I J R B A T, Vol. VI (Special Issue 1), January 2018 : 322- 333 ISSN 2347 – 517X
INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY

www.vmsindia.org

NUTRITIONAL STATUS AND PHYSICAL FITNESS OF MALE SWIMMERS

Neeta Bhawnani[1] **& Prajakta Nande**[2]
[1]M. Sc., M. Phil. (Food Science & Nutrition)
[2]Assistant Professor in Food Science & Nutrition
Department of Home Science
Rashtrasant Tukadoji Maharaj Nagpur University
Mahatma Jyotiba Phule Educational Campus, Amravati Road-440033, Nagpur (Maharashtra)
Email ID: neeta_bhawnani@yahoo.co.in

ABSTRACT

The study deals with the assessment of nutritional status and physical fitness of male swimmers (n=41, aged 10+ to 14+ years). Only competitive swimmers engaged in regular practice were chosen. Body weight & height of subjects were measured. Based on skinfolds at biceps, triceps, subscapular & suprailiac, body density, body fat (BF) & lean body mass (LBM) were derived. Cardio respiratory endurance & arm & shoulder strength of swimmers was tested using Harvard step test & push ups. Irrespective of age, majority of swimmers were found to be taller and heavier than the standards for their age. With the age, increment in BF content and LBM was noticed in age groups 12+, 13+ & 14+ yrs. Body weight reflected high and significant correlation with BF and LBM in majority of swimmers. Age wise increment in BF content can be attributed to growth period of subjects whereas higher LBM is a positive effect of regular participation in the sports. Irrespective of age, mean daily energy intake of swimmers was found to be less than RDAs. Maximum % of swimmers showed good cardio respiratory fitness. Majority of swimmers from all age group scored 'below 20' for arm and shoulder endurance.

Keywords: Recommended dietary allowances (RDAs), body fat (BF), lean body mass (LBM), nutritional status, physical fitness.

INTRODUCATION

Swimming is a lifetime sports that benefits the body and the whole person and have indirect benefits which is very necessary for competitive sport person. Physical Fitness and training are very much dependent on nutritional status of sports persons (Durnin, 1967). Athletes world over are in constant search of a "perfect diet" to accomplish a high level of performance. No single food or food group holds the secret to outstanding performance; this results from hard training, proper diet, psychological discipline and good health. Adolescence is one of the most challenging periods in human development. The relatively uniform growth of childhood is suddenly altered by an increase in the velocity of the growth. These sudden changes create special nutritional needs (Spear, 2004). Increased attention has been paid to the sports in childhood and adolescence, since it has realized that top performance in many sports is reached only if appropriate training is started at very early age (Sodhi and Sidhu, 1991)

Anthropometric variables are valuable for selection of swimming event. Since anthropometric parameters at age before biological maturation (8-10 years old for females and 9-11 years old for males) can be predicted for adults, coaches can select individual swim stroke based on appearance of young athletes (Soares and Riechle, 1999). Gender differences in aerobic capacity reflect the gender differences in body composition. In general, men have higher aerobic capacity because of their larger lean body mass, the active metabolic body tissue. These highly metabolic tissues of the body thus use more oxygen than do other tissues, such as fat (Williiams, 1994; Debnath & Debnath, 2005) Physical fitness plays a vital role in the sports and optimum level of it is essential for maintaining sport performance. Optimal physical fitness makes possible a lifestyle that unfit cannot enjoy. To develop and maintain physical fitness requires vigorous effort by the total body. Being physically fit is more than just being fast or strong. The physical fitness contains of three components, flexibility, muscular strength and endurance and cardiovascular endurance. Although flexibility or muscular strength and endurance are important components of health and well being, cardiovascular endurance is the best physiological index of total body endurance. Life depends on the strength of the heart and lungs to deliver nutrient and oxygen to the cell (Grodner et al., 1995). Since studies on nutrition and physical fitness (aerobic fitness) for the pediatric athletes/ sports children were very less conducted so the present study was undertaken to know nutritional status & physical fitness of children engaged in competitive swimming.

