Assessment of Nutritional Status and Physical Fitness of Female Swimmers

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Abstract

The aim of the research study was to assess the nutritional status & physical fitness of 37 young female swimmers, aged 10-14 yrs. Only competitive swimmers engaged in regular practice were chosen. Three day's dietary recall method was used to calculate nutrient intake. Body Fat % (BF %) & Lean Body Mass (LBM) were estimated based on total of skinfold measurements at biceps, triceps, subscapular & suprailiac. Majority of the swimmers met standards of body weight for age & height. BF % of swimmers ranged from 10.72 – 35.53 % (3.71 – 20.03 kg). LBM increased with age (24.52 ± 3.96, 28.20 ± 3.52, 28.74 ± 3.54, 30.99 ± 5.38 & 36.64 ± 7.65 kg for age groups 10+, 11+, 12+, 13+ & 14+ respectively). The results revealed higher mean intake of fat & protein but lower intake of energy as compared to recommended dietary allowances (RDAs). Intake of energy & three major nutrients showed positive correlation with weight indicating positive effect of food consumption on weight gain. Irrespective of age groups, mean intakes of thiamine, riboflavin, niacin, folic acid, vitamin C, calcium, phosphorus & iron of swimmers were found to be more than RDAs. Cardio respiratory fitness showed negative correlation with energy intake (r = -0.12 to -0.38), strongly suggesting need for sufficient energy to carry out sports activities. Majority of swimmers rated above minimum standard of endurance for arm and shoulder & successfully passed flexibility test but showed poor abdominal strength.

KEY WORDS: Nutritional Status, Physical Fitness, Recommended Dietary Allowances (RDAs), Endurance, Cardio Respiratory Fitness, Flexibility

Introduction

Sports are important part of every society, every country, and every part of our planet. In one way or the other, everyone is involved in sport or some sports, whether they are playing or watching or just knows someone who does either. "Sport" activity is integral to all round development of the personality. Achievement in sports has a considerable bearing on the national prestige and morale. India has a rich tradition of sports and physical fitness *(Nath, 1993)*.

Unlike in the past, modern sports are highly competitive, the use of modern equipment, nurturing of talent from a very tender age, stress on hard and physical training along scientific lines and introduction of modern infrastructure and highly sophisticated equipment have changed the very complexion of modern sports. International sports events have become a showcase of nation pride and power *(Debath, 1994)*.

Swimming is a lifetime sports that benefits the body and the whole person. Swimming is said to be a good exercise for health. It promotes strength, stamina and mobility and improves cardiovascular fitness. There are many benefits- physiological benefits and other indirect benefits. Many swimmers find an indirect benefit from swimming. They develop life skill such as sportsmanship, time management, self-discipline, goal setting. Confidence is developed and an increased sense of self worth through their participation in the sport *(Giridhar, 2006).*

Body composition, body build, and nutritional status play an important role in sports performance. In fact, such factors seem to dictate the particular sports an individual will be suited for *(Agrawal, 2007).* Nutrition and exercise physiology share a natural linkage, form the foundation for physical performance; it provides fuel for biological work and chemicals for extracting and using the potential energy within this fuel. Nutrients from food also provide essential elements for repairing existing cells and synthesizing new tissue *(Katch et al., 2001).* Physical fitness and training are very much dependent on nutritional status of sports personnel. Diet significantly influences the performance of athletes. It is unfortunate to note that many student athletes may not be adequately nourished due to poor understanding of sport nutrition, lack of nutrition knowledge and practice *(Kelkar et al., 2006).*

Present study was undertaken to assess the nutritional status & physical fitness of female swimmers.

Material and Methods

Selection of Subjects

A total of 37 competitive female swimmers, aged 10 to 14 years were considered for the present study. Players engaged in regular practice & participated in regular sport tournaments were considered. Subjects were subdivided into five age groups, viz. 10+, 11+, 12+, 13+, 14+ years for further analyses (Table1).

Table 1: Age Wise Classification of Subjects (N=37)

SR. NO.	AGE GROUP (YRS)	NUMBER OF SUBJECTS (N)
1	10+	9
2	11+	8
3	12+	8
4	13+	7
5	14+	5

Major areas of the study protocol were: -

- Anthropometric Measurements
- Body Composition
- Dietary Information & Nutrient Intake
- Biochemical Status
- Physical Fitness Level

Anthropometric Measurements-

Following measurements were taken:-

- Body weight
- Standing height
- Mid upper arm circumference (MUAC)
- Chest circumference (CHC)
- Waist Circumference (WC)
- Hip circumference (HC)
- Thigh circumference (TC)
- Calf Circumference (CAC)
- Shoulder width (SW)

Measurements were taken using standard procedures *(Sodhi & Sidhu, 1991; Debnath, 1994; Bamji et al., 2005)* & equipments & compared with NCHS/ICMR standards.

Body Composition

Following sites were used to measure skinfold thickness:-

- Biceps
- Triceps
- Subscapular
- Suprailiac

High quality precision skinfold caliper was used for measuring fat folds (Slim Guide: Creative Health Products, Plymouth MICH PATENT PEND). Measurements were taken in triplicate to avoid any errors and mean was calculated and taken as final value.

Body Density *(Durnin & Rahaman, 1967)*, Body Fat (% & kg) *[Siri, 1956]*, and Lean Body Mass (LBM) *[Katch & McArdle, 1983]* were derived based on skinfold measurements at four sites.

Dietary Information

Precise information on food consumption pattern of subjects was gathered through 24-hour dietary recall method for consecutive three days (three day's dietary recall). Data on food habits, meal timings and common dietary pattern was gathered. The intake of nutrients was computed using the values given in the Nutritive Value of the Indian Foods *(Gopalan et al, 2004)*. Nutrient intakes were compared with their respective RDAs.

Blood pressure & pulse rate were recorded with the help of physician.

Physical fitness of each swimmer was assessed using following procedures-

- *Cardio-respiratory Endurance Test***-** by Harvard Step Test *(Kansal, 1996).*
- *Arm & Shoulder Strength***-** by Bent Knee Sit-Ups *(Margaret, 1986).*
- *Flexibility Strength***-** Weber Floor Touch Test *(Margaret, 1986).*
- *Abdominal Strength and Endurance***-**for girl's modified push ups (Physical Fitness Pentathlon Event Standard designed by Quaker American Athletic Union (AAU) *(Nelson, 1997).*

Statistical Analysis

Mean, standard deviation, percentage, & range were calculated. Students "t" test was used to derive conclusions from comparisons between various parameters. Correlations between dietary intake, anthropometric measurements, body composition parameters & physical fitness parameters were derived using Pearson's Product Moment Coefficient of Correlation. A level of probability at both 0.05 and 0.01 levels of significance was assumed.

