Chapter II

REVIEW OF RELATED LITERATURE

The research scholar has gone through related literature is available which were relevant to do present study. A brief review of the same is presented in this chapter.

Faude O, Meyer T, Rosenberger F, Fries M, Huber G, Kindermann W. ¹ The present study aimed at examining the physiological characteristics and metabolic demands of badminton single match play. Twelve internationally ranked badminton players (eight women and four men) performed an incremental treadmill test [VO(2peak = )50.3 +/- 4.1 ml min(-1) kg(-1) (women) and 61.8 +/- 5.9 ml min(-1) kg(-1) (men), respectively]. On a separate day, they played a simulated badminton match of two 15 min with simultaneous gas exchange (breath-by-breath) and heart rate measurements. Additionally, blood lactate concentrations were determined before, after 15 min and at the end of the match. Furthermore, the duration of rallies and rests in between, the score as well as the number of shots

per rally were recorded. A total of 630 rallies was analysed. Mean rally and rest duration were $5.5 \pm 4.4$ s and $11.4 \pm 6.0$ s, respectively, with an average $5.1 \pm 3.9$ shots played per rally. Mean oxygen uptake (VO2), heart rate (HR), and blood lactate concentrations during badminton matches were $39.6 \pm 5.7$ ml min(-1) kg(-1) (73.3% VO2peak), 169 \pm 9 min(-1) (89.0% HR(peak)) and 1.9 \pm 0.7 mmol l(-1), respectively. For a single subject 95% confidence intervals for VO2 and HR during match play were on average 45.7-100.9% VO2peak and 78.3-99.8% HR(peak). High average intensity of badminton match play and considerable variability of several physiological variables demonstrate the importance of anaerobic alactacid and aerobic energy production in competitive badminton. A well-developed aerobic endurance capacity seems necessary for fast recovery between rallies or intensive training workouts.

Cabello Manrique D, Gonzalez-Badillo JJ\textsuperscript{2} OBJECTIVE: To describe the characteristics of badminton in order to determine the energy requirements, temporal structure, and movements in the game that indicate performance level. To use the findings to plan training with greater precision. METHODS: Eleven badminton players (mean

(SD) age 21.8 (3.26) years) with international experience from four different countries (France, Italy, Spain, and Portugal) were studied. Two of the Spanish players were monitored in several matches, giving a total of 14 samples, all during the 1999 Spanish International Tournament. Blood lactate concentration was measured with a reflective photometer. Maximum and average heart rates were recorded with a heart rate monitor. Temporal structure and actions during the matches were determined from video recordings. All variables were measured during and after the game and later analysed using a descriptive study. RESULTS: The results confirmed the high demands of the sport, with a maximum heart rate of 190.5 beats/min and an average of 173.5 beats/min during matches over 28 minutes long and performance intervals of 6.4 seconds and rest time of 12.9 seconds between exchanges. CONCLUSIONS: The results suggest that badminton is characterized by repetitive efforts of alactic nature and great intensity which are continuously performed throughout the match. An awareness of these characteristics, together with data on the correlations between certain actions such as unforced errors and winning shots and the final result of the match, will aid in more appropriate planning and monitoring of specific training.
Chin MK, Wong AS, So RC, Siu OT, Steininger K, Lo DT. There is a scarcity of descriptive data on the performance capacity of elite badminton players, whose fitness requirements are quite specific. The purpose of this paper is to investigate the physiological response of elite badminton players in a sport-specific fitness test. Twelve Hong Kong national badminton team players performed a field test on a badminton court. Six light bulbs were connected to a programming device causing individual bulbs to light up in a given sequence. The players were instructed to react to the flashes by running towards them, and striking shuttles mounted in the vicinity of the bulbs. Exercise intensity was controlled by altering the interval between successive lightings. A low correlation ($r = 0.65$) was found between the results of the field test and the rank-order list of subjects, based on an objective on-field physiological assessment and subjective ranking. This may be explained by the requirements of other factors besides physical fitness which contribute to success in elite level badminton competition. These factors may include, for example, technical skill, mental power, and aesthetic judgements on the court. Maximum mean (s.d.) heart rate data (187(8) beats.min$^{-1}$) and blood lactate values (10.4(2.9) mmol.l$^{-1}$)

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in this study showed that players were under maximal load during the field test. From the testing data, it seems reasonable to speculate that the intensity of level 3 (20 light pulses.min-1; 3.0 s.pulse-1) and level 4 (22 light pulses.min-1; 2.7 s.pulse-1) simulates the requirement of actual games energy expenditure of the Hong Kong badminton players exercising at close to their anaerobic threshold. The results also show that an estimate of fitness can be derived from measurements involving exercise closely resembling that which is specific for the sports activity in question. Improved training advice and guidance may result from such studies.