METHODOLOGY

Selection of subjects

A total of 41 competitive male swimmers from well known swimming clubs & training institutes of Nagpur from age group 10 + to 14 + years were purposively selected. 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 (Table 1).

Anthropometric Measurements

Body weight and standing height of swimmers were taken using standard procedures & equipments & compared with NCHS/ICMR standards.

Body Composition

Skinfolds at biceps, triceps, subscapular & suprailiac were measured using high quality precision skinfold caliper. Each skinfold measurement was taken in triplicate to avoid any errors and mean was calculated and taken as final value. Using total skinfolds, body density (Durnin & Rahaman, 1967) was calculated. Further body fat (BF%) and lean body mass (LBM) were calculated (Siri, 1956; Katch & McArdle, 1984 & Nande, P. J. & Vali, S. A., 2010).

Dietary Information & Nutrient Intake

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

Physical Fitness

Cardio respiratory endurance of swimmers was assessed by Harvard step test (Kansal, 1996) whereas arm & shoulder strength was assessed by push up test (Fisher, 1968).

Statistical Analysis

Mean, standard deviation, percentage & range were calculated. Students "t" test was used to derive conclusions from comparisons between various parameters. Correlations 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 (Garrett & Woodwarth, 2005).

RESULTS AND DISCUSSION

Measurement of height and rate of gain in weight are the best parameters for assessing physical growth. Height and weight are interrelated. 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 (Park, 1998). Table 2 shows mean values of height & weight of male swimmers grouped age wise. It can be noticed that all male swimmers were taller and heavier (with the exception of 11+ yrs group) than their respective standards. Research suggests that the best swimmers tend to be tall and with long arms and long hands. The size of their hands gives them great "water grasp", and only a very small hand movement keeps them afloat (Juan, 2006). Even after a person reached puberty swimming may help in increasing the height (Grow taller naturally, 2013).

Skinfold thickness represents about 40 to 60 % of the total body fat in the subcutaneous region of the body, and can be directly measured using a well calibrated caliper. Table 3 shows data on body density, BF% & LBM for male swimmers. With the age, increment in body fat content & lean body mass was noticed in males swimmers aged 12+, 13+ & 14+. This may be attributed to growth & sports training. Differences in individual BF & LBM values were noted. Part of the reason why some people are better swimmers than others has to do

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY

www.vmsindia.org

with body density. The average person's body density is slightly less than that of water. Muscle has greater density than fat. Therefore, very muscular people tend to be poor at staying afloat. Old ideas held that the increased body fat made them float better; meaning less energy went into keeping them on top of the water (Juan, 2006).

Debnath and Baua (2004) found that swimming sprinters they studied were significantly taller, had longer arms, greater biceps, triceps, sub scapular skinfolds & fat percentage when compared with track and field sprinters.

Hassapidous et al. (2001) found out that percent body fat was lower for athletes including swimmers compared with controls.

Table 4 shows coefficient of correlation between body weight & various body composition parameters. There existed direct relationship between body weight & triceps, subscapular & suprailiac. Body weight reflected high & significant correlation with BF & LBM in majority groups of swimmers. Increment in body fat content can be attributed to growth period of subjects whereas higher lean body mass is a positive effect of regular participation in the sport.

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 persons/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. For the present research, it was observed that majority of swimmers were following regular meal timings. Table 5 shows data on mean daily intake of energy, carbohydrate, fat & protein for male swimmers.

