CHAPTER II

REVIEW OF RELATED LITERATURE

Presented in this chapter are the reviews of related literature that the investigator has come across through the search for related material.

Ramadan investigated the maximal \( CO_2 \) consumption, anaerobic power maximum, body composition, somatotype, the Profile of mood states and the State-Trait Anxiety characteristics of the Kuwaiti World cup soccer team.

\( VO_2 \) max. was determined using a progressive cycle ergometer protocol with data obtained by standard semi-open circuit spirometry. Anaerobic power was calculated using the highest value of three vertical jumps applied to the Lewes formula \((\sqrt{4.9 \times \text{Weight} \times \sqrt{D}})\).

Body composition was estimated by skinfolds and somatotype was by the Heath-Carter method. Translated versions of Profile of Mood States and State-Trait Anxiety were used.

The Kuwaiti Team exhibited moderately high aerobic (51.9 ml/kg min-1) and anaerobic (119.5 kg. m/sec) power, both values being significantly higher than college norms. Relative

Jasem Mohammad Ramadan, "Selected Physiological, Psychological and Anthropometric Characteristics of the Kuwaiti World Cup Soccer Team," Dissertation Abstracts International 46 (October 1985): 924-A
body fatness (8.9%) and a balanced mesomorphic somatotype was comparable to those athletes on other high level team sports.

Analysis by playing position revealed the goalkeeper to have higher anaerobic power max., percentage fat, mesomorphy, and both state and trait anxiety levels along with lower VO₂ max. compared to players of other positions.

The structural and functional measures taken for this study appeared to indicate that the Kuwait team had appropriate potential for world cup competition.

Eileen² studied the use of hematological measures for the detection of overwork in cross-country runners. Subjects for this study were 15 members of the men's varsity cross-country team at Springfield College. Blood samples were taken from the subjects 20 times during the season. Each sample was analyzed for haemoglobin content, red cell count and white cell count. All the subjects' times from 6 competitive meets were recorded. Analysis was done and R and following conclusions were drawn:

a) a sample measure of haemoglobin, white cell count or red cell count taken prior to a meet does not accurately

predict running performance; the change in blood compartments from one reading to the meet, just before a meet does not predict running performance although the findings were contradictory in this analysis.

Lavoie\textsuperscript{3} conducted histological and biochemical study of skeletal muscle of swimmers and the effects of a training program in water on these parameters. A group of 10 Canadian world class and 14 recreational swimmers were evaluated for triceps brachii muscle fiber composition, fiber area, and succinatodehydrogenase and phosphofructokinase activities before and after a 6 month training period and an 8 week training program respectively. VO\textsubscript{2} max, max. heart rate, max. blood lactate productions were also measured using a swimming test before and after training.

No differences were found in fiber type distribution among groups nor between pre and post training values. Cross sectional area of muscle fibers of elite swimmers showed hypertrophy of both fast twitch and slow twitch fibers as compared to normal values.

\textsuperscript{3}Jean Marc Lavoie, "Histological and Biochemical Study of Skeletal Muscles of Swimmers and the Effects of a Training Program in Water on these Parameters," Dissertation Abstracts International 40 (December 1979): 3187-8.
A significant increase in succinate dehydrogenase (8.3-27.3 umole Kg/min) and phosphofructokinase (5.6 to 36.3) activities was observed for elite swimmers following training.

Following training an increase in VO₂ max. was observed in the elite and recreational swimming groups whereas a decrease in the mad HR was observed in the elite group.

Higher fast twitch fiber surface areas, substrate dehydrogenase, phosphofructokinase activity, and VO₂ max. indicate that swimming training stimulates a skeletal muscle adaptation that results in higher capacities in both aerobic and anaerobic metabolisms.

Gorden⁴ predicted basketball playing ability from cardio-vascular capacity, leg power, upper body strength and endurance, body composition, and height. Subjects were 20 women varsity basketball players from two colleges, one from each college. Separate prediction equations were developed for five criteria measures an ability rating of four offensive-defensive descriptive terms. The Tufts Richards General Personality Rating, a composite score of the two measures, was used as a comparative rating scale which utilized game

statistics, and a ranking of players by the coach. The data were analyzed by the step wise multiple regression programme. The best prediction equation was found to be: Basketball ability = 9.053 + 1.364 (12 min. run).

Brook\(^5\) has stated that due to differences in leg length among athletes it seems logical that leg length would be a better indicator of stride length than height, and Hoffman (1972) gives a ratio of leg length to stride length for world class female sprinters of 2.38 to 2.50.

