PHYSICAL FITNESS

Interest for physical fitness has been on the increase in the 20th century. This interest has been more popular in technologically advance countries. The more popular in the European and American countries have taken a special interest in their physical fitness. This movement has even come to Asian Countries. The reason is clear that a fit and healthy person is a great asset to the society. Fit and healthy citizen can contribute to the betterment of the society. To keep fit, has become a way of life. Physical aspect has thus, become an essential aspect of the human personality.

Fitness is pre-requisite for everyone. He may be a child, a school going child, an office goer, a labour person. Though health and fitness are not synonymous, fitness plays an essential role in health considerations.

Most authors define physical fitness as the capacity to carry out every day activities without excessive fatigue and with enough energy in reserve for emergencies. But the recent research in Medical literature has not accepted this definition. The recent medical research indicate the inactivity is one factor of coronary heart disease which relates to cardio-vascular disease.

Physical fitness is thus defined as the capability of the heart, blood vessel, lungs and muscles to function at optimal efficiency. Optimal
efficiency means the most favourable health needed for the enthusiastic and pleasurable participation in daily task and recreation activities. Optimal physical fitness makes possible a lifestyle that the unfit cannot enjoy. To develop and maintain physical fitness, vigorous efforts of the total body are essential.

A fit person adjust to increased physical demands and return to a normal state more quickly than the unfit person. People who keep fit greatly enlarge their fullness of living. They can do a day’s work with ease, they can meet emergencies and can do more recreational activities. Physical fitness thus, provide health and energy needed to fully appreciate the joy of life. Physical fitness today, has thus, been interpreted as total fitness. The concept local fitness includes following components:-

1. Psychological fitness

2. Physiological fitness

3. Body mechanism or effective performance in skill.

4. Physical anthropometry.

5. Social fitness.

According to Clarke, “Physical fitness is the ability to carry out daily task with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure time, pursuits and to meet unforeseen emergencies”. He further explain physical fitness as the ability to last, to bear up, to withstand stress and preserve under difficult circumstances where an unfit person
would quit. Physical fitness is more than, “being well or not being sick” and extend on a scale from abundant life to death.

PHYSIOLOGICAL ASPECT OF THE PHYSICAL FITNESS

There is close relation between exercise and the function of heart, lungs and muscles. To understand physical fitness. It is essential to know about these systems too. Bud Getchell quoted, “it is well accepted that over all physiological functioning of the body will benefit, if the body is properly stimulated on a regular basis with exercises. In contrast disuse of the body quickly results in a decline of the vital functions needed for good health and well being”,

It is universally accepted that the physiological functions of the body improves with use and decline with disuse. More specifically, the heart, lungs and muscles become stronger and more durable, the more they are used.

To understand the physical fitness, we need a fundamental knowledge of human physiology and of the mechanism involved in developing and maintaining physical fitness. This understanding also helps creating a positive attitude towards physical fitness. This chapter provides a simple explanation of the physiology of exercise, the effect of exercise on body and other essentials for a better understanding of physical fitness.

STRUCTURE OF THE BODY

The smallest structural and functional unit of the body is cell. Cells
are found in countless sizes and shapes - The basic substance of the cell is protoplasm a jelly like material, where biochemical processes are continually carried out.

Group of cells joined together are termed tissues and combination of different tissues forms an organ. The organs unite to form an organic system. For example, various kinds of tissues such as nerves, muscles, tissues are found in heart.

THE MUSCULAR SYSTEM

Skeletal muscle is composed of group of hair-like fibers that join into tendon at each end. Each fiber is a cell in itself and can change its length when it is stimulated.

The energy for movement of muscles comes from oxygen and nutrient which are supplied by the heart, lungs and blood vessels. These organs also work to remove the waste products.

