CHAPTER II
REVIEW OF LITERATURE

The contemporary status of research on physical fitness is an out
come of the vast literature available on physical fitness: 
comparison of physical fitness with other aspects, factor analysis 
of variables representing physical fitness, multiple correlation 
and regression analysis with the developed criteria and so on. 
This study involves the literature pertinent to the construction 
and standardisation of physical fitness test, yet, pertinent 
literature, and though peripheral to physical fitness, deemed to 
be relevant and that which are effective for the meaningful study 
is also incorporated.

Ray\(^1\) in a comparative study of physical and mental abilities 
and achievement, found that physical ability is a more reliable 
predictor of academic standing. He was also of the opinion that 
athletes were superior in mental abilities. \(^2\) Sharma, however, 
found no significant differences of physical fitness between high 
and low academic groups.

No significant relationship was observed between physical

\(^1\) Howard C. Ray, "Inter-relationships of Physical and Mental 
Abilities and Achievements of High School Boys," Research 
Quarterly, XI (March, 1940), 129.

\(^2\) Radhakrishna Sharma, "Comparison of Physical Fitness of High 
and Low Academic Groups," (Unpublished Master's Thesis, 
L.N.C.P.E., 1982).
fitness and work capacity as reported by Scott et. al. Brogdon found that Anglo-American males with large gross body size were superior in performing physical fitness tests. Clarke and Carter reported the highest multiple correlation with strength index, weight and height. They had chosen weight and age as the basis for preparing normative scales. The results revealed a multiple correlation of 0.977 for leg lift, back lift and push-ups of upper elementary school boys; 'R' of 0.987 for leg lift, Roger's arm strength score and 'R' of 0.998 when grip strength was added of the junior high school boys; and, 'R' of 0.985 for leg lift and Roger's arm strength score of senior high school boys.

Joseph in his study found that strength, endurance and speed specially correlated to extraversion. Significant correlation between physical fitness and motor ability observed by Quraishi.

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Dey,\textsuperscript{8} Sharma\textsuperscript{9} in their respective studies enumerates the laws and significance and the futility of predictors with respect to speed, strength, endurance as well as cardiovascular endurance and agility.

A significant correlation of 0.76 was obtained by Eckert and Day\textsuperscript{10} between maximal pushing strength and work load in push-ups. Nelson and Fahrney\textsuperscript{11} found significant correlations (0.74, 0.79 and 0.75) between strength and speed of elbow flexion movement of three different groups.

In an experimental study by Wedemeyer,\textsuperscript{12} no significant relationship was observed among 2 min. sit-ups test, strength and weight. Endurance factor appeared to improve more, when compared to strength factor. In the notes on AAHPER Youth fitness test to total dynamic strength, Berger and Meber\textsuperscript{13} envisaged "the

\textsuperscript{13}Richard A. Berger and Daniel Meber, "Relationship of AAHPER Youth Fitness Test to Total Dynamic Strength," Research Quarterly, XXXVIII (May, 1967), 314.
coefficient of 0.564 between AAHPER Youth fitness test and total
dynamic strength component in this fitness Test."

No positive relationship was found by Colgate\textsuperscript{14} between
arm–shoulder strength and arm speed. In another similar study
Gray\textsuperscript{15} was of the opinion that strength was more specific than was
anticipated. He also found that shoulder extension strength had
highest principal axis loadings for all the three school levels of
his examination.

Berger and Blaschke\textsuperscript{16} found a correlation of 0.76 between
dynamic strength and motor ability.

Pierson and O'Connell\textsuperscript{17} in their study inferred that grip
strength was significant with weight, whereas age and height were
not.

\textsuperscript{14}John A. Colgate, "Arm Strength Relative to Arm Speed,"

\textsuperscript{15}Charles A. Gray, "Factor Analysis of Cable Tension Strength Test
for Upper Elementary, Junior High and Senior High School Boys,"
Completed Research in Health, Physical Education and Recreation,
IX (1967), 363.

