Chapter II

REVIEW OF RELATED LITERATURE

The research scholar has made sincere effort to locate and collect the literature relevant to the study. The related literature collected from different sources have been presented as an abstract form in this chapter.

A study was conducted by Dey\(^1\) recently with the view to assess and compare the physical characteristics of top class male swimmers of South Asian Countries viz. India, Bangladesh, Srilanka and Maldives at the Human Performance Laboratory at Sports Authority of India, Calcutta. After complete analysis of the data the Maldives swimmers were found to have poor height and weight in comparison to their other international counterparts. The average height of the top class swimmers has been reported to be ranging between 181 cms. and 191 cms. It has also been reported that free style swimmers (50 m., 100 m.) have a maximum height of 191 cms. and free style (1500 m.) swimmers have a maximum height of 181 cms. on an average.

Khanna and Saha\(^2\) conducted a study on physique and


physiological characteristics of Indian National Junior and Senior swimmers with reference to age. The aim of this study was to assess the physical and physiological characteristics of junior and senior swimmers - male and female and also to determine the faculties in which further improvement amongst the swimmers is required, to achieve the international standard. Swimmers were subjected to graded protocol of exercise using treadmill till maximum exhaustion. Oxygen consumption, heart rate, ventilation and breathing equivalent were recorded, after every 30 seconds, with the help of computerised EOS-print. Oxygen debt was computed from the recovery oxygen consumption. Body fat was assessed from skinfold thickness, somatotype was calculated by the method of Heath and Carter.

It was found that Indian swimmers have very less weight as compared to the Olympians. Mesomorphic component of physique is lacking while the endomorphic component of Indian swimmers is higher. Aerobic capacity and anaerobic capacity of junior and senior swimmers is not at part with their International counterparts.

Dubey\(^3\) investigated on anthropometry and arm and leg speed performance of Indian top class swimmers as predictors

of swim speed. She studied on the following variables - height, weight, arm length, thigh length, fore leg length, leg length, body composition, vital capacity, maximum expiratory pressure, maximum breath holding capacity, peak flow rate, pulse rate, systolic and diastolic pressure, arm and leg speed. The analysis of data revealed significant relationship of 50 mtr. front crawl swim speed to each of the following anthropometric, physiological and arm and leg speed variables: height ($r = -0.5942$), weight ($r = -0.6582$), arm length ($r = -0.3767$), thigh length ($r = -0.3903$), fore leg length ($r = -0.5043$), leg length ($r = -0.4796$), body composition ($r = -0.4816$), vital capacity ($r = 0.6375$), maximum expiratory pressure ($r = -0.3905$), peak flow rate ($r = -0.6098$), arm speed ($r = -0.6887$).

Rork⁴ conducted a study to determine the floating ability of women on a homogeneous group of 27 young adult women, all of whom were expert swimmers. Observations were made in an indoor fresh water swimming pool. On the basis of the findings the human floaters were classified in two groups: (1) Those who have a small specific gravity due to either adiposity or a large pulmonary volume or both; and (2) those who have a large surface area. Floating ability is greatest when all three attributes are simultaneously present.

Sodhi\(^5\) while discussing swimmer's physical measurement pointed out that in 1953 Cureton studied on Olympic swimmers by taking a variety of physical measurements. Sprint swimmers were found to be stronger in arm, leg and body strength. The middle distance swimmers found to have greater vital capacity and more than the average amount of adipose tissue. Their relatively great floating capacity suggested light bones and less dense muscular tissue, a trend towards endomorphy. There were no extreme ectomorphs or endomorphs in the competitive swimming groups. All were average in strength, the sprinter tending towards ectomorphy and the middle distance swimmers towards endomorphy.

Kohlrausch\(^6\) studied on the athletes who participated in the 1928 Olympic Games at Amsterdam. Kohlrausch, discovered the 22 best sprinters in the world to be 142.3 lb. in weight and 67.9" in height, with a weight/height index of 2.17 and vital capacity of 4300 cc. as average measurements. The middle distance runners averaged 147.7 lb. in weight, 58.9" in height, 2.19 for body build and 4800 cc. as the vital capacity. The long distance


runners averaged 132.7 lb. in weight, 66.8" in height, 2.10 for body build and 4950 cc as vital capacity.