All cells need energy to function. The nutrient from the food we eat and the oxygen from our blood are utilised within the cell in a series of chemical reaction from ATP (adenosine triphosphate). ATP is found in every cell of the body and is necessary for contracting muscles and performing other cell processes that require energy. Once the ATP is used, it must be restored, therefore, more food and oxygen is needed by the cells. During exhaustive exercise, an ample supply of oxygen is not available in the muscle. In such circumstances the other process of re-building ATP are that of the use of CP (Creatine Phosphate) and when CP supply is
exhausted, another source of quick energy is Glycogen (stored energy) when the muscle cell is not getting adequate supply of oxygen and the break down of the Glycogen produces lactic acid (waste) and enhance the ability of the muscle to contract until an accumulation of this waste becomes so great that the contraction stops. These events are called anaerobic (without oxygen) phase. This phase can last only for few minutes. Oxygen is needed to burn the available food in order to restore the ATP and CP. In most of the exercise aerobic and anaerobic process takes place simultaneously. However, in rhythm exercise or the endurance type of exercise the aerobic process works such as walking, slow running, swimming, and cycling etc.

Human muscle is composed of two types of fibers- slow twitch and fast twitch. The slow twitch fiber has higher over all capacity for aerobic energy production than fast twitch fiber, and are capable of endurance type of exercise. These fibers provide major portion of energy as we walk, run or do cycling.

On the other hand, fast twitch fiber are especially adapted to short explosive bursts of contraction. These fibers provide immediate energy when we suddenly rush or run for an activity, such as sprint running.

THE CARDIORESPIRATORY SYSTEM

It is clear that a close relation exists between muscular system and cardiorespiratory system and the nervous system. At the grass-root human life and efficient functioning of the body depends upon cellular level. Each
cell needs a ready supply of oxygen and food while carbon dioxide and other waste products must be carried away from it. Adequate functioning of the circulatory and respiratory system is needed for the process. The cardiovascular system (the heart and blood vessel) keep the blood circulating throughout the body. The respiratory system (the lungs and air passage) removes carbon dioxide and replaces it with fresh oxygen. Because of their inter-dependence the two systems are called cario-respiratory system. Healthy functioning of the cariorespiratory system is thus of paramount importance for the maintenance of physical fitness and health.

THE BLOOD

The blood is the fluid that flows the circulatory system. It is a slurry of blood cells, foodstuffs, minerals, gases and many other substances that are vital to the proper functioning of the body. The blood transport nutrient and oxygen to the tissues. It also carries away waste products from the cell because of the chemical process and the cell activity. The blood stream also distribute the heart generated from the cell activity.

Approximately 45% of the blood volume is composed of red blood cell, white blood cell and platelets. The remainder is called plasma. The red blood cells are composed or iron protein molecules called hemoglobin. Plasma is a complex liquid consisting of food, minerals, harmones and chemical substance needed by the cell for co-ordinating and regulating cellular functions.

An artery is an elastic vessel that carries blood away from the heart.
A vein return blood to the heart from the tissues. The cells receives their fuel and oxygen through this walled structure called capilaries which are distributed through out tissues of the body. Carbon dioxide and other end products are picked up in the tissues and carried back in the veins to the right atrium of the heart.

THE HEART

The heart beats constantly and pump blood through out the body at approximately 72 beat per minute or 103, 680 beat per day. It circulate at least 2000 gallons of blood every day.

The heart is composed of two upper chamber called atri and two lower chambers called ventricles. The right atrium and right ventricle are separated from their counterparts on the left by a muscular wall. This separation allows the heart to work as two separate pumps (right and left). Each atrium is connected to its corresponding ventricle by a one way valve. The right side receives blood from the body which is low in oxygen and pump it to lungs. At the same time left side receives fresh oxygenated blood from the lungs and pum it out through the aorta, the largest artery in the body, to all tissues in the body.

THE HEART RATE

The heart rate and the amount of the blood from the heart with each beat varies with changing needs of the body. At rest, the heart pumps about five liters of blood a minute. It is capable of increasing this cariac output by 15 to 25 liters of blood a minute when the body is active.
THE LUNGS

The lungs, located within the rib cage, are the organs of respiration that regulate the exchange of air between the blood and external environment. The air enters the body by either the nose or mouth. It then passes into the throat which is also a passage way for food. The throat branches into two tubes, the esophagus through which the food passes to the stomach and the trachea through which the air passes to the lungs. The trachea extend downward towards the lungs. It divides into two branches called bronchi, one leading to the each lung and further subdivides throughout the organ. Eventually this subdivision ends in tiny ducts attached to about a billion microscopic air sacs called alveoli. These air sacs are clustered together, giving the lungs a spongy texture. Blood capillaries surrounds the alveoli.