Results

Anthropometric variables are valuable for selection of swimming event. On the basis of anthropometric parameters, coaches can select individual swim stroke based on appearance of young athletes. Measurement of weight and rate of gain in weight are the best parameters for assessing physical growth. Weight in relation to height is considered more important than weight alone. It helps to determine whether a child is within range of "normal" weight for his height *(Sores dos Santos and Riechle, 1999)*. Table 2 shows mean values of height & weight of female swimmers grouped age wise. Female swimmers in the age groups 10+, 11+ & 12+ were found taller whereas those from age groups 13+ and 14+ were found shorter than the respective standards of height for age (t = 3.61 for 11+ & t = 3.61 for 13+, p<0.01; t = 0.32 – 1.55, p>0.05 for rest of groups). Majority of swimmers were meeting standards of body weight with insignificant differences between actual mean body weight and standards of weight for age and height (t = 0.11 – 2.09, p>0.05). As one grows in height, weight should also increase. High positive correlation between height and weight was derived for all age groups of swimmers (r = 0.58 to 0.92, p<0.01 for 10+, 11+ & 12+ & p>0.05 for 13+ & 14+). Body weight showed positive correlation with intake of energy & three major energy giving nutrients indicating positive effect of food consumption on weight gain (Table 16).

Table 2. Data on Height and Weight of Female Swimmers

Age Group (Yrs)	Height (cm)				Weight (kg)			
	Mean±SD	Range	Std●	"t"	Mean±SD	Range	Std **	"t"
10 +	142.50±5.516	133.00 – 150.00	**138.3**	1.55	32.66±5.297	25.00 – 41.00	**32.5**	0.29
11 +	149.43±5.440	140.00 – 155.00	**142.0**	3.61*	37.38±4.662	28.00 – 45.00	**33.7**	2.09
12 +	148.81±6.642	139.50 – 159.00	**148.0**	0.32	38.93±5.559	33.00 – 51.00	**38.7**	0.11
13 +	148.86±4.580	142.00 – 155.00	**155.0**	3.27 *	44.93±8.640	29.00 – 58.00	**44.0**	0.26
14 +	156.40±7.310	150.00 – 170.00	**159.0**	0.58	48.80±8.424	39.00 – 64.00	**48.0**	0.16

Std - Standard

● - Height for age [NCHS / ICMR Standards, 2004], **- Weight for height [NCHS/ICMR Standards, 2004]

* - shows significant difference at both 0.05 & 0.01 levels (P<0.01), Rest of values show insignificant differences at both 0.05 & 0.01 levels (P>0.05)

Table 3. Statistical derivatives of shoulder width and body circumferences of Female Swimmers

Age Group, yrs	Shoulder Width (cm)		Body Circumferences (cm)											
			MUAC, cm		Chest Circumference, cm		Waist Circumference, cm		Hip Circumference, cm		Thigh Circumference, cm		Calf Circumference, cm	
	M±SD	Range	M±SD	Range	M±SD	Range	M±SD	Range	M±SD	Range	M±SD	Range	M±SD	Range
10 +	32.9±1.5	30–35	20.3±1.6	18–23.0	68.0±5.3	60–79	58.2±8.1	39–69	75.4±5.7	68–84	42.8±4.5	35–49	26.7±1.97	23.5–29.5
11 +	36.5±0.04	33–41	20.4±2.2	17–25	71.9±4.2	63–77	62.3±3.5	57–67	76.6±4.7	69–85	43.1±3.6	37–48	27.9±2.58	23–30
12 +	35.1±0.7	34–36	22.0±1.6	20–25.5	75.5±5.6	69–83	64.2±4.8	58–73	82.2±5.4	76–94	45.3±3.8	40–53	28.5±2.57	25–33
13 +	34.9±2.1	31–38	23.3±2.1	19–26	79.9±8.0	64–90	68.4±4.7	64–77	85.7±5.7	76–94	49.6±4.4	42–57	30.3±2.64	25–33
14 +	37.6±1.2	36–39	23.8±2.7	21–28	83.0±7.9	71–94	73.5±8.1	64–84	89.0±6.7	82–99	48.7±3.9	45–56	27.8±2.80	23–30

Table 3 shows data on shoulder width and body circumferences of swimmers. Swimmers from age group 10+ represented smaller mean shoulder width (32.9 ± 1.49 cm) and those from age group 14+ represented largest mean shoulder width (37.6 ± 1.20 cm) among all groups.

Mean MUAC values show increasing trend for all age groups (20.3 – 23.8 cm). MUAC reflected high positive correlation with body weight (r = 0.73 to 0.94, p<0.01 for 12+ & p>0.05 for rest of groups) & low to medium positive correlation with triceps (r = 0.32 to 0.60, p>0.05) (Table 16).

Mean chest circumference values for age groups 10+, 11+, 12+, 13+ & 14+ were 68.0, 71.9, 75.5, 79.9 and 83.0 cm respectively. Direct relationship was noticed between waist and hip circumference. As age advanced there found an increasing trend of both waist and hip circumference. However, individual within group variations were noticed as also noticed from range values presented in Table 3. Mean thigh & calf circumference also depicted increasing trend with advancing age. Positive correlations were noticed between body weight & thigh circumference, calf circumference & shoulder width (Table 16).