Rapporteur\(^6\) studied specific athletic preparation for basketball. Physiology is also necessary to develop an athlete. The biological indications of the development of a basketball player include the knowledge of the distributing a) mechanisms of energy at muscular level b) anaerobic alactic process - ATP - CP energy source. This mechanism is strongest because it uses phosphates, substances that are rich of energy but their availability is scarce and they become used up after 7.8 seconds of maximum muscular action and up to 40-45 sec. This mechanism is especially important in basketball as it provides


85% of the energy to the working muscles. Power is the anaerobic alactacid greatest capacity which Basketball requires. Power is also connected to the speed of the biochemical reaction that releases energy. Forty-five percent of energy is produced by anaerobic process. Aerobic process is much used in basketball form where sixty three percent of energy comes from.

Francesco* gave some information on how muscle functions, in whatever physical activity it is involved in his work ie. biochemical mechanism of basketball players.

Any cell, either nervous, hepatic or muscular) functions, with the help of ATP. ATP is a complex molecule composed of one molecule of Adenosine (A) and from three (T) of Phosphorous (P). The first phosphate radical is blue. The second and the third are red, which are therefore the two most important ones. Bond breakage from ATP to ADP includes anaerobic demolition of glycogen. Anaerobic lactacid mechanism produces lactic acid(max. after 10 sec.) that is the most disadvantageous aspect. With low intensity of work one consumes the fats, with high intensity work one consumes sugar.


Consequently, in a marathon the aerobic mechanism is highly developed, because it is supplied by many aerobic muscular fibers. To analyze in details how these mechanisms operate in basketball. To analyze what are the fundamental gestures.

Marchoka and Sruck analyzed the body build of 26 members of the national weight lifting senior team representing all weight categories. They used Mekler Profile Method and Parkal Natural indices. The investigation programme included a wide set of characteristics permitting evaluation of somatic build as regards length, breadth, circumferences, small lengths and medicine level of breadth characteristics in body build of group studied as regards proportions. Particular attention was drawn to long trunk, short arm and thigh, broad chest and very large arm circumference.

Hagerman and Howie tested thirty New Zealand oarsmen for their work output, and heart rate was measured during a rowing ergometer exercise. Ergometer work output and exercise and recovery heart rates were utilized to objective assesses.

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rowing fitness. The results of these tests served as important evaluative function in the selection of a representative national crew. The 13 subjects ultimately selected for international competition produced more work on the ergometer and did so with seemingly less energy expend than unselected oarsmen. A significant difference was found between the two groups for acute recovery heart rate at the end of 10 minutes, favoring the selected oarsmen. No differences were found between the two groups for acute recovery heart-rate (1 min. post exercise) the use of objective analysis seemed to select the best oarsmen more effectively and revealed those subjects with outstanding potential.

Moffatt et al. investigated body composition, physical dimensions and maximal physiological responses of female high school gymnasts to non-athletic high school females.

Thirteen female high school gymnasts were compared with 13 randomly selected non-athletic females' parameters chosen were body weight, height, total body volume, residua.

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volume, body fat was calculated from body density using Siri formula and lean body weight was determined by difference. Six fat fold sites, triceps, sub-scapulae, supra-iliac, abdomen, thigh and calf. Girth measurement included neck, shoulders, chest, waist, abdomen, hips, biceps, forehead, wrist, thigh, knee, calf and ankle. A continuous treadmill test was administered. Open circuit spirometry methods were utilized for the collection of metabolic data. Respiratory gases were also selected. Anaerobic power output and anaerobic capacity were determined by the bicycle ergometer test.

Statistical - Independent t-tests were made to compare the groups. Multivariate Analysis of Variance was employed to compare various fat folds, circumferences and diameters.

The Gymnasts had 10% less relative fat than controls of the same age. The lower body fat of the female gymnast was also evident from fat folds. Female High School gymnasts had similar skeletal structure when compared to non-athletic controls. Non-athletic High School females had less lean tissue and more fat as indicated by densitometry and anthropometry. The percentage body fat of these gymnasts was less 14.8% less than that reported for more mature female gymnasts. The female gymnast also exhibited higher VO₂ Max. and performed better on
tests to estimate anaerobic capacity and anaerobic power output then controls.

Evereth and Sills' studied the relationship between grip strength to stature. The hand grip was used as a test of determining strength by Sargent in 1880 at Harvard. Since no studies were found of the relationship of grip strength to hand length, hand width, palm length and finger length, it was decided to investigate the possible influence of these variables upon hand grip strength. Somato type ratings were also included in the test battery in an effort to gain additional information relative to the influence of endomorphy, mesomorphy & ectomorphy upon grip strength.

