CHAPTER II
REVIEW OF RELATED LITERATURE
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The present researcher could not come across any studies in relation with physical fitness and anthropometric measurement conducted on the student population of Nepal. The researcher has attempted in this chapter to locate the literature related to this study. The researcher had gone through related literature available which was relevant to the present study. A number of researches were found to be completed in the Western and European countries in the field of construction of Test Batteries and Anthropometric measurement, but for the present study the research scholar had restricted the scope of review to those studies which were directly related and relevant to the present study. The relevant studies from various sources that the research scholar could review have been presented in this chapter, in order to provide the background materials to evaluate the significance of this study as well as to interpret its findings. The studies reviewed by the researcher have been grouped into six areas as given below:

1. Physical fitness,
2. Motor fitness,
3. General motor fitness,
4. Cardio-Respiratory fitness,
(5) Physical fitness normative study, and
(6) Fitness and Anthropometric Relationship.

1. Physical Fitness:

An attempt to identify differences in physical fitness levels between national populations of youth was made in 1954 by Kraus and Hirschland\(^1\) in which the results of the Kraus-Weber test of muscular fitness for American children and for European children were compared. The results revealed that American children were found inferior to the other groups.

Rogers (1925)\(^2\) standardised testing procedures of physical fitness and developed norm- tables of composite test of seven elements (lung capacity, grip strength, back and leg lift, pull-ups, dips for boys, and push-ups for girls). With the construction of norm tables for many combinations of sex, age and weight, two major scores are possible- the strength index and the physical fitness index - each of which has a distinctly different purpose. By the construction of these norm tables, Rogers created the physical fitness index (PFI).

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\(^2\) F.R. Rogers. Physical capacity Tests in the Administration of Physical Education (New York : Bureau of publications, Teachers college, Columbia University, 1926)
The President's Council on Physical fitness and sports recommended a screening test for the school boys, consisting of "Recovery Index test, a step test, pull-ups (boys), flexed arm hang (girls), sit-ups and squat thrusts for 10 seconds". To pass the screening test items, the standards are available.

Berger developed the use of 1-RM as a method for evaluating strength improvement. The 1-RM test consists of determining the maximum amount of weight a person can raise only once for a given movement. In a subsequent study, Berger formed a criterion of total strength, by summing the 1-RM loads for six weight-lifting movements. The highest correlation was 0.87 for the military press. With the addition of back hyperextension, a multiple correlation of 0.92 was obtained.

The term "physical fitness" had been included in many familiar test batteries commonly used in the schools. In many cases, the inclusion of "fitness" in such titles was found the most unfortunate error and one that logically could count, at least in part, for the current apathy of some people towards total personal fitness. This was not an

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4 R.A. Berger, "Classification of students on the basis of strength". Research Quarterly (34: 3, Dec. 1963) p 514
indictment of "physical fitness" test batteries. Most of the batteries were found excellent and include tests that had some definite value, but the present researcher felt that many of the tests in these batteries were not actually tests of physical fitness. Such as the physical fitness test constructed by AAHPER (1980), Campbell (1977), Texas physical fitness test (1973), North caroline test (1961) were actually motor fitness tests. Misconceptions, then, can result from inappropriate names of the test batteries or from failure to educate those tested as to the meaning of each individual test in the battery. It had not been usually made clear to those tested which individual tests are truly measures of physical fitness and which were more appropriately measures of ability and skill.

2. Motor Fitness:

The term "motor fitness" became popular during World War II. Actually, motor fitness is a limited aspect of general motor ability, with emphasis placed on the underlying element of vigorous physical activity, but does not include the neuromuscular co-ordination involved in motor skill. The physical components that constitute motor fitness are "muscular endurance, strength, cardio-respiratory endurance, power, agility, speed and
Flexibility (Clarke and Clarke: 1987). Numerous tests of motor fitness were devised but in this section the researcher reviewed only those tests which consist of the combination of the above physical components as cited below:

Zuti and Corbin\(^5\) conducted a research on physical fitness norms for college freshmen. They took 3,000 freshmen of Kansas State University within the age from 17.6 years to 19.5 years. The tests were conducted for strength test, flexibility, body composition, and cardiovascular fitness. The results appear to indicate that the college freshmen at Kansas State University were about average and that the standards were appropriate for use for Americans.

In 1980, AARPERD\(^6\) published its new health related physical fitness test manual. The test was designed for boys and girls of age from six to seventeen. Data were collected on over 12,000 boys and girls from throughout the nation, and used to develop gender-specific percentile rank norms for each test.


\(^6\) Janyce Kay Nelson. "The function of Age, Gender and Body size characteristics on physical Fitness performance" (Unpublished Doctoral Dissertation, University of Houston, U.S.A. 1982)
Box prepared\(^7\) percentile norms tables for selected measures of strength, power, agility, flexibility, body composition, cardiovascular and muscular endurance from data collected in five schools of the unity Christian school system of muscles on Ville.

Campbell\(^8\) designed the Scarborough fitness kit to allow grade nine and ten students to evaluate their level of fitness in seven major areas (agility, flexibility, vital capacity, strength, percentage of body fat, and cardio-vascular efficiency) and to provide information that will allow physical education teacher to prescribe a personal fitness programme. Data had been collected from the first year and Scarborough norms for each test have been established.

In Brown's study\(^9\) the four-item motor fitness test; Sarjent jump, 30 second squat thrust, 2-minute sit-ups and chin-ups given to the Washington State University freshmen and validated against Roger's physical fitness index, the

\(^7\)David.L.Box."Physical Ability Testing of Male students in grade four through twelve". Completed Research in Health, physical education and Recreation. (9: 1967)p77

\(^8\)W.C.Campbell."A High School Physical Fitness Testing Kit."CAHPER (43:3; 1977) p. 3.

strength index and the subjective ratings of the developmental (subfit) class students by their instructors. No significant differences between means and standard deviations were found for the two sets of data and the norms based on them were statistically sound.

In order to determine the fitness status of Navy personnel, a modified four-item physical fitness test for men was developed by Churdar. The items contained in the test battery were: push-ups or pull-ups, five-minute sit-ups, vertical jump or standing board jump and 300-yards shuttle run. The T-score norms were developed for Navy personnel and the norms for University and high school students were also available.

Borrow conducted study to develop an easily administered test for motor ability for collegemen. Expert opinion was used in the validation process and eight factors of motor ability and twenty-nine items measuring those factors were chosen. The selected tests were administered to 222 collegemen and statistical analysis covered item reliability and objectivity correlation. The following test items were used: Zig-zag running, medicine ball put,

10John B. Churdar, "Navy physical fitness Tests for Men"*The Physical Educator*. (28: 2, May 1971) p 100

standing broad jump, 60 yards dash, soft-ball throw and wall pass. The standard motor ability rating was found.