Table 4: Data on Skinfold Thickness at Biceps, Triceps, Subscapular and Suprailiac of Female Swimmers

Age Group, yrs	Skinfold Thickness Measurements (mm)							
	Biceps		Triceps		Subscapular		Suprailiac	
	M±SD	Range	M±SD	Range	M±SD	Range	M±SD	Range
10 +	10.44±4.59	4.00–19.00	13.44±5.27	5.00–25.00	10.11±3.64	4.00–16.00	13.00±5.54	3.00–20.00
11 +	7.50±4.00	3.00–15.00	10.88±3.06	6.00–17.00	9.38±4.55	5.00–20.00	11.13±3.89	6.00–18.00
12 +	8.19±3.46	4.00–13.50	12.88±2.42	10.00–17.00	10.13±2.20	8.00–14.00	11.63±2.55	8.00–17.00
13 +	13.71±3.53	8.00–19.00	17.29±2.60	13.00–21.00	15.57±5.29	10.00–26.00	16.86±4.29	12.00–24.00
14 +	8.80±3.71	5.00–15.00	15.40±4.59	9.00–23.00	12.40±6.80	5.00–25.00	13.20±6.97	5.00–26.00

Table 4 shows data on skinfold measurement of swimmers. Mean biceps, triceps, subscapular & suprailiac of swimmers ranged between 7.5- 13.71, 10.88- 17.29, 9.38- 15.57 & 11.13- 16.86 mm respectively. Height of swimmers from age groups 10+, 12+ & 13+ showed low to medium positive correlation ($p>0.05$) with triceps, subscapular & suprailiac. Increase in skinfold thickness was noticed with an increase in body weight in majority of swimmers. Subscapular skinfold showed positive correlation with chest circumference ($r = 0.37$ to 0.62, $p>0.05$) (Table 16). Swimmers from age group 13+ showed highest mean skinfolds at all four sites.

Total skinfolds were required for calculation of body density, body fat (BF) and LBM data of which is depicted in Table 5. On the basis of body density, BF (% & kg) was computed which was found to be highest in swimmers from 13+ age group (30.75 % & 13.94 kg). Overall, BF % of swimmers ranged from 10.72 – 35.53 (3.71 – 20.03 kg). In age group 14+, an inverse relationship between body fat content & body weight was observed indicating beneficial effect of sport training ($r = -0.07$, $p>0.05$) (Table 16).

LBM increased with age (24.52 ± 3.96, 28.20 ± 3.52, 28.74 ±3.54, 30.99 ± 5.38 & 36.64 ± 7.65 kg for age groups 10+, 11+, 12+, 13+ & 14+ respectively). LBM showed high, positive & significant ($p<0.01$) correlation with body weight which indicate increase in muscle mass with gain in body weight (Table 16).

Food habits are influenced by cultural background, religious belief, social norms, and geographical location, availability of particular food items and likes or dislikes. Eating in a regular meal pattern is most important for sports person /athletes because they need intense energy for practice. Irregular meal timings make the food intake less predictable both in the amount of food energy provided and in its nutrient quality.

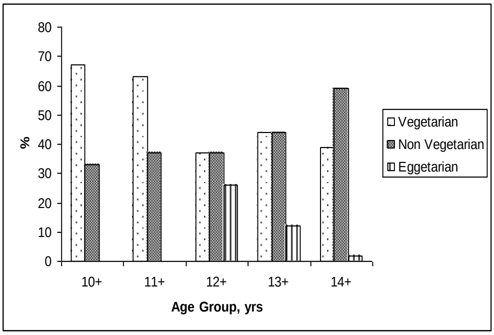

Figure 1: Percentage distribution of female swimmers based on food habits

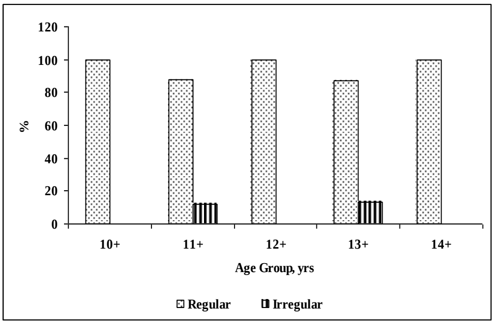

Figure 2: Percentage distribution of female swimmers based on meal timings

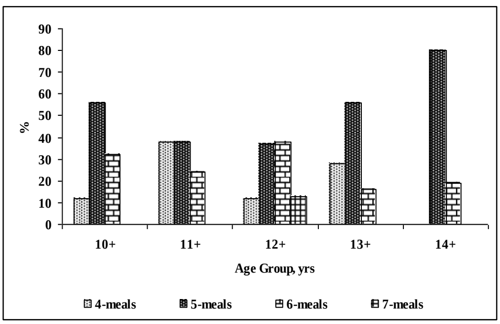

Figure 3: Percentage distribution of female swimmers based on common dietary pattern

Figures 1, 2 and 3 show percentage wise distribution of female swimmers based on food habits, meal timing and common dietary pattern respectively. % of vegetarians was more in swimmers from age groups 10+ & 11+ whereas that of non vegetarians was more in 14+ (Figure 1). 100 % swimmers from age groups 10+, 12+ & 14+ were following regular meal timings (Figure 2). Swimmers found to be following a dietary pattern of 4-5 meals daily (Figure 3).

Table 5: Data on Body Weight, Total Skinfolds and Body Density for Female Swimmers

Age Group (Yrs)	Body Weight, (kg)		Total Skinfolds (mm)		Body Density	
	M±SD	Range	M±SD	Range	M±SD	Range
10 +	32.7±5.3	25–41	47.0± 18.3	16–80	1.04 ± 0.02	1.02– 1.07
11 +	42.7±4.7	28–45	38.9± 13.4	20–65	1.043± 0.009	1.03– 1.06
12 +	38.93±5.6	33–51	42.8± 8.99	31-57	1.04± 0.006	1.03– 1.05
13 +	44.93±8.6	29–58	63.4± 12.9	51–85	1.03± 0.005	1.02– 1.04
14 +	48.8±8.4	39–64	49.8± 21.4	28–89	1.042± 0.018	1.02– 1.07

Table 6: Data on Body Fat and Lean Body Mass for Female Swimmers

Age Group (Yrs)	Body Fat (%)		Body Fat (kg)		Lean Body Mass (kg)	
	M±SD	Range	M±SD	Range	M±SD	Range
10 +	24.6± 7.3	10.7– 33.8	8.15± 3.10	3.71– 12.27	24.52± 3.96	17.86– 31.25
11 +	24.5± 4.0	17.3– 31.3	9.18± 2.07	6.07– 12.20	28.20± 3.52	20.96– 34.26
12 +	26.0± 2.5	22.2– 29.5	10.20± 2.22	7.34– 14.70	28.74± 3.54	25.35– 36.30
13 +	30.8± 2.3	28.4– 35.5	13.94± 3.48	8.55– 20.03	30.99± 5.38	20.46– 37.97
14 +	25.0± 8.1	10.7– 35.1	12.16± 4.26	5.04– 17.55	36.64± 7.650	28.43– 48.96