The air is breathed into the lungs, the oxygen passes through the walls of the alveoli into capillaries and it combines with hemoglobin in the red blood cell. The oxygenated blood return to the heart, which pump it to all part of the body. Through out the body, oxygen picked up by the cell that need it and the blood in turn pick up carbon dioxide and other waste product and is carried back to the heart by the veins and then to the lungs where it gives up and breath out.

At rest the lungs breaths in about 6 to 8 liters of air each minute. The rate increase corresponding to the intensity and duration of exertion. While walking, climbing stairs, running or playing basketball, cell requires more
oxygen and breathing increase in both depth and rate. The level of ventilation may reach well over 100 liters a minute in all out athletic performance.

EXERCISE AND THE HEART

Participation in vigorous activities such as running, Basketball, swimming etc. Increases the cell’s need for oxygen. Accordingly, it also increases the level of waste products to be removed from them. The working cell need increased blood flow. The heart must pump faster, and must increase its stroke volume.

Inability to get enough oxygen and accumulation of the waste products hinders the ability of the muscles to contract and the muscles are fatigued. This need can be met by increasing the speed with which the blood goes through the circulatory system. The functional ability of the heart to pump blood and the ability of the muscle fiber to utilise oxygen are the key to successful muscular performance.

EFFECT OF TRAINING ON THE HEART

The heart rate varies with the intensity and duration of exercise. An increased heart rate is accompanied by an increase in the amount of blood pumped per beat and the magnitude of the stroke volume depends on the functional strength of the heart. It is a physiological fact that the regularly exercised heart will improve its performance both at rest and during physical exercise. As a result of systematic training, the heart will be able to pump more blood per beat.
As the exercise begins the heart rate increases. The heart rate is directly proportional to the work load. Experiments have proved that the regular exercise lower the heart rate and this is a simple indication of physical fitness too. The increase in the heart rate from its resting level is less in a conditional and fit person.

A more rapid recovery of the heart rate after a workout also indicate cardiac efficiency. In other words the physically fit person generally has a lower heart rate and more rapid recovery time for any given exercise work load.

Vigorous exercise also increase breathing rate. The regular exercise also bring changes as a result of adaptation of the body to exercise and are called the training effect of exercise.

The cariac output at rest is approximately the same for those who exercise regularly and those who do not. However, 6 to 8 weeks endurance training, reduce the resting heart rate along with an increase in stroke volume. This means that more blood is pumped with each heart beat, the heart does not have to beat as often to supply the body with blood. In addition, the slower heart rate and increased stroke volume provides a greater rest for the heart between beats. A slow heart rate, complete with a relatively large stroke volume means an efficient circularity system.

MOTOR FITNESS

In simple words motor fitness may be defined as capacity for vigorous work. It covers different aspect of physical fitness such as
endurance, power, strength, agility, flexibility and balance etc. In a way it is physical aspect of fitness and it covers the activities like running, jumping, dodging, falling, climbing swimming, lifting and efforts of endurance. This aspect of fitness became popular during the world war as it was felt necessary for the defence forces to exhibit motor fitness in defensive and offensive activities at that moment.

Motor fitness tests were easy to be conducted with less equipment. There is need for such tests in our schools. The investigator will suggest that each school should conduct these tests not only to know the fitness level of the students but to motivate students towards physical activities.

**MOTOR PERFORMANCE PARAMETERS**

**Co-ordination**

Co-ordination is most common factor of the nervous system, the skeletal muscular system may be defined as the smooth flow of movement in the execution of a motor task. Ability of the football player depends upon his co-ordination of different movement involved in football. If there is no co-ordination, the player will be injured and fatigued.

**BALANCE**

Balance is a specific kind of co-ordination involving reflexes, vision, the hearing capability, the cerberllum and skeletal muscular system. Static balance is a position in one fixed position. Dynamic balance refer to the maintenance of equilibrium while moving. Common test for balancing are use of balancing beam, standing on one foot etc.
POWER

Power is one of the basic parameter of motor ability. Strength activities performed with speed on power or explosive movement such as vertical jump, shot put, tennis service, badminton smash, etc.