The purpose of the Arnett\textsuperscript{12} study was to develop short (Minimum items) motor fitness test batteries for high school girls which could be economically administered in terms of equipment and class time. The components which might contribute to motor fitness were listed and appropriate items pertaining to the components were selected for their content validity and suitability utilizing appropriate statistical techniques. The modified pull ups, 600 yds run and standing jump were selected as the items for the batteries. The Purdue motor fitness test batteries recommended over the other three batteries since this battery had a validity coefficient of at least 0.755 and an estimated reliability coefficient of 0.848.

Phillips\textsuperscript{13} developed three-item battery (JCR Test) consisting of the vertical jump (J), Chinning (C), and 100 yard shuttle run (R), intended to measure the ability of the individual to perform fundamental motor skills, such as


jumping, chinning, running and dodging, which involve the basic elements of power, speed, agility and endurance. Reliability coefficient ranging from 0.91 to 0.97, and validity coefficient from 0.59 to 0.90, were reported for the test. Six-sigma scale scoring tables for college-age men were available.

Texas Physical Fitness Education Foundation developed a group of tests and award to help teachers in grades four to twelve (ages eight to eighteen), diagnose the physical weaknesses of students, identify students with acceptable levels of fitness, and motivate all students to achieve excellence in physical fitness as they strive for self-improvement. The programme consists of two test batteries: one designed to evaluate physical fitness (chin-ups, dips or 90-second flexed arm hang for the muscular strength and endurance of the arms and shoulder girdles; two-minute bent leg sit-ups for muscular strength and endurance of abdominal region; twelve-minute run/walk or 1.5 mile run for grades seven to twelve, and nine-minute run/walk or one mile run for grades four to six to measure cardio-respiratory endurance); and another to evaluate motor ability (50-yard dash for speed, 15-second shuttle run for agility, vertical jump or standing broad jump for power).

Oregon motor fitness test batteries were constructed separately for boys and girls, each at the upper elementary.

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junior high school, and senior high school levels in 1962. Motor fitness components and test items to represent each component were proposed by a statewide committee. The components were: arm and shoulder girdle muscular endurance, abdominal muscular endurance, muscular power, running speed, circulatory-respiratory endurance, and trunk-hip flexibility. The construction of the tests followed essentially the same pattern for both sexes at the three school levels. The T-scale scoring table for the boy's and girls' Oregon motor fitness test was developed separately.

Motor fitness tests had been constructed at Indiana University (1944) for the following groups: college men, high school boys and girls, and elementary school children. The test items for elementary and high school boys and girls were straddle chins, floor push-ups, vertical jump, and squat-thrusts for twenty seconds. For college men, the items were pull-ups or straddle chins, floor push-ups, and vertical jump or standing broad jump. For college men, norms were based on the six-sigma scale for each of the tests. Norms for the other age groups were based on McClay's classification index.

A new revision of the California physical performance test for boys and girls from ten to eighteen years of

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16 Ibid p. 163.
age was announced in 1961. A single battery of six test items was adopted consisting of standing long jump, knee bent sit-ups in one minute, side step, pull-ups, chair push-ups, and six-minute jog-walk. Subsequently, the flexed arm hang was allowed as an alternate test for girls who could not perform a single pull-up. The norms consist of separate percentile tables for boys and girls at each age for each of the six tests.\(^{17}\)

Fitness test had been constructed by North Carolina State.\(^{18}\) The test items were thirty-second bent-knee sit-ups, thirty-second side stepping, standing broad jump, and thirty-second squat thrusts for boys and girls; in addition, boys of ages twelve to seventeen performed full push-ups, and all girls and boys of ages nine to eleven performed a modified form of pull-ups. Percentile norms were available separately for boys and girls at each age nine through seventeen years. Levels of achievement were designated as follows: Inferior, poor, average, good and excellent.

An elementary school motor fitness test was developed by Kirchner (1970) for the Washington Association for Health, Physical Education and Recreation; this test was adopted by the

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Washington State Department of Physical Education and Recreation. The test items were standing broad jump, bench push-ups, curl-ups, squat-jumps, and 30-yard dash. T-score norms were available for each sex at each from seven to twelve years. 19

The Vermont Governor's Council on Physical fitness (1982) 20 had provided a motor fitness test battery for students from Kindergarten to grade twelve for use by the schools in the state. To keep school levels intact and to utilise the AAHPERD battery when applicable, the modified tests were recommended for the elementary school and the AAHPERD tests for the secondary school. The modified test battery compose: standing long jump, bent knee sit-ups, desk push-ups, and a figure-8 run are optional for secondary school boys and girls in order to enter achievements for special Vermont fitness awards. Norms for the test items were available separately for boys and girls at each age from five to eighteen years; they take the form of performance required for four award levels, known as: certificate, 30th percentile; standard, 50th percentile; merit, 80th percentile; Governor, 85th percentile.

An attempt had been made by Japan Overseas


20 R.E. Sparks (Ed) Vermont School Fitness Test Manual (Montpelier: Governor's council on Physical Fitness 1982)
Co-operation Volunteers (1987)\textsuperscript{21} in Nepal, with the purpose of finding out the physical fitness level of the students of Nepal. The test item consists of: side step (agility), vertical jump (power), Back and Grip strength (Strength), Trunk extension and flexion (Flexibility), and stepping up and down (endurance). The test score had been interpreted on the basis of judgement table used in Japan and mean standard deviation was calculated.

The researcher of the above study in his report accepted various weaknesses of his research. His acceptance of the drawback of the present research and critical analysis of the report indicated that the report was not authentic and reliable due to the small sample size and the procedure used while administering the test.

The underlying assumption of the existence of a trait called motor ability has never been substantiated through a rigorously developed network of scientific evidence. It is evident that the items included in motor ability tests can be improved with practice; thus, these items cannot measure innate motor ability. Barrow and McGee (1980) observe that, "even though motor ability improves with training, experience, and

\textsuperscript{21}Toshio Kawai. A Report of Physical Fitness Test in Nepal. (Kathmandu : Japan overseas co-operation volunteers, 1987).
maturity, individual differences in students tend to remain the same throughout the school years". Nonetheless, at the time motor ability tests were being constructed, the measurement techniques were quite sophisticated and served as models for subsequent test development in other aspects of physical education and exercise science. Currently, the tests have limited usefulness, either as measures of general motor ability or as a means of ability grouping.