Table 7: Data on Mean Daily Intake of Energy for Female Swimmers

Age Group (Yrs)	Energy (kcal)			
	M±SD	Range	RDA	"t"
10 +	1851±1978	1599-2317	1907	0.81
11 +	1903±107	1760-2055	1956	1.32
12 +	1894±140	1698-2169	2032	1.17
13 +	1851±163	1588-2076	2037	2.78Δ
14 +	2010±174	1753- 2245	2066	0.51

Table 7: Data on Mean Daily Intake of Energy, Carbohydrate, Fat, and Protein for Female Swimmers

Age Group (Yrs)	Carbohydrate (g)		Fat (g)		RDA	"t" Value
	M±SD	Range	M±SD	Range		
10 +	283±33.32	236-348	53±9.65	40-74	35	5.38*
11 +	300±31.23	247-344	49±10.62	23-58	35	3.05*
12 +	301±34.61	256–352	48±7.94	33–58	32	5.42*
13 +	291± 3.01	226–350	48±5.08	40–57	32	8.79*
14 +	307±0.89	245–344	56±7.24	46–66	32	5.45*

Table 7. Data on Mean Daily Intake of dietary fibres for Female Swimmers

Age Group (Yrs)	Fiber (g)	
	M±SD	Range
10 +	16±6.91	13–33
11 +	16±5.03	11–25
12 +	15±6.61	9–30
13 +	16±6.65	10–30
14 +	18±5.20	10–27

∗ - significant difference at both 0.05 & 0.01 levels ($p<0.01$); Δ - significant difference at 0.05 level but insignificant difference at 0.01 level ($0.01<p< 0.05$). Rest of the values show insignificant difference at both 0.05 & 0.01 levels ($P>0.05$).

Table 7. Data on Percentage of Energy Derived From Carbohydrate, Fat and Protein for Female Swimmers

Age Group (Yrs)	% Energy from		
	Carbohydrate	Fat	Protein
10 +	61	26	13
11 +	63	23	14
12 +	64	23	13
13 +	63	23	14
14 +	61	25	14

Table 8. Data on Mean Daily Intake of Carotene & Thiamine

Age Group (Yrs)	Carotene (µg)			Thiamine (mg)		
	M±SD Range	RDA	"t" Value	M±SD Range	RDA	"t"
10 +	794±447.5 *276.6-1872.8*	2400	10.20*	2.89±1.03 1.46-4.71	0.92	4.14*
11 +	1676±663 *547- 2874*	2400	1.15	2.45±0.78 1.30-3.42	0.95	4.58*
12 +	1158±778 *518- 3168*	2400	4.22*	3.55±2.31 1.34-9.28	0.95	2.77Δ
13 +	1074±1530 *104- 4795*	2400	2.11	3.12±0.94 1.80-4.46	0.93	5.62*
14 +	650±224 *319- 99*	2400	12.77*	2.86±1.59 0.77-4.82	1.00	2.90Δ

Table 8. Data on Mean Daily Intake of Riboflavin & Niacine

Age Group (Yrs)	Riboflavin (mg)				Niacin (mg)	
	M±SD Range	RDA	M±SD Range	RDA	M±SD Range	RDA
10 +	1.9±2.2 0.7-7.6	1.11	1.94±2.24 0.7-7.6	1.11	1.9±2.2 0.7-7.6	1.11
11 +	2.3±2.2 0.9-.4	1.14	2.3±2.2 0.9-7.4	1.14	2.3±2.2 0.9-7.4	1.14
12 +	1.7±2.1 0.7-7.4	1.14	1.7±2.1 0.75-7.35	1.14	1.7±2.1 0.8-7.4	1.14
13 +	1.8±2.3 0.4-7.5	1.11	1.8±2.3 0.4-7.5	1.11	1.8±2.3 0.4-7.5	1.11
14 +	2.3±2.6 0.6-7.5	1.21	2.4±2.6 0.6-7.5	1.21	2.3±2.6 0.6-7.4	1.21

Table 8. Data on Mean Daily Intake of Folic acid & Vitamin C.

Age Group (Yrs)	Folic Acid (µg)				Vitamin C (mg)	
	M±SD Range	RDA	M±SD Range	RDA	M±SD Range	RDA
1 0 +	252.1±72.4 *185.5-445.4*	70	252.1±72.4 *185.5-445.4*	70	252.1±72.4 *185.5-45.4*	70
1 1 +	321.0±70.2 *206.7-396.4*	70	321.0±70.2 *206.7-396.4*	70	321.0±70.2 *206.7-396.4*	70
1 2 +	291.0±51.4 *187.3-359.7*	70	291.0±51.4 *187.3-359.7*	70	291.0±51.4 *187.3-59.7*	70
1 3 +	337.5±116.1 *192.5-489.7*	70	337.5±116.1 *192.5-489.7*	70	337.5±116.1 *192.5-489.7*	70
1 4 +	242.1±100.5 *81.3-383.5*	70	242.1±100.5 *81.3-383.5*	70	242.1±100.5 *81.3-383.5*	70

∗ - significant difference at both 0.05 & 0.01 levels ($P<0.01$); Δ - significant difference at 0.05 level but insignificant difference at 0.01level ($0.01< P < 0.05$). Rest of the values show insignificant difference at both 0.05 & 0.01 levels ($P>0.05$).
Numbers in Italic in M ± SD column show Range.