Amusa and Ignatius\textsuperscript{7} conducted a study on eighteen male swimmers of the University of Ibadon who were competition bound and trained for three months in radiness for the Nigerian Universities Games on body composition, circulo-respiratory endurance, heart rate, oxygen consumption, vital capacity, muscular strength, leg power, joint flexibility, agility and leg speed with a view to describing their profile. The findings of the study corroborate well with the suggestion of the International Committee for the standardization of physical fitness tests (1974) that strength, endurance, body type, flexibility, speed and agility are relatively important human factors in distance and sprint swimming.

Louise\textsuperscript{8} studied on the physiological adaptations to strength and endurance training. This study was designed to determine the effects of a seven-week isokinetic strength and endurance training programme on untrained females ages twenty to thirty-four.

\textsuperscript{7}Lateef O. Amusa and Ignatius Onyewadume, "A Profile of the University of Ibadon Male Swimmers," \textit{NIS Scientific Journal} 10 (October 1987) : 35-42.

\textsuperscript{8}Pohlman Louise, "Physiological Adaptations to Strength and Endurance Training," \textit{Dissertation Abstracts International} 43:8 (February 1983) : 2597-A.
Maximal oxygen consumption significantly increased 21 per cent and 15 per cent in the Strength and Endurance Group (S/E) and Endurance Group (E) respectively. Power values for the S/E group decreased for left leg extension, for both legs combined, and when expressed relative to total body weight. The strength group demonstrated numerous power increases. Other changes in these physiological parameters were significant for the various groups. No changes were shown in body composition for any group. The decline in power observed in the S/E group and the lack of significant increase in power noted in the E group suggest that training designed to improve power and strength should not incorporate endurance exercise.

Mishra\(^9\) investigated the relationship of selected physical and physiological variables to performance in fifty meter front crawl swimming of 25 physical education college swimmers. He found that there was significant positive relationship between arm strength, ankle flexibility and vital capacity to swimming speed. He also found that there was no significant relationship between body surface area and swimming speed.

Carlson\textsuperscript{10} investigated on morphological, cardio-respiratory and biomechanical model of endurance running performance. It was concluded that selected cardio-respiratory, body size, composition and structure and biomechanics variables contribute significantly to endurance running performance in trained adult recreational runners. As hypothesised, the degree of the contribution of the cardio-respiratory measures as determinants of endurance performance was greater than the contributions of the body size, composition and structure and running mechanics variables.

Edmund and Brush\textsuperscript{11} carried out a study on physiological and anthropometric assessment of successful teenage female distance runners. Physiological and anthropometric measurements were taken in a group of young women. Mean age 16.2 years who had been training regularly by running approximately 50 mile per week for two years. Their mean $\text{VO}_2\text{max}$ 63.24 ml/kg/min. is among the highest recorded in a group of young women. The anthropometric measures include: skinfolds and circumferences. These young women appeared to be of average height, low in body fat, have a high component of ectomorphy and a smaller


\textsuperscript{11}J. Bruke Edmund and Florence C. Brush, "Physiological and Anthropometric Assessment of Successful Teenage Female Middle Distance Runners," Research Quarterly 5 (May 1979): 180.
over all skeletal frame work than the non-athletes.

Bell\textsuperscript{12} examined on ten male adolescent and young adult swimmers to determine the effects of two breathing patterns on selected physiological parameters during a simulated 200 yard free style swim. It was concluded that during training and performance, the evidence suggests that under a given workload greater metabolic capacity was required when breathing every stroke and higher intensities of work could be tolerated when breathing was done only during alternate strokes.

Holmer\textsuperscript{13} has stated that competitive swimmers are characterised by excellent cardio-respiratory function. This fact can be explained by the changed breathing pattern involved in swimming, where there is increased pressure on the thoracic cage and water pressure is encountered and overcome by force exhalation. Additional demands on the respiratory muscles lead to increased functional capacity and economical operation of the cardio-vascular systems in particular. These results are in accordance with the breadychardia associated with regular prolonged physical exercise.


Matheson\textsuperscript{14} studied the relationship between swimming and selected physiological and anthropometric development and skill variables in 10-12 years old female competitive swimmers was determined. Forty girls were tested and measured over selected variables. Each also completed 400 yard time trials. The inter-correlation matrix indicated that best single predictors of swimming performance were height, aerobic capacity and stroke efficiency.

McCafferty\textsuperscript{15} studied on physiological parameters of identical twins. They are known to be very similar, including respiratory measurements and strength data. Extremely different training techniques (weight lifting versus endurance training) appear to induce different characteristics in identical twins. Differences in heart size and maximal oxygen uptake found. The endurance runner had a greater endurance capacity.

