys and girls in the age range of 10 to18 years;
2) study age changes and sex differences in the components of health related fitness, motor fitness and total physical fitness in Jats; and
3) emphasise the benefits of remaining physically fit in the youngsters, and impart them knowledge for incorporating various components of health related fitness and motor fitness in their exercise schedules.

MATERIALS AND METHODS

A cross sectional sample of five hundred eighty (580) Jat school children (Boys=308, Girls=272) in the age range of 10 to 18 years was selected for the present study. Physical fitness measurements were taken by visiting eight government-run schools in the Jat predominant areas of the National capital Territory of Delhi. Table 1 depicts age and sex wise distribution of the sample.

Jats are industrious cultivators having strong perseverance skills. They claim that due to their traditional skills, they are the 'Martial race' and the greatest warriors of all times. The institution of *Panchayat* and the custom of marrying the widow of the elder brother are the characteristic features of the Jats. Jat is an endogamous caste group, who practice 'gotra' (subcaste) exogamy. Jats are the inhabitants of Punjab, Haryana, Rajasthan and Delhi. The present study was conducted in the Jat dominated areas on the outskirts of Delhi.

Table 1: Age and sex-wise distribution of the sample of study

Age Cohort	*Boys*	*Girls*	*Total*
9.500-10.500	27	27	54
10.500-11.500	26	40	66
11.500-12.500	37	33	70
12.500-13.500	36	35	71
13.500-14.500	35	25	60
14.500-15.500	46	33	79
15.500-16.500	40	27	67
16.500-17.500	34	26	60
17.500-18.500	27	26	53
Total	308	272	580

Information was collected on subject's socio-cultural background, family history of physical activity, parental account, nutritional intake and subject's physical activity level. AAHPER (American Alliance for Health, Physical Education, and Recreation) Youth Fitness Test Battery (1976) was employed with a few additions to assess physical fitness. The AAPHER tests included pull ups for boys/ flexed arm hang for girls, standing broad jump, shuttle run, fifty yard run, and six hundred yard run walk tests. In addition, hand grip strength of both hands, Harvard's step test, sit and reach, softball throw, plate tapping, and balance flamingo stand tests were also administered. The suggestions forwarded by earlier investigators (Renson et al., 1980; Council of Europe, 1988; Claessens et al., 1990) were considered for the proper administration of the tests. A brief description of the tests is provided below.

Grip Dynamometer Tests: Using grip dynamometer, hand grip strengths of right and left hands of subject were measured thrice. Best of the three readings was recorded as the score, in kilograms. The scores were recorded separately for the right and the left hand.

Standing Broad Jump: Standing with feet

approximately 10 cm apart and the toes just behind the take off line, subject was asked to jump vertically forward with the arms swinging backward and the knees bent. The jump was accomplished by simultaneously extending the knees and swinging the arms forward. The best of the three trials was noted as the distance, in cm, between take off line to the posterior part of the heel (where it touched the ground) of the foot nearest to the take off line, and this was taken as score.

Pull Ups (For Boys Only): For pull ups, a metal or wooden bar approximately 4 cm in diameter was fixed high enough so that subject could hang with arms and legs fully extended and feet off the floor. After assuming the hanging position, subject raised his body by his arms until his chin was placed over the bar and then lowered his body to a full hang as in the starting position. Subject was asked to repeat the event as many times as possible and the number of completed pull ups were recorded as score. This test was conducted on boys only. In case of girls, as an alternate, flexed arm hang has been recommended and taken in the present study.

Flexed Arm Hang (For Girls Only): Flexed arm hang in girls was employed using a horizontal metal or wooden bar approximately equal to subject's standing height. Subject was asked to hang on the bar with the elbows flexed, and raise her body off the floor to a position where the chin was above the bar, and the chest close to the bar. Subject was asked to hold this position as long as possible and the length of the time subject held this position was recorded in seconds and taken as score.

Sit-ups: For the sit-up test subject was asked to lie on his/ her back with knees bent, feet on the floor and heels about 25-30 cm away from the buttocks. Having an angle of less than 90 degrees at the knees, subject was asked to put hands on the back of his/her neck with fingers clasped and elbows placed squarely on the floor. The feet were held by his/her partner to keep them in touch with the floor. Subject was asked to tighten his/her abdominal muscles and bring his/her head and elbows forward as he/she curled up, finally touching elbows to knees. Subject returned to the starting position with the elbows on the surface. This action constituted one sit-up. The number of correctly operated sit-ups performed in 60 seconds were recorded as score, using a stopwatch.

Six Hundred Yard Run-walk: After marking the track, preferably a square field measured accurately to assess the rounds required to cover a distance of 600 yards (548.64 m approx.), subject was asked to start running at the signal, 'Ready? Go!'. To avoid over exhaustion, subjects were allowed to intersperse the run with walking, but they were explained that the primary objective was to cover the distance in the shortest possible time. A stopwatch was used to record the time in minutes and seconds. More was the time taken to cover the distance, poorer was the performance. Hence, in order to provide similar direction to result of this test as in case of other tests (where increase in score signified better performance), scores of all the run tests were recorded in terms of the speed (m/sec), in the present study. Speed (m/sec) was calculated by dividing the distance travelled with the time taken to cover the distance.