Table 9. Data on Mean Daily Intake of Minerals (Calcium & Phosphorus) for Female Swimmers

Age Group (Yrs)	Calcium (mg)			Phosphorus (mg)		
	M±SD Range	RDA	"t"	M±SD Range	RDA	"t"
10 +	682±141 *465- 878*	600	1.84	1533±169 391-1776	600	15.71*
11 +	824±96 *695-008*	600	6.17*	1702±224 138-1988	600	13.01*
12 +	903±308 *56-1497*	600	2.60Δ	1542±381 846-2117	600	6.53*
13 +	631±193 *415- 901*	600	0.38	1593±396 1007-2334	600	6.10*
14 +	845±363 *342-1231*	600	1.10	2004±326 1533-2405	600	7.02*

∗ - significant difference at both 0.05 & 0.01 levels ($P<0.01$); Δ - Shows significant difference at 0.05 level but insignificant difference at 0.01level ($0.01< P < 0.05$). Rest of the values show insignificant difference at both 0.05 & 0.01 levels ($P>0.05$).
Numbers in Italic in M ± SD column show Range.
Mg-Magnesium; Na-Sodium; K-Potassium

Table 10. Data on Approximate Mean Daily Intake of Water for Female Swimmers

Age Group (Yrs)	Approximate Daily Water Intake (Glasses)	
	M ± SD	Range
10 +	13 ± 2.15	10 - 16
11 +	13 ± 2.05	10 - 16
12 +	12 ± 1.85	10 - 16
13 +	15 ± 2.56	12 - 20
14 +	13 ± 2.04	10 - 16

Table 11. Data on Mean Systolic Blood Pressure (SBP)

Age Group (Yrs)	SBP (mm / Hg)			
	M ± SD	Range	Std *	"t"
10 +	116±4.969	110 -120	120	2.54 Δ
11 +	113±4.841	110 -120	120	3.11 ∗
12 +	116±4.841	110 -120	120	2.05 #
13 +	116±4.949	110 -120	120	2.11 #
14 +	114±4.899	110 -120	120	2 #

Table 11. Data on Mean Diastolic Blood Pressure (DBP)

Age Group (Yrs)	SBP (mm / Hg)			
	M ± SD	Range	Std *	"t"
10 +	76±4.969	70 - 80	80	76±4.969
11 +	77±5.000	70 -80	80	77±5.000
12 +	75±5.000	70 - 80	80	75±5.000
13 +	76±4.949	70 - 80	80	76±4.949
14 +	74±4.899	70 - 80	80	74±4.899

Table 11. Data on Mean Pulse Rate

Age Group (Yrs)	Pulse Rate (beats|min)			
	M ± SD	Range	Std *	"t"
10 +	78±5.877	69 - 86	72	2.84 Δ
11 +	82±6.556	70 - 88	72	4.15 ∗
12 +	76±4.484	70 - 82	72	2.43 Δ
13 +	77±6.782	62 - 84	72	1.79 #
14 +	76±2.227	72 - 79	72	2.79 Δ

SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; Std – Standard;*-"Nutrition" – Quarterly Publication (NIN, 2000). Vol.34 (4): 15.
- Insignificant difference at both 0.05 & 0.01 levels (P>0.05); ∗ - significant difference at both 0.05 & 0.01 levels (P<0.01); Δ - Shows significant difference at 0.05 level but insignificant difference at 0.01 level (0.01< P < 0.05).

Table 12. Percentage Wise Distribution of Female Swimmers Based On Cardio Respiratory Fitness

Age Group (Yrs)	CARDIO RESPIRATORY FITNESS PROFILE OF SUBJECTS				
	Excellent	Very Good	Good	Fair	Poor
	%	%	%	%	%
10 +	-	-	55.56	-	44.44
11 +	-	--	75	-	25
12 +	37.5	12.5	37.5	-	12.5
13 +	-	28.57	28.57	-	42.86
14 +	40	20	-	-	40

Table 13. Percentage Wise Distribution of Female Swimmers Based on Arm & Shoulder Endurance

Age Group (Yrs)	RATING FOR ENDURANCE OF ARM & SHOULDER					
	Below Minimum Standard		Minimum Standard		Above Minimum Standard	
	No	%	No	%	No	%
10	4	44.44	-	-	5	55.56
11	3	37.5	-	-	5	62.5
12	-	-	1	12.5	7	87.5
13 +	5	71.42	1	14.29	1	14.29
14 +	2	40	-	-	3	60

Anthropometric variables are valuable for selection of swimming event. On the basis of anthropometric parameters, coaches can select individual swim stroke based on appearance of young athletes. Measurement of weight and rate of gain in weight are the best parameters for assessing physical growth. Weight in relation to height is considered more important than weight alone. It helps to determine whether a child is within range of "normal" weight for his height *(Sores dos Santos and Riechle, 1999)*. Table 2 shows mean values of height & weight of female swimmers grouped age wise. Female swimmers in the age groups 10+, 11+ & 12+ were found taller whereas those from age groups 13+ and 14+ were found shorter than the respective standards of height for age (t = 3.61 for 11+ & t = 3.61 for 13+, p<0.01; t = 0.32 – 1.55, p>0.05 for rest of groups). Majority of swimmers were meeting standards of body weight with insignificant differences between actual mean body weight and standards of weight for age and height (t = 0.11 – 2.09, p>0.05). As one grows in height weight should also increase. High positive correlation between height and weight was derived for all age groups of swimmers (r = 0.58 to 0.92, p<0.01 for 10+, 11+ & 12+ & p>0.05 for 13+ & 14+). Body weight showed positive correlation with intake of energy & three major energy giving nutrients indicating positive effect of food consumption on weight gain (Table 16).

Table 14. Percentage Wise Distribution of Female Swimmers Based On Abdominal Strength & Endurance

Age Group (Yrs)	PERCENTILE FOR ABDOMINAL STRENGTH & ENDURANCE									
	90 %	80 %	75 %	60 %	50 %	40 %	30 %	25 %	20 %	10 %
10 +	-	-	-	11.11	-	22.22	-	-	-	66.67
11 +	-	12.5	-	12.5	12.5	12.5	-	-	12.5	37.5
12 +	37.5	12.5	12.5	12.5	25	-	-	-	-	-
13 +	-	14.28	-	14.28	-	14.28	14.28	28.6	-	14.28
14 +	20	40	-	-	-	20	-	-	-	20

Table 15. Percentage Wise Distribution of Female Swimmers Based on Flexibility Test Results

Sr. No.	Age Group (Yrs)	FLEXIBILITY TEST RESULTS			
		Pass		Fail	
		No	%	No	%
1	10 + (n = 9)	8	88.88	1	11.12
2	11 + (n = 8)	7	87.5	1	12.5
3	12 + (n = 8)	6	75	2	25
4	13 + (n = 7)	5	71.43	2	28.57
5	14 + (n = 5)	5	100	-	-

Table 3 shows data on shoulder width and body circumferences of swimmers. Swimmers from age group 10+ represented smaller mean shoulder width (32.9 ± 1.49 cm) and those from age group 14+ represented largest mean shoulder width (37.6 ± 1.20 cm) among all groups.

