Chapter III

REVIEW OF RELATED LITERATURE

The review of literature related to the study presented in abstract form in this chapter would provide basic clues on the prediction of performance as well as the relationship of anthropometric, body composition, and physiological variables to assess the performance in Physical Education and Yogic Programme.

The literature reviewed has been collected mainly from the libraries of Lakshmibai National College of Physical Education, Gwalior, Post-graduate Training College of Physical Education, Banipur, West Bengal, and the State Institute of Physical Education for Women, Calcutta. The reviews that are presented here may focus light on the background for this study.

Burke and Brush\(^1\) studied physiological and anthropometric measures of young women who had been training regularly by running approximately 50 miles per week for two years. Anthropometric measures included segment of lengths, diameters, skin folds, and circumferences. He found out that these women athletes were low in subcutaneous body fat for this age and sex.

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\(^1\)Burke, Edmund J., and Brush, Florence C. "Physiological and Anthropometric Assessment of Successful Teenage Female Distance Runners", \textit{Research Quarterly} 50 (May 1975) : 18.
Cureton\textsuperscript{2} in his study of champion athletes has stated that all round athletic ability is characterised by wide shoulder width compared to hip width. Davenport's Crural Index is a valuable guide for the selection of individual built in an agility pattern for bony leverage, higher values of leg length, trunk length, indicated agility types. Ability of putting and throwing is indicated by relatively greater height and arm span.

Novak and others\textsuperscript{3} investigated to determine working capacity, body composition and anthropometry of female Olympic athletes. The subjects in his study were eight distance runners, seven swimmers and five gymnasts. He concluded that distance runners showed significantly higher oxygen intake which was also achieved at significantly higher work loads compared to swimmers, lean body mass was significantly lower in swimmers.

Seltzer\textsuperscript{4} conducted a study with 175 subjects to correlate various anthropometric measures with endurance performance


in i) treadmill, ii) pack test, iii) step test and demonstrated a virtual absence of relationship between statute weight, chest circumference, leg length, lower leg length with the criteria both before and after a training period. He also concluded that Ponderal Index = Height/3/Weight which correlate .29 ± 049. Individuals poor in this index were poor in performance. He concluded that there was no evidence of any advantage of the tall, long-legged individuals compared to those with short statute in the pack and step test.

Chetia\textsuperscript{5} undertook a study to find out the relationship of leg-length, thigh-girth, calf-girth and abdominal strength to standing broad jump on 44 college male students. The result indicated that there were significant relationships between standing broad jump and leg length, calf girth and abdominal strength.

Carter and others\textsuperscript{6} study on Montrial Olympic Athletes, concluded after examination that jumpers were heavier and had larger thigh and calf girth than the sprinters and distance runners. They also had larger lower extremity length than

\textsuperscript{5}Uday Kamal Chetia, "Relationship of Leg-length, Thigh Girth, Calf-girth, and Abdominal Strength to Standing Board jump", (Unpublished Master's Thesis, Jiwaji University,1982).p-34.

the sprinters and larger sum of six skinfold than the distance runners. The distance runners had smaller upper arm and forearm girth than sprinters or jumpers, but larger bi-illiac breadths than sprinters. There were no significant differences on age, height, sitting height, upper extremity length or biaxial breadths.

Grewal and Sidhu\textsuperscript{7} carried an intensive study on 17 female volleyball players of Indian Volleyball Team. They observed that by taking age, height, weight and ponderal index along with Herata’s Method of "Absolute Evaluating Method of Physique" the women volleyball players at national level can be selected.

Mayhew\textsuperscript{8} carried out a study to determine if selected physiological and anthropometric factors that contribute to endurance running performance in adolescent male track athletes contribute similarly to endurance running performance in adolescent female track athletes. He concluded that significant differences in body composition and structure, haematological parameters, aerobic capacity and endurance running


\textsuperscript{8}Jerry Lawrence Mayhew, "Related Contribution of Body Composition, Selected Haematological Parameters and Aerobic Capacity to Endurance Running Performance to Male and Female Adolescent Track Athlete", \textit{Dissertation Abstracts International} 37 (July 1976): 179-180 -A.
performance exist between adolescent male and female track athletes. It is further concluded that circulo-respiratory, body structure and body composition variables contribute significantly to endurance running performance in both male and female track athletes, but the degree to which selected variables contributed was not always the same between sex.