Docherty D. 4The present study investigated the heart rate response to playing tennis with special reference to the skill levels and ages of the participants. Data obtained in a similar manner during earlier studies of badminton and squash players were compared with that obtained during tennis. The number of rallies, mean rally time and actual playing time in 30 minutes of play was also compared for the different skill levels and sports. Results showed that playing tennis raised the players' heart rates to 68-70% of their predicted maximum heart rate (PMHR). Playing squash and badminton could raise heart

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rates to 80-85% of the players' PMHR which was significantly higher than the values obtained for tennis. The actual skill level of the participants within their chosen sport did not have a significant effect in predicting the physical demands of squash or tennis but was important in predicting the heart rate response of badminton players. The more skillful the badminton player the greater the cardiac response as a result of game play. Analysis of time spent in actual play revealed that tennis players were involved in play for only five of the thirty minutes of game play, compared to 15 and 10 min respectively for squash and badminton. Skill level within each sport was only a significant factor in predicting length of play for squash players in which the medium and highly skilled groups played significantly longer than those of a lower level of skill.

Majumdar P, Khanna GL, Malik V, Sachdeva S, Arif M, Mandal M.\(^5\) **OBJECTIVE:** To estimate the training load of specific on court training regimens based on the magnitude of variation of heart rate-lactate response during specific training and to determine the magnitude of variation of biochemical parameters (urea, uric acid, and

creatine phosphokinase (CPK) 12 hours after the specific training programme so as to assess training stress. METHODS: The study was conducted on six national male badminton players. Maximum oxygen consumption (VO2), ventilation (VE), heart rate, and respiratory quotient were measured by a protocol of graded treadmill exercise. Twelve training sessions and 35 singles matches were analysed. Heart rate and blood lactate were monitored during technical training routines and match play. Fasting blood samples collected on two occasions—that is, during off season and 12 hours after specific training—were analysed for serum urea, uric acid, and CPK. RESULTS: Analysis of the on court training regimens showed lactate values of 8-10.5 mmol/l in different phases. The percentage of maximum heart rate ranged from 82% to 100%. Urea, uric acid, and CPK activity showed significant changes from (mean (SD)) 4.93 (0.75) mmol/l to 5.49 (0.84) mmol/l, 0.23 (0.04) to 0.33 (0.06) mmol/l, and 312 (211.8) to 363 (216.4) IU/l respectively. CONCLUSION: Maximum lactate reported in the literature ranges from 3-6 mmol/l. Comparatively high lactate values and high percentage of maximum heart rate found in on court training show a considerable stress on muscular and cardiovascular system. The training load needs appropriate monitoring to avoid over-training. Workouts that are too
intensive may interfere with coordination, a factor that is important in sports requiring highly technical skill such as badminton.

Eichorn and Eckert⁶ conducted a study on orientation in eye-hand coordination tasks. Longitudinal data on six eye-hand coordination tasks for children aged 5 ½ through 8 ½ years were factor analyzed in terms of functional and structural cognitive orientation. The data were collected when the boys and girls, followed longitudinally, were 5 ½, 6 ½, 7 ½ and 8 ½ year old. All children had previously participated in other phases of the Berkley Growth study. Each was tested alone by familiar examiners in a quiet room. The eye-hand coordination tasks were: foam board, Dearborn foam boards, needle threading, three hole coordination, bolt and nut, and tapping. Means and standard deviation, by sex and age, were calculated for all the tasks. Multivariate analysis was performed only for three tasks performed by both sexes at all age levels. The data, grouped by age and sex, were subjected to Varimax Rotated Factor analysis. Sex differences in factor loadings suggested differences in orientation, with boys' scores loading more frequently on functional speed tasks than girls'.