Mean MUAC values show increasing trend for all age groups (20.3 – 23.8 cm). MUAC reflected high positive correlation with body weight (r = 0.73 to 0.94, $p<0.01$ for 12+ & $p>0.05$ for rest of groups) & low to medium positive correlation with triceps (r = 0.32 to 0.60, $p>0.05$) (Table 16).

Mean chest circumference values for age groups 10+, 11+, 12+, 13+ & 14+ were 68.0, 71.9, 75.5, 79.9 and 83.0 cm respectively. Direct relationship was noticed between waist and hip circumference. As age advanced there found an increasing trend of both waist and hip circumference. However, individual within group variations were noticed as also noticed from range values presented in Table 3. Mean thigh & calf circumference also depicted increasing trend with advancing age. Positive correlations were noticed between body weight & thigh circumference, calf circumference & shoulder width (Table 16).

Table 4 shows data on skinfold measurement of swimmers. Mean biceps, triceps, subscapular & suprailiac of swimmers ranged between 7.5- 13.71, 10.88- 17.29, 9.38- 15.57 & 11.13- 16.86 mm respectively. Height of swimmers from age groups 10+, 12+ & 13+ showed low to medium positive correlation ($p>0.05$) with triceps, subscapular & suprailiac. Increase in skinfold thickness was noticed with an increase in body weight in majority of swimmers. Subscapular skinfold showed positive correlation with chest circumference (r = 0.37 to 0.62, $p>0.05$) (Table 16). Swimmers from age group 13+ showed highest mean skinfolds at all four sites.

Total skinfolds were required for calculation of body density, body fat (BF) and LBM data of which is depicted in Table 5. On the basis of body density, BF (% & kg) was computed which was found to be highest in swimmers from 13+ age group (30.75 % & 13.94 kg). Overall, BF % of swimmers ranged from 10.72 – 35.53 (3.71 – 20.03 kg). In age group 14+, an inverse relationship between body fat content & body weight was observed indicating beneficial effect of sport training ($r = - 0.07$, $p>0.05$) (Table 16).

LBM increased with age (24.52 ± 3.96, 28.20 ± 3.52, 28.74 ±3.54, 30.99 ± 5.38 & 36.64 ± 7.65 kg for age groups 10+, 11+, 12+, 13+ & 14+ respectively). LBM showed high, positive & significant ($p<0.01$) correlation with body weight which indicate increase in muscle mass with gain in body weight (Table 16).

Food habits are influenced by cultural background, religious belief, social norms, geographical location, availability of particular food items and likes or dislikes. Eating in a regular meal pattern is most important for sports person /athletes because they need intense energy for practice. Irregular meal timings make the food intake less predictable both in the amount of food energy provided and in its nutrient quality. Figures 1, 2 and 3 show percentage wise distribution of female swimmers based on food habits, meal timing and common dietary pattern respectively. % of vegetarians was more in swimmers from age groups 10+ & 11+ whereas that of non vegetarians was more in 14+ (Figure 1). 100 % swimmers from age groups 10+, 12+ & 14+ were following regular meal timings (Figure 2). Swimmers found to be following a dietary pattern of 4-5 meals daily (Figure 3).

Table 6 depicts data on mean daily intake of energy, carbohydrate, fat, protein and fiber. All four age groups of swimmers showed mean daily energy intake less than RDAs. Difference was significant difference at 0.05 level but insignificant difference at 0.01 level ($t = 2.78$, $0.01<p<0.05$) for 13+ age group while rests of the groups showed insignificant differences ($t = 0.51-1.17$, $p>0.05$). Range values reflected individual variations with energy between 1588-1317 kcal (Table 6).

Mean carbohydrate intake of swimmers ranged between 236-348, 247-344, 256-352, 226-350 & 245-344 g with means of 283, 300, 301, 291 & 307 g for age groups 10+, 11+, 12+, 13+ & 14+ respectively. Mean fat and protein intake of swimmers from all age groups was found to exceed than their RDAs. Differences between fat intake and RDAs were highly significant for ($t = 3.05-8.79$, $p<0.01$). Fat is a concentrated source of energy & could lead to fat deposition in the body. Here, in the present study, fat intake reflected positive correlation with body fat content with significant difference in 14+ age group ($r = 0.09$ to 0.98) (Table 16). Differences between protein intake and RDAs were insignificant for ($t = 0.43-1.86$, $p>0.05$). Mean protein intake ranged between 60±3.68 to 69±7.15 g & showed positive correlation with development of LBM ($r = 0.08$ to 0.62, $p>0.05$) indicating need of sufficient amount of protein in daily diet (Table 16).

Percentage energy derived from three major nutrients was 61-64, 23-26 & 13-14 % for carbohydrate, fat & protein respectively (Table 7).

No major differences were seen for mean fiber intake of swimmers which was 15-18g/day (Table 6).

Table 8 represents data on mean daily intake of vitamins. Irrespective of age group, mean intakes of thiamine, riboflavin, niacin & folic acid among swimmers were found to be more than RDAs. Differences were insignificant for all age groups for riboflavin and niacin intake (t = 0.68-1.36 for riboflavin & t = 0.81-1.39 for niacin; p>0.05) and significant for thiamine & folic acid intake (t = 2.77-5.62 for thiamine & t = 2.31-11.39 for folic acid; p<0.01). The B vitamins are of special interest to athletes and exercisers because they govern the energy producing reactions of metabolism. Vitamin needs are increased because of the high rates of growth *(Smolin, 1997, Houtkooper et al., 1998). Manore & Thompson (2000)* studied the effect of physical activity on thiamine, riboflavin & vitamin B-6 requirements. Because exercise stresses metabolic pathways that depend on thiamine, riboflavin, & vitamin B-6 the requirements for these vitamins may be increased in athletes & active individuals.