AGILITY

Agility is normally defined as ability to change direction quickly and effectively while moving with full speed. This quality is essential for success in sports. The common test, to test this parameter involves zig-zag run, running through obstacles, side stepping, etc.

SPEED

Speed of specific and localised movement is called movement time. Speed is measured by total body movement from one place to another place at least for a distance of 50 meters. The details have been discussed separately.

REACTION TIME

Reaction time is the length of time required to initiate a response to a specific stimulus. It is essential for wrestlers, boxers, fencer, etc.

FITNESS PARAMETER

Physical fitness has been a subject of general interest and a good amount of literature is also available to establish its value. A good number of physical fitness test batteries have also been devised to ascertain individual
fitness level. Sometime these batteries include test of what the modern research indicate as motor fitness. To understand the finer relation of physical fitness and motor fitness, it is essential to know the parameters of physical fitness and motor fitness.

**PHYSICAL FITNESS PARAMETERS**

**Strength**

Strength has been recognised as one of the most important factor of physical fitness. Strength is the ability of the body or its segment to apply force. To apply force implies the importance of strength in daily life as all movements are performed against some resistance. Strength is contributor to power because power = Force \times Velocity. Increased strength results in the ability to apply more force and thus, it contributes to power. It is generally believed that strength is the only contractile force of muscles, but strength involves combination of three factors.

1. **Agonists**: The combined contractile force of the muscles causing the movements.

2. **Antagonist**: The ability to co-ordinate the agonist muscle with antagonist muscles.

3. The mechanical ratio of the bones involved (lever).

   The first factor depends on the maximum contractile force of each muscle agonistic to the movement. This force can be increased by progressive resistance exercises. The second factor depends on the ability
to co-ordinate the contraction of the individual muscles. This can be improved by exercising particular movements. The third factor depends on the angle of pull of the muscles and relative length of the resistance arm and effort of each lever.

Strength is also a factor in muscular endurance which is the ability of the muscles to resist fatigue while doing work. Strength also contribute to agility because adequate strength is required to control the weight of the body. Strength is also a factor in running because great force is required to accelerate the body and to keep it in motion at top speed. There is no doubt that lack of sufficient strength is serious handicap in physical fitness.

**HOW TO INCREASE STRENGTH**

To increase the strength component of fitness muscle must be contracted against heavy resistance and the resistance must be increased as the muscle becomes stronger. Hence, any exercise which applies over load will stimulate an increase in strength. Strength is thus increased by following methods:-

1. Hard manual labour or various athletic performance.
2. Special exercise against body weight as in pull ups or dips.
3. Heavy resistance exercise against external movable resistance such as weight training.
4. Application of muscle tension (isometric contraction) against a fixed object or another body part.
The above methods can be divided in two ways. The first three methods results in isotonic contraction as the muscle change in length with the movements. The fourth method is isometric (static) contraction, where the muscle apply tension but do not shorten and do not move the body segments.

**ISOTONIC (DYNAMIC) STRENGTH TRAINING**

The weight training exercises were used very little in athletic before IIInd World War, these exercises were not considered much beneficial. During IIInd World War Thomas Delorme and associates experienced success with heavy resistance exercise in rehabilitation of patients. Following Delorme work quite lot of research has been done and it was found that effect of this type of training were highly beneficial. Hence, this type of training was highly beneficial. Hence, weight training has become popular among sportsmen. It is now established fact that strength can be increased rapidly by exercising against heavy resistance for a few repetitions.

Delrome and Wilkin (1951) recommended the following programme to be done on alternate days.

- one set of 10 repetition with 1/2 10 RMS.
- one set of 10 repetitions with 3/4 10 RMS.
- one set of 10 repetitions with 10 RMS.

(10 RMS means the Repetitions of an exercise using the maximum weight that can be lifted successively 10 times).
This method is still considered effective. Berger (1962) found that strength increase most rapidly when 4 to 8 RMS are used with 3 sets i.e. 4 to 8 repetition with maximum weight with 3 sets.

Berger and Hartoge (1967) found that 10 separate lift with maximum load for each lift increase strength faster than one set of 10 RMS. Though there are difference of opinion for building strength but following common guidelines are agreed upon.

1. Proper and specific exercise must be selected for developing strength in a certain muscles used in a particular activity.