Harvard Step Test: Subject was asked to step on and off a bench, 20 inches (50.8 cm approx.) high for boys and 17 inches (43.2 cm approx.) for girls, 30 times a minute, for five minutes, or until he/she was unable to maintain the pace. Care was taken that subject did not have any heavy meal at least half an hour before or after the test. Duration of exercise in seconds was recorded and after stopping the exercise, subject was allowed to relax for one minute. Thereafter, the pulse count was recorded between 1-11/2 minutes after exercise, using a stopwatch. Rapid fitness index (RFI) was calculated as follows:

$$\text{RFI} = \frac{\text{Duration of exercise (in seconds)}}{5.5\,(\text{Pulse Count} - 1\tfrac{1}{2}\text{ min. after exercise}}$$

Sit and Reach: Subject was asked to sit firmly against a vertical support with the knees extended in front. Buttock leg length, the horizontal distance between the vertical support and subject's feet was noted using a steel tape. Thereafter, subject was asked to touch with both arms, the feet extended before him/ her. Buttock arm reach length, the horizontal distance between the vertical support and the point of maximum arm reach was also recorded. Flexibility of the

individual was calculated by using the method suggested by Claessens et al. (1990) which is as under:

Flexibility = 15 - (Buttock leg length - Buttock arm reach length)

Shuttle Run: Two parallel lines were marked on the floor 30 feet (9.14 m approx.) apart. Two blocks of wood of dimension 5cm × 5cm × 10cm, were placed behind one of the lines, and subject started from behind the other line. On the signal, 'Ready? Go!', subject ran to the blocks, picked one up, ran back to the starting line, and placed the block behind the line. He/ she then ran back and picked up the second block, which was carried back across the starting line. Time taken to complete this procedure was noted in seconds as the score, using a stopwatch. Speed (m/sec) of shuttle run was calculated by dividing the distance covered (9.14 m) with the time taken and was the modified score.

Plate Tapping: In standing position, subject was asked to touch alternately and as quickly as possible, two plates of 20 cm diameter placed 60 cm apart on the same level, for 20 seconds. The score was recorded as the total number of taps in 20 seconds.

Fifty Yard Run: After marking a distance of 50 yards (45.5 m approx.), subject was asked to start with the command, 'Ready? Go!'. Using a stopwatch, the time taken in seconds, taken to cover the distance was recorded. Speed (m/sec) of the run was calculated by dividing the distance covered (45.5 m) with the time taken in seconds to cover the distance.

Softball Throw: Subject was asked to throw overhand as far as possible a standard softball having 12 inches (30.48 cm approx.) circumference from behind the take off line. The throw was measured from the take off line to the point of landing. Three throws were allowed and the score was the farthest of the three throws measured to the nearest centimetre.

Balance Flamingo Stand: Subject was asked to balance on a beam (50 cm long, 4 cm high and 3 cm wide) for one minute with the preferred foot on the longitudinal axis of the beam and the other leg bent backward and held by the hand of the same side at the foot level. The score was obtained by dividing 60 with the points (number of times) at which subject stepped off the balance flamingo stand in one minute.

Since the raw scores of the afore-mentioned tests differed in their direction and magnitude, it was not appropriate to combine (add) these raw scores for the estimation of either total physical fitness or its components. Therefore, the raw scores were converted into the standardised scores-Z Scores for all the tests. Standardized score is expressed in terms of standard deviations from the mean. A Z score converts the raw scores to a mean of 0 and to a standard deviation of 1.0. Z Scores were calculated using the formula :

$$Z = (X - M) / S$$

where, Z is the Z Score , X is the raw score of an individual in a physical fitness test, M and S are respectively the mean and the standard deviation of the score for that particular test calculated for the total sample.

Table 2: Physical Fitness: Individual tests and components

Components	*Tests*
Health related Fitness	
Strength	
Static	Right hand grip strength
	Left hand grip strength
Explosive	Standing broad jump
Functional	Pull ups (boys)/Flex arm hand (girls)
	Sit-ups
Cardio-resp. endurance	Six hundred yard run-walk
	Harvard step test
Flexibility	Sit and reach
Motor Fitness	
Agility	Plate tapping
	Shuttle run
Speed	Fifty yard run
	Softball throw
Balance	Balance flamingo stand

Components of physical fitness were assessed by combining the standard scores (Z Scores) of one or more tests specified for its determination (Table 2). For example, strength was determined by adding the Z scores of static, explosive and functional strengths. Static strength comprised the total of Z scores of right hand and left hand grip strengths. Explosive strength contained Z score of standing broad jump test results. Similarly, functional strength was determined by combining the Z scores of pull up test (for boys)/ flexed arm hang test (for girls) and sit-up test. Reliability of the tests to be considered for

determining a particular component of fitness was validated in earlier studies (Malina et al., 1985 ; Dinucci et al., 1990). Table 2 provides a detailed account of these components of physical fitness along with the list of the tests which are used in their evaluation. Health related fitness comprised a total of the Z scores of strength, cardio-respiratory endurance and flexibility. Motor fitness, on the other hand, comprised the sum of the Z scores of agility, speed and balance. The Z-scores of all the tests of physical fitness were added to record the total physical fitness score of a subject.

Age group wise mean values of the test scores along with their standard errors, were calculated separately for boys and girls. ANOVA (analysis of variance) was used for calculating sex differences. 5% probability was taken as the level of significance.

RESULTS AND DISCUSSION

Grip strength of both right and left hands increases with advancement in age, from10 to18 years, in Jat boys and girls (Fig.1 and Fig. 2). Boys are stronger in grip strength than the girls in all the age groups. Grip strength in boys and girls is nearly the same before 12 years, thereafter, grip strength increases faster in boys than in girls. Between 16 to 17 years, girls show a decline in values, while the boys continue to increase their performance with age. Grip strength of the left hand is found to be lower than that of the right hand. Nath and his colleagues found similar age trends in muscular strength among the Punjabis of Delhi (Nath et al., 1979). Significantly better performance of males in hand grip tests than the females were also reported while measuring occupational motor fitness in nurses (Zinzen et al., 1995).