The antioxidant vitamins – such as vitamin A, C & beta-carotene– play an important role in protecting the cell membrane from oxidative damage. Exercise can increase the oxidative processes in the muscle, leading to increased generation of lipid peroxides & free radicals *(Keith, 1994)*. In the present study, irrespective of age, mean daily intake of carotene of swimmers was found to be significantly less than RDAs. Differences were highly significant (p<0.01) for swimmers from age groups 10+ (t = 10.20), 12+ (t = 4.22) & 14+ (t = 12.77) and insignificant (p>0.05) for swimmers from age groups 11+ (t = 1.15) & 13+ (t = 2.11). Low carotene intake may be due wrong food choices or may be due likes or dislikes of carotene rich foods such as green leafy vegetables, yellow fruits and vegetables which was observed in the swimmers. In contrast to intake of carotene, mean intake of vitamin C of swimmers from age groups 11+, & 12+ was found to be highly exceeding their respective RDAs (t = 4.96 & 3.42 respectively, p<0.01). Higher intake of vitamin C in all age groups could be attributed to inclusion of higher amount of seasonal fruits & vegetables rich in vitamin C (Table 8).

Table 9 demonstrates mean daily intakes of minerals for swimmers. Mean intake of both calcium & phosphorus in female swimmers from all age groups was observed to be more than their respective RDAs (t = 0.38-6.17; differences were significant at p<0.01 for 11+ & at 0.01< p < 0.05 for 12+ & insignificant at p>0.05 for 10+, 13+ & 14+ for calcium & t = 6.10-15.71; differences were very highly significant at p<0.01 for swimmers from all age groups for phosphorus). Calcium: phosphorus ratio was derived & a range of 0.40 to 0.59 among swimmers.

Mean iron intake for swimmers from all age groups was found to be insignificantly more than their respective RDAs for age groups 10+, 11+ & 13+ (t = 1.73, 1.62 & 1.59, respectively, p>0.05). With advancing age, swimmers were unable to meet their requirement for iron (t = 1.31 & 1.53, p>0.05 for age groups 13+ & 14+) (Table 9). A combination of factors increases athlete's chances of depleting his or her iron stores. Inadequate dietary intakes of iron-rich foods combined with iron losses aggravated by physical activity compromise iron status. Physical activity may cause increased iron losses in sweat, feces and urine, plus increased destruction of red blood cells that occurs during exercise *(Boyle, 2000).*

Mean daily total sodium & potassium intake among swimmers was found to be in the range of 1920-2304 mg & 2261-3788 mg respectively. Total sodium indicates sodium from food stuffs & sodium from salt. Magnesium intake of swimmers ranged from 389 to 516 mg. all age groups of swimmers showed significantly less mean intake of zinc as compared to RDAs ($t = 3.47$-11.10, $p<0.01$) (Table 9).

Table 10 depicts approximate mean daily intake of water by swimmers. Swimmers drank approximately 12.0 ± 1.85 to 15.0 ± 2.56 glasses of water daily. Water is the nutrient most critical to athletic performance. Without adequate water, performance can suffer in less than an hour. Water is necessary for the body's cooling system. It also transports nutrients throughout the tissues and maintains adequate blood volume. During exercise there is always the risk of becoming dehydrated (fluid volume deficit), especially when the temperature is hot. When athletes sweat, they lose water *(Williams, 1990; Grodner et al., 1996; Paquot, 2001).*

A physically fit heart beats at a lower rate and pumps more blood per beat at rest. Regular endurance exercise results in an increased capacity to use oxygen, leading to the ability for more physical work *(Strauss and Richard, 1984).* Table 11 presents data on blood pressure & pulse rate of swimmers. Mean systolic blood pressure (SBP) & diastolic blood pressure (DBP) of swimmers from all age groups was found to be less than the standards. Mean pulse rate value of swimmers from all age groups was found to be more than the normal value of 72. The mean heart rate & blood pressure of the selected athletes studied by *Chandrashekhar et al., (1988)* was found to be less than the normal values of 72 beats / min & 120 / 80 mmHg respectively.

Fitness involves cardio respiratory endurance, muscle strength and endurance, flexibility and desirable body composition. These components of fitness are important for athletes but also extend to every aspect and task of daily life *(Strauss and Richard, 1984).* Data on cardio respiratory fitness, arm & shoulder endurance, abdominal strength & endurance and flexibility test results of female swimmers are showed in Tables 12, 13, 14 and 15 respectively.

Assessing cardiovascular fitness encompasses testing the ability of the respiratory, cardiovascular, and skeletal muscle tissue to take in deliver, and utilize oxygen while performing prolong exercise of moderate to high intensity *(Manore et al., 2000 & Manore & Thompson, 2000).* For the present study, 40 & 37.5 % swimmers from age groups 14+ & 12+ rated "excellent" for their cardio respiratory fitness. 12.5, 28.57 & 20 % swimmers from age groups 12+, 13+ & 14+ showed very good cardio respiratory profile whereas 55.56, 75, 37.5, & 28.57 % swimmers from age groups 10+, 11+, 12+ & 13+ respectively rated "good" for their cardio respiratory fitness. The highest percentage value for poor cardio respiratory fitness was found in 10 + age group of female swimmers (44.44 %) which might be because of slower pace of swimming, overall intensity, duration, motivation and overall health status of swimmers (Table 12). Swimmers were unable to meet their energy demands (Table 6) which had a deleterious influence on their cardio respiratory fitness. Cardio respiratory fitness correlated negatively with energy intake (r = -0.38, -0.12, -0.18 & -0.21 for 11+, 12+, 13+ & 14+ age groups, respectively) strongly suggesting need for sufficient energy to carry out sports activities (Table 16).