It can be noted irrespective of sex and age, all swimmers reflected deficit energy intake (percentage deficit range from 5.94 to 24.43 for male swimmers when

I J R B A T, Vol. VI (Special Issue 1), January 2018 : 322- 333 ISSN 2347 – 517X
INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY
© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No.659/13(N)
www.vmsindia.org

compared with respective RDAs of energy intake). Majority age groups of male swimmers showed significant differences between energy intake and RDA values at both 0.05 and 0.01 levels (with exception of age group 10 + whose mean energy intake was found to be highest among all age groups), with "t" value in the range of 3.97 to 8.08, p<0.01. Also, 10 + age group of male swimmers showed highest value of mean carbohydrate intake (254.81±381.66 g). No significant differences were noted among all age groups of male swimmers for minimum and maximum values of carbohydrate intake (Table 5).

Mean daily fat intake for male swimmers were significantly exceeding the respective RDAs for their age. Daily mean intake of protein of male swimmers from various age groups did not show much difference (63.04 ± 8.319 g to 66.14 ± 7.273 g). Age groups 10 + and 11 + showed significantly higher mean protein intake than RDAs (t=4.66 & 3.31, respectively, p<0.01). In contrast to this, age groups 12 +, 13 +, and 14 + depicted lower mean protein intake than RDAs (t=0.07 (p>0.05), 0.48 (p>0.05) & 2.18 (p<0.01), respectively, Table 5). A huge gap was noted for minimum and maximum protein intake values.

Percentage of energy derived from carbohydrate, fat and protein for male swimmers ranged from 60.98 to 63.66, 23.20 to 25.46 & 13.14 to13.86, respectively.

Farajian et al. (2004) studied Greek national swimming teams & they found that mean energy intake & carbohydrate consumption for male athletes was 3416 kcal & 4.5 g/kg of body weight, respectively whereas fat intake was 153 g for males.

Paschoal and Amancio (2004) studied nutritional status of Brazilian elite swimmers & they noted an adequate ingestion of calories by the sample. The swimmers also showed low carbohydrate & high protein intake.

Table 6 shows coefficient of correlation between body composition & nutrient intake.

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY
© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No.659/13(N)
www.vmsindia.org

Energy intake reflected positive correlation with LBM & BF% in majority of age groups of swimmers. Energy yielding nutrients did not show much impact either on the development of lean body mass or body fat content as also clear from Table 6.

Table 7 depicts percentage wise distribution of male swimmers based on cardio respiratory fitness. Maximum % of male swimmers reflected good cardio respiratory fitness. The highest percent for "good cardio respiratory fitness" was seen in 11 + age group of male swimmers (85.71 %) as seen in Table 7. 50% 13+ aged swimmers rated "excellent" for their cardio respiratory fitness.

It can be noticed from Table 8 that maximum % of male swimmers from all age groups scored 'below 20' for arm & shoulder endurance. The reduced scaling might be because of lack of motivation while performing the test.

Cardio respiratory endurance among male swimmers showed positive correlation with intake of energy & energy yielding nutrients. Arm & shoulder strength showed direct relationship with energy intake in all age groups of swimmers.

CONCLUSION

Majority of the swimmers were taller and heavier than the standards. LBM increased with age which might be attributed to regular practice and constant involvement in sport. There is a growing need for sports nutrition counseling and education to help athletes to improve their eating habits as it was seen that all swimmers consumed deficient energy. Failure to consume right diet may hamper performance. Nutrition must be equally emphasized both during as well as after competition. Thus, 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.

I J R B A T, Vol. VI (Special Issue 1), January 2018 : 322- 333 ISSN 2347 – 517X

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY

© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No.659/13(N)

www.vmsindia.org

Table 1: Age Wise Classification of Subjects

Sr. No.	Age Groups (yrs)	Number of Subjects
1	10 +	10
2	11 +	7
3	12 +	9
4	13 +	8
5	14 +	7
Total		**41**