3) General Motor Fitness Study:

Traditionally, General motor ability has been considered as one's level of ability in a wide range of activity. In a 1984 review of research studies in this area, Battinelli concluded that the "acquisition of motor abilities and motor skills through motor learning is dependent upon general as well as specific factors. He suggested that the general components of motor ability were muscular strength, muscular endurance, cardiovascular endurance, power, speed, balance, flexibility and agility".

Literally hundreds of tests were available, but were not attempted to be categorized in terms of motor fitness or

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general motor fitness. So, the present researcher had selected those tests in which the test of co-ordination and balance are included excepting the other physical components, such as: strength, endurance, cardiovascular endurance, power, speed, flexibility and agility. Certain selected studies have been reviewed in the proceeding paragraph:-

Patrick²⁴ had constructed a motor fitness test battery for girls in lower elementary grades. The items included in this test were Clarke's strength composite, McCloy's sit and reach, dodging run, Bass length wire, stick balance and vertical jump. It measured the essential components of motor fitness, such as, muscular strength, muscular endurance, cardiovascular endurance, flexibility, agility, balance and power.

A battery of physical performance test was selected by Fleishman²⁵ in 1964 on the basis of the factors isolated from much larger batteries of tests. Fleishman reviewed the previously published literature in the field of physical fitness, and aided by his own personal experience in pretesting and pilot studies. He selected a battery of 30 test items generally considered to be measures of strength and another battery of 30

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test items hypothesised to be measures of speed, flexibility, balance and co-ordination. Norms, or standards performance scores, were developed for boys and girls between the age of 15 to 18 years on the basis of the scores for more than 2,000 students for most of the tests.

Experimenting with ten test items, Powell and Howe developed the Newton test of motor ability for high school girls, composed of standing broad jump, a 'baby' hurdle race, and a scrable test. The multiple correlation of these with a composite criterion of eighteen items, selected on the basis of strength, power, speed, and co-ordination, was 0.91. Other criteria were also used, in which these same items occupied a favoured position Six-sigma standard score achievement scales for each of the three tests in the battery and for "total points" were prepared.

While developing motor fitness criteria, Cureton recognised six components, as follows: endurance, power, strength, agility, flexibility, and balance. Fourteen-items and eighteen-items test batteries were developed, validating against a thirty-item criterion. Subsequently, a

seven-item motor fitness test was proposed for use when greater administrative simplicity is desired. The items in this battery were: dive and roll, medicine ball put, bar vault, chinning, leg lifts and sit-ups, breath holding and man lift. Scoring is simplified by using the pass or fail plan. This procedure screens out the subjects poor in ability, and does not require a severe effort on the part of the majority of subjects.

Elder (1958)\(^2\) developed a motor fitness test designed to evaluate the following eight basic components: strength, endurance, power, agility, flexibility, speed, balance, body size and age. The composite score on fourteen motor fitness items served as the criterion for the selection of tests to compose the final battery. The tests thus selected were: floor push-ups, standing broad jump, trunk flexion forward, Cozen's dodge run, and 20-second squat-thrust. Six-sigma scale norms were developed for six divisions of the California classification system, which was based on the boys' age, height and weight.

In 1958, a test was published for New York State designed to provide schools with a convenient instrument for periodic evaluation of status and progress in physical fitness of

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boys and girls in grades four to twelve. This test resulted from co-operative efforts of the State Education Department, testing and research experts, and physical education staff members and school district administrators. The tests thus selected were: posture rating chart, target throw, push-ups and pull-ups, side step, 50-yards dash, squat stand and tread-mill run. C-scale norms, expressed as achievement levels, were reported for boys and girls at each grade level with percentile rank equivalents for each component and for total scores with and without posture.

An 8-item test of motor fitness had been developed in the Cleveland senior high school by Pitchpatric and Kozace. The items included agility run, trunk flexion, standing broad jump, squat balance (boys) or foot balance (girls), pull-ups, and a step test. No validity was reported. Norms were given, based on the scores of 9,000 boys and 9,000 girls.

A test was devised at Yale University to appraise the motor fitness of freshmen students by Blesh and Scholz. The six-item test was selected on a two-fold basis-capable of being administered accurately with little equipment, and

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30 Ibid. p 308
significant in indicating the overall strength of different body parts. The test items and the minimum standards for the physical education programme were pull-ups (8), push-ups (25), sit-ups (50); fence vault (4 feet 6 inches), standing broad jump (86 inches), and vertical jump (18 inches). The Harvard step test was initially included in battery as an endurance measure but was discontinued because of the testing time involved with large numbers. Statistical analysis of scientific authenticity and norms were not available.

Cozens\textsuperscript{32} devised a test of general motor ability for college men through a thorough study utilizing the fundamental elements underlying the skill approach to the measurement of motor ability. After more then 40 tests were analysed and classified under the seven basic elements, one test was selected for each component. The test thus selected were - Baseball throw for distance, Football punt for distance, Bar snap, standing broad jump, Dips, Dodging run, and quarter-mile run. The raw score for an event provided the data to enter the proper achievement table and find the sigma scale score. The weighted sigma score for each event was readily derived from a conversion chart.

After extensive experimentation involving 35 different test items, Scott proposed two test batteries for use in appraising the motor ability of college women and high school girls. Battery first, comprised the following: basketball throw, 4-second dash, wall pass and standing broad jump. Battery second, consists of basketball throw, standing broad jump, and obstacle run. The criterion consisted of a composite of judgement rating of experts. T-scales were available for the conversion of scores.

Latchaw proposed seven tests that were devised from a number of established tests to measure performance in selected motor skills in grades four through six, boys and girls. The tests include: Basketball wall pass, volleyball wall pass, vertical jump, standing broad jump, shuttle run, soccer wall volley, and softball repeated throws. Face validity was accepted for each test; and the tests proved reliable. T-scale norms were available for the interpretation of scores.

McCloys developed ingenious and interrelated batteries purporting to measure general motor ability and general motor capacity, singly and together, for both boys and girls.

The general motor ability batteries for boys consisted of pull-up, sprint varying from 50 to 100-yard, broad jump, running high jump, and weight throwing; for girls: push-ups, sprint broad jump and weight throw. In both sexes, events were scored on McCloy's scoring tables, the sum of which was combined by special formula. In the development of the general motor ability tests, results on individual test elements were correlated with the total score on a large battery of achievement tests.35

Larson36 constructed the two general motor ability tests, one as an indoor test and the other as an outdoor test, after experimenting with twenty-five motor ability items. Indoor test consists of dodging run, bar snap, chinning, dipping and vertical jump; outdoor test consists of baseball throw for distance, chinning, bar snap, and vertical jump. The multiple correlations with the criterion measure were: for the indoor test, 0.97; for the outdoor test, 0.98.