Piscapo\textsuperscript{9} studied 647 male subjects of age group 10-12 years from each ethnic group of Italian, Jewish and Negros. Eleven skinfold and other anthropometric measurements were made on each subject. He concluded that:

1. Low correlation was obtained between skinfold and height, higher \((r)\) co-efficient were found between skinfold and weight measurements. Significant differences between the three ethnic groups were found relative to abdominal, chest and posterior arm skinfold measurements of each age level.

Golding\textsuperscript{10} in a study of 30 college men did not find significant relationship between anthropometric measurement and cardio-vascular step test: however, body shape and body composition inversely correlated with Harvard Step Test Scores.

Well\textsuperscript{11} investigated in his study the physical characteristics, body composition, pulmonary function and aerobic capacities of male and female marathon runners. He selected seven male and four female engaged in endurance training. Vital capacity, residual volume, body density and percentage of body fat were calculated. He concluded that elite class male and female distance runners have a body build with little body fat and large lung volumes.


Laubach and others\textsuperscript{12} included two measures of cardio-vascular fitness as Harvard Step Test, Ohio State University Step Test and Twenty direct and derived anthropometric measurements were obtained on thirty college men and inter-relationship was investigated. The anthropometric measurements of fat and body composition correlated significantly with scores obtained in Harvard Step Test. Neither Stature, sitting height, lower extremity length or the mesomorphic component of body build sure to affect the score of the two tests. He concluded that within the limitation of the study, it would appear that measures of body weight fat composition are more of a limiting factor in the performance of Harvard Step Test or Cardio-vascular efficiency.

Hosler, Marrow, Jr. and Jackson\textsuperscript{13} studied 180 collegiate women volleyball players and concluded that women collegiate volleyball players tended to be slightly taller, heavier, broad shoul-

\textsuperscript{12}L.L. Laubach et al., "Relationship Between Two Measures of Cardio-vascular Fitness and Selected Body Measurements of College Men", \textit{Research Quarterly} 55 (December 1982) : 615.

dered and narrow hips than other three groups. Leannes of the upper extremity was significantly larger in rowers and water polo players, while the lower extremities were significantly larger in rowers only. Total body fat in absolute values was found significantly higher in water polo players.

Anderson\textsuperscript{14} investigated on twenty female engaged in one week pre-training session consisting of riding a bi-cycle ergometer 200 yards per week at a heart rate of 135-145 beats per minute for ten minutes followed by an eleven week training programme. Pre and post measures were recorded on cardio-vascular efficiency, eleven blood constituents, systolic amplitude and percentage of body fat. He had one control group and other two groups were trained separately at a heart rate of 125-135 beats and 145-155 beats per minute respectively. He concluded that a significant reduction in percentage body fat in experimental group and big increase in cardio-vascular efficiency when compared to control group.

\textsuperscript{14} Eugene R. Anderson,"The Effects of Varying Workload Intensity and Duration of Exercise Time on Selected Cardio-vascular and Anthropometric Measures", Completed Research in Health, physical and Recreation 20 (May 1978) : 262.
Yoest\textsuperscript{15} in his study of comparison of relationship between cardio-vascular fitness and selected anthropometric measurements in eight grade boys and college male subjects, and concluded that age, height, lean body mass and body surface area did not significantly limit performance in Ohio State University Step Test. However, body composition representing body fat, limited the performance of college men only. In adolescents, scores in the step test improved larger percentage of lean body mass.

Woodword and associates\textsuperscript{16} in their study relating to maximal oxygen consumption, body composition and anthropometry on selected olympic male athletes observed that the tallest rowers and water polo players had significantly larger skeletal width, and length measurements. The skinfold measurements showed larger fat folds on the trunk and extremities in water polo players compared to the other three groups.

\textsuperscript{15}Elemer William Yoest, "Relationship Between Cardio-vascular Fitness and Selected Anthropometric Measurements of English Eight Grade Boys and College Men", Dissertation Abstracts International 34 (November 1973) : 2374-A.

\textsuperscript{16}W.A. Woodword et al., "Maximal Oxygen Consumption, Body Composition and Anthropometry of Selected Olympic Male Athletes", The Journal of Sports Medicine and Physical Fitness 18 (June 1978): 139-149.
Abdo\textsuperscript{17} in a relationship study, concluded that excess weight had the greatest deleterious effect on cardio-vascular efficiency. The correlation was definitely higher for subjects with normal weight. The linear correlation between cardio-vascular efficiency and ponderal index was significant.