400 students ranging an age from 14 to 29 yrs were measured Zero order correlations (Multiple Correlations were found out).

The study concluded that weight correlated higher with had grip this caused greater decreases in most partial correlations, when it was held constant and was included in the correlations of each order.

Hand width had higher correlation with hand grip strength, while hand and finger length ranked fourth and fifth respectively. Height ranked third in the zero order correlations with the hand grip strength, caused the greatest decrease in two of the partial correlations and was included in the Correlation (R) of each order except the second. Mesomorphy ranked 7th in zero order correlation with hand grip strength but did not cause much decrease in the partial correlation. Age ranked 6th. Weight was the most influential variable in the prediction of hand grip strength.

Sills\textsuperscript{12} analyzed the Relationship of Body Components to the Performance of Motor Skills. Moreover, he analyzed the relationship of these three components to a selected list of anthropometric indices.

One hundred and fifty-eight subjects were measured, tested and somatotyped, the average age of the group was 18 years and six months. All subjects were members of the Freshman class and were participants in the in the basic skills course in Physical Education.

\textsuperscript{12} Frank D. Sills, "A Factor Analysis of Somatotypes and of their Relationship to Achievements in Motor Skills". \textit{The Research Quarterly} 21:4 (December 1950): 42.
A battery of 16 test was administered to the subjects. The test battery included situps (Two minutes), pull ups, squat thrusts (30secs.) squat jumps 100 yards pick a back run and 300 yard shuttle run. The remaining tests included parallel bar dips, hand grips, leg lifts, back lift. Sargent jump, dodge run 60yard dash, &ib shot put, standing broad jump, the Iowa Brace Test (Revision). Twenty Two anthropometric measurement were taken: weight, height, height to trochanter on, sitting height to cervical, arm length, acromion to styliion, biacromial shoulder width, chest depth, chest width, no-illiac width, elbow width, knee width, neck girth, chest girth, thigh girth, calf girth, fat chest front, fat chest back, fat abdomen and fat supra iliac.

For statistical purposes, height and weight were included in raw form while remaining measurements were either utilized as indices or dropped from this analysis entirely. On the basis of their probable relationship to the three body components. The following indices were computed and included in the correlation matrix a) Thigh girth / Knee width b) Waist girth / B-iliac width c) Sum of fat measurement / height d) Shoulder width / height e) Chest girth / height f) Arm length / arm girth g) Sum of knee and Elbow joints / Height h) Shoulder width / B-iliac width.

Thirty variables were placed in the correlation matrix. Preliminary investigations of the variables and their inter
correlations were found applying the factorial analysis. The following conclusions were drawn: (1) The body components endomorphy, mesomorphy, and ommorphsy were identified as discreet. Ectomorphy was not identified as a separate factor but as a negative aspect of endomorphy and mesomorphy.

2) The strength factor found on this factor analysis had no significant loadings in respect to the body components endomorphy, mesomorphy, ectomorphy and ommorphsy.

3) On the basis of their relative positions on the factors mesomorphy and ommorphsy the somatotype ratings for mesomorphy and ommorphsy appeared to be related to one another.

John Bloomfield studied the anatomical and physiological differences between three groups of swimmers of varying abilities. Subjects were 120 senior level swimmers who were divided into three ability groups. On the basis of two criterions of the means from the 33 tests administered in the study, only in three of the comparisons did the means of the national level group significantly surpass those of the high level.

University swimmers. In contrast, the means of the national level group were significantly higher than those of the low-level University swimmers in the test. The High level University swimmers' means were in turn, significantly higher than those of the Low level University swimmers in nine instances. In no instances were the means of the High and Low level swimmers significantly higher than those of the National level swimmers, nor were the means of the Low level swimmers in any instances higher than those of either of the other two groups.

Bakogeorge\textsuperscript{14} studied the relationship of Selected Anthropometrical and Physiological Variables to the Balke Treadmill test and Terminal Step test and Test: Inter-relationship. The performance times in the Balke Treadmill test and the Terminal Step test correlated 0.78 in one sample and 0.89 in a second sample. The Step test accounted for about sixty percent of the variance in the Treadmill test but adding other measures did not improve the Prediction materially. Pre-Exercise heart rate showed low but significant correlation with performance times. Exercise hear rate showed significant correlation with

\textsuperscript{14}Peter Andrew Bakogeorge, "The Relationship of Selected Anthropometrical and Physiological Variables to the Balke Treadmill Test and Terminal Step Test and Test Interrelationship", Completed Research in Health, Physical Education and Recreation 7 (July 1965): 53
performance times. The correlation increased progressively with the times at which the heart rate was taken. Neither post exercise rates or strength measures were significantly correlated with performance times.