The department of physical education for men at Oberlin college37 had developed a general motor ability test to be used as a means of qualifying students for the elective

programme in physical education. The test consists of running, jumping, vaulting, climbing, pulling and lifting, pushing, throwing, swimming, tumbling and balancing. The above ten-item test was scored on the basis of one hundred points - ten points were credited for the successful performance of each of the tests.

The review of literature in relation to general motor fitness study indicated that a number of tests have been developed for assessing general motor fitness of school and university level students and mostly all of those were developed in European countries. The researcher felt that most of the general motor ability tests had similar patterns and the test items included in the different batteries were more or less similar.

It was felt that dodging, vertical jump, broad jump, pull-ups, push-ups and running were the common items of the tests. It was also found that almost all (except Cozen's test) tests did not include any items for the cardio-respiratory endurance test.

4) Cardio - Respiratory Fitness:

As is well recognized, circulatory-respiratory endurance is a basic component of physical fitness. This form of endurance is characterized by moderate contraction of large muscle groups for relatively long periods of time. Several investigators had studied the measurable elements involved in
cardio-respiratory endurance through factor analysis procedures.

The earliest circulatory-respiratory endurance tests primarily involved various responses of the cardio-vascular system to exercise. Among these were the Crampton blood-plotois test, Barach energy index, Schneider physical efficiency index, McCloy efficiency index, Tuttle pluse ratio test, and McCurdy-Larson test of organic efficiency. Besides these some relevant studies gleaned from various sources have been reviewed.

The distance an individual can run in 12 minutes was proposed and popularized by Cooper as a test of circulatory-respiratory endurance; the basic research was conducted with United States 15,000 Air force personnel in 1968; further he supervised 12-minute and 1.5 mile test on 30,000 men and women, both in the laboratory and in the field. Cooper has recommended 12-minute run/walk test prior to starting the prescribed Aerobic programme. Subsequently, he and his wife utilized the same test for women. The distance was recorded in miles and the circulatory-respiratory adequacy of the individual was ranked based on a points system.

The purpose of the Kurucz's et al. study was to construct a submaximal cardiovascular fitness test. The Blake treadmill test was used as the criterion measure. Both reliability and validity were satisfactory. To determine strenuousness of the test, energy cost using open circuit spirometry was measured.

Foster's test as another early cardiovascular test, was based on the fact that exercise increases the heart rate almost in direct proportion to the exercise intensity. Foster standardized the exercise, determined the reaction of high school boys in good physical condition, and constructed norms of condition. The test consists of, (a) recording normal standing pulse; (b) running in place for 30 seconds at the rate of three steps per second; (c) counting the pulse for 5 seconds and converting it to the minute rate, both immediately after running and again after subject had stood at ease for 45 seconds; and (d) computing efficiency rating from the scoring table.

Michigan pulse rate test for physical fitness test was devised as a possible index of physical condition and was easily administered to a class-size group, with students counting their own pulse; (b) performing a 15-second bout of spot running

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at a rate of three steps per second; (c) counting standing pulse rate beginning ½, 1, 2 and 3 minutes after cessation of exercise; and (d) rating according to scale based on recovery time.\(^{41}\)

In California (1949)\(^{42}\) an endeavor was made by state education Department of California to meet the need for a battery of functional tests for elementary and secondary pupils that can be given at the beginning of the school year to a group of 20 to 30 pupils at one time to categorize them into two groups: (a) needing immediate medical examination and (b) apparently able to participate in the physical education programme until the regular medical examination was given. The California test reflects general organic efficiency by such items as determination of body weight in relation to age and height, breath-holding, pulse rate return following body-bending for 30 seconds, potato race (girls) or half-mile run in 3½ minutes (boys), and recording the findings of physical inspection of pupils for corroborative evidence.

Challenged by the need for a simple circulatory test of physical fitness during World War II., Brouha and his


associates (1943) in the Harvard fatigue laboratories developed a test for college men purporting to measure the general capacity of the body to adapt itself to and recover from hard work. The test consists of observing pulse reaction to 5 or less minutes of stepping exercise on a 20-inch bench. The scoring is done by the formula and the index is interpreted according to the established standards.

A 'rapid' form of Harvard step test was proposed by Johnson and Robinson. The exercise phase was the same as for the regular test; however, the pulse was counted once from 1 to 1½. The single post-exercise pulse count was justified because of a high correlation between the first and the sum of the three pulse counts of the original test. The score was obtained from the formula. The norm was available for the rapid or short form.

A number of other step tests have been proposed to adopt the test to groups other than collegemen. Skubic and Hodgkins proposed a three minute step test for girls and

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women. The rate of stepping was 24 steps per minute; the height of the bench was 18 inches. Following exercise, the subjects rested for one minute in a sitting position; the pulse was then counted for thirty seconds at the carotid artery by palpitation. In subsequent studies, Skubic and Hodgkins developed national norms for their cardio-vascular efficiency test.

The Queens college step test for college women was presented by McArdle and associates. For this test, the women steps up and down on a bleacher step for three minutes at a cadence of 22 steps per minute. At the end of the stepping, the subject remains standing while a partner counts her pulse rate by palpitation of the carotid artery for fifteen seconds, from five to twenty seconds after exercise. Subsequently, percentile norms for post-exercise fifteen-second pulse rates were presented.

Harvey and Scott proposed the Kent State University step test for college women. This test consists of stepping on a bench 18 inches high at a cadence of thirty steps.

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per minute for one minute; pulse rate was counted for 30
seconds, from 1 to 1½ minutes after stepping.

The Harvard step test had been used by the various
researchers: Brouha and Gallagher (1943), Brouha and Ball
(1952), Clarke (1943), in numerous cases with modifications and
the reliability of the test was calculated which was highly
positive.

Nelson⁴⁸ presented the Louisiana State University
Step test, which was intended for males and females in grades
nine to college. The exercise consists of bench, chair or
bleacher stepping (approximately 17-18 inches high) for three
minutes: cadences of 24 steps per minute for girls and 30 steps
per minute for boys were prescribed. Five 10-second counts were
made as follows: before exercise and five seconds, one, two,
and three minutes after exercise; each count was multiplied by
10 to represent a one-minute pulse rate. A chart was used to
plot each student’s results for the five heart rate values.