2. Heavy resistance exercises are recommended every second day.

3. Near maximum weight for fewer repetition (4 to 8 repetition) should be used.

4. As strength increases, the weight must be progressively increased.

**ISOMETRIC (STATIC) STRENGTH TRAINING**

Hettinger and Muller of Germany in 1953 introduced static muscle exercises for developing strength. These exercises have also remained quite popular. This process involved static contraction of muscle at near or maximum for 6 second with 5 to 10 repetitions. Royre (1958) reported that strength will increase more rapidly if the contraction are done at various positions. More house (1953) Ball and Rich (1964) reported in their research
that different amount of tension and different duration of contraction in different muscle produced significant strength gain. Currently, it is agreed upon that-

1. Strength at a particular body position can be increased rapidly by using one or more maximum contraction of 8 to 10 seconds each day.

2. If increase in strength is needed in the whole body then several (5 to 10) contraction should be done at various positions.

3. Fodrapid strength increase, exercise should be done daily otherwise exercises are recommended on alternate days.

4. The best breathing technique is to take a deep breath at the beginning of the contraction, hold it for few seconds and exhale slowly during the later part of the exercise.

**ISOTONIC AND ISOMETRIC TRAINING A COMPARISON**

It has been agreed that dynamic strength increases with dynamic exercises and static strength increases with static exercises. Following are the advantages of Isotonic strength training.

1. There is a psychological advantage in isotonic exercise because the performer can see the work being done by him.

2. Isotonic exercise results in more muscle hypertrophy. This is done to increase capillarization which is stimulated more by Isotonic exercise than isometric exercise.

(30)
3. Isotonic exercise develops strength more throughout the range of motion.

4. There is much more gain in neuromuscular co-ordination as a result of Isotonic exercise than Isometric exercise.

5. Cross training effect results much more with Isotonic exercise as compared to Isometric exercise.

6. Berger and Blaschke (1967) reported that strength gain through Isotonic exercises has much more application to motor performance.

On the other hand, Isometric exercises have also been found useful as for these exercises require less time, less space, and little equipment and strength gain is also rapid.

OTHER METHODS OF STRENGTH TRAINING

Some of the research studies claim that strength can be gained at a rapid rate by combining Isotonic and Isometric exercises. This is done by contracting the muscles isometrically against a rope or cable or pulley for about 10 seconds then reducing the resistance to allow a slow motion Isotonic contraction to occur. Several mechanical devices have been developed for this type of exercises.

Another method is that, Isotonic exercises are done in slow motion, e.g. maximum weight is moved for 10 seconds and then it is lowered at the same rate. A 10 seconds rest is recommended in between repetition.
In another method, activity itself is performed under conditions of resistance for example, weighted vests, Ankle weight other weighted objects heavier, implements etc. Some experts believe that this method reduces co-ordination and timing and there is only a little strength gain, because the resistance is too, little to provide a strong stimulus for strength.

**PHYSIOLOGICAL ASPECT OF THE STRENGTH TRAINING**

The following physiological changes occur as the strength increases:

1. **Increased Size of Muscle Fibers:** The individual muscle fibre increase in size as a result of strength training, hence an increase in the growth of the muscle. Some of the recent research indicate that there is also increase in the number of muscle fibre i.e. new fibres are created as a result of training but this theory need more justification.

2. **Increased Number of Active Fibres:** Only a portion of muscle fibres is able to respond to impulse or a given time. This position can be increased by training. The fibres which are unable to contract are called inactive fibres. With the training the fibre can be activated and thus contribute to strength. It is believed that a well trained muscle has 90% active fibres whereas untrained muscle has 60% of the total muscle fibres in that muscle. Hence, a well trained muscle can apply more force.

3. **Increased Protein Contents:** Hettinger (1961) pointed out that numberous studies on muscle chemistry have shown that the amount of protein increase as a result of training. The amount of Glycogen and various other substance also changes. Johl (1964) states that there is a definite
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increase in actomyosin the protein used most in muscle contraction. Increase of actomyosin contribute to greater force of muscle contraction.

4. **Increased Fluid Contents**: Well conditioned muscles contains a large amount of water than other muscles. Though this increase is very little yet even this increase in fluid would contribute proportionately to muscle growth.