Michael15 and others took this investigation to evaluate and quantify physiological differences among groups of distance runners. The subjects included 20 elite distance runners (8 marathon, 12 middle-long distance and 8 good runners.) Working capacity and cardio-respiratory function were determined by sub-maximal and maximal Treadmill test and body composition by hydrostatic weighing. The variables studied were maximum Oxygen uptake, VO₂ sub-max, Lactic acid sub-max, lean body weight and fat weight. MANCOVA showed that the good runners differed from the elite runners (P<0.01) and the elite marathon runners differed from elite middle long distance runners (P<0.05).

Discriminant analysis showed that both function significant. The first was a general physiological efficiency factor that separated the good elite runners. The second separated the elite marathon and middle long distance groups. The second function showed

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that the marathon runners had lower lactate acid sub-max. values. The middle long distance runners had higher VO2 max. values. Classification analysis was used to evaluate the accuracy of discriminant functions were used to develop a multivariate scaling model for evaluating distance runners. Two premain runners, one marathon and one middle long distance runner were found to be at the extremes of the scale. The data showed that the discriminant and function provided a valid model for evaluating differences among elite distance runners.

Power and Walker measured and described the cardio-respiratory characteristics, body composition and grip strength of outstanding female junior tennis players. Subjects were 10 female junior tennis players.

Each subject had been training for tennis for 4 years. Means and standard errors of physical and playing characteristics of subjects were taken out. Data was collected on age, height, weight, body fat, years of participation, hours of tennis practice per week for six weeks prior to testing were collected.

Testing parameters included were: Blood pressure, Underwater weighing, Percent body fat, Skin folds at biceps, Triceps, Girth measurements of both arms, forearms and Grip strength.

The next phase involved measurements of Vital capacity, Forced Expiratory Volume, PF, Max. Ventilatory Volume, Graded Treadmill test to determine aerobic power. Gas samples were analysed minute by minute starting at minute one of the test.

A paired T-test was used for significant differences between anthropometric measurements on the preferred and non-preferred sides of the body.

The paper determines the characteristics of the subjects and suggests that highly skilled junior female tennis players differ from young trained females in that they exhibit a higher VO2 max. relatively high grip strength in the preferred hand and a ventilatory capacity that exceeds those of untrained populations of the same age group as mentioned.

Conley¹⁷ conducted a study to determine the relationship between female distance running performance on a 10km road race and body composition, VO₂ max., running economy and the

utilization of VO₂ max. at submaximal speed. The subjects were 14 trained and competition experienced female runners. No significant relationships were found between running performance and either running economy or relative body fat. A with the male heterogeneous group, trained female road racing performance is significantly related to VO₂ max. and % VO₂ but not related to body composition or running economy. It was further concluded that on a 10 km road race, trained females operate at % VO₂ max. similar to that of trained male counterparts.

Cunningham and Anderson tested six high school cross country runners, whom were members of the team that was the Massachutes state high school championship. Mean anthropometric values found this team to be shorter, lighter and less fat when compared to age related norms. The mean somato type was considered more ectomorphic and less mesomorphic than elite endurance athletes. It was concluded that members of a championship cross country team exhibit a physiological profile that is characteristic of endurance athlete team members show little inter-individual variation. No adverse effects of season long

training was noted. Several well-known cardiovascular risk factors were considered low normal in this group.

Burke and Brush\textsuperscript{19} conducted a study to assess physiological and anthropometric measures of teenage female distance runners who had been training regularly by running approximately 50 miles per week for 2 years their mean VO\textsubscript{2} max. of 63.24 ml/kg is among the highest ever recorded in a group of young women. Anthropometric measures included selected segment lengths, diameters, skinfolds and circumferences. These young women appear to be of average height, low in body weight and subcutaneous body fat, have a high component of ectomorphy and a smaller overall skeletal frame work than non-athletes.