The President’s Council on physical fitness and
sports of America proposed the use of a recovery index test,
which was a modification of the Harvard step test. The differences in procedures were that the duration of stepping was four minutes and the height of the bench varied from 14 to 16 to 20 inches depending on the height of the subject, although no height designations were given. To determine the recovery index, three post-exercise heart rates were taken and summed: 1-1½, 2-2½ and 3-3½ minutes. Reference was then made to the norms.

The Ohio State University step test was developed by Kurucz, Fox and Mathews as a submaximal test of cardiovascular fitness for men aged eighteen years and over. The test was based on the concept that the time required to reach a heart rate of 150 beats per minute is a valid indicator of the subject’s capacity for more strenuous work. The individual’s score was the number of innings completed.

Astrand and Ryhming developed a submaximal work test in which the subject either steps up and down on a bench, pedals a bicycle ergometer, or runs on a treadmill. The best results were obtained when the test work resulted in a


steady-state heart level between 125 and 170 during exercise. For scoring this test for physical fitness, Astrand and Ryhming prepared a monogram, which was subsequently adjusted for lower loads. 51

Balke 52 devised a submaximal test that measures the duration of exercise required to produce a heart rate of 180 beats per minute. The examinee walked on the treadmill at a constant speed, approximately 3.5 mph. Blood pressure was also usually recorded. After the first minute and each succeeding minute of exercise, the slope was increased by a 1 percent grade. The equipment required to administer the test was a treadmill, stop-watch and electrocardiograph. The test score was the number of minutes required to attain a heart rate of 180. A classification scale was available to interpret the test scores of adult men.

Performance measures for the evaluation of anaerobic ability have included, for example, timed track runs (Thomson, 1961) and timed treadmill run to exhaustion (Cunningham and Faulkner, 1969; Houston and Thomson, 1977; Rate and Pyke, 1978). However, the most popular test modality

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52 Margaret J. Safrin. Introduction to Measurement in physical Education and Exercise. (St. Louis: Times Mirror/Mosby college publishing, 1986) p 258
status. Consequently, several tests had been developed to estimate VO₂ Max (Astrand and Ryhming, 1954; Cooper, 1968; McArdle et al., 1972). However, many of these tests were difficult to administer, necessitated expensive equipment and trained personnel, and required a maximal effort by the subject. In addition, many field tests were population specific and/or lack cross-validation (Fox, 1973; Mustropaclo, 1970; McArdle et al., 1972).

A number of tests have been developed for assessing physical fitness of school aged children, but few provide an adequate index of cardio-respiratory endurance. This study was undertaken in response to the need for a simple test of endurance which is easy to administer, requires minimal equipment and which is applicable to children within the elementary and secondary school systems.

5) Physical Fitness Normative Study:

A Norm is a standard to which an obtained score may be compared. Tests that have an accompanying set of norms are much more useful than those that do not have. Norms have

a definite value and are necessary in order to interpret test scores. In physical education, norms may be based upon various combinations of age, height and weight. Several researchers in the field of test construction for physical fitness or skill test had developed the norms, and some of them had developed the norms of the particular test in their own situation (e.g. National or State). Few tests in physical education had a good set of norms. In this section of review collection the present researcher has collected only those studies which are mainly normative study and are cited below:

Bitcon 56 constructed norms tables for grades 9-12 by taking pull-ups, two minute sit-ups, standing broad jump and a 300 yards shuttle run and showed their validity against the AAHPER youth fitness test. Validity and reliability coefficients were 0.934 and 0.961 respectively.

In Hatter's study 57 physical fitness test scores obtained on 128 students at San Diego Military Academy, were compared with national, state and local norms by use of Chi-square with significance determined at the five percent level of confidence, of thirty, six age-test comparisons favoured the

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56. Laurence E. Bitcon. "Validation of a four item fitness Test and Norms for High school Boys in the State of Iowa". Completed Research in Health, Physical Education and Recreation. (8: 1965) p 37

academy over national norms, one did not. In five the academy performance was less than state norms and one exceeded state norms. In five of fifteen possible comparisons, the academy performance was less than San Diego city school norms. A physical education programme to complement the military programme of the San Diego Military Academy was recommended.

Dorothy \(^{58}\) evolved norms of physical fitness for college women from 57 colleges and the data of 3,300 subjects were collected for seven test items. In order to be consistent with the already published norms, for children, youth and college men percentile norms were calculated from 0 to 100 at interval of 5.

Mistikawi in his study \(^{59}\) prepared the national norms for the one-minute basketball throw for goal, pull-ups, potato race, standing hop-step and jump, push-ups, standing broad jump and softball target throw items of the YMCA national athletic achievement programme. YMCA throughout the United States tested 2000 boys in each group, and the author obtained five percent of the scores at the Salem YMCA, Oregon.

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Russmussen observed that median scores of South Dakota boys of all ages were higher than those of national sample, in all test items of AAHPER test except pull-ups and shuttle run.

Australian Council of Health, Physical Education and Recreation had conducted the survey throughout Australia to ascertain the current levels of fitness, health and physical performance of school children between the ages of seven and fifteen years. The results were used to establish sex and age norms for a cross-section of the school based population. Information gathered was intended to aid future planning and evaluation of school physical education programmes. The physical performance tests would provide the basis for a fitness award scheme to be introduced for school children.

Dis conducted a study of Norms in physical fitness tests for boys of class 9-11 of Government Schools of Delhi, with the purpose of computing a norm for evaluating performance in physical fitness as required in the curriculum for the required programme of physical education. AAHPER youth fitness test and N.P.F.D. battery 'A' were administered and norms were worked out. A comparison of obtained data with

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American students shows that Indian students seem to be poor in abdominal strength and shoulder girdle strength.  

A physical ability test battery for Newzealand schools was developed by modifying the Fleishman battery of physical ability tests by McCaughan to produce national norms for a battery of physical ability tests that can be used to assess the relative fitness of NewZealand secondary school boys. Modifying four original tests (No. 1, 4, 6 and 9) nine tests recommended by Fleishman were used. Percentile and T-score norms had been produced from over 58,000 test scores with the results covering boys of ages 13 to 17 years, in nine tests of physical ability.

Robson et al. had conducted a study on a simple physical fitness test battery for elementary school children. They took 152 boys and 150 girls of Kendriya Vidyalaya, Gwalior. The test battery was practicable and simpler than the existing physical fitness tests and measures most of the essential motor

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qualities of elementary school children. The norms were prepared for the selected items and can be used for classifying the children into ability groups by assessing their physical fitness.