Manly\textsuperscript{16} conducted a study on eleven varsity swimmers from Virginia Polytechnic Institute and State University and ten boys who were member of AAU Youth Group Swimming Teams,

\textsuperscript{14} Zarilee Matheson, "Selected Physiological, Anthropometric and Skill Variables Contributing to Success in 10 -12 Years Old Female Competitive Swimming," Completed Research in Health, Physical Education and Recreation 20 (1978) : 293.

\textsuperscript{15} Bill McCafferty, Swimming Technique 13 (1976) : 126.

to determine the relationship of selected metabolic, pulmonary and anthropometric factors to performance in 100 yards butterfly swimming event. It was concluded that maximal breathing capacity was the only predictor in the youth group swimming performance at the .05 level of confidence. Further, a high multiple correlation was found among four variables namely maximum breathing capacity, vital capacity, oxygen debt and strength to performance in 100 yards butterfly swimming.

Rae\(^{17}\) had studied on chronic intensive physical training and cardiac function in female swimmers. The cardiac function of nine female swimmers, ages 9 - 17, was compared to that of eight control subjects of the same age. The swimmers, members of a year round competitive age group swim programme, engaged in workouts six days a week covering distances up to 14000 meters per workout. Significant differences between trained young female swimmers and size were in the functional parameters of maximum oxygen consumption and heart rate.

Lowson\(^{18}\) found out that, maximum oxygen uptake, maximum

\(^{17}\)Ridinger Rhonda Rae, "Chronic, Intensive Physical Training and Cardiac Function in Female Swimmers," Dissertation Abstracts International 36 (December 1975) : 3491-92 A.

\(^{18}\)David Loyd Lowson, "Physiological Parameters Limiting Performance in Middle Distance and Sprint Running," Dissertation Abstracts International 36 (September 1975) : 1372-A.
oxygen deficit and Margaria Kalamen Index were the parameters most highly related to 440 yard running performance. Two mile running performance was found to be dependent upon the aerobic capacity of the subjects. Percentage of slow twitch fibers, percentage of body fat and vital capacity also showed a significant relationship to two mile running performance.

The resistance of the water is overcome by moving the arms and legs in a particular fashion and the swimmer receives his propulsive forces from his arms and legs to pull him through the water.\(^{19}\) His speed of swimming is a resultant of the amount and speed of water pulled or pushed backwards, more water can be pulled or pushed simply by increasing the pulling surface, the frequency of pulling and kicking. The pulling surface is fully dependent upon the length and size of the limbs. Longer the limbs, more the amount of water pulled or pushed, and better the speed. The body build of Johnny Weismiller, the man who dominated the world in free style swimming (crawl technique) in 1920's was considered the ideal; wide shoulder, 6 feet 2 inches in height, slim hips and large feet.\(^{20}\)

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Sprague\textsuperscript{21} studied the relationship of certain physical measurements with swimming speed for all competitive strokes. The physical measurements were height, weight, sitting height, lower leg length, foot length, forearm length, waist girth, hip width, shoulder width, chest thickness, triceps, skinfold, shoulder flexion, ankle flexion and vital capacity. The most consistent physical measures were foot length and biceps size. In each case longer feet were associated with faster time.

According to Harry\textsuperscript{22} height is an advantage, smallers a disadvantage. Because he did not see any male swimmers under five feet eleven inches in height, or any female under five feet seven inches, winning an Olympic sprint. Most men have been over six feet.

Grigor\textsuperscript{23} studied the effect of progressive weight training programme on the performance of swimming 100 metres crawl stroke of male and female competitive swimmers between age 10 to 16 years. It was concluded that the subjects who participated


progressive weight training programme significantly improved their performance in swimming 100 yard distance using crawl stroke.

Thirty University of Oregon students who were fairly proficient in swimming were trained and conditioned for five weeks. Scores on test batteries used to measure physical fitness, motor fitness, and gross strength improved significantly. No significant difference was obtained for cardio-vascular condition.²⁴

Causack²⁵ is of the opinion that breathing should be demand and not at every second stroke. He has long advocated controlled breathing in both free style and butterfly sprinting. He trains his sprinters with quite an amount of fast swimming with a set number of breaths or without breathing at all. It is a fact that over the years every one of the swimmers from his squad who made the finals in national championships or came out with honours in State Championship was capable of doing fifty metres at a very good speed with very restricted breathing or without breathing at all.