Upton and Hagor\textsuperscript{20} conducted a study on seventy three female volunteers age 13 to 15 yrs on height, weight, percentage fat, Forced Vital capacity, Forced Expiratory Volume, Max. Voluntary Ventilation. During the Treadmill test, each subject was continuously monitored via a 12 lead WCG. Heart rate was 12

\textsuperscript{19}Emuel J. Burke and Florence C. Brush, "Physiological and Anthropometric Assessment of Successful Teenage Female Distance Runners", \textit{Research Quarterly} 50:2 (March 1979): 185

\textsuperscript{20}S. J. Upton and R. D. Hagor, "Comparison of the Physiological Profiles of Middle-Aged Women Distance Runners and Sedentary Women", \textit{Research Quarterly for Exercise and Sports} 54:1 (March 1983): 83
lead recording at the end of each stage of the test. Blood Pressure was monitored at end of each walking stage using a sphygmomanometer and pressure cuff. All subjects were similar in age and weight but the untrained subjects were significantly greater than the trained subjects in total body weight. The sedentary women possessed a significantly greater maximal aerobic power.

Browning²¹ made a Comparison of Sprinters and Distance Runners on Selected Anatomical and Physiological Parameters. Sixteen volunteers of the 1968 Florida State University Track Squad were divided into two groups: sprint group 100 to 400 yards' men and distance group 800 to 2 mile men. Subjects were tested on 40 parameters. The sprint group had significantly larger means than the distance group on weight, heart rate recovery 1/2 t-time following the sprint work cut, resting diastolic Blood Pressure preceding maximal work cut. The distance men had a larger mean performance time on the endurance work bout. Significant correlation were obtained between the Coach's rank total work performed during the endurance work bout and the

²¹Fredric Browning, "A Comparison of Sprint and Distance Runners on Selected, Anatomical and Physiological Parameters", Completed Research in Health, Physical Education and Recreation 12 (1970):95
event rank, had response time and total extensor strength and
flexor strength.

Jack studied the Relation of Physiological factors to
Football Performance. Minutes played during the 1958 football
season was used as criterion. Players were measured in 50 yard
dash, right grip, left grip and arm push & pull strength. Speed
correlated 60 and total strength 41 with the criterion. Both
correlations were significant, but the predictive value for minutes
played was less.

Ellis used selected physiological and psychological
variables for prediction of performance in the 12 min. run. 19
measures were taken on 39 male students and placed in
multipleslinear regression model. ANOVA was used to determine
which predictor or combination of predictors would best determine
the distance one would cover in the 12 min. run. The measures
used as predictors were: maximal O2 uptake, Blood pressure,
Heart rate, Percentage recovery from the Astrand Bicycle.

22Jack Duane Ellena, "Relation of Physiological Factors to
Football Performance", Completed Research in Health, Physical
Education and Recreation 2(February '86):26

23Walter Terrel Ellis, "An Exploratory study using selected
physiological and psychological variables for prediction of
performance in the 12 min. run", Completed Research in Health,
Physical Education and Recreation 12 (December '70) 214
Ergometer test, reciprocal of the ponderal in index, manifest anxiety test anxiety, index of social status, neurotic anxiety, and introversion-extroversion. The most criterion variance was accounted for by the measure of percentage recovery. The two equations that represented the best predictors were maximum $O_2$ uptake (liter per minute) and percentage recovery and resting heart rate. No psychological variable used in the study accounted for the significant amount of criterion variance.

Slaughter studied the relationship of Somatotype and Body Composition to Physical Performance in 7 to 12 year old boys. The objective methods of measuring somatypes, Sheldon's trunk index method and Heath-Carter's anthropometric method were used. Body composition was estimated as fat and lean mass from the measurement, using a whole-body counter and from two skinfold thickness measures. Physical performance measures consisted of three tests of running (mile run, 800 yard run and 50 yard dash) and two tests of jumping (standing broad jump and vertical jumps). In general somatotype components had

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24M. H. Slaughter, T. G. Lohman and J. E. Misner. "Relationship of Somatotype and Body Composition to Physical Performance in 7 to 12 year old Boys". The Research Quarterly 48. 1 (March 1977): 159
lower correlations with running and jumping variables than did body composition.

Leedy and others studied the relationship between Physical Performance Items and Body Composition.

The purpose of the study was a) to determine the relationship between body composition and physical performance and related items and b) to determine whether or not certain physical performance and related items might be useful in estimating body composition in terms of total lean mass and percentage lean body mass as measured by potassium 40 determinations in adult men. Data on 19 physical performance items were obtained from 40 subjects between 21 and 57 years of age. The results are of value to researchers in Physical Education in particular for estimating gross body composition using certain physical performance items.

Cress and Thorsen studied the Motor Performance of College Women with respect to Body Structure and Design.