Crew and Meador\textsuperscript{18} investigated the relationship between body composition measures, reaction time and run time at 5.16 and 40 yards. In addition, each player's optimal playing weight (POPW) was predicted and the effect of being above or below one's predicted optimal playing weight and reaction times and run times were evaluated. Negative correlations between percentage of fat and run times were found to be increased as the distance increased. The players who weighed more than their POPW were found to have a slower reaction time and significantly slower run time when compared to those players who weighted less than their POPW.

\textsuperscript{17}Samia M.A.Abdo, "Leg Strength and Height, Weight Factors in Relation to Cardio-vascular Efficiency of College Women", Completed Research in Health, Physical Education and Recreation 8(1966): 62.

Cureton, Baiban, and Lohman\textsuperscript{19} conducted a study on relationship between body density, total body potassium, skin-fold measurement and AAHPER Youth Fitness Test. Performances, were determined on 49 prepubescent boys, eight to eleven years of age. It was concluded that not only variations in body composition should be considered when interpreting result of AAHPER Test also to be taken into account.

POLLOCK, Cureton and Gruinger\textsuperscript{20} performed an experiment on two experimental groups and control groups of men between 28 and 39 years of age. The training programme was same for both the groups, consisting of approximately 30 minutes of continuous running, jogging and walking with increasing intensity as exercise tolerance improved. Body composition assessment consisted of body weight and the sum of six skinfold measures obtained over chest exiller.


triceps, abdomen, supra-iliac and front thigh. The result in terms of the sum of six skinfold test showed that the control group became fatter the twice a week group remained about the same and the four times-a-week group lost appreciably.

Joe selected 40 Junior High School boys participating in a weight training programme, two days a week for six months. Seventeen boys served as control group. The test items consisted of the Junior Amateur Athletic Union Physical Fitness Test, Anthropometric measures and the California Test for personality. The experimental groups registered a significant difference at .05 level of confidence, over the controlled group in anthropometric measurements and the five out of the six physical test items, while no significant improvement was found in personality test.

Frank made an investigation of selected physiological parameters during terminal stages

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of severe exercises. He selected nine physiological parameters and examined in five male subjects who were divided into sedentary control group and an experimental group that trained for eight weeks. The results showed that training had a beneficial effect on exercise diastolic blood pressure, heart rate and oxygen consumption and the recovery rate of blood pressure and heartrate.

Malanghlin\textsuperscript{23} studied 90 volunteer participants in four months physical fitness programme which was of one and a half hour each for three days a week, with major emphasis on running. Forty-eight physiological variables were selected and these variables were found to be interrelated, both initially and finally. The data were analysed by simple correlation, analysis of variance, "t" test and multivariate approaches; bio-chemical differences were not found between high and low fitness groups both in pre and post-test.

Meyer\textsuperscript{24} conducted a study on adult male (N = 52) described as sedentary who participated for a period of 8 weeks in prescribed exercise programme of either running, swimming, calisthenics or sports activity while a group of control subjects continued to follow their normal routine. Subjects were pre-tested and post-tested on parameters of cardiovascular fitness, lean body mass and serum cholesterol content of the blood. A statistically significant difference was found between the increased cardiovascular fitness on the running group and all the other groups. No significant differences were found when mean differences between pre-test and post-test scores of the groups were compared for the variables of lean body mass or serum cholesterol content of blood.

Bayed\textsuperscript{25} studied the physiological effect of two variables resistance weight training programme on male and female with the age ranges from 18 to


35 years. The results revealed that all the groups gained significant increase in shoulder abduction (power and endurance) while the female groups were the only ones to increase in strength. Body composition result indicated significant increase for all groups in body density and lean body weight (except female strength). Girth measurement results showed significant increase in thigh and biceps for all groups. Skinfold measurements showed a significant decrease in triceps and bicep measurements. Work on treadmill showed significant increase in only the female endurance group.

Waltin and Schendel for their study selected twenty one middle aged (31-60 years) men. All subjects participated in a jogging programme for ten weeks, three days a week. At the start of the training the subjects first walked and then jogged to 55 yard intervals of one and a half mile covering a distance of 3 miles at the end of 10 weeks. Before and after the programme

26Charles C. Waltin and Jack S. Schendel, "Physiological Changes in Middle Aged Men Following a Ten-weeks, Jogging Programme," Research Digest 23 (November 1973) : 3.
they performed a six minute sub-maximal exercise bout on a bicycle-ergometer to determine if any difference existed in heart rate and blood pressure. Difference between the means of pre and post tests of heart rate under pre-exercise, sub-maximal exercise and post exercise conditions were all significant at .01 level. Diastolic blood pressure was significantly lower than the initial mean. The difference in systolic blood pressure was not significant. The investigator, concluded that the decrease in heart rate and diastolic blood pressure at rest during sub-maximal exercise and during the recovery period, indicate a more efficient blood transport less strain on the cardio-vascular system and functional reserves and an increase in sub-maximal work capacity.