Motor performance items which could be adapted to physical fitness measures of primary grade children were investigated by Glover. Nine judges evaluated 18 test items twice, and chose seven fitness items for administration to boys and girls in the primary grades. The seven items were treated statistically to ascertain reliabilities, mean and standard deviations, intercorrelation, and tentative percentile norms. The validity of the test items was based on the literature reviewed and the empirical judgements of the nine judges. The standing broad jump, the shuttle race, the seal crawl test and the sit-ups appeared to be the best test items.

Morrison administered a twenty-items criterion battery to 120 college women at Madison college during a four-week period. T-scores were summed for each category of test items (body impetus, giving impetus to an object, and using an implement to give impetus to an object) and for the battery


of twenty items. The data were treated by means of the BIMD 34 programme. A three-item and a five-item battery were selected to predict basic sports skills ability. The validity coefficient, reliability and objectivity coefficient were calculated and norms for five groups of ability were developed for both tests.

It was the purpose of Florence et al. study to set up a battery of test which may be used to classify freshman college women according to their motor ability. For purposes of administration, a short battery of test (40 yds maze run, Ball change, Trunk bend, Jump and Reach) was set up. This battery consisted of those tests which had the highest self correlation, the highest correlation with the criterion. The raw scores on each test were changed to a percentile rank score so that it might be possible later to make comparisons between individuals on a common basis for the entire battery.

In the study of Nichols and Riddoch a range of twenty two fitness tests and related measures was evaluated for use in secondary schools (2,500 pupils, aged 11-16 years), with most tests taken from the 'Eurofit' provisional battery. The

67 Alden Florence et al. "A Motor Ability Test for University Women for the classification of Entering Students into Homogeneous group". Research Quarterly (3: 1; March 1932) p 85.

test results from each battery were accumulated on a data base; the pupils undertaking the school battery were grouped by year and sex. Norms were calculated for each group from the accumulated results, and each subject obtained a printed summary sheet giving the norms, individual scores and a grading for each test.

Roche 69 examined the performance of 2011 boys and girls aged 7 to 17 in a 9-minute run/walk test for students aged 7 to 10 and a 12-minute run/walk test for students aged 11 to 17; scores from this test were percentile ranked according to age and sex, and were presented for use as a field test of running endurance.

Coutts 70 conducted a study to establish norms for the Cooper's 12-minute run/walk test applicable to young males; eighty boys, eleven to fourteen years of age, served as the subjects. The difference between the two groups was statistically significant (p .01). The correlation coefficient between aerobic capacity and run/walk performance was 0.55, while the correlation was statistically significant (p .01). caution was


70 Kenneth D. Coutts " Application of cooper's 12 minute Run/walk Test to young males". Research Quarterly. (42: March 1971) p 54.
advised in attempting to predict aerobic capacity from run/walk performance with young urban subjects.

Yadav\textsuperscript{71} conducted a study on 'standardization of physical fitness norms of the school children of Haryana (13 to 16 years of age) with the purpose of estimating the fitness level, establishing the norms for physical fitness and comparing the standard of physical fitness of urban and rural boys of Haryana. For the purpose of this study 3600 school boys of the twelve districts of Haryana were randomly selected and the performance of the boys was recorded on 50 mt dash, shot put, standing broad jump, zig-zag run, sit-ups and step test. The norms in terms of percentile rank of said group were developed.

While going through available literature in physical fitness normative study, it was very clearly seen that the norms differ with age, sex, heredity and geographical location. A same set of test used in two countries have not matched with the prescribed norms. So, it is concluded that development and construction of separate norms is necessary according to the need and characteristics of the said population.

6) Fitness and Anthropometric Relationship :

Anthropometric measurements were central concerns of

the first phase of the scientific era of measurement which began in 1860's. The first application of anthropometry in physical education began in 1861 when Dr. Selward Hitchcock undertook a study of Amherst collegemen. This led to the publication of anthropometric tables almost annually for forty years. Hitchcock's aim was to ascertain the ideal or typical man as a guide for fostering the development of normal individual.

With the race of scientific thinking various studies regarding anthropometric measurement had been undertaken and various relationship had been established with performance and physical fitness. Some of them closely related with physical fitness are cited below.

Hindmarsh carried out a study in which following tests were administered to hundred Canadian born White boys; Anthropometric - height, weight, height-weight ratio, arm length sitting height and leg length; performance - one-minute sit-ups, standing broad jump and one-minute squat thrust; trunk flexibility criteria, Leighton trunk and hip extension-flexion test, Cureton trunk flexion test, modified Scott French bobbing test, and Kraus-Weber flexion test. The correlation between the

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73 R.G. Hindmarsh "The Relationship between various Anthropometric and physical performance Test and selected Trunk Flexibility Criteria". Completed Research in Health Physical Education and Recreation. (2: 1960) p 59
anthropometric and performance test and flexibility criteria were low, the height was .36 between the standing broad jump and scott French test. The Kraus-Weber test correlated 0.997 with Scott French test, 0.830 with Leighton test.

Terrel determined the relationship between anthropometric measurements and physical fitness scores of fifty pre-puberty and post-puberty females of junior high school age. It was concluded that there was no relationship between anthropometric measurements and physical fitness scores. Negros had significantly longer legs, longer arms and hands, longer feet, a wider shoulder girdle and a narrower pelvic girdle than Caucasians. The performance of a Negro was superior to that of Caucasians on 50-yard dash and softball throw for distance.

In his study of comparison of relationship between cardiovascular fitness and selected anthropometric measurements in eighth grade boys and college male subjects Yoest concluded that age, height, lean body mass and body surface area did not significantly limit performance in Ohio State University Step test;

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74 R.E. Terrel. "Relationship of pre and post puberty Anthropometric Measurements and physical fitness Test scores of American Negro and Caucasian Females as measured by the AAHPER physical fitness Battery". Completed Research in Health, Physical Education and Recreation (10: 1968) p72.

however, body composition representing body fat, limited the performance of college men only. In adolescence, scores in the step test improve longer percentage of lean body tissue.

The provincial authority of Manitoba had conducted a project on leadership in Canada by developing the "Manitoba physical and Motor Fitness Test" in 1977. Desirable fitness and life style objectives were identified for Canadian school children and teachers. The following test items were selected to measure the fitness objectives: body weight, standing height, agility run, sit and reach, sit-ups, flexed arm hang, skin-fold measurements, and the metre run. A unique aspect of the test manual was the inclusion of criterion reference standards for students, aged five to nineteen, and teachers, aged twenty to sixty plus. Tables of percentile norms were also available for students.