Masculinity and Femininity ratings were studied in relation

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to motor performance scores of college women. Arm Strength, Muscular Explosive Power, Pure Speed and the Hunter Test of Motor Ability showed a significant positive relationship to Andic ratings and a significant negative relationship to gemic ratings. Subjects were classified as being "above", "at", or "below" the established mean andic and gemic factors. Comparison of mean scores revealed those above the andic mean to be superior on tests of speed, arm strength, motor ability. Those below the mean of the gemic factor were found to be superior or those same tests and on explosive power. The extent to which the Physical expression of masculinity exceeded that of femininity was more highly related to performance scores than were either masculinity or femininity ratings alone.

Barcy and Cureton\(^{27}\) undertook the Factorial Analysis of Physique and Performance.

The principal axes of an intercorrelation matrix (\(\varphi=37\)) of physique and performance data from 85 boys 7-11 years of age were located and rotated to an oblique simple structure in order.

to determine the nature of the factors involved in the physique of young boys and the relationships between these factors and performance. With the influence of body size virtually nullified by the rotation procedures, the Somatotype of factors of physique were observed, one related to growth in transverse circulations and adipose tissue, and two related to growth in vertical dimensions. Three factors related to motor performance were also isolated: power, endurance, and dynamic shoulder strength. The morphological and performance measurements were found to be essentially unrelated.

Hinton and Rarick studied the correlation of Roger's that of Physical Capacity to the Cubberley Cozens Test of Basketball Achievement for the study were school girls. The Cubberley Cozens Basketball achievement tests consisted of throw for goal, jump and reach, push pass for accuracy, pivot and pass, throw for distance and pivot and dribble. The Roger's physical fitness test consisted of a battery of strength tests from which the strength index is obtained. The nine parts of the test were weight, height, lung capacity, right grip, left grip, leg lift, back lift, pull up and push up.

The multiple correlation of variables of lung capacity, back lift and arm strength with the criterion (basketball achievement test) indicated a positive relationship and also that these variables may be used to achieve basketball achievement scores.

Harrison\textsuperscript{29} studied the relationship of strength and anthropometric measures to physical performance involving the trunk and legs.

The purpose of this research was to investigate further the relationships of strength and anthropometric measures to physical performance primarily involving the trunk and legs. In this study, 16 strength and 10 anthropometric tests were related by correlation method to trunk and leg measures involving dynamometric strength, muscular endurance, agility and power. The subjects were 53 unselected, non-disabled male students at the University of Oregon.

The inter-correlations among some of the anthropometric variables were especially high: 0.91 standing height with leg length, 0.88 foot length with leg length and 0.87 body weight with

\textsuperscript{29}H. Harrison Clarke, "Relationship of Strength and Anthropometric Measures to Physical Performance Involving the Trunk and Legs", \textit{The Research Quarterly} \textbf{28}:3 (October 1957):223.
both hip width and thigh girth.

The highest strength inter-correlations was 0.65 between trunk flexion and trunk extension significant multiple correlations obtained were: 0.74 for leg strength and trunk flexion strength, 0.71 for back lift with knee extension strength, hip width, trunk flexion strength; and knee flexion strength, and 0.66 for standing broad jump with adipose tissue over the abdomen (negative) and hip extension strength (positive).

Hebblinck and Johan\textsuperscript{30} studied the anthropometric measurements, somatotype ratings and certain motor fitness tests of physical education majors in South Africa.

The purpose of this study was to determine a number of physical characteristics and somatotype ratings of college physical education majors at the University of Stellenbosch and the relationship of these characteristics and ratings with certain motor fitness tests.

Subjects were 52 male physical education majors. Selected anthropometric measurements were: height, weight, shoulder width, neck girth, waist girth. Those selected

\textsuperscript{30} Marcel Hebblinck and Johan W. Postma, "Anthropometric Measurements, Somatotype Ratings and Certain Motor Fitness Tests of Physical Education Majors in South Africa," \textit{The Research Quarterly} 34:3 (October 1963): 327
anthropometric measurements and somatotype ratings of physical education majors were studied and their relation to the performance of certain motor fitness tests was determined. The anthropometric data showed a predominant trend toward the athletic types as described by Kretschmer. The relationship between body measurements and the motor fitness tests was found to be low or significant except the relationship between neck girth and the shot put.

There was evidence that biaxial or width had not kept pace with growth in height when data of this study were compared with data collected earlier.

The mesomorphic trait was the most distinctive feature of the subject's somatotype. The mesomorphic trait was the most distinctive feature of the subject's somatotype. The mesomorphic were superior in all motor fitness tests except in 60 yard dash and the ecto-mesomorphic excelled the endomorphic in all tests except shot put.