Fig. 3 depicts that broad jump performance in Jat boys improves remarkably with age, whereas in girls this trend is not so clear. In Flemish girls, however, standing broad jump performance was found to increase with age (Simons et al.,1990). Between 10 to 12 years the sex difference in this trait is not conspicuous, but after 12 years, Jat boys have significantly higher values than girls of the corresponding age group. The increase in boys is much faster than in girls, specially after 12 years.

Fig. 1. Right hand grip strength in Jat boys and girls

Fig. 2. Left hand grip strength in Jat boys and girls

Boys did more sit-ups per minute than girls (Fig. 4). After a steady increase in values between 10 to 12 years, a decline in the speed is perceptible between 12 to 13 years in both the sexes. Thereafter, boys improve their performance rapidly, while the girls do so at a slower pace.

Average number of pull ups increase with an increase in age in Jat boys, except between 14-15 and 16-17 years (Fig. 5). Boys of 11 to 12 years age group show poor performance whereas, boys of 12 to 14 years perform much better. The time for maintaining the flexed arm hanging position in Jat girls increases with age till 14 years (Fig. 6). Between 14 to 17 years,

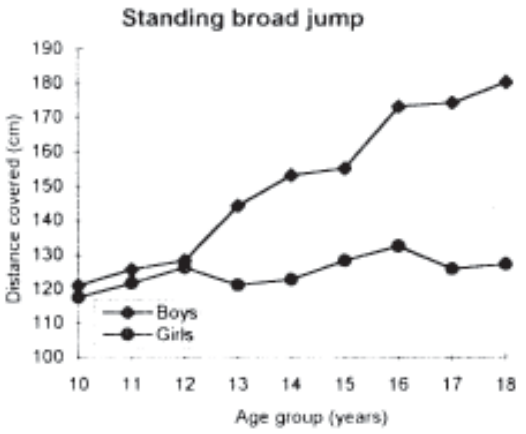

Fig. 3. Standing broad jump in Jat boys and girls

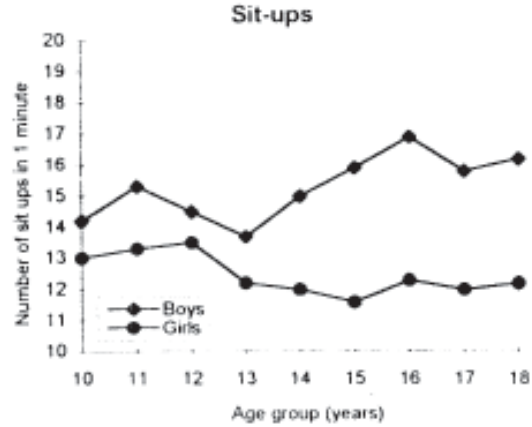

Fig. 4. Number of Sit-ups in one minute in Jat boys and girls

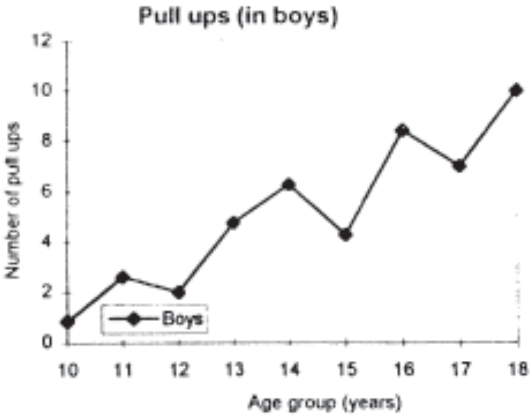

Fig. 5. Pull ups in Jat boys

there is a slight decline in performance. Thereafter, an improvement is observed between 17 to 18 years. Beunen et al. (1997) found that body mass plays an important role in maintaining the flexed arm hanging position in girls. Motivation and co-operation can also boost them to score higher in this test.

Rapid fitness index (RFI), as calculated from the Harvard's step test, determines the ability of a person to recuperate after exercise. It is the maximum in 13 year old Jat children (Fig.7). It is higher in Jat boys than in girls. In the initial age groups, not much difference is observed between boys and girls, but as the age advances, the difference becomes prominent. Running

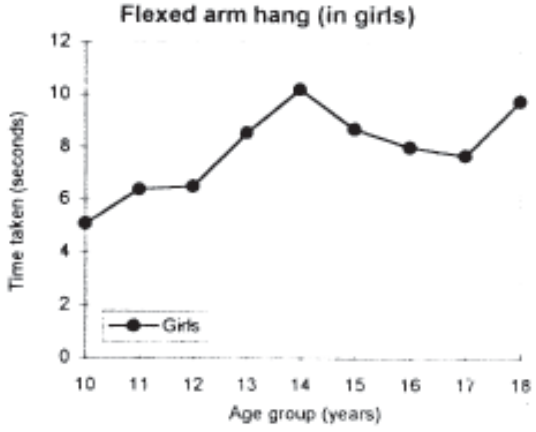

Fig. 6. Flexed arm hand in Jat girls

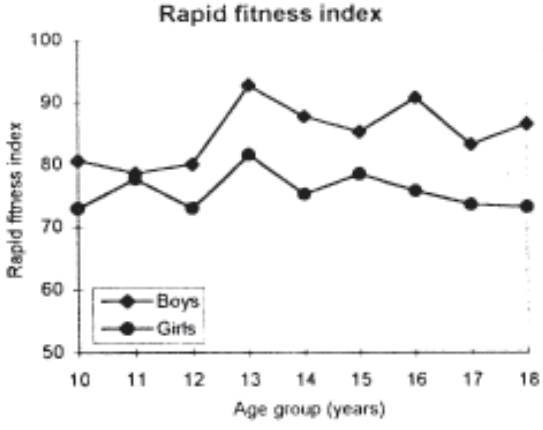

Fig. 7. Rapid fitness index in Jat boys and girls

speed increases with age in boys, whereas it is not so in girls (Fig. 8). Jat girls run faster than boys till 13 years of age, as observed from the result of six hundred yard run walk test. Girls of the following age groups run much slower than the boys.