Robson and Singh\textsuperscript{27} study was to find out the relationship of cardio-respiratory performance of physical education professional students to selected anthropometric measurements and respiratory variables. They found, no significant relationship

between cardio-respiratory performance to various physiological variables and anthropometric measurements. However, when inter-correlation were worked-out between independent variables significant correlation at .05 level of confidence was seen.

Olsen and Edelstain\textsuperscript{28} studied the spot reduction of subcutaneous adipose tissue. Skinfold measurements were taken on both arms of 32 High School boys. One arm served as control, the other arm completed three sets of 7 km. curb and three sets of 7 km. schedule for six weeks. The results indicated that hard exercise in a specific area of the arm causes a reduction of the adipose tissue in that arm.

Alteri\textsuperscript{29} selected 63 college female between seventeen and twenty two years of age to study the effects of endurance and interval running on selected physiological parameters. Resting pulse rate was one of the physiological parameters selected. Analysis of data revealed that both


\textsuperscript{29} Reger Engene Alteri, "The Effects of Interval and Endurance Running Upon Anthropometric and Physiological Parameters in College Age Females", Dissertation Abstracts International 36 (December 1975) : 3483-A.
treatment significantly lowered resting pulse rate.

According to Shaver\(^{30}\) endurance training tends to lower the resting heart rate (Bradycardia) for instance, resting heart rates in highly trained athletes may be as low or lower than 40-45 beats per minute on the other hand, in healthy but untrained subjects resting heart rates may be as high as 90 to 100 beats per minute. Thus, the trained subject is generally characterized as having a low resting heart rate and the untrained as a high resting heart rate.

Karpovich and Sinning\(^{31}\) were of opinion that both systolic and diastolic pressures change during exercise. The diastolic pressure change little and systolic pressure changes considerably, the pulse pressure tends to increase and decrease with the systolic pressure.


Campbell\textsuperscript{32} conducted a study on heart rate of male college students during basketball season. He selected seven subjects for that season and concluded that a session's basketball does not produce significant change in resting heart rate. He also concluded that it does not produce a significant reduction in the time required for the heart rate to return to 90 beats/minute. A significant reduction was observed in mean recovery intervals.

James\textsuperscript{33} investigated the effect of isometric and isotonic exercises on heart rate and blood pressure and sought to determine the relationship of these effects to physical work capacity. He concluded that both isotonic and isometric exercises resulted in significant changes in heart rate,

\textsuperscript{32}Donald E. Campbell, "Heart Rate of Selected Male College Freshmen during a Season of Basketball", \textit{Research Quarterly} 39 (December 1968) : 880.

\textsuperscript{33}Sam E.D. James, "The Effect of Isometric and Isotonic Exercises on Heart Rate and Blood Pressure and their Relationship with Physical Work Capacity in College Men", \textit{Dissertation Abstracts International} 34 (February 1978) : 4838-A.
systolic blood pressure, diastolic blood pressure and pulse pressure.

Gentry 34 carried out a study to determine the effect of nine week aerobic jogging programme on selected cardio-vascular functions of young male college students through a time course evaluation procedure. Pre-test and post-rest administered at the end of the third, sixth and ninth week were employed in order to evaluate the effect of training programme. Significant decreases were observed in resting diastolic blood pressure and steady state heart rate while no change was observed in exercise cardiac output resting and exercise cardiac index and also in resting heart rate.

Tuttle 35 conducted a study to find the efficiency of high school boys as shown by the pulse rate test. The subjects were given stepping exercise on 13 inches bench for a period of one


minute. He observed that high physical efficiency had a faster recovery and lower resting heart rate than that of untrained individuals.

Frank 36 conducted a study to investigate change in various physiological components of college men after participating in four different conditioning programme such as: i) Cooper's Aerobic Programme, ii) Interval Conditioning Programme, iii) Regular Physical Education Programme. One group was kept as control with no formal physical education programme for ten weeks. The physiological components measured were body weight, skinfold, resting blood pressure, exercise blood pressure, serum cholesterol and serum triglycerides. Significant differences were found favouring the aerobic, interval and physical education groups when comparing variable with those of control group. He concluded that all three groups improved significantly in cardio-vascular fitness as compared to control group. The interval conditioning group showed that exercise systolic blood pressure was significantly lower than that of control group.