Manilal, Sebastian and Thomas\textsuperscript{7} conducted a study to compare the coordinative abilities of junior Indian Basketball players and junior Indian Volleyball players. Twenty one girls who had attended the Junior Indian Basketball coaching camp and twenty one girls who had attended the junior Indian volleyball coaching camp were selected as subjects. Four coordinative ability tests suggested by Peter Hirtz were administered to evaluate the coordinative abilities of the subjects. The \textit{t} test was employed to determine the mean difference in different coordinative abilities between volleyball and basketball female players. The research study has revealed that female basketball players have better differentiation ability of hands and balancing ability than volleyball players. The results also showed that the volleyball players have better space orientation ability and reaction ability than basketball players.

Kraemer\textsuperscript{8} investigated the physiological and performance responses to a stimulated freestyle wrestling tournament after typical weight loss techniques used by amateur wrestler. Twelve Division I collegiate wrestlers (mean±SD; 19.33±1.16 yr) lost 6% of total body


weight during the week before a simulated, 2-d freestyle wrestling tournament. A battery of tests was performed at baseline and before and immediately after each individual match of the tournament. The test battery included assessment of body composition, reaction/movement time, lower and upper body power and isokinetic strength, and a venous blood sample. The result showed lower body power and upper body isometric strength were significantly reduced as the tournament progressed (P≤0.05). Significant elevations in testosterone, cortisol, and lactate were observed after each match (P≤0.05). However, there was a significant reduction (P≤0.05) in resting testosterone values in the later matches. Norepinephrine increases significantly (P≤0.05) after each match, whereas epinephrine increased significantly (P≤0.05) after each match except the last match of each day. Plasma osmolality was consistently higher than normal values at all times including baseline, with significant increase observed after each match (P≤0.05). Tournament wrestling augments the physiological and performance decrements of weight loss and its impact is progressive over 2 d of competition. The combined effects of these stresses may ultimately be reflected in a wrestler’s ability to maintain physical performance throughout a tournament.
Swaroop et al. conducted studies on children, involved in various active sports disciplines, especially in football. This was an attempt to investigate the age group of 10-11 years with special reference to \( \text{Vo}_2 \) max and pulmonary capacities. The study was conducted on 23 children in the age group of 10-11 years who had been selected in a Football Academy at Chandigarh. At the time of evaluation, these children had training age of one year. The aerobic capacity or maximum oxygen uptake capacity (\( \text{vo}_2 \) max) was estimated with the help of a COSMED K4 portable telemetric analyzer (COSMED, Italy), following a graded protocol of exercise on a bicycle ergometer, till exhaustion. The initial load was 1 watt/kg and was increased at the rate of 0.5 watt/kg after every 12 min, till exhaustion. The physiological variables were recorded every 30 secs. The anaerobic threshold level of the subjects was determined by gas exchange method from the deviation point of \( \text{Ve-Vco}_2 \), \( \text{Ve-Vo}_2 \) relationship and breathing equivalent. The respiratory profiles, like, forced Vital Capacity, FFV-1, and peak expiratory flow rate were estimated using a computerized spirometer. The mean relative \( \text{Vo}_2 \) max of these child footballers was 56.6±3.9 ml/kg/min and the AT \( \text{Vo}_2 \) was

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79.5±7.3 % \( \text{Vo}_2 \) max. These were comparable to those of the adult players. The static and dynamic lung volumes depended more on the corporal data than the training status. The study highlights that training can improve aerobic adaptation in child footballers, like adults and thus the \( \text{Vo}_2 \) max and anaerobic threshold level of child players reach a status comparable to adult footballers. The lung capacities of child footballers depend more on age, height and weight than on the training adaptation and for this reason the lung capacities of the child players are lower than their adult counterparts.