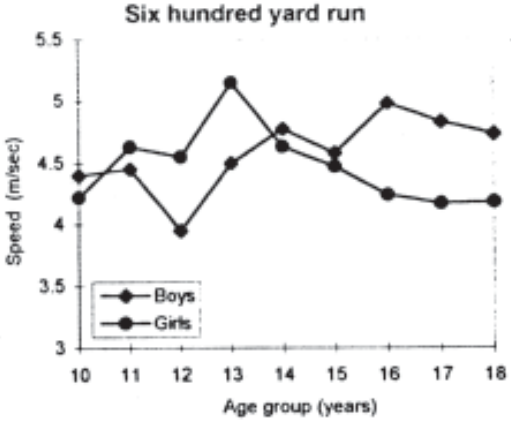

Fig. 8. Speed of six hundred yard run in Jat boys and girls

The flexibility improves with age in Jat boys, whereas it declines in girls (Fig. 9). Boys are found to be more flexible than the age-matched girls. According to the flexibility scores, as calculated from sit and reach test, boys of 12 and 18 years are the most flexible. The younger girls are more flexible than the older ones. While the Jat boys indulge more in outdoor activities and other physically strenuous tasks, Jat girls are shy by nature and do not take active part even in hard physical activities at school. Coupled with this, accumulation of fat results in decreased flexibility in girls.

The speed of shuttle run in Jat boys improves as they advance in age (Fig. 10). No age specific trend is, however, exhibited by the girls. Boys run much faster than girls after 12 years of age. The result of plate tapping test portrays a general improvement in performance with age in Jat boys and girls (Fig. 11). Sex differences in plate tapping scores are not much marked. Till 14 years, boys perform slightly better than girls, but thereafter girls have better scores.

The speed of fifty yard run improves with increase in age in Jat boys and girls (Fig. 12). This increase is faster in Jat boys than in Jat girls, specially after 12 years of age. Girls show a