Erikson found in an investigation that the marathon swimmers are generally husky and usually overweight. The study has concluded the 80 per cent of the successful channel swimmers were 20 per cent or more over weight than normal persons. Thus, body fat serves to provide insulation and buoyancy, besides providing a source of energy for long term efforts when metabolism mechanisms have been learned.

Michale while reviewing the effects on pulmonary function, mentioned competitive swimmers are usually credited with large vital capacities. The mean for world class eight swimmers in Cureton's 1948 study (11:45), was 6.28 litres. Bloomfield and Sigeriseth (11:46), report means of 5.12 litres for 24 sprint swimmers and 5.64 litres for 24 distance swimmers. Pugh and others, (16:269), commented that surprisingly the vital capacities of channel swimmers were not high. The average for eight men was 4.8 litres and for one woman 3.2 litres (11:45).

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Magel and Ardle\textsuperscript{28} suggested that the biomechanics and physiology of swimming are continually interacting. Propulsion depends on muscular strength and effective stroke mechanics. Whereas the sprint events require maximum power, the distance events call for maximum efficiency. The ability of a swimmer to maintain a high velocity depends on muscular endurance, efficiency, and his total capacity for energy expenditure (maximum oxygen uptake). Sprint swimming at high velocity (50 and 100 yards) requires a greater percentage of strength than does distance swimming (1500 metres) at slower speeds. Strength, or rather power (work done per unit time), appears to be the more important factor in developing speed in the shorter sprints.

In a status study by Rossen\textsuperscript{29} on eight champion sprint swimmers at the University of Oregon, all swimmers were found 6 feet tall, having meso-ectomorphic body build with narrow hips, wide squared shoulders, and long but thin legs. They had poor flexibility in their shoulders and ankles but had smooth and coordinated movements in the water. All of them were non-buoyant


\textsuperscript{29}Dan Van Rossen, "Developing a Sprinter," \textit{Swimming World} II (December 1970) : 5.
having great strength and fast reaction. They had great confidence in themselves and set higher goals than most.

The study conducted by Saltin\textsuperscript{30} on vital capacity revealed that swimmers and divers possessed an enlarged lung capacity as a result of training. It indicated that training had resulted in increased vital capacity.

Pugh and others\textsuperscript{31} evaluated the body build of 12 channel swimmers were extremely high in endomorphy. Even among world class swimmers, sprint swimmers were higher on mesomorphy and the 400 and 1,500 metre men were higher on endomorphy. The distance swimmer were also more bouyant floated closer to the horizontal than the sprinters.

Thompson and others\textsuperscript{32} studied the effect of various training programmes on speed of swimming. Six groups of subjects were tested to determine various training programmes affected performance in speed in swimming 30 yards. No evidence of


improvement was found after one group of subjects had been exposed to absolutely no exercise for six weeks and, also after a group of subjects had participated in various exercise with weights three times weekly for six weeks. Two groups of swimmers who participated in practicing starts, kicking, arm stroking, and sprinting 30 and 60 yards significantly improved their performances in speed in swimming. One group of subjects followed the preceding programme three times weekly and another group used the same routine six times a week. Two other groups, one of which was exposed to weight training and swimming, and one of which was exposed only in 30 yard sprints and practicing starts, both showed statistically significant differences in performance.

Huss and Cureton\textsuperscript{33} tested 52 university swimmers on cardio-vascular and energy metabolism. Gross oxygen intake and gross oxygen debt correlated .54 and .58 respectively with 440 yard crawl swimming time. Gross oxygen intake also correlated between .42 and .50 with the brachial pulse wave systolic amplitude, and diastolic amplitude.

Monetoye\textsuperscript{34} conducted a study on breath holding ability


of 22 physical education majors at the University of Illinois. It revealed a statistical significant decrease in breath holding time when the duration of exercise before the test was increased. It was concluded that (1) increased duration of exercise resulted in decrease breath holding time, (2) Practice could lead to increased breath holding time, (3) certain individuals were capable of holding their breath until unconsciousness occurred.

Clarke\textsuperscript{35} pointed out that speed also depends upon strength. This is merely an other way of saying that stronger man can lift more rapidly than can a weaker one or than the strength or motor limits the speed of an automobile. If all these aspects are equal of an individual the stronger the individual faster he can run.