Hedelin et. al \(^9\) investigated nine elite canoeists concerning changes in performance, heart rate variability (HRV), and blood chemical parameters over a 6-d training camp. The training regimen consisted of cross-country skiing and strength training, in total 13±1.6 h, corresponding to a 50% increase in training load. Time to exhaustion (runt) decreased from 19.1±1.0 to 18.0 ±1.2 min (\( p<0.05 \)). \( \text{Vo}_2 \) max and max lactate (\( L_{a_{\text{max}}} \)) both decreased significantly (\( p<0.05 \)) over the training period (4.99±0.97 to 4.74±0.98 L.min\(^{-1}\) and from 10.08 ±1.25 to 8.89 ±1.03 mmol.L\(^{-1}\) respectively) Heart rates (HR) decreased

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significantly at all workloads. Plasma volume increased by 7+7% (p<0.05). Resting cortisol, decreased from 677±244 to 492±222 nmol.L⁻¹ (p<0.05), whereas resting levels of adrenaline and noradrenaline remained unchanged. The change between tests in RunT correlated significantly with the change in HRₘₐₓ (r=0.79; P=0.01). There were no group changes in high or low frequency HRV, neither at rest nor following a tilt. The reduced maximal performance indicates a state of fatigue/overreaching and peripheral factors are suggested to limit performance even though both HRₘₐₓ and Laₘₐₓ were reduced. The reduced sub maximal heart rates are probably a result of increased plasma volumes. HRV in this group didn’t seem to be affected by short-term over training.

Barrow¹¹ conducted a study to develop an easily administered test for motor ability for college men. Expert opinion was used in the validation process and eight factors of motor ability and 29 items measuring those factors were chosen. The selected test were administered to 222 college men and statistical analysis covered items were used: zig-zag running, Medicine Ball Put, Standing Broad Jump,

60 yards Dash, Soft Ball Throw, Wall Pass. The standard motor ability rating was found.

Richerson\textsuperscript{12} studied the relationship of several physical fitness variable in elementary school (100 fourth grade) boys and girls data on the following variables were collected, age, weight, height, leg strength, body movement, time 50 yards dash, shuttle run, and standing broad jump. The mean scores on AAHPER Test items were compared on National norms. Several significant correlation’s were found the light being weight with leg strength (46) leg strength with shuttle run (35) and leg strength with 50 yards dash (.86).

Katch and Danialson\textsuperscript{13} conducted a study on bicycle ergometer endurance in women as related to maximum leg force, leg volume and body composition. Twenty-nine college women were the subjects for the study. Pedaled against a constant frictional resistance of 2.5 Kg for six minutes. Maximum leg force measured during cycling at 50 rpm on an isometric ergometer correlated $r=0.73$, 0.74 and 0.57 with performance at 2,3 and 5 minutes of pedaling respectively. The study

\textsuperscript{12} Harold V. Richerson, “The Relationship Of Physical Fitness Variables In Selected Elementary School Children” Completed Research In Health Physical Education And Recreation 10 (1968):76.

also concluded that lean body weight and leg volume correlated with performance were significant but low \( (p<0.5) \) using partial correlation method of computing coefficients of correlation tended to have a positive body image.

Ponthiex and Barker\(^{14}\) conducted a study on the relationship between race and physical fitness. The Study identified statistically significant relationship between race and measures of physical fitness included in the AAHPER Youth Fitness test. A large number of students were subjected. The statistical procedure employed was point biserial correlation analysis.

Racial difference in physical fitness generally favoured Negro pupils, especially among boys. The finding of this research revealed that the Negro school boys studied, exceeded the white boys significantly in 5 components of physical fitness as measured by AAHPER's Youth Fitness Test, while there was no significant difference between their performance on the other two measures. The Negro girls surpassed the white girls in 4 variables and the white girls

surpassed the Negro’s on 2 and there was no significant difference in the girls performance on the remaining test.

Dey\textsuperscript{15} in his study of selected Anthropometrics measurement and physical fitness components of offensive and defensive football players concluded cardio-vascular endurance and explosive strength than those of defensive players have significantly higher leg length, thigh girth, height, weight and crural index as compared of offensive players. The group did not differ significantly in speed, calf girth and ponderal index.

Rawal\textsuperscript{16} conducted a study to compare the coordinative abilities of basketball and handball players. 30 intervarsity players of basketball and handball of LNIPE, Gwalior were selected for the study. The data was collected by administrating various coordinative ability tests as suggested by Peter Hirtz. To find out the significant difference ‘t’-ratio was employed at 0.05 level of significance. The results of the study were:

\textsuperscript{15} Tara Shankar Dey, “Variation in selected Anthropometric Measurement and Physical Fitness components of Offensive and Defensive Football players” (Unpublished Master’s Thesis Jiwaji University, Gwalior 1984).