Table 16. Coefficient of Correlation between Various Anthropometric Measurements, Body Composition, Nutrient Intake and Physical Fitness Profile of Female Swimmers

Sr. No.	PARAMETERS	AGE GROUP (YEARS)				
		10 + (n = 9)	11 + (n = 8)	12 + (n = 8)	13 + (n = 7)	14 + (n = 5)
1	Height Vs. Weight	0.90●	0.92●	0.85●	0.58	0.82
2	Height Vs. MUAC	0.51	0.47	0.83*	0.31	0.75
3	Height Vs. Triceps	0.35	-0.11	0.47	0.39	-0.47
4	Height Vs. Subscapular	0.53	-0.33	0.42	0.67	0.03
5	Height Vs. Suprailiac	0.43	-0.36	0.30	0.56	0.02
6	Height Vs. Total Skinfolds	0.45	-0.36	0.39	0.73	-0.16
7	Height Vs. LBM	0.73*	0.53	0.89●	0.48	0.61
8	Height Vs. BF Content	0.27	-0.34	0.30	0.74	0.15
9	Weight Vs. MUAC	0.73*	0.70*	0.90●	0.78*	0.94*
10	Weight Vs. Shoulder Width	0.67*	0.62	0.40	0.77*	0.61
11	Weight Vs. Thigh Circumference	0.71*	0.48	0.73*	0.93●	0.34
12	Weight Vs. Calf Circumference	0.37	-0.2	0.82*	0.95●	0.17
13	Weight Vs. Biceps	0.54	0.43	0.67	0.16	-0.33
14	Weight Vs. Triceps	0.36	0.57	0.78*	0.27	-0.47
15	Weight Vs. Subscapular	0.61	-0.00	0.64	0.60	0.08
16	Weight Vs. Suprailiac	0.55	-0.18	-0.10	0.87*	-0.02
17	Weight Vs. Total Skinfolds	0.52	-0.18	0.60	0.63	-0.16
18	Weight Vs. LBM	0.81●	0.90●	0.98●	0.98●	0.86
19	Weight Vs. BF Content	0.31	0.21	0.62	0.61	-0.07
20	MUAC Vs. Biceps	0.69*	0.44	0.48	-0.22	0.01
21	MUAC Vs. Triceps	0.51	0.50	0.60	0.32	-0.16
22	Chest Circumference Vs. Subscapular	0.37	-0.11	0.62	0.55	0.37
23	Waist Circumference Vs. Suprailiac	0.07	-0.20	0.45	0.87*	0.67
24	Carbohydrate Vs. Weight	0.20	0.04	0.40	0.53	-0.64
25	Carbohydrate Vs. LBM	0.10	-0.17	0.43	0.49	-0.21
26	Carbohydrate Vs. BF Content	0.21	0.37	0.33	0.55	-0.39
27	Fat Vs. Weight	0.26	0.31	-0.36	0.12	0.44
28	Fat Vs. LBM	0.42	0.30	-0.38	-0.52	-0.06
29	Fat Vs. BF Content	0.09	0.18	0.30	0.71	0.98*
30	Protein Vs. Weight	-0.07	0.01	0.67	0.63	-0.45
31	Protein Vs. LBM	0.08	0.11	0.62	0.58	0.27
32	Protein Vs. BF Content	-0.03	-0.16	0.70*	0.66	-0.41
33	Energy Vs. Weight	0.24	0.33	0.39	0.44	-0.51
34	Energy Vs. LBM	0.25	0.11	0.39	0.43	-0.53
35	Energy Vs. BF Content	0.10	0.55	0.36	0.44	-0.07
36	Energy Vs Cardio Respiratory Fitness	0.13	-0.38	-0.12	-0.18	-0.21
37	Iron Vs Cardio Respiratory Fitness	-0.38	-0.35	-0.32	-0.21	-0.13
38	Energy Vs Abdominal Strength & Endurance	0.04	-0.15	0.76*	0.37	-0.63
39	Carbohydrate Vs Abdominal Strength & Endurance	-0.11	-0.31	0.51	0.25	-0.65
40	Fat Vs Abdominal Strength & Endurance	0.07	0.38	0.12	0.38	0.03
41	Protein Vs Abdominal Strength & Endurance	0.04	0.44	0.75*	0.09	0.15
42	Iron Vs Abdominal Strength & Endurance	0.56	0.44	-0.34	0.03	-0.70
43	Energy Vs Arm & Shoulder Endurance	0.04	0.08	0.02	0.54	0.46
44	Carbohydrate Vs Arm & Shoulder Endurance	0.01	-0.19	-0.17	0.56	0.46
45	Fat Vs Arm & Shoulder Endurance	0.07	0.05	0.33	-0.34	-0.25
46	Protein Vs Arm & Shoulder Endurance	0.01	-0.45	0.09	0.51	0.72
47	Iron Vs Arm & Shoulder Endurance	0.28	-0.34	0.02	0.25	-0.43

● - Significant at both 5 % & 1 % level [$p<0.01$]
* - Significant at 5 % level but insignificant at 1 % level [$0.01<p<0.05$]. The rest of the values show insignificant differences [$p>0.05$]

With the exception of swimmers from age group 13+, majority of swimmers from 10 +, 11 +, 12 + and 14 + age groups were rated above minimum standard of endurance for arm and shoulder (Table 13).

Majority of female swimmers showed poor abdominal strength and endurance (below 10 percentile) (Table14). It might be because of either lack of regular abdominal exercises or due to low motivation during endurance. Energy & three major energy yielding nutrients showed direct positive relationship with abdominal strength and endurance & with arm and shoulder endurance indicating need of good quality food in required quantity (Table 16).

Flexibility is the ability to move a muscle through a full range of motion. A lack of flexible joints and muscles hinders the performance of routine movement *(Thani, 2001)*. From Table 15, it can be seen that majority of swimmers successfully passed the flexibility test.

To obtain maximum results, the sportsperson has to be fit. Amongst all aspects of various factors playing major role in this foundation of fitness, good nutrition gets a lion's share in 'building' an appropriate body for the best performance. The body needs the right kind of fuel to hit the record. Nutrition not only plays a role in performance, but it also helps to prevent injuries, enhance recovery from exercise, help maintain body weight, & improve overall health.

Summary & Conclusion

Present study revealed that majority of swimmers was meeting standards of body weight for the age & height. It is said that height is genetically influenced. This might be the reason of swimmers not meeting the standards of height for their age. LBM increased with age which might be attributed to regular practice & constant involvement in the sport. The results of this study tend to confirm the fact that regular engagement in sports lead to increase in LBM which clearly depicts a relationship between sports training & a tendency towards a healthier life. Swimmers were not meeting their daily energy demands which might be due yo comparatively less carbohydrate content of diet as swimmers were exceeding their requirements for fat & protein. An athlete's needs are large to delay fatigue, prevent cramp, maintain strength and enhance endurance. It is imperative for the nutritionist to provide guidance during their travel, maintain time and choose foods of the right type to help in recovery and also to guide in choosing foods before, during and after an event. Physical activity places a huge demand on energy requirements and systematic exercise, as in athletes need a well-planned diet. Diet plays a very significant role in giving the winning edge to the athletes.

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