5. **Increased Capillarisation**: Karpovitch (1965) and Morehouse and Rosch in 1958 and Hettinger in 1961 agreed that there is an increase supply of capillaries with the muscle as a result of strength training. The increased capillarization is necessary to supply adequate oxygen and nutrient to the muscle fibres and improve muscular function.

6. **Increased Connective Tissue**: Regular and heavy work places additional stress on connective tissue of the muscle as a result the tissues are thickened and becomes tough and hence result in improved muscle function and also serves as a saviour from injuries.

7. **Decreased Fat within Muscle Tissues**: Fatty tissues accumulates around visceral organs, and within skeletal muscle. This fat creates friction and reduces the efficiency of contraction. Fat tends to accumulate in the inactive muscles. Training reduces the amount of fat in the muscles thus it can contract more efficiency and effectively.

**CHANGE IN MUSCLE CHEMISTRY**

Johnson (1960) Hettinger (1961) and Karpovitch (1965) indicated
that in addition to increase in protein and water, several other changes occur in the chemical composition of muscles as a result of training. Johnson reported that there is a definite increase in Glycogen, Phosphor creatine and hemoglobin. Hettinger claims that there is an increase in the effectiveness of enzymes and coensymes in the decomposition of the reserve nutrient in the muscle and this results in more energy for work. Well conditioned muscles produces less lactic acid than the poorly conditioned muscle.

FACTOR INFLUENCING STRENGTH

   Numerous factors relating to strength influence strength. Importance of these are enumerated as below:

   1. **Length of Muscles:** The contractile force of the muscle increases with the extension of the muscle. The contractile force is thus the greatest when the muscle is fully extended or stretched. The contractile force of a muscle is directly related to the muscles cross sectional measurement. The increase in size is proportionate to the increase in strength. For example, two muscles having equal cross-section differs in application of force due to varying amount of fatty tissue as the fat lacks ability to contract and also interferes with the shortening of muscle fibres. The proportion of active fibres in a muscle also influence the contractile forces.

   2. **Mechanical Aspect:** Strength has a mechanical element because the body function as a system of lever. A pull at right angle to lever give the maximum mechanical efficiency. The greater the deviation from the right angle, the less efficient is the pull.
3. **Strength Training and Muscles:** There are different opinion regarding increase of strength because of training in different conditions. It is agreed that strength increases by progressive resistance exercises. The important points in this regards are as follows:-

1. Physiologically each individual differs from each other, some people are more responsive to training than other because of their physiological differences.

2. The same person will respond differently to training as his state of conditioning changes. Strength gain is slower as the strength level get closer towards potential strength.

3. The person’s age also influence the strength training strength increase quite rapidly upto 25 years of the age and tends to become less responsive, year by year. Women are responsive to training up to 20 years of age and then after they become less responsive.

4. Strength do not increases equally in all the muscles some muscle groups may increase 5%, others may increase even 10%. This difference causes them to respond at different rate.

5. If the strength training programme is terminated, the strength gained will be lost about 1/3 the rate it was gained. This means that strength gained rapidly is lost rapidly when training is stopped, whereas strength gained more gradually last longer.

6. Weather conditions affect the strength training and the strength gain
by individuals. The conducive weather for strength gain is neither
the extreme nor hot weather nor the extreme cold. Moderate weather
conditions are good for strength training and strength increase is
more rapid.

FOOD AND DIET

It is well established that the ability to maintain a high level of
conducting and to improve conditioning is greatly hindered by inadequate
diet. Some researchers claims that certain food supplements make
significant contribution to conditioning. But it is believed that if the diet is
sound, there is little contribution of the food supplement.

BODY TYPE

Studies done Sills (1950-53) and Lanbach (1966) indicate that people
who are predominantly mesomorphy (heavily muscled athletic type) are
stronger than people of other body type. Endomorphs (heavy round shaped)
are considerably less strong than mesomorphs but slightly stronger than
ectomorphs (Slender and lightly muscled). Further it was learnt that
mesomorphs were also superior in speed, motor ability and endurance.
Ectomorphs were better than endomorphs in these traits.