Table 2: Data on Height and Weight of Male Swimmers

Age Groups (Yrs)	Height (cm)					Weight (kg)				
	M ± SD	Range	Std ●	"t" Values	% Excess/ Deficit	M ± SD	Range	Std **	"t" Values	% Excess/ Deficit
10 + n =10)	140.50 ± 6.151	129.00 – 153.05	137.5	1.46 #	+ 2.18	32.50 ± 6.353	20.50 – 43.00	31.4	0.52 #	+ 3.50
11 + (n = 7)	140.93 ± 8.813	129.00 – 157.00	140	0.26 #	+ 0.64	30.93 ± 8.126	21.00 – 48.00	32.2	0.38 #	- 3.85
12 + (n = 9)	156.22 ± 4.766	148.50 – 163.00	147	5.52 *	+ 6.26	45.17 ± 9.006	35.00 – 58.00	37	2.58 Δ	+ 22.08
13 + (n = 8)	158.88 ± 12.033	139.00 – 176.50	153	1.29 #	+ 3.86	48.50 ± 12.180	28.50 – 63.00	40.9	1.65 #	+ 18.58
14 + (n = 7)	167.43 ± 8.604	149.00 – 176.00	160	2.10 #	+ 4.63	58.00 ± 13.204	31.00 – 71.00	47	2.03 #	+ 23.40

Std - Standard; ● - Height for age [NCHS/ICMR Standards, 2004]; ** - Weight for height [NCHS/ ICMR Standards, 2004]; # - 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 - significant difference at 0.05 level but insignificant difference at 0.01 level ($0.01<p<0.05$).

Table 3: Data on body density, body fat and lean body mass for male Swimmers

Age Groups (Yrs)	Body Density (g/ml)		Body Fat (%)		Lean Body Mass (kg)	
	M ± SD	Range	M ± SD	Range	M ± SD	Range
10 + (n =10)	1.0563±0.017	1.0245-1.0816	18.73±7.600	7.65-33.16	24.90±5.686	10.81-32.54
11 + (n = 7)	1.0612±0.007	1.0541-1.0742	16.45±2.979	10.81-19.60	24.97±6.025	17.66-38.60
12 + (n = 9)	1.0534±0.012	1.0195-1.0711	19.98±6.294	12.14-35.53	35.72±5.403	29.78-45.83
13 + (n = 8)	1.0478±0.006	1.0390-1.0603	22.43±2.740	16.85-26.42	37.49±9.190	23.70-48.85
14 + (n = 7)	1.0489±0.011	1.0296-1.0658	21.96±4.936	14.44-30.77	44.72±8.570	26.82-54.09

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY
© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No.659/13(N)
www.vmsindia.org

Table 4: Coefficient of correlation between body weight & various body composition parameters

Age Groups (Yrs)	Coefficient of Correlation of Body Weight with:						
	Biceps	Triceps	Subscapular	Suprailiac	Total Skinfolds	Body Fat%	Lean Body mass
10 + (n =10)	0.77	0.76	0.78	0.69	0.77	0.48	0.76
11 + (n = 7)	0.51	0.77	0.16	0.60	0.70	0.96	0.95
12 + (n = 9)	0.56	0.72	0.52	0.84	0.63	0.88	0.91
13 + (n = 8)	- 0.30	0.28	0.34	0.58	0.35	0.94	0.99
14 + (n = 7)	0.47	0.73	0.73	0.82	0.74	0.93	0.97

Table 5: Data on mean daily intake of energy, carbohydrate, fat & protein by swimmers