\textsuperscript{16}Richard A Berger and Leon A Blaschke, "Comparison of
Relationships between Motor Ability and Static and Dynamic

\textsuperscript{17}William R. Pierson and Eugene R. O'Connell, "Age, Height,
Weight and Grip Strength," Research Quarterly, XXXIII (October,
1962), 5439.
Hunt,\textsuperscript{18} with an extensive observation, suggested that age, height and weight could be retained as criteria for physical fitness and motor ability tests till alternatives are available through investigations. This contribution throws open the arbitrary nature of available assumptions warranting further research. Cozens and Cubberley\textsuperscript{19} found significant correlation between basketball throw and factor of height and weight. He also concluded that factors of age, weight and height have almost a negligible effect upon performance while setting up achievement scales for college women. Seymour\textsuperscript{20} projected the fact that age is not a criterion in physical fitness test and he suggests the possibility of reducing test items with no substantial loss of accuracy.

Bookwalter et. al.,\textsuperscript{21} found that age and weight are influencing factors for grip strength.

Sperling\textsuperscript{22} was of the opinion that one test cannot be

\textsuperscript{18}Stanely Hunt, "The Relationship between Height, Weight, Age and Ability to Perform MANITOBA'S Physical and Motor Fitness Performance Test for Junior High School Boys," Dissertation Abstracts International, XXXV (March, 1975), 5904-A.


\textsuperscript{20}Emery W. Seymour, "Follow-up Study on Simplification of the Strength and Physical Fitness Indexes," Research Quarterly, XXXI (May, 1960), 208.


\textsuperscript{22}Abraham Sperling, "Comparison of the Roger's Test and the City College of New York Physical Proficiency Test as Basis for Classifying Students for Activity in Physical Education," Research Quarterly, XI (March, 1940), 144.
substituted by another test and that each test has its own validity for the purposes of classification.

Physical fitness has differed from place to place and varied from time to time. Knutten,\textsuperscript{23} in a significant comparative study that emphasizes trans-continental standards, wherein AAPHER Youth Fitness test on Danish (European) school children with that of the American standard showed that Danish children responded with scores that exceeded the American measures. In another similar study, Kraus and Hirschland\textsuperscript{24} found physical fitness difference between American and European children. They compared data regarding 4264 American and 2870 European school children. 57.9% American children failed to complete the six minimum muscular fitness tests, whereas only 8.7% of European children failed to do the same test. This depicts that European children excelled in their fitness when compared to Americans. In another study Miyashita and Sadamoto\textsuperscript{25} found differences in physical fitness of Japanese children compared to that of European and North American children, wherein the fitness records of last 15 to 20 years were compared.

\textsuperscript{23}Howard G. Knutten, "Comparison of Fitness of Danish and American School Children," Research Quarterly, XXXII (May, 1961), 190.


Espencha de and Meleney\(^{26}\) checked and compared the fitness records of school boys and girls of the same age level, and concluded that 24 years ago boys and girls were superior in dash and broad jump whereas in all other factors the modern boys and girls were superior.

Rosenstein and Frost,\(^{27}\) in their attempt to compare initial and final physical fitness scores of senior high school boys who were administered the New York State physical fitness test, were able to report significantly good performance by the pupils participating in this programme. Likewise, Saunders et al.,\(^{28}\) in their comparative study on high school children found a significant difference between the pupils opting for physical education and those who were not exposed to physical education.

Singh and Jayadhas\(^{29}\) found that students of the coastal areas were superior in their physical fitness in comparison to students


\(^{27}\) Irwin Rosenstein and Revben B. Frost, "Physical Fitness of Senior High School Boys and Girls Participating in Selected Physical Education Programs in New York State," Research Quarterly, XXXV (October, 1964), 403.


from areas of high altitude. Mookerjee\textsuperscript{30} in his study, concluded that physical fitness of rural boys was superior to that of urban boys. But, Tuteja's\textsuperscript{31} observation in his comparative study did not yield any significant difference of physical fitness of rural and urban boys.

Some classic studies that have used factor analysis (Larson\textsuperscript{32}, McCloy\textsuperscript{33}, Barry and Cureton\textsuperscript{34}, Klovan\textsuperscript{35}, Ismail and Cowell\textsuperscript{36}) have been examined to know the theory and interpretation of factor analysis in depth.

Studies pertinent to the present investigation, that have subscribed to Factor analysis, Multiple Correlations and Multiple Regression analysis are reviewed as follows.


\textsuperscript{34} A.J. Barry and T.K. Cureton, "Factorial Analysis of Physique and Performance in Pre-Pubescent Boys," Research Quarterly, XXXII (October, 1961), 283.


Philips\textsuperscript{37} concluded that power has shown significant correlation with strength and speed. She examined 200 college women on 27 test items selected from different tests. The data was subjected to Thurstone method of factor analysis, which yielded 4 factors viz., speed, general strength and abdominal strength as major components of physical education tests; and the fourth factor was left un-identified.