1. Basketball and Handball players differ significantly in balance ability and reaction ability.

2. Basketball players and handball players do not differ significantly in orientation ability, differentiation ability and rhythm ability.

Dey\textsuperscript{17} conducted a study to compare co-ordinative abilities among different gymnastic ability groups. 100 Gymnasts of Intervarsity level were selected randomly who participated in All India Intervarsity Gymnastic Championship, Amritsar in 2001-2002. To find out the significant difference, the analysis of variance was employed for testing the hypothesis at 0.05 level of significance. The result of the study showed significant difference between the level of gymnasts in the reaction ability, whereas the orientation ability, differentiation ability, balance ability and rhythm ability showed no significant difference.

Ghosh\textsuperscript{18} conducted a study to compare the co-ordinative abilities between the athletes of track events and the athletes of field events. 30

\textsuperscript{17} Apu Dey, "Comparison of Co-ordinative Abilities among different level of Gymnasts" (Unpublished Masters Thesis, LNIPE, Gwalior 2002).

\textsuperscript{18} Gautam Ghosh, "A Comparative Study of Co-ordinative Abilities between the athletes of Track events and Field events" (Unpublished Masters Thesis, LNIPE, Gwalior 2002).
athletes of LNIPE Gwalior were selected as subjects for this study. In order to find out the significant difference of five coordinative abilities between sprinters and jumpers, the two sample 't' ratio test was employed for testing the hypothesis at 0.05 level. Results indicated that:

1. Significant difference was found between the sprinters and jumpers in reaction and orientation ability.
2. There was no significant difference between sprinters and jumpers in differentiation ability, balance ability and rhythm ability.

Bakshi\(^{19}\) conducted a study on two groups of sports persons on co-ordinative abilities. The two groups were the track & field athletes and swimmers. The two groups were chosen because both the activities involved cyclic type of movement. They were tested on the co-ordinative abilities test as suggested by Peter Hirtz. The subjects chosen were either of inter collegiate level or inter university level. The test revealed that there was no significant difference in co-ordinative abilities of swimmers and track and field athletes.

\(^{19}\) Reema Bakshi, “Comparison of Two Groups in Co-ordinative Abilities” (Unpublished Master’s Thesis, Jiwaji University, Gwalior, 1994).
Senan\textsuperscript{20} conducted a study to compare the co-ordiantive abilities of B.P.E. Student of LNIPE, Gwalior. 90 boys of B.P.E., I, II and III year of LNIPE, Gwalior were selected as subject for this study for testing the significant difference among the means in different co-ordinative ability tests of various groups. One way analysis of variance was used which was followed by Post-hoc comparison test to determine the significance between paired means. It was found that in case of orientation ability, differentiation ability and reaction ability, there was significant difference between I, II and III Year. But in case of balance ability there was no significant difference between I, II and III Year.

Sawata\textsuperscript{21} conducted a study to cross sectionally study the selected coodinative abilities and flexibility test of under graduates of LNIPE, Gwalior. 75 subjects from each class level of under graduation were selected from LNIPE, Gwalior. To find out the significant difference the analysis of variance was employed for testing the hypothesis at 0.05 level of significance.

\textsuperscript{20} Shinc C. Senan, “Comparative Study of Coordinative ability of Bachelor of Physical Education Students” (Unpublished Masters thesis, Jiwaji University, 1994).

Findings of the study were:

1. There was significant difference between the class levels from I Year till III Year in differentiation ability.

2. There was no significant difference between the class levels of I, II and III Year in orientation ability.

Kumar\(^22\) studied the cross section analysis of coordinative abilities of boys from 10 to 16 years of age. 240 boys with all age groups of Kendriya Vidyalaya No.1, Gwalior were selected as subjects for the study. To find out significant difference of means among various groups, an analysis of variance (F-ratio) was applied, which was followed by Scheffe’s test of post hoc comparison to determine the significance between the paired means. The analysis of data revealed that variance existed among different age groups in different coordinative abilities.