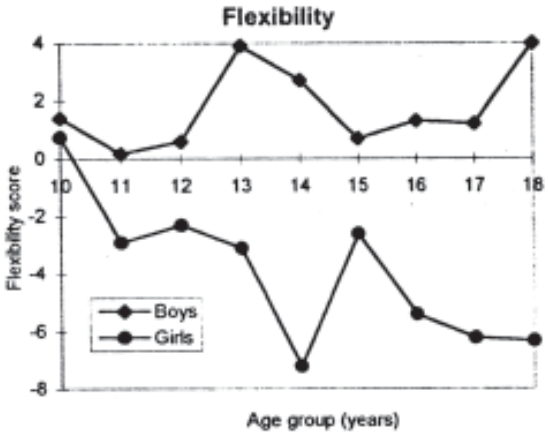

Fig. 9. Flexibility score in Jat boys and girls

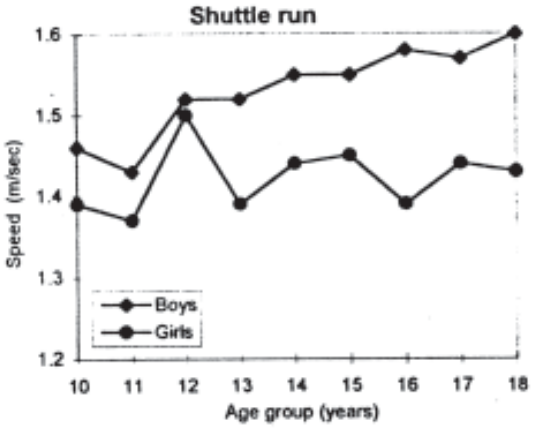

Fig. 10. Speed of shuttle run in Jat boys and girls

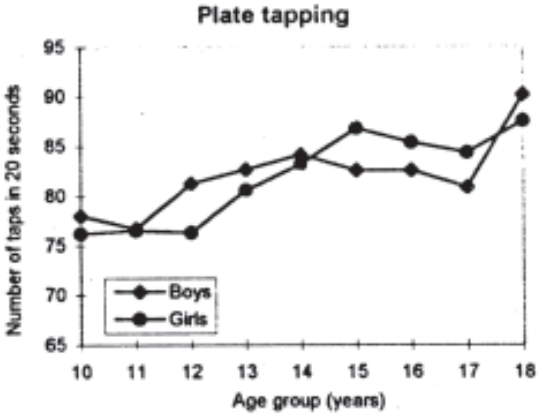

Fig. 11. Speed of limb movement in Jat boys and girls

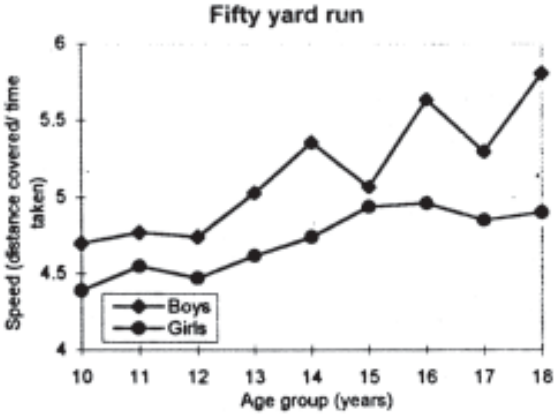

Fig. 12. Speed of fifty yard run in Jat boys and girls

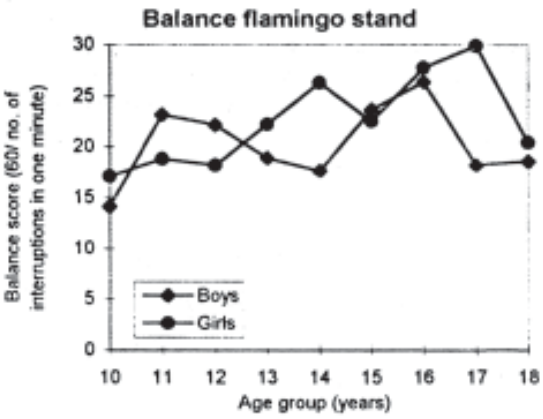

Fig. 14. Balance in Jat boys and girls

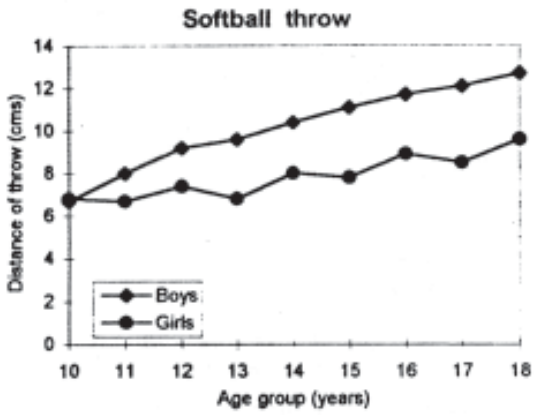

Fig. 13. Softball throw in Jat boys and girls

steady but slow advancement in speed with age. Starting from the same level, Jat boys display better throwing ability than the girls after 12 years of age, as evident from the results of softball throw for distance test (Fig. 13). Nelson and his colleagues (Nelson et al., 1986) observed a combination of body composition and familial environment to be responsible for the difference in throwing performance of boys and girls. Jat girls have better balancing skills than boys (Fig. 14). While the boys show a continued decline in score between 11 and 14 years of age, girls show considerable improvement between 15 to 17 years.

Table 3 provides the analysis of variance (ANOVA) results for sex differences in the physi-

Table 3: Sex differences in Physical fitness tests in various age groups using ANOVA

Age	*Physical Fitness Tests (F Values)*											
groups	*Grip strength (R)**	*Grip strength (L)**	*Broad jump*	*Sit-up*	*600 yard run*	*RFI*	*Sit and reach*	*Plate tapping*	*Shuttle run*	*Fifty yard run*	*Softball throw*	*Balance Flamingo*
10	0.43	0.67	0.76	3.63	1.48	4.16	0.18	0.55	2.52	1.55	0.03	0.01
11	1.59	0.13	0.87	9.63	0.17	0.05	4.18	0.01	2.72	0.67	6.93	0.12
12	0.65	1.80	0.20	3.44	2.43	4.75	4.38	3.99	0.16	13.38	13.38	1.50
13	25.11	21.80	30.83	5.88	6.63	7.12	11.04	1.01	16.82	4.95	54.38	8.38
14	10.30	10.00	45.52	23.40	0.03	13.14	24.39	0.18	8.01	5.48	31.35	9.83
15	22.79	22.98	35.62	42.60	0.35	3.97	3.07	4.97	8.42	1.25	61.23	1.62
16	42.35	45.09	47.26	48.56	31.95	13.35	9.42	3.18	28.95	6.54	44.15	9.71
17	103.97	84.62	92.76	35.41	25.42	10.77	13.84	2.27	10.20	6.16	72.24	13.12
18	132.00	154.34	94.89	22.09	13.29	16.54	24.54	2.16	15.31	3.74	25.71	3.51

Underlined values of F (Analysis of variance) are significant at 5% probability
*(R) and (L) denote right and left hand respectively

cal fitness tests. It is clear from the table that in most of the tests, in the initial age groups of 10 to 12 years, sex differences are small and non-significant, but become significant after 12 years of age. Previous studies showed that differences in body size and proportion between the sexes accentuated with the attainment of puberty and its associated hormonal changes (Guyda, 1986 ; Simons et al., 1990). According to Lieberman (1982), these differences in body size and composition are primarily due to the effects of androgens acting upon the individual's preadolescent physique. The crucial interaction between body composition and energy expenditure was found to be of considerable consequence in physical fitness evaluation of children and adults (Parizkova, 1973). Rowland (1996) explained the gender-related differences in physiological responses to physical fitness exercises through sex differences in body composition. There is a marked change in body composition during puberty. Girls accumulate body fat, whereas boys increase their muscle mass. The relationship between the size of the body "motor" (i.e. exercising muscle mass) and the "baggage" (body fat) which it is obliged to carry, is of utmost importance in fitness related studies. This relationship changes both with age and sex. Thus, age and sex related differences in physical fitness accrue (Shephard, 1986). Jats are usually conservative in their attitude as far as women are concerned.. Jat girls are shy by nature and apart from doing household chores, they do not venture into arduous tasks. Due to this, the girls are physically less active. In contrast, the boys are encouraged to build up their bodies by participating in sports and other activities. The Jats claim themselves to be of the 'Martial race', and have been known since ages for their active participation in serving the Nation, by joining the defence services. In order to accomplish this dream, they realise the importance of being physically fit. Therefore, boys are taught to maintain their bodies since childhood, whereas it is not so in girls. In this study, a steady improvement in boys' fitness over that of the coeval girls' is in consonance to this practice.