In Neely's study cable-tension strength tests and thirty six anthropometric measures were obtained from twenty four girls in each grade from four to twelve. The following strength tests were selected that would adequately reflect the total

musculature for upper elementary school girls: shoulder extension, hip extension and trunk flexion; for junior high school girls: shoulder extension, hip flexion and ankle planter flexion. In this study, scores on the selected strength tests, age and weight were obtained from 124 girls in each grade, 372 at each school level, 1116 overall. Norms were constructed following Roger’s method of constructing strength index norms.  

Conger and Wessel examined quite extensively the relationship between certain anthropometric measures and certain tests of strength and motor ability among physical education majors and non-majors. Strength test included grip strength and pulling strength, back lift, leg lift and total strength. The results indicated that the major group had significantly higher scores on all the tests.

In 1964, Bailey conducted the Saskatchewan child growth and development study. The study continued until 1973 and included physiological, anthropometric, motor, somatotype, skeletal personality, and social behaviour measurements. On the basis of this study, the growth and acceleration curves were

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79 D.A. Bailey Saskatchewan child Growth and Development Study. (Saskatoon : College of physical Education: University of Saskatchewan, 1976).
established and the intercorrelations between variables were observed.

Gross and Casciani \textsuperscript{80} utilized data from over 13,000 students to determine the value of age, height and weight, as a classification device for the AAHPER youth fitness test. They reported that in all four groups—senior and junior high school girls, senior and junior high school boys—the factor of age, height and weight had practically no value, singly or in combination, as classifiers for the seven test items. In other words, each group could be considered as a homogeneous group with respect to the effects of these factors on the fitness measures.

Somatotype rating and anthropometric measurement \textsuperscript{81} were studied by Hebbelinck and Postma as to their relationship to performances on motor fitness tests. Generally, the correlations between body measurement and motor performance were low. The subjects classified as mesomorphs were superior in all motor fitness tests except the sixty-yard dash, and the ectomesomorphs excelled the endomesomorphs except in the shot put event.


Selected anthropometric, strength and power characteristics of White and Negro boys were studied by Martin in 1967. The Negro group had significantly greater lower leg, thigh total, leg length, foot length, standing reach height and vertical jump performance. The white group had greater bi-illiac width and the groups were not significantly different in knee extension strength.  

A study to determine the relationship of selected anthropometric measurements to leg strength was developed by Carolyn Nicholson in 1964, for college women. The result shows that although the multiple correlation was significantly good, but it was insufficient for effective prediction of leg strength.

In Clarke's study, sixteen strength and ten anthropometric tests were related by correlational method to eight trunk and leg measures, involving dynamometric strength, muscular endurance, agility and power. The intercorrelations among some of the anthropometric variables were especially high:

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0.91, standing height with leg length; 0.88, foot length with leg length and 0.87, body weight with both hip width and thigh girth. The highest strength test intercorrelation was 0.65 between trunk flexion and extension. Significant multiple correlations obtained were: 0.74 for leg lift with body weight, ankle dorsal flexion 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)\textsuperscript{84}

Height, weight, and twenty eight tests commonly used to measure strength were administered by Avent\textsuperscript{85} to 101 nine and ten years old and 100 eleven and twelve year old Caucasian girls. Regression equations were set up for estimating the following: general static strength based on McCloy's unweighted strength score and dynamometrical measures; general dynamic strength based on the average of T-scores of five dynamic strength measures and ten dynamic strength variables; and total static and dynamic strength based on the average of

\textsuperscript{84}H.H.Clarke. "Relationship of strength and Anthropometric Measures to physical performance involving the Trunk and Legs". Research Quarterly. (28: 3; 1958) p 223.

T-scores derived from dynamometrical measures and the five-item
dynamic strength measures. Norms were established.

A study to determine the relationship of certain
anthropometrical, motor ability and reaction movement
measurements were developed by Bremberg. Seven
anthropometrical characteristics, four motor ability tests and
eighteen reaction-movement times were recorded for sixty-five
high school girls. Correlational analysis showed that little
relationship existed between the anthropometrical, motor and
reaction-movement variables.

In Warden's study, twelve anthropometric
measures and twenty-three derived indexes were obtained from
seventy-two girls at each level along with twenty-five cable
tensiometer strength tests which were averaged as the criterion.
The measures, indexes and strength criterion were
intercorrelated. Anthropometric measures intercorrelated higher
for elementary school girls, but the indexes intercorrelated
higher at the junior and senior high levels than at the
elementary level.

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86 C.E. Bremberg. "A study to Determine the Relationship
of certain Anthropometrical, Motor ability and Reaction
movement measurements of high school girls". Completed
Research in Health, Physical Education and Recreation
(8: 1966) p 72.

87 Cherylee Warden. "Bases of Norms for cable Tension
Strength Tests for upper Elementary, junior high and
Senior high school girls". Completed Research in Health
Physical Education and Recreation (8: 1966) p 81.
Age, height, weight, I.Q., leg strength, body movement time, 50-yard dash, shuttle run and standing broad jump of 100 fourth grade boys and girls were administered and correlated by Ritcheson. The mean scores of AAHPER test items were compared to national norms. Several significant correlations were found with the highest being weight with leg strength (0.48), leg strength with shuttle run (-0.35), and leg strength with 50-yard dash (-0.38).

In Lowenberger's study, twenty three cable tension strength tests and twelve anthropometric measures, from which 20 indices were also derived, were given to 18 men (N=72) at each age from 18 to 21 years at the University of Saskatchewan, Regina Campus. By multiple correlation and factor analysis procedures, three strength tests were chosen: ankle planter flexion, shoulder extension and knee extensions. The highest two-variable multiple correlation of anthropometric measures and indices with the strength criterion was 0.58. The measures were arm girth and abdominal girth. For norms, a total of 372 college men, ages from 18 to 21 years, were randomly selected from students enrolled at the two universities of Saskatchewan.

campus at Regina and Saskatoon. Two strength norm-tables were established: (I) double-entry table based on arm girth and abdominal girth according to the procedures adopted by Rogers in constructing strength index norms; (II) T-scale according to McCall's method.

Baackes utilised data from 87 male students of high school, to determine the relationship of selected anthropometric and physical performances measures to performance in running hop-step and jump. He concluded that all the variables as measured in the study showed significant relationship with criterion beyond the 0.05 level of confidence.