Dixit\(^23\) investigated the interrelationship of the reaction time, speed of movement and agility and their comparison among players

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\(^{23}\) Poonam Dixit, “Interrelationship of Reaction Time, Speed of Movement and Agility and Their Comparison Among the Players from Selected Sports” (Unpublished Master’s Thesis, Jiwaji University, Gwalior, 1982).
from selected sports. She studied 48 male college students, 12 subjects from each selected sports (football, volleyball, kho-kho and kabaddi) from Lakshmibai National College of Physical Education, Gwalior in the year 1982.

She found that reaction time, agility and speed of movement showed that players from these sports did not differ significantly, which may be due to the fact that the selected sports put same demand on these qualities and involve the use of same training method for their development.

The purpose of the study undertaken by Slater and Hammel was:

1. To compare reaction time measures for arm displacement and visual stimulus.
2. To compare reaction time measures for selected group of physical education and liberal art.

Analysis of the data revealed that only a modest relationship existed between the two reaction time measures. Significant difference in reaction time existed among several group for both reaction measures.
Mol\textsuperscript{24} conducted a study to determine relationship of selected coordinative abilities to shooting performance in hockey. 20 intervarsity male hockey players of LNIPE Gwalior were selected as subjects for the study. To find out significant relationship of coordinative abilities to shooting performance, product moment correlation was employed.

The analysis of data revealed that there was no significant relationship of coordinative abilities to shooting performance.

Gautam\textsuperscript{25} conducted a study to determine relationship of coordinative abilities to shooting performance in basketball. 25 female basketball players of L.N.I.P.E., Gwalior were selected as subjects for this study. The necessary date was collected by administering coordinative ability test as suggested by Peter Hirtz. To find significant relationship, product movement correlation was employed. The analysis of data revealed that there was no significant relationship of coordinative abilities to shooting performance in basketball.


Sarkar\textsuperscript{26} conducted a study to determine relationship of coordinative abilities to shooting performance in soccer. 25 male football players of LNIPE, Gwalior were selected as the subject of this study. Data was collected by administrating various coordinative abilities test as suggested by Peter Hirtz. To find significant relationship product movement correlation was employed. The result of the study was that there was no significant relationship between shooting performance and coordinative abilities of footballers.

Sisodia\textsuperscript{27} conducted a study to determine the effect of transcendental mediation programme on selected physiological variables and coordinative abilities. 60 students studying in LNIPE and Jiwaji University, Gwalior were selected as subjects of the study. The necessary data was collected by administrating various coordinative ability tests as suggested by Peter Hirtz. The significant difference between the pre-test and post-test means for the score in each of the variable within the group were analysed by ‘t’ test and the significance of mean difference between the pre-test and post test scores in each of

\textsuperscript{26} Gourang Sarkar, “Relationship of Coordinative abilities to shooting performance in soccer” (Unpublished Masters Thesis LNIPE, Gwalior 1999).

the criterion variable among the group were analysed by employing analysis of co-variance. Findings were:

1. In case of reaction ability, transcendental mediation had shown significant change in comparison to control group.

2. In case of orientation ability, transcendental mediation did not improve performance significantly in comparison to the control group.

3. Transcendental mediation was found effective in enhancing differentiation ability performance as compare to non-mediators.

4. Balance ability was improved significantly as compared to control group.

5. In case of Rhythmic Ability, transcendental mediation had improved performance significantly in comparison to the non-mediators.

Hodgkins\textsuperscript{28} carried out a study on reaction time and speed of movement in males and females of various age. Nine hundred men, women and children ranging in ages from 16-84 to determine the difference in speed of reaction and movement time. The study revealed

\textsuperscript{28} Jean Hodgkins, "Reaction Time and speed of movement in Males and females of various age", \textit{Research Quarterly} 34 (October 1963) : 335.
that (a) Males are faster than females both in reaction time and movement. (b) speed of both increase up to early adulthood and then decrease (c) peak speed in maintained longer by males in movement and by females in reaction time and (d) in majority of groups studied no relation exist between speed of movement and speed of reaction.