According to a recent viewpoint, physical fitness has two dimensions viz., health related fitness and motor fitness (Dinucci et al., 1990; Malina, 1994; Malina et al., 1995). The same perspective was taken in the present study. Health related fitness and motor fitness and their components were evaluated from various physical fitness tests (Table 2). Health related fitness comprises strength, cardio-respiratory endurance and flexibility as components, whereas motor fitness includes agility, speed and balance.

Strength is further classified as static, explosive and functional strengths. Static strength increases with advance in age (Table 4). Body size was found to be the best predictor of static muscular strength in boys and girls in a study on the complexity of the interrelationships between body size, biological maturation, strength and motor fitness in 7-12 year old children (Kartzmarzyk et al., 1997). Static, explosive and functional strengths are higher in boys than in girls, particularly after 12 years of age.

Table 4: Static strength, Explosive strength and Functional strength by age and sex

Age	*Static strength*					*Explosive strength*					*Functional strength*				
groups	*Males*		*Females*		*ANOVA*	*Males*		*Females*		*ANOVA*	*Males*		*Females*		*ANOVA*
	Mean	*S.E.*	*Mean*	*S.E.*	*(F value)*	*Mean*	*S.E.*	*Mean*	*S.E.*	*(F value)*	*Mean*	*S.E.*	*Mean*	*S.E.*	*(F value)*
10	-1.90	0.17	-2.12	0.15	0.55	-0.65	0.09	-0.78	0.10	0.76	-1.00	0.18	-0.67	0.20	1.36
11	-1.70	0.14	-1.80	0.10	0.72	-0.48	0.11	-0.63	0.10	0.87	-0.25	0.17	-0.35	0.21	1.08
12	-1.30	0.13	-1.60	0.14	1.23	-0.38	0.13	-0.46	0.09	0.20	-0.62	0.12	-0.24	0.19	2.62
13	-0.07	0.22	-1.32	0.09	25.11	0.18	0.11	-0.65	0.09	30.83	-0.28	0.30	-0.34	0.23	0.02
14	0.71	0.23	-0.36	0.20	10.52	0.51	0.10	-0.58	0.11	45.52	0.47	0.27	-0.07	0.36	1.47
15	1.39	0.23	-0.10	0.15	23.72	0.58	0.12	0.38	0.07	35.62	0.30	0.21	-0.49	0.23	6.04
16	2.48	0.21	0.35	0.22	45.42	1.24	0.14	-0.23	0.14	47.26	1.54	0.29	-0.40	0.25	22.04
17	2.83	0.22	0.01	0.13	98.04	1.28	0.12	-0.47	0.13	92.76	0.88	0.22	-0.57	0.26	17.83
18	3.51	0.22	0.20	0.14	149.18	1.50	0.17	-0.42	0.09	94.89	1.67	0.28	-0.13	0.20	26.28

Values of Mean and S.E. (Standard error) are based on Z Scores (Standardized Scores)
Underlined values of F (Analysis of variance are significant at 5% probability leve
*Static, Explosive and Functional strengths are the components of Strength

Strength, a combination of static, explosive and functional strengths, increases with age in Jat boys and girls (Table 5). Boys above the age of 12 years are stronger than the coeval girls. Apart from the biological factors, the socio-cultural factors also influence sex differences in strength. Therefore, girls have lower strength than the age-matched boys. The improvement in scores with age is slower in girls as compared to that in boys.

Flexibility comprises a range of motions at joints through which the limbs are able to move. It is an important component of physical fitness even when the focus of a training program is to increase muscle strength and endurance. Flexibility movements usually act as good 'warm-up' and 'cool-down' exercises. It also helps in avoiding injury due to sudden strain or movement of limbs. Lack of flexibility is often implicated in the development of acute and chronic

Table 5: Strength, Cardiorespiratory endurance and Flexibility by age and sex

Age	*Strength*					*Cardiorespiratory endurance*					*Flexibility*				
groups	*Males*		*Females*		*ANOVA*	*Males*		*Females*		*ANOVA*	*Males*		*Females*		*ANOVA*
	Mean	*S.E.*	*Mean*	*S.E.*	*(F value)*	*Mean*	*S.E.*	*Mean*	*S.E.*	*(F value)*	*Mean*	*S.E.*	*Mean*	*S.E.*	*(F value)*
10	-3.61	0.31	-3.59	0.33	0.00	-0.18	0.20	-0.81	0.28	3.13	0.27	0.12	0.19	0.14	0.18
11	-2.45	0.26	-2.86	0.28	0.95	-0.26	0.27	-0.12	0.28	0.12	0.12	0.13	-0.25	0.12	4.18
12	-2.38	0.25	-2.31	0.26	0.03	-0.71	0.27	-0.52	0.35	0.19	0.18	0.12	-0.18	0.11	4.38
13	-0.17	0.51	-2.32	0.32	12.16	0.70	0.21	0.68	0.22	0.00	0.58	0.18	-0.27	0.17	11.04
14	1.70	0.45	-1.02	0.52	15.33	0.68	0.26	-0.27	0.21	7.09	0.43	0.15	-0.78	0.19	24.39
15	2.29	0.45	-0.98	0.33	28.40	0.31	0.23	-0.24	0.18	3.14	0.18	0.14	-0.22	0.18	3.07
16	5.27	0.51	-0.28	0.47	56.82	1.11	0.25	-0.67	0.18	25.91	0.26	0.19	-0.55	0.15	9.42
17	5.00	0.42	-1.00	0.43	96.47	0.44	0.16	-0.89	0.13	36.39	0.25	0.18	-0.66	0.14	13.84
18	6.69	0.49	-0.35	0.32	140.44	0.55	0.24	-0.91	0.16	23.69	0.59	0.22	-0.67	0.12	24.54