Disch\textsuperscript{38} in an effort to draw the dimensionality of speed of body movement administered 23 tests to 73 males. By subjecting the data to factor analysis four factors of speed, i.e., sprinting, controlled, leg and arm speeds, were extracted.

When 128 undergraduate physical education majors were administered 49 test variables by McKinny and Dean\textsuperscript{39} using principal components factor analysis with varimax rotation, yielded five factors. They constructed two motor fitness test batteries for male physical education majors. Each battery consisted of five test variables.

Measure of flexibility by factor analysis was attempted by

\textsuperscript{37}Marjorie Philips, "Study of a Series of Physical Education Tests by Factor Analysis," Research Quarterly, XX (March, 1949), 60.


\textsuperscript{39}S.R. McKinney and Donald Dean, "The Construction of a Motor Fitness Test Battery for Undergraduate Male Physical Education Majors," Dissertation Abstracts International, XXXII (January, 1972), 3762-A.
Harris, wherein 53 variables of flexibility were administered to 147 college women. She concluded that any of the joint action or a composite test would hardly give the satisfactory index of flexibility because of its high specificity in an individual.

Eighteen different power tests predicted to measure anaerobic power, were administered to 31 college men by Manning et al. Factor analysis extracted five factors, but, none of the five factors agreed with the hypothesized criterion of anaerobic power. Results also revealed that un-related aspects exist among the variables and that they were not measuring similar qualities, thus emphasizing ambiguity.

Hundred junior girls were tested with 30 variables by McCraw who made an effort to identify motor learning factor, relationship between motor learning and physical ability. Factor analysis did not show significant difference among factors. He also concluded that factor of motor learning cannot be evaluated through physical ability.

Liba administered 29 tests to 52 college women to assess

strength through oblique and alpha factor solutions. Results indicated that two solutions yeilded different factors and only some of the predicted factors were supported.

Power has close association with speed factor rather than strength factor. This thought was depicted by Start et.al., when they subjected their data to varimax analysis and the results were confirmed by promax analysis, which also enabled them to obtain two second order factors.

Sixteen test items on 50 male college students have been administered by Jackson and Frankiewiez in their effort to find the factors of the human muscular strength. Multiple factor analysis modes confirmed four factors of muscular strength (Static-force-arms, Explosive-power-arms, Dynamic-work-arms and Static-power-legs). The other two factors Dynamic-work-legs and Explosive power-legs did not support the robust factor.

Jackson made an effort to further clarify the factors of strength. 76 college men were administered 26 test variables. Through eight decimal factor solutions, it was concluded that the study does not support factors of strength (Dynamic, Static and

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explosive) as reported early by Fleishman; however dynamic strength appeared to be more dependent upon individual differences in body weight than on the type of movement.

Bissonnette identified four factors as components of physical fitness: those are static strength, hip flexibility, recovery pulse and muscular endurance. In a factor analytic study Burke Jr. attempted to find the validity of selected tests of physical work capacity. He inferred that 600 yard, 1 minute and 2 minute runs as valid measures of endurance or aerobic working capacity, and 10 and 50 yard dashes as measures of speed or anaerobic working capacity.

Twenty one variables administered to 200 college fresh entrant women by Cumbee using multiple group method of factoring extract yeilded eight factors of motor co-ordination, of which only five were identified. A comparison of centroid and multiple group method of factoring was also attempted wherein the results showed similar solutions by both methods of analysis.

One hundred Chinese junior high school boys were administered

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a devised physical fitness test by Huang. Factor analysis here yielded seven factors. 70 per cent of total variance of physical fitness was observed. The factors identified by him were speed-explosive strength, size of the body, endurance, co-ordination, strength of leg muscles, dynamic flexibility, dynamic strength and flexibility.

Barrow administered 29 test items on 222 college men to construct a motor ability test. Doolittle technique of multiple correlations and regression technique were employed to compute the data. Results revealed multiple 'R's of 0.950 and 0.925 for two test batteries constructed. Six factors named by him were power, arm and shoulder co-ordination, agility, hand and eye co-ordination, strength and speed.

Nineteen tests were administered by McHone et. al. on 123 college men to construct a short test battery for high school boys. The test battery so constructed provided multiple correlation co-efficients of 0.9159, 0.8964, 0.8770, 0.9086 and 0.8942 with the test items.