Davis et al. studied the anaerobic threshold and maximal aerobic power for three modes of exercise.

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Alterations in selected respiratory gas exchange parameters have been proposed as sensitive indices of the onset of metabolic acidosis anaerobic threshold (AT) during incremental exercise. Their purposes was to investigate the validity and feasibility of anaerobic threshold detection using routine laboratory measures of gas exchange, i.e., non-linear increase in VE and VCO₂ and abrupt increase among three modes of exercise (arm cranking, leg cycling and treadmill walk) with double determinations obtained from 30 college age, male volunteer subjects.

The anaerobic thresholds for arm cranking, leg cycling and treadmill walk/running were obtained. While all pair wise arm versus leg comparisons were significantly different. Using nine additional subjects performing leg cycling tests a significant correlation of r=0.95 was found between gas exchange anaerobic threshold measurements (expressed as % VO₂ max.) and venous blood lactate anaerobic threshold measurements (% VO₂ max.) they concluded that the gas exchange anaerobic threshold is a valid and valuable indirect method for the detection of the development of lactic acidosis during incremental exercise.
Corbin examined the relationship between scores on the Physical Work Capacity 170 bicycle test and performance time in running 200, 400, 600 and 800 yards. In addition, peak heart rates during the run were also recorded and correlated to physical work capacity was also determined.

Subjects were 64 boys, 16 from each grade 3 through 6 in the college station, Texas, Public Schools; each subject ran the distance of 200, 400, 600 and 800 yards. When their heart rates were determined and their performances were recorded.

The correlation coefficients computed between the said variables showed that physical work capacity correlated significantly with 200 yard run and age. Rather it was concluded that age is a capacity than earlier running times or heart rates during 200, 400, 600 and 800 yards.

Conger and Wessel studied physical performance and body form as related to physical activity of college women.

The problems of this study were to investigate the interrelationship of selected functional and body form measures.

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32 Charles B. Corbin, "Relationship between Physical Work Capacity and Running Performance of Young Boys", The Research Quarterly 43:1 (March 1972) 235

33 Patricia R. Conger and Janet A. Wessel, "Physical Performance and Body Form as Related to Physical Activity of College Women", Research Quarterly 39:4 (December 1968) 908
and to examine the differences between groups varying in activity levels. The volunteers for the study, 35 college women were placed in activity groups termed "most active" and "least active" according to their response on an activity history recall questionnaire. Functional measures included strength and flexibility. Strength was measured with a cable tensionmeter and followed the procedures outlined by H. Clarke. Flexibility was measured using a Leighton Flexometer. Body form measures included height, weight, percentage body fat, fat free body weight, specific gravity and ponderal index. The range, mean and standard deviations were computed for all parameters. The Person's Product Moment Correlation was employed to determine their interrelationships of all variables. Equality of variances among selected parameters was determined by F-test; Cochran-Cox and two sample t-tests were used to determine the equality of means among selected parameters in the activity groups. Significant differences at the 0.05 level were found, between the means of weight, fat free body weight, trunk extension flexibility, with the most active group exhibiting higher values. The least active group showed significantly greater shoulder extension flexibility, shoulder inward rotation flexibility and angle flexion flexibility.
Grimby et al. studied Cardiac Output among Submaximal and Maximal Exercise in active Middle Aged Athletes. In well-trained middle-aged (44-55 years) athletes, Oxygen uptake, cardiac output, heart rate, and arterial blood pressure were determined at rest in the supine and sitting positions; and during submaximal and maximal exercise in the sitting positions. The heart volume was measured at rest. The max. O2 uptake was 35 lit./min. and the maximal cardiac output 26.8 lit./min. The stroke volume was 19.5% However at rest supine than during exercise and reached an average max. value of 163ml. The relation between max. SV<--HV does not differ from what was found in young individuals. Various Oxygen differences were 45ml/lit. during maximum exercise. The low arteriovenous O2 uptake and might be explained by the relatively low haemoglobin concentration combined with peripheral factors. In the present study cardiac Output values up to about 30lit./min. were found during maximal exercise. This is a high value even in comparison with young well-trained men. At

sub-maximal work loads the cardiac output is relatively higher compared with material of untrained men.

Perbix\textsuperscript{35} related Somatotype and Motor Fitness on Women. The basic problem was to determine the relationship between somatotype ratings and the form elements of motor fitness for two groups of women. These two groups were major students on Physical Education service courses at the University of Illinois. The problem was divided into two parts. The first of these was to determine and compare the distribution of somatotype ratings for both groups of women. The second was to determine the relation of each motor fitness trait to each of the three somatotype component ratings and compare the two groups.