The interval conditioning and control group showed

better recovery heart rate following maximal work on Harvard Step Test than did either of two other groups.

Farrell\textsuperscript{37} selected 18 male distance runners for his study. Body density, residual lungs volume and relative body fat were determined, according to the procedure. An average of eight treadmill run at various speeds were performed by each subject. Heart rate was determined during the last 15 seconds of each minute from suitably placed lead using a "Quinton" "ECG" monitory system. He concluded that subjects showed characteristically high VO\textsubscript{2} max. and low relative body fat of distance runners. The heart rate required to run at a treadmill velocity of 268 beats/minute which corresponds to 77 to 111 per cent of the individual's maximal heart rate. It was concluded that heart rate calculated by regression equation are in excess of the subjects maximal heart rate.

\textsuperscript{37}Peter A. Farrell \textit{et al.}, "Exercise Heart Rate as a Predictor of Running Performance", \textit{Research Quarterly} 51 (March 1979) : 201.
Mecallister \(^{38}\) studied 16 female subjects on three different bicycle ergometer work tasks, each at a work load of 600 kgm./min. Test A was standard bicycle ergometer ride. In test B a 20 per-cent maximal hard grip contraction was sustained and the test C, subjects rode without hands on the handle in order to eliminate isometric contraction entirely. Physiological variables such as heart rate, systolic blood pressure, diastolic blood pressure, pulse pressure were included in the study. He observed that a significant increase in heart rate and systolic pressure were found in Test B. The results indicated that heart rate and blood pressure of young healthy women increase significantly when a moderately low hand grip contraction is introduced during exercise.

Bawes \(^{39}\) studied the effect of specific exercises on skinfold measurements. He took college women as his subjects; 20 in an experimental and 24 in


control group. The skinfold sites selected were: posterior surface of upper arm, iliac crest of the mid axillary line and a middle side of thigh opposite superior ridge of Patella. The experimental subjects were enrolled in a physical education class for women which met for three one hour period per week for ten weeks. Thirty minutes per period were devoted to exercises, which consisted of body mechanics exercises for the first five weeks and modern dance techniques, composition and lectures for the second five weeks. For the experimental group, significant losers of arm skinfold occurred mostly during the second five weeks.

Singler\textsuperscript{40} selected 51 college men as subjects to study the effect of vigorous exercise programme on skinfold thickness. The subjects were divided into two groups. The experimental group participated in the Canadian Programme for eight weeks while

\textsuperscript{40}David Singler, "The Effect of Vigorous Exercise Programme on the Subcutaneous Fat, Total Body Fat and Body Density of Young Adult Males", \textit{Completed Research in Health, Physical Education and Recreation} 2 (1969): 143.
the remaining subjects did not participate in vigorous physical activity. It was observed that there was no significant change in the skinfold measurement.

Tufts\textsuperscript{41} investigated the effect of diet and physical activities upon 15 Alese College Women enrolled in a weight control class. They met for 35 minutes three times a week a semester. The diet applied was the "1000 Calorie exchange plan" established by the American Diabetic Association. The physical activities varied from day to day but consisted of calisthenic, rhythmic, folk dancing, badminton, basketball, kicking, jogging, bicycling and circuit training. Body weight and eleven skinfold measurements were taken to evaluate body composition. Analysis of data showed significant reduction in skinfold measurement.

Philip in his study took six men over a period of 24 weeks and he trained, detrained and retrained them. Each of the three phases was for eight weeks. The exercise regimen for the training and retraining period consisted of 30 minutes of warm up, 30 minutes of running, and 30 minutes of participating in handball or other games. During training and retraining, blood cholesterol was reduced from 298 mg. per cent to 196 mg. per cent. During determining, it rose to its former level.

Frank selected 76 college age men to study the effects of physical conditioning programme on selected physiological components, including serum cholesterol. The subjects were divided into four different groups, three of which participated in different physical conditioning programme. One

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was control group which had no formal physical conditioning programme. The different physical conditioning programmes were: i) Cooper's Aerobic Programme, ii) Interval conditioning programme, iii) Regular physical endurance programme, iv) Control group. It was observed that among the four groups, Interval conditioning, Aerobic conditioning and Regular physical education groups were significant in reducing serum cholesterol in comparison to the control group. Control group showed significant increase in serum cholesterol.