Age Groups (Yrs)	Energy (kcal)				Carbohydrate (g)		Fat (g)				Protein (g)			
	M ± SD	Range	RDAs	"t" Values	M ± SD	Range	M ± SD	Range	RDAs	"t" Values	M ± SD	Range	RDAs	"t" Values
10 + (n =10)	2013 ± 176	1619 - 2325	2140	1.32	320.37 ± 6.78	254.81 – 381.66	51.88 ± 8.44	31.34 – 59.89	35	5.99*	66.14 ± 7.27	49.53 – 75.96	47.9	4.66*
11 + (n = 7)	1907 ± 113	1725 - 2069	2193	7.15*	290.70 ± 21.22	254.68 – 318.65	53.94 ± 3.66	47.57 – 59.16	35	12.54*	64.63 ± 8.04	53.92 – 74.95	45.4	3.31*
12 + (n = 9)	1981 ± 192	1559 - 2245	2248	3.97*	309.25 ± 39.93	210.92 – 347.48	53.51 ± 4.932	49.27 – 66.36	32	12.43*	65.56 ± 6.80	56.24 – 75.51	65.9	0.07
13 + (n = 8)	1860 ± 164	1696 - 2099	2340	7.77*	288.44 ± 34.15	250.74 – 335.36	49.77 ± 8.34	30.20 – 62.00	32	6.02*	64.46 ± 7.59	54.35 – 77.99	67.9	0.48
14 + (n = 7)	1865 ± 182	1605 - 2112	2468	8.08*	290.65 ± 46.94	234.95 – 349.76	50.02 ± 5.327	44.79 – 58.70	32	8.23*	63.04 ± 8.32	50.89 – 73.86	77.1	2.18*

* - shows significant difference at both 0.05 & 0.01 levels (p<0.01); Rest of the values show insignificant difference at both 0.05 & 0.01 levels (p>0.05).

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY
© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No.659/13(N)
www.vmsindia.org

Table 6: Coefficient of correlation between body composition and nutrient intake for male swimmers

Age Groups (Yrs)	Energy Intake vs.		Protein Intake vs.		Fat Intake vs.		Carbohydrate Intake vs.	
	Lean Body Mass	Body Fat	Lean Body Mass	Body Fat	Lean Body Mass	Body Fat	Lean Body Mass	Body Fat
10 + (n =10)	0.18	0.28	- 0.18	0.49	0.01	0.61	0.25	-0.08
11 + (n = 7)	0.51	0.08	0.43	0.11	0.27	- 0.04	0.41	-0.22
12 + (n = 9)	0.42	0.30	0.28	0.33	0.50	- 0.002	0.31	0.31
13 + (n = 8)	0.18	- 0.20	- 0.29	0.001	0.16	0.02	0.13	-0.19
14 + (n = 7)	- 0.29	0.04	- 0.59	- 0.16	0.11	- 0.23	-0.49	0.13

Table 7: Percentage wise distribution of male swimmers based on cardio respiratory fitness

Age Groups (Yrs)	Cardio Respiratory Fitness Profile of Subjects									
	Excellent		Very Good		Good		Fair		Poor	
	No	%	No	%	No	%	No	%	No	%
10 + (n =10)	-	-	-	-	8	80	-	-	2	20
11 + (n = 7)	-	-	-	-	6	85.71	-	-	1	14.29
12 + (n = 9)	1	11.11	-	-	6	66.67	-	-	2	22.22
13 + (n = 8)	4	50	1	12.5	-	-	1	12.5	2	25
14 + (n = 7)	-	-	2	28.57	4	57.14	1	14.29	-	-

Table 8: Percentage wise distribution of male swimmers based on arm & shoulder endurance

Age Groups (Yrs)	Scale Point for Endurance of Arm & Shoulder									
	100		75		50		25		Below 20	
	No	%	No	%	No	%	No	%	No	%
10 + (n =10)	-	-	-	-	-	-	-	-	10	100
11 + (n = 7)	1	14.29	-	-	-	-	1	14.29	5	71.42
12 + (n = 9)	-	-	1	11.11	-	-	-	-	8	88.89
13 + (n = 8)	-	-	-	-	-	-	1	12.5	7	87.5
14 + (n = 7)	-	-	-	-	1	14.29	-	-	6	85.71

REFERENCES

- Debnath K. & Baua G. S. (2004), "Physique, Body Composition and Somatotype of Female National Gymnasts, Swimming and Track Sprinters", *Journal of Sports and Sports Science*, 24(4): Pp. 15-18.
- Debnath K. & Debnath M. (2005), "Physique, Body Composition and Somatotype of Long Distance Female Swimmers", *Journal of Sports*

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY
© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No.659/13(N)
www.vmsindia.org

and Sports Science, 28: Pp. 21-25.