Malmisur\textsuperscript{29} investigated selected physical characteristics of junior Davis Cup player and their relation to success in tennis ability, arm shoulder coordination, pure speed, depth perception, reaction time, movement time, dynamic balance. All rebounding, height and weight showed no significant correlation with success in tennis for this group.

Barrow and Rosemary\textsuperscript{30} have emphasized the importance of balance ability in various sports activity and their physiological mechanism. They have opined that balance is an important aspect of efficient motor response and is one of the basic motor factors. It is the ability of an individual to maintain neuromuscular system in static condition for an efficient posture while it is moving. The first type of balance is referred to as static and the other is dynamic. Both are basic

\hspace{1cm}\textsuperscript{29} Michael Malmisur, "Selection of Physical Characteristic of junior Davis cup player and their relation to success in tennis" Completed Research in Health, Physical Education and Reaction 1 (1967): 92.

\hspace{1cm}\textsuperscript{30} Harold M. Barrow P.E.D. and Rosemary Mc Gee, A Practical approach to measurement in Physical Education (Philadelphia : Kee and Fibiger, 1979) p. 118-119.
to movement under varying conditions. Both indicated certain amount of case and poise maintaining position.

Black and Johnson\textsuperscript{31} studied the effect of swimming training on reaction time of athletes who where non swimmers. Result of this study indicated that reaction time of college athletes was improved during swimming instruction as compared to the control group.

Espenschade and Dable\textsuperscript{32} conducted two studies of dynamic balance in adolescent bodies. It was found that dynamic balance related to height and weight but correlated substantially with the physical abilities important in physical education programme.

In a research study undertaken by Gross and Thompson\textsuperscript{33} to determine the relationship of dynamic balance to the speed and ability in swimming, nineteen factors in motor educability were considered. One of the factors listed was balance also. The finding of the study indicated that the individual who had better dynamic balance can swim faster than those who has poor dynamic balance.


\textsuperscript{32} Anna Espenschade and Robert R. Dable, "Dynamic Balance in Adolescent Boys" Research Quarterly 24 (October 1953): 270.

\textsuperscript{33} Elmer A. Gross and High L. Thompson, "Relationship of dynamics to speed and ability in swimming" Research Quarterly 25 (Dec 1957): 342
Wilson\textsuperscript{34} found when a series of rhythm signals were presented with equal probability that any of them might be accompanied by a stimulus to react, the average reaction time was 6\% faster than when the signal were non-rhythmic. Further, he concluded that reaction time is faster when potential stimuli are presented in a rhythm, rather than non-rhythmic series during the development of fundamental motor scales at the elementary grade level than can teaching and practice without rhythm accompaniment.

Lemon and Sherbon\textsuperscript{35} conducted a study on the relationship of certain measures of rhythmic ability and motor ability in girls and women. The test of rhythm was administered with controlled technique to 100 college women who were selected at random from three groups. There was definite although low correlation between rhythmic ability and motor ability in college women as measured by the three test i.e. brace scale of motor ability, Carl Seashore test of motor rhythm and an original rhythm test.

\textsuperscript{34} Don J. Wilson “Quickness of reaction and movement related to rhythmically and non-rhythmically of signal presentation” Research Quarterly 30 : 1 (1957) : 101.

\textsuperscript{35} Eloine Lemon and Elizabeth Sherbon, “A study of the relationship of certain measures of rhythmic ability and motor ability in girls and women” Research quarterly 5 : 1 (March 1934) : 82.
Whitall and Jill\textsuperscript{36} studied about the interlimb coordination in running and galloping using a dynamical system perspective. It was proposed that interlimb coordination is organized to exploit the dynamic properties of the body with the minimal cognitive input. He selected a group of three year old and adult female who were filmed as they traveled 10 meter runway. Inter limb coordination was assessed temporal and amplitude phasing measures. Entertainment and phase locking were measured respectively. Structural stability was measured using deviation-phasing measures.

Fifty male subjects ages thirteen and fourteen were tested by Carlyle\textsuperscript{37} on their ability to balance on a stationery base and on a moving base. For each subject, scores were recorded for each of 3 trials on each test. Analysis of the data revealed that for each test the gain between the trail 1 and 3 was significant. Theirs computed for all possible combination of scores indicated that there was a marked relationship between balance on a stationery base and balance on a moving base.