SEX DIFFERENCES

Research support the claim that on the average women are about 2/3
as strong as men. However, the strength varies in different muscle group.
The strength differences between two sexes can be accounted for mostly,
by the differences in muscle mass. Women are also less responsive to
strength training as compared to men.

SPEED

Speed is an important factor in physical fitness. It is also one of the
most important factor in almost all the games and sports. Speed is
determined by length of stride and frequency of stride. In order to increase
running of speed both of these factors must be increased. Length of stride
is dependent upon leg length and leg power. Leg speed is dependent upon
speed of muscle contraction and neuro muscular co-ordination.

HOW TO INCREASE SPEED

Speed is basically a result of applying force to mass. In human
movement, the body or segment of it represent the mass and the muscle
contractions represent the force. If the force is greater than the resistance,
movement will occur. As the force becomes greater, the speed, at which
the mass moves, will increase proportionately.

REDUCING THE NEGATIVE FORCES

Some of the negative forces tends to be constant while others can
be changed. Gravity is represented by body mass (weight) and remains
almost constant except that weight can be gained or lost. Velocity changes
are variable and can be controlled rather easily. Unnecessary movement
can be eliminated and efficiency of necessary movement can be improved.
FOR INCREASING SPEED

Sprinting is essentially a power performance. It depends on one's ability to project the body forcefully and rapidly from alternate feet. Traditionally it has been thought that there are three possibilities for increasing speed.

1. Increasing the power of the legs extensor muscles (Force \times Velocity)
2. To practise running at top speed.
3. To improve specific co-ordination.
4. To correct errors in running mechanism.

Air or water resistance can be reduced by changing body position. For example, a cyclist, a skater or a skier reduces air resistance by leaning forward. The coach and trainees can find out different methods for reducing negative forces depending upon the activity.

**Increasing Positive Forces:** The process included-

1. Speed of muscle contraction.
2. The force which muscle can apply against resistances.
4. The leverage involved in the movement.

SPEED OF MUSCLE CONTRACTION

The speed of muscle contraction is inherent in the muscles tissues. Different muscles contract at different rate. It is established that muscle
contraction can be increased by repeated fast movements. This process improves nerve innervation to the muscle and the same time increase the efficiency of the muscles. The speed of muscle is directly proportional to speed of contraction of the muscles. Speed can be increased by increasing the abilities.

**CO-ORDINATION**

Increased co-ordination can increase the speed of specific movements. As the agonistic muscles become better co-ordinated they can overcome external resistance with greater speed and as co-ordination between agonistic and antagonistic becomes better the contractile efficiency also increases the fatigue effect is also postponed.

**THE LEVER SYSTEM**

In motor performance the body function as system of levers and the leverage can be improved. The speed at the end of the lever is directly proportional to the levers length. This is related to discuss throw and hammer throw etc. The speed can thus be increased by employing an optimum combination of angular velocity and length of the lever involved.

**FACTORS INFLUENCING SPEED: IMPORTANT FACTORS INFLUENCING SPEED ARE:**

1. **Muscle Length:** A.V. Hill (1955) states, a muscle fibre that is ten time longer than another fibre, can shorten ten time as fast, provided the intrinsic properties of the two fibres are the same. This means that
muscles with long fibres have speed advantage over muscles with short fibres.

2. **Force and Acceleration:** According to Newton’s 2nd Law of Motion, acceleration of the body is proportional to the force causing it. It means if the force is doubled the rate of acceleration will also be double. Sprinter increase acceleration by increasing the force he applies against the surface on which he runs. A swimmer accelerate his speed by increasing the force of the kick and stroke against the water in correct direction.

3. **Effect of the Theoretical Square Law:** The negative forces effect the speed, the law states that air and water resistance vary with swaure of velocity which means that if the velocity is increased by 2, the air and water resistance against it, will increase to 4. If velocity increases by the resistance will increase by 16.

4. **Age and Sex:** Age and sex also have bearing on speed. Generally, men increase speed upto the age of 20 after which speed tends to decrease at a gradual rate. Women reaches to their maximum speed at a younger age of 16 or 17 years. Hodgkins (1963) found that peak speed is maintained longer by males, whereas peak reaction time is maintained longer by females. Records of speed as men. This difference is because of the strength factor which is more in men than in women.

5. **Temperature:** Hill (1951) found that