A multiple correlation of 0.56 was found between the

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variables of a test battery and criterion by Wellman. She also found correlation of 0.72 between physical fitness index and Brace test; and, a correlation of 0.73 between speed and agility tests.

To find out the reliability of the Roger's Strength test, the Kraus-Weber test of minimuscular fitness and a battery of motor fitness, Fox administered the test items to 169 fresh man junior high school girls of Washington, and observed a moderate correlation (0.54) between the Washington test battery and the physical fitness index.

Cozens administered 22 test variables to 250 college men. Through multiple correlations and regression analysis a strength test battery of five items was constructed. Strength as a dependent variable was supported by Multiple 'R' of 0.982 with the selected 10 test items.

Thirteen selected test variables were administered to 120 high school girls by Arnett to construct a Purdue motor fitness test. Multiple regression analysis was used to construct a test battery of three items. The constructed test battery had a

54 Katherine Fox, "The Reliability and Validity of Selected Physical Fitness Test for High School Girls," Research Quarterly, XXX (December, 1959), 403.
validity co-efficient of 0.755 and a reliability coefficient of 0.848.

In a study by Clarke and Schoff, 57 18 cable tension strength tests were administered to 826 boys (9-12 years of age) for the construction of a muscular strength test for boys. Multiple correlation analysis yielded four test items for the battery.

When the data of two groups were computed to get the multiple regression equation, for predicting Roger's strength index, Widney 58 found multiple 'R' of 0.98 and above (for the two groups) between the strength index and leg-lifts, and arm and back lift strength.

Falls, et. al., 59 analysed 53 variables to develop a physical fitness test battery, where in, he subjected the data to factor analysis and regression analysis. Factor loadings were used as validity correlations to reduce the number of variables. Then the data was subjected to multiple regression analysis to develop a test battery for the isolated factors.

57 H. Harrison Clarke and Theodore G. Schopf, "Construction of a Muscular Strength Test for Boys in Grade 4, 5 and 6," Research Quarterly, XXXIII (December, 1962), 515.
Glasgow in an attempt to construct a gross muscular strength test battery, administered 21 cable tension strength tests to 234 physically disabled boys. Factor analytic solutions yielded 3 factors. These items of a constructed test battery were adduction, hip outward rotation and trunk extension.

 Fifteen test variables were administered to 128 high school girls by Carpenter. Factor analysis, here, yielded four factors namely strength, body co-ordination, motor educability and a fourth which was left un-named. The data was also subjected to multiple correlations analysis by using the test items with highest factor loadings, to predict identified factors. A test battery of nine items was constructed and T-score norms have been incorporated.

 Coleman administered 11 test variables of strength to 100 college men. Factor analysis extracted 3 factors namely strength, speed and weight. He also found that weight highly correlated with the strength factor. The data was further analysed for Multiple and partial correlations. While so analysing, factor loadings and other possible combinations of variables were

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considered. The results revealed that Roger's strength index was a very adequate measure of strength as a distinct factor in individual athletic performances. A multiple 'R' of 0.880 was established among 4 pounds and 16 pounds shot-putting and weight.

One hundred and sixty college students were administered two different groups of physical variables (8 and 15 items each) by Larson\textsuperscript{63} to predict components of strength and to construct a test combination of strength variables. Zero-order correlation, factor analysis and multiple correlation analysis were used to compute the data. Two significant factors of strength were identified and they were named as dynamic strength and static dynamometrical strength. A strength test battery of 3 variables (chinning, dips and vertical jump) was constructed.

Specific fitness test studies in Badminton,\textsuperscript{64} Volleyball\textsuperscript{65} and construction of skill test in Hockey\textsuperscript{66} have been reported in India so far, but the studies regarding construction of physical fitness test for high school boys is not yet reported. Since the

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\textsuperscript{63}Leonard A. Larson, "A Factor and Validity Analysis of Strength Variables and Tests with a Test Combination of Chinning, Dipping and Vertical Jump," Research Quarterly, XI (December, 1940), 82.

\textsuperscript{64}Shivnarayan, "Construction and Standardisation of Specific Physical Fitness Test for Badminton Players in North India," (Unpublished Ph.D. Thesis, Jiwaji University, Gwalior, 1987).


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construction of a test is itself basic in nature, this work envisages fresh inputs to existing methodologies that would have a bearing in the constantly evolving techniques in the construction and standardization of physical fitness tests.