\textsuperscript{36} Whitall and Jill, “A development study of interlimb coordination in running and galloping” Dissertation Abstract International 49 (1989) : 21 49-A.

Wyrich\textsuperscript{38} undertook two static balance tasks on 15 subjects two times a day for fifteen days. To determine the effect of that task height might have upon static balance, one task was raised to the height of 4 feet above the ground. The height balance task yielded a high temporal stability coefficient ($r=0.97$) and it was concluded that balance performance in general ability that is not specific to task height.

Waterland and Justle\textsuperscript{39} undertook an investigation to determine whether there is a difference between the reaction times of those running short distance and those running the distance running and see if three is any correlation between speed in running and reaction time. It was observed by them that there exists a high degree of relationship between reaction time and speed in running a short distance.

The mean reaction times of the distance group as defined in this study are distinctly different. The result deducted by Waterland and Justle were that the short distance men next in speed of response (0.149 sec) and the distance men have slowest reaction time (0.169 sec).

\textsuperscript{38} Wannen Wyrich, “Effect of task Height and practice on static balance”\textit{Research Quarterly} 40 (Mary 1969) :215.

Espenschade and Dable\textsuperscript{40} conducted two studies of dynamic balance in adolescent boys. It was found that dynamic balance is not related to height and weight but correlates substantially with physical abilities important in Physical Education programme.

The study of initial position and total body reaction time was conducted by Slater Hamme\textsuperscript{41}. The variation in body position involved the distribution of body weight and the position of the knees. No controls were placed upon the degree of knee bending.

The results were as follows.

1. For each weight distribution group, no significant differences were found for starting reaction involving the position of the knees.

2. A part experiment study indicated that most subject. Consistently rocked back on their heels in coupling reaction.


\textsuperscript{40} Espenschade and Dable, "Development of coordination in boys and girls" \textit{Research Quarterly} 18 (March 1947) : 30-43.

\textsuperscript{41} A.J. Slater Hammel, "Initial Body position and total body reaction time" \textit{Research Quarterly} 24 (March 1953) : 91.
4. It was suggested that starting reaction from the ball of the test require more, therefore, the time required to lower the heels to the floor was included in the reaction time.

Singh\(^{42}\) describes coordinative abilities into seven, they are 1) Orientation Ability 2) Differentiation Ability 3) Coupling Ability 4) Adaptation Ability 5) Balance Ability 6) Rhythm Ability 7) Reaction Ability. In this view, coordinative abilities are important for learning of sport techniques and for their continuous refinement and modification during long term training process. The motor learning ability depends to large extent on the level of coordinative abilities. The coordinative abilities are also indispensable for learning different exercises needed for training and which are used for recreation and recovery in training process. The optimal developed coordinative abilities especially in the childhood are an invaluable asset for learning of complex technique in the advance stage, is depended upon the level of required coordinative abilities. Further, the level of certain coordinative abilities can help in the location of talent for different sports.

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Lotter\(^{43}\) investigated to determine the interrelationship among reaction time and speed of movement in different limbs. Two movements basic to sport skills, a modified baseball throw and football kicks were studied in 105 college athletes of various activities. There was only a moderately high correlation between the relation ability of right and left arms between the right and left legs. Arms vs Legs correlation were significant but low. A similar pattern of correlation between limbs was formed for movement ability but all correlations were considerably lower and movement specificity was high. The reliability of individual difference was high in all the measure.

Clair\(^{44}\) divided 100 male students in two groups of 50 each and then athletes and non-athletes. The athletes consisted of 10 each basketball, gymnastic, baseball, football player, line men and football backs. 25 tests were administered to each subjects. The findings indicated that performance and agility test were accounted for the part, by reaction time, speed of movement, strength, balance, change of direction and body size and form a significant difference was found between the mean scores of the various group of athletes.

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\(^{43}\) Williard S. Lotter, Interrelationship among Reaction Times and speed of movement in different limbs Research Quarterly 31 (May 1960) : 147.

\(^{44}\) Jannet W. Clair, "An Introduction for test for Agility" Completed Research in Health Physical Education and Recreation (1960) : 44.