Wear and Miller studied the relationship of physique and developmental level, as determined by the Wetzelgrid to performance in fitness tests of junior high school boys. They found subjects who were median in physique and normal in development to be the best performers, and the subjects of heavy physiques to be the poorest in performance.

Smit undertook a basic investigation aimed at


discovering the general anthropometric differences between the various races. The subjects included the four main racial groups of the Republic of South Africa (White, Bantu, Coloured and Indian) comprising a total of 2,250 children of six to fifteen years. Upper arm circumference and calf circumference were two of many anthropometric variables in this investigation. The circumferences of the upper arm and calf showed no significant difference in the case of Bantu, Coloured and Indian subjects, but both measurements differed significantly in Whites as compared with those of the other three racial groups.²

In their study of 166 Olympic track and field competitors and eight swimmers at the 1960 Rome Olympic, Correnti and Zauili observed significant differences in age, height and weight among various events. It was also observed that within certain events body shapes or forms were similar but sizes varied. They also oversaw relationship among body proportions, dimensions and performance.

In his study related to somatotype and body composition to physical performance on seven to twelve years old


boys. Salughter et al. concluded that somatotype was not highly related to physical performance. However, ponderal index was correlated better with performance scores. Somatotype components have lower correlation with running and jumping variables than body composition or body size variables.

In their study on national level archers, Sundarrajjan et al. concluded that physical measurements (i.e. height, weight, bi-acromial diameter and arm length) were correlated with the performance of the individual archer at the varying distances. Further it was concluded that physical measurements were correlated also with the total performance score.

Espen Schade studied relationship between physical performance of school children to age, height and weight. The purpose of the study was to evaluate these factors on the basis of grouping of students and the establishment of norms for the performance. Where the age was held constant relationships of all performances with height, weight were low. Highest correlations were obtained for boys of junior high school in the events of

jumping and throwing. Significant changes with age do occur in most events of both sexes. Age was recommended as a basis for test norms. If grouping according to size is desired, the California classification was superior.  

In a bi-racial study of anthropometric measurements in standing broad jump, medicine ball put and zig-zag run Nemour concluded that though Negro boys and girls were taller than caucasian appendage and were taller than caucasians, they were not superior in the events of power and agility.

Jones after an intensive study of motor performance in adolescent boys concluded that height was correlated very well with muscular strength and physical ability when closely associated with the variables of weight and mesomorphy.

De Garay et al. after an intensive study of anthropometric measures of Olympic athletes concluded that level performance in a particular event demands particular type of

body size and shape, other aspects being similar. They established high correlation between the structure of an athlete and the specific task (event) in which he excels. \(^99\)

In the attempt to develop scientific criteria for the selection of building athletes based on their morphological status, Kansal \(^100\) studied 246 male students ranging from 11 to 17 years of age. Their height, weight, bi-cremial, humerus by-condylas, chest and calf circumferences and performance in 100 metre running, shot put and standing broad jump were examined. He concluded that the above-said body measurements showed significant degree of relationship with individual performance test studies. Further, with the help of these differential role, preparation of criteria selection for choosing building athletes at young age was also attempted.

A theoretical model was developed by Grimstone and his associates \(^101\) to identify anthropometric variables relevant to

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success in swimming. Frontal areas, cross-sectional areas, and lengths of body segments were measured on twelve members of a men’s college team using a photographic procedure. Motion picture films were taken of the subjects competing in free-style events and were analysed to determine the average stroke length, average stroke frequency, and average stroking speed. Correlation and multiple regression procedures were used to determine the relationships among the anthropometric variables and swimming performance. Of the 21 anthropometric variables selected with the aid of the theoretical model, 6 were found to be significantly related to one or more of the measures of swimming performance when the influence of event distance was partialled out (p < 0.05).

The physique of an athlete may have a strong influence on performance due to the specific demands of the sport involved. Studies of Olympic competitors in various sports had indicated that they often have distinctive physical characteristics. Carter" for example, concluded that:

"... Champion performers at various level of a particular sport exhibit similar patterns of body-size and somatotype with patterns tending to become narrower as levels of performance increase."

The relationship between human physique and function has long been a source of interest to scientists. Relationships between selected anthropometric dimensions and

motor performance have been reviewed. The magnitude of the correlations between anthropometric dimensions and motor performance, however, was generally low and at best moderate. For all practical purposes they were not meaningfully predictive. Finally, most of the data were derived from cross-sectional samples, and the small amount of longitudinal data available were treated in a cross-sectional manner. This immediately emphasizes the need for longitudinal analysis of the relationship between anthropometry and performance.

Conclusion:

The term "Physical fitness" had been included in many familiar test batteries commonly used in the schools. Most of the batteries were found excellent and include tests that had some definite value, but the present researcher felt that many of the tests in these batteries were not actually tests of Physical fitness (AAHPER: 1980, Campbell: 1977, Texas physical fitness test: 1973), but were actually motor fitness tests.

The term "motor fitness" became popular during World War II. Numerous tests of motor fitness were devised but the present researcher reviewed only those tests which consist of the combination of physical components namely-muscular strength, muscular endurance, cardio-respiratory endurance, power, agility, speed and flexibility (Clarke and Clarke: 1987). Literally hundreds of tests were available, but were not
attempted to be categorized in terms of motor fitness or general motor fitness (Patric: 1972, Cureton: 1947, Elder: 1950, Blesh and Scholz: 1967). The review of literature in relation to general motor fitness study indicated that most of the general motor ability tests had similar patterns and the test items included in the different batteries were dodging, vertical jump, broad jump, pull-ups, push-ups and running, which were the common items of the tests.

A number of tests have been developed for assessing physical fitness of school-aged children, but few provide an adequate index of cardio-respiratory endurance and almost all are based on the data of American, European and Australian children.

While going through available literature in physical fitness normative study, it was very clearly seen that the norms differ with age, sex, heredity and geographical location. The same set of tests used in two countries have not matched with the prescribed norms. A number of normative studies had been conducted, but the present researcher could not come across any study on reviewing the available literature of normative study of the students of Nepal. Similarly, it was felt that relationship between human physique and function has long been a source of interest to scientists. But almost all the
investigations were based on the data of other countries (Such as: America, Canada, New Zealand, Japan, etc.) and not on the data of the children of Nepal.

In view of the review of literature, it was observed that present study was the first attempt of its kind in Nepal to construct and evolve physical fitness test batteries and their norms. Further it was also found that it was the first attempt to compare the physical fitness of school grade boys among the various regions of Nepal, and to explore the anthropometric measure of the students of Nepal and to correlate it with physical fitness.