Johnson and associates\textsuperscript{44} studied 11 varsity swimmers who consumed diet in which 40 per cent of the calories were derived from fat. During the training season the swimmers maintained low cholesterol level.

In the study of the effect of physical training programme on blood plasma cholesterol, Rochelle\textsuperscript{45} selected 12 normal subjects, six of whom acted


as control group. A conditioning programme consisting of a daily two-mile run for time was administered on experimental group. Each subject attempted to improve his running time each day. The time of two mile run ranged from 12 to 15 minutes. Cholesterol levels were significantly reduced during course of training in the case of experimental group. A temporary rise in plasma cholesterol occurred during exercise, probably indicative of fat mobilisation and ultimate utilization during physical exercise.

Golding, undertook a 20 year longitudinal study to find out the effect of exercise on blood cholesterol. 45 men participating during the first year and new subjects were added in the following year. In the third year the first two groups were combined and a new group was started. This routine procedure continued annually till the study was completed. Eighteen men participated in the programme for 10 or 11 years; about 36 took part for nine or more years. The number of participants became larger and larger as years went by. The exercise

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programme started at a very low level of intensity, utilising warm up exercises and swimming. The programme content increased in intensity each week, the number of exercise repetition was increased, new calisthenics were added and the swimming distance was lengthened. During the first year, significant reduction occurred in serum cholesterol and this trend continued into the second and third years. During the fourth and fifth years, the cholesterol level increased although it was still significantly below the original levels. A reduction occurred again in the seventh year.

Mathew and Fox⁴⁷ were of opinion that the regular exercise programme cause decrease in both blood cholesterol and triglyceride level.

The purpose of Muk's⁴⁸ study was to measure physiological variables in youth as a result of participation in the University of South California summer family fitness programme. Five variables


⁴⁸ Festa Margaret Laura Muk's, "Selected Physiological Effects of Youth Resultant From Participation in the University of South California Summer Family Fitness Programme", Dissertation Abstracts International 42 (1982): 3058-A.
were investigated. They were body percentage of fat, total serum cholesterol, serum triglycerides (LDL % of total cholesterol) and HDL % of total cholesterol.

The subjects were 29 obese youth aged 7-14. Twenty one were treatment subjects and eight were controlled subjects. All participants had their body percentage fat measured by underwater densitometry before and after the six week treatment programme. Serum lipido were measured in both treatments and control group before and after six week treatment programme.

Result indicated statistically significant decrease in female treatment subjects, body percentage fat and the HDL % cholesterol in control subjects, no significant change was demonstrated in male treatment subject's body percentage of fat, intreatment subject's total cholesterol and controlled children's serum triglycerides in the LDL % of total cholesterol of treatment subject and in the HDL % of total cholesterol of treatment subjects, statistically significant increase were in female control subjects body fat percentage total cholesterol and LDL % of total cholesterol.
Holmgren and others\(^{49}\) in their study and concluded that intermittent long term training (gymnastic exercises or running once or twice a week for several weeks) resulted in significant increase in haemoglobin. Analysis of data also revealed significant increase in haemoglobin as a result of continuous short term training involving skiing every day for eight to ten days.

DeVries\(^{50}\) stated that physical conditioning can increase the total haemoglobin as a result of the increased blood volume, but there will not be any increase in haemoglobin concentration per unit volume.

Beandet\(^{51}\) undertook a study on the comparison of selected physiological parameters in men and women.

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\(^{51}\) Suzanne Michale Beandet ,"A. Comparison of Selected Physiological Parameters in Men and Women of Similar Aerobic Capacity" Dissertation Abstracts International 40 (August 1949) : 736-A.
of similar aerobic capacity. Physiological parameters involved in oxygen transport were compared in men and women similar aerobic capacities as assessed by maximum oxygen uptake. The parameter of cardiac out-put divided by body weight, haemoglobin concentration and per cent body fat were examined to detect differences that might exist due to sex or fitness level. The results showed that cardiac out-put increased with fitness level and was greater in men. Cardiac out-put divided by body weight increase with increase in fitness level but showed no difference due to fitness level. Per cent body fat was greater in women and decreased with increase in fitness level.

Mathews and Fox\textsuperscript{52} stated that the Physical training causes change in blood volume and haemoglobin increase.

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In this study Stephens studied the effect of isotonic and isometric exercises on selected physiological variables, haemoglobin concentration is one of them. No increase in haemoglobin concentration was observed under exercise conditions. But isotonic conditions resulted in greater haemoglobin concentration than isometric.

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