Values of Mean and S.E. (Standard error) are based on Z Scores (standardised scores)
Underlined values of F (analysis of variance) are significant at 5% probability
*Strength, Cardiorespiratory endurance and Flexibility are the components of Health related fitness

Cardio-respiratory endurance is considered as the most important aspect of physical fitness. It is the ability to take in, transport and utilise oxygen. In this study, it was estimated from simple performance tests. It was evaluated by adding the Z scores of the speed of six-hundred yard run walk test, and rapid fitness index calculated from Harvard's step test. Boys of 16 years age group and the girls of 13 years age group have the maximum cardio-respiratory endurance (Table 5). Sex differences in cardio-respiratory endurance are discernible after 13 years of age. Mocellin (1971) observed that the sex differences in cardio-respiratory endurance increased somewhat with age and became most apparent at 12 to 13 years. Simons and his co-workers in a study on Flemish children found a consequent steady improvement in cardio-respiratory endurance in boys, whereas in girls it stabilised after 13 years of age (Simons et al., 1990). Body composition also affects cardio-respiratory endurance. Boileau and Lohman (1977) reported a decline in the cardio-respiratory endurance with an increase in body fat in children.

injuries such as lower back problems. Flexibility was determined by obtaining the Z score of sit and reach test results. It remains relatively unchanged over years in the age range of 10-18 years in Jat boys and girls (Table 5). Significant sex differences in flexibility scores occur at all the age groups, except at 10 and 15 years. Jat boys are more flexible than Jat girls. Earlier studies reported that in the Western countries, girls were more flexible than boys (Merni et al., 1981; Haubenstricker and Seefeldt, 1986 ; Simons et al., 1990 ; Malina et al., 1995 ; Zinzen et al., 1995). As there is an enormous difference in the attitude, lifestyle and social development of the Western and the Indian children, this variation in results of flexibility of boys and girls is possible. However, further studies are required in this direction.

Motor fitness of an individual is discernible by agility, speed and balance (Table 2). Agility was determined by adding the standard scores (Z scores) of speed of shuttle run and plate tapping test. Agility, or the ability to change speed and direction rapidly with precision and without

loss of balance depends on strength, endurance, speed, balance and skill of an individual. Jat children show an overall increase in agility as they advance in age (Table 6). Sex differences in agility are usually marked after 12 years of age.

Speed of movement depends on the combination of two elements- reaction time and movement time. Reaction time is the time taken from the availability of stimulus to the beginning of a movement, whereas movement time is the time required from the beginning of the movement to its completion. A person with a high speed is able to make a series of movements in a short span of time. Speed was determined by adding the Z scores of softball throw for distance and fifty yard run. Speed continues to increase with age in Jat boys (Table 6). In girls, an improvement in speed is noticed between 10 to 12 years of age. Thereafter, no specific age trend is visible. This is in consonance with a physical fitness study on Flemish children by Simons et al. (1990) in which the distribution of speed was found to be rather symmetrical with age, but became asymmetrical during adolescence. Boys gain speed significantly faster than girls. Eiben et al. (1991) found that sex differences in running speed can be observed at 13-14 years and beyond, because the girls no longer improve their performance after this age, whereas the boys show a steady improvement in running performance with an advance in age.

Balance is the maintenance of equilibrium through neuromuscular control. It depends on the ability to use visual information and input from balance receptors located in the eyes, muscles, and inner ear. Only a slight improvement in balancing skill is found with age in Jat boys (Table 6). Girls between 13-17 years of age possess better balancing skills than the younger girls or

Table 6: Agility, Speed and Balance by age and sex

Age	*Agility*					*Speed*					*Balance*				
groups	*Males*		*Females*		*ANOVA*	*Males*		*Females*		*ANOVA*	*Males*		*Females*		*ANOVA*
	Mean	*S.E.*	*Mean*	*S.E.*	*(F value)*	*Mean*	*S.E.*	*Mean*	*S.E.*	*(F value)*	*Mean*	*S.E.*	*Mean*	*S.E.*	*(F value)*
10	-0.55	0.26	-1.09	0.28	1.96	-1.19	0.25	-1.52	0.16	1.19	-0.34	0.18	-0.20	-0.14	0.37
11	-0.83	0.36	-1.23	0.21	1.00	-0.63	0.99	-1.36	0.22	5.12	0.08	0.18	-0.12	0.11	1.05
12	0.15	0.32	-0.51	0.25	2.54	-0.20	0.15	-1.20	0.16	19.70	0.03	0.15	-0.15	0.14	0.78
13	0.30	0.22	-0.65	0.19	10.48	0.28	0.22	-1.25	0.12	34.34	-0.11	0.16	0.03	0.15	0.48
14	0.66	0.19	-0.06	0.25	5.43	1.00	0.20	-0.65	0.15	36.16	-0.18	0.17	0.23	0.20	2.30
15	0.46	0.22	0.33	0.20	0.15	0.91	0.22	-0.49	0.18	20.78	0.10	0.17	0.05	0.18	0.04
16	0.66	0.15	0.12	0.20	9.55	1.82	0.23	-0.06	0.17	34.99	0.23	0.19	0.30	0.17	0.05
17	0.37	0.23	-0.02	0.28	1.11	1.54	0.15	-0.37	0.19	62.66	-0.15	0.17	0.40	0.17	4.93
18	1.55	0.23	0.33	0.27	11.27	2.36	0.37	0.11	0.10	31.84	-0.13	0.24	-0.04	0.18	0.08