- Durnin & Rahaman (1967), "The Assessment of Amount of Fat in Human Body from Measurement of Skinfold Thickness", *British Journal of Nutrition*, Pp. 21, Pp: 682, 683, 687, 688.
- Durnin. J. V. G. A. (1967), "The Influence of Nutrition", *Canadian Medical Association Journal*, Pp. 96, 715.
- Farajian P., Kavouras, Yannakoulis M. & Sidossis L. (2004), "Dietary Intake And Nutritional Practices Of Elite Greek Aquatic Athletes", *International Journal of Sports Nutrition Exercise Metabolism*, 14(5), citation from - http://www.humankinetics.com/IJSNEM/journalAbout. cfm.
- Fisher J. T. (1968), "Physical Fitness Program", *Journal of Physical Education*", Pp: 65, 120.
- Garrett H. E. & Woodwarth (2005), "Statistics in Psychology & Education", 12th Edition Paragon International Publication India, Pp: 126, 185,186.
- Gopalan, Sastri B. V. R & Balasubramanian S. C. (2004), "Nutritive Value of Indian Foods", Reprint, NIN, Hyderabad, Pp: 47-73.
- Grodner M., Anderson S. L. & Deyoung S. (1995), "Foundation and Clinical Application of Nutrition", Mosby Publication, Pp: 222.
- Grow taller Naturally (2013), "Can Swimming make you grow taller", growtallernatural.com> exercise.
- Hassapidous M. N. & Manstrantoni A. (2001), "Dietary Intake of Elite Female Athletes in Greece", Journal of Human Nutrition and Dietetics, 14, Pp.: 391-396, citation from - www.doaj.com.
- Juan S. (2006), "What makes a good swimmer? citation from- http://www.theregister.co.uk/2006/08/25/the_odd_body_swimming/
- Kansal D. K (1996), "Test and Measurement in Sport & Physical Education, D. V. S

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY

www.vmsindia.org

Publication (New Delhi), Pp: 138, 139, 147, 150.

- Katch & Mc Ardle (1983), "Nutritional, Weight Control and Exercise", 2nd Edition, Lea and Fibiger, USA, Pp: 336, 337.
- Nande P. J. & Vali S. A. (2010) "Fitness Evaluation Test for Competitive Sport". 1st Edition; Himalaya Publishing House, Pp: 3.
- Park K. (1998), "Textbook of Preventive and Social Medicine, Banarsidas Bhanot Publisher (India), Pp: 359, 360.
- Paschoal V. P. & Amanico O. S. (2004), "Nutritional Status of Brazilian Elite Swimmers", *International Journal of Sports Nutrition Exercise Metabolism*, 14 (1), citation from - http://www.humankinetics.co m /IJSNEM/journalAbout.cfm.
- Siri W. E. (1956), "Advances in Biology and Medical Physic", London and New York, Academic Press, Pp: 113.
- Soares dos Santos S. & Riechle H. (1999). "Relationship among Anthropometric Characteristics, Stroke Frequency and Stroke Length in Brazilian Elite Swimmers" ISBS'98 Proceedings II. Sanders and Linsten, Eds., Perth, Western Australia, p: 251-254, citation from - usaswimming.org/USASWeb/... ?TabId=234&Alias=Rainbow&Lang=en.
- Sodhi & Sidhu (1991), "Sports Anthropometry-A Kinanthropometric Approach", ANOVA Publication (Mohali), Pp: 48, 113.
- Spear B. A. (2004), "Nutrition in Adolescence", Krause's Food, Nutrition and Therapy", 11th Edition, W. B. Saunders Company, Pp: 375.
- Wikipedia Encyclopedia (2007), "Body Composition", citation from – http://en.wikipedia.org/wiki/Body_Compostion.
- William Sue Rodwell (1994), "Essential of Nutrition and Diet Therapy", 6th Edition, Mosby Publication, Pp: 272, 273.