The procedure followed was somatotype ratings for this study were a part of those made on Dr. W. M. Shelcon's survey of women in an effort to establish norms of women's physique. The ratings were done on a 7 point rating scale, the higher rating indicating performance. The elements of motor fitness and the test used were: 1) Flexibility 2) Agility 3) Strength 4) Power

\textsuperscript{35}Joyce A. Perbix, "Relationship between Somatotype and Motor Fitness in Women", \textit{The Research Quarterly} 25:1 (March 1954): 484

The Persons Product Moment Method was used to determine the reliability of three of the tests used.

Conclusions (Applicable to Illinois University Women)

i) Endomorphy dominant component

ii) Women who chose physical education as a major trend as a group to have more dominant mesomorphic traits.

iii) No relationship between trunk extension and somatotype

iv) Significant relations between mesomorphy and knee push up

v) Inverse relationship between endomorphy and the Illinois Agility Run when the mesomorphic component not predominant:

vi) Medicine ball put correlation with mesomorphy.
Reindell et al. studied the Relationship of Body Fat to Motor Fitness Test Scores.

The purpose of the study was to Examine the Relationships between Percentage Body fat and Selected Motor Fitness Tests, Scores using Hydrostatic Weighing Methods to determine Body Density and thus Body Fat.

The subjects were 61 young men on active duty with the Armed Forces were randomly selected to serve as test subjects in this experiment.

Age, Height, Weight and body fat were taken. The motor fitness was measured using push-ups, sit-ups, squat thrust, standing broad jump, 75 yard dash and 220 yard dash.

Correlations were found out between the body fat (percentage) and the motor fitness test scores and with body weight. Significant negative correlations of form \(-0.29\) to \(-0.68\) were found between percentage body fat and selected motor fitness tests.

The correlation between motor skill and body weight show that all but one of the motor fitness test items included in the study were not significantly affected by weight.

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Conclusions drawn were as follows:

1) Significant negative correlations of form from -0.29 to -0.68 were obtained between performance on the selected motor fitness test items and percent body fat.

2) The motor fitness test items most affected by fat were those which involve running and jumping.

3) The weight did not significantly effect the performance of any of the test items except the 220yd dash.

Sills and Evereth\(^7\) studied the relationship of extreme somatotypes to performance in motor and strength test.

The purpose of this study was to further clarify the relationship of endomorphy, mesomorphy and ectomorphy, to the performance of motor skills and tests of strength.

Forty three University of Iowa students served as subjects for the study. These students were divided into three groups of 14 mesomorphy, 13 endomorphy and 16 ectomorphy. Each

subject was required to take 12 tests. The experiment was designed to include three tests of each activity. 1) Strength 2) Agility 3) Speed 4) Endurance. Dynamometric tests of combined hand grip strength, back and leg strengths and back strength were given to the subjects. For endurance a modification of Carlson's Test was employed. The 50 yard dash for 10 sec, running.

The author recognised that the structural differences in the body types influenced the results. The strength tests were valid tests for the three extreme types. The mesomorphs and ectomorphs were superior to the endomorphs in the three agility tests. The most significant result for the endurance test was that obtained for the mile run, since not one of the endomorphs was able to run this distance.

The conclusions drawn were:

1) Mesomorphs were stronger than endomorphs or ectomorphs.

2) Endomorphs were stronger than ectomorphs.

3) Ectomorphs are superior to endomorphs in speed and agility.

4) Mesomorphs were superior to both ectomorphs and endomorphs in speed, agility and endurance.

5) Excess weight was a handicap to ectomorphs.
6) Consideration should be given to body types in tests forming standards for achievements on strength and motor tests.

In this chapter are description of the subjects, the dependent and independent variable, administration of test and collection of data, the design of study, and statistical treatment of data.

Subjects

The subjects selected for the study were Junior Women Basketball players of top four winning teams in the Junior National Basketball Championships held at Satara, Maharashtra in May 1994. As the subjects were of different economic strata it is reasonable to assume some difference in the physical condition of the players.

Dependent Characteristics

Basket Ball playing ability was the dependent characteristic for this study.

Independent Characteristics

The independent characteristics were Resting Pulse Rate, Explosive Power, Grip Strength, Body Composition (Triceps, Suprailliac and Thigh), Copper's 9 min run and walk test, Height and Weight.