Values of Mean and S.E. (Standars error) are based on Z Scores (standardised scores)
Underlined values of F (analysis of variance) are significant at 5% probability
*Agility, Speed and Balance are the components of Motor fitness

Table 7: Health related fitness, Motor fitness and Total physical fitness by age and sex

Age	*Health related fitness*					*Motor fitness*					*Total physical fitness*				
groups	*Males*		*Females*		*ANOVA*	*Males*		*Females*		*ANOVA*	*Males*		*Females*		*ANOVA*
	Mean	*S.E.*	*Mean*	*S.E.*	*(F value)*	*Mean*	*S.E.*	*Mean*	*S.E.*	*(F value)*	*Mean*	*S.E.*	*Mean*	*S.E.*	*(F value)*
10	-3.52	0.39	-4.20	0.56	0.98	-2.09	0.50	-2.83	0.37	1.36	-5.62	0.78	-7.04	0.77	1.64
11	-2.60	0.50	-3.23	0.46	0.82	-1.39	0.48	-2.73	0.37	4.86	-3.99	0.88	-5.97	0.70	3.05
12	-2.91	0.47	-3.01	0.50	0.02	-0.01	0.37	-1.87	0.38	11.74	-2.92	0.71	-4.88	0.71	3.68
13	1.11	0.75	-1.92	0.41	12.28	0.46	0.44	-1.87	0.33	17.19	1.58	1.07	-3.79	0.60	18.66
14	2.82	0.68	-2.08	0.66	24.91	1.47	0.35	-0.48	0.44	12.20	4.30	0.89	-2.57	1.02	25.45
15	2.79	0.68	-1.45	0.43	22.86	1.48	0.39	-0.10	0.39	7.60	4.28	0.95	-1.56	0.66	21.56
16	6.64	0.70	-1.52	0.67	64.26	2.73	0.39	0.11	0.35	21.86	9.37	0.95	-1.40	0.93	59.94
17	5.70	0.48	-2.59	0.57	124.33	1.76	0.33	0.01	0.48	9.53	7.47	0.66	-2.57	0.97	77.28
18	7.85	0.69	-1.93	0.39	148.95	3.78	0.56	0.40	0.39	23.69	11.63	1.02	-1.53	0.56	123.82

Values of Mean and S.E. (Standard error) are based on Z Scores (standardised scores)
Underlined values of F (analysis of variance) are significant at 5% probability level

coeval boys. Sex differences in balance are generally not marked. Thomas and French (1985) found that prior to puberty, girls were superior than boys in balance and co-ordination, but tended to loose this skill as they gained more fat mass in later ages. Besides biological changes, practice can help boys and girls to improve their balancing skills.

Health related fitness shows a positive trend in age changes (Table 7). A clear sexual dimorphism is perceivable after 12 years of age. The girls of age 13 years and above are significantly poorer in health related fitness than the coeval boys. Differences in body size in the boys and girls belonging to different age groups also helped in explaining marked sex differences in the tests of strength, cardio-respiratory endurance and flexibility. Norgan (1994) forwarded same reasons to explain age and sex differences in physical fitness of European children. Besides, Renson and Vanreusel (1990) found that participation in sports activities or other physical activities at school or at home also influenced an individual's performance in these tests. The motor fitness of an individual enables one to perform a skill successfully and precisely. Motor fitness of an individual was determined by adding the Z scores of agility, speed, and balance. As the successful completion of motor fitness test depends on the perfection and accuracy of subject, the age wise improvement in motor fitness, is less evident than in the case of health related fitness (Table 7). Boys are more active than girls in motor abilities. Biological differences may be responsible for the gender differences in motor fitness. The socialisation of Jat boys and girls regarding sports and physical activity is quite different, which also explains these differences.

Total physical fitness score is the sum of standardised scores (Z scores) of all the physical fitness tests. This score reflects the overall physical fitness of an individual, combining both health related fitness and motor fitness. Table 7 depicts a general improvement in total physical fitness scores of Jat boys and girls with an increase in age. Boys achieve higher scores than the girls. The difference in total physical fitness scores obtained by the two sexes become significant after 12 years of age.

CONCLUSION

The scores of physical fitness tests generally increase with age in both Jat boys and girls, but not at the same rate. Boys show faster increase with age than girls in the tests of grip strength, broad jump, sit-ups, rapid fitness index, flexibility, shuttle run, fifty yard run and softball throw. Girls perform either equally or better than boys in six hundred yard run, plate tapping and balance tests. Sex differences in most of the tests are generally statistically significant after 12 years of age.

Among the components of physical fitness, strength, cardio-respiratory endurance, flexibility, agility and speed improve with age in Jat boys and girls. Improvement in performance with age is rapid in boys than in girls in all these components, whereas girls have better balancing skills. Sex differences are significant beyond 12 years of age. Health related fitness of Jat boys and girls demonstrate a clear developmental trend with age. Motor fitness, on the other hand, improves slightly with age. Significant sexual differences in health related fitness and motor fitness of Jats are perceivable after 12 years of age. Sex differences are explainable in terms of post-pubertal changes, body size and composition, social factors, habitual activity and athleticism.

Through this study, Jat children and adolescents were made aware of their current physical fitness status and were also motivated to include various components of physical fitness into their daily exercise schedules in order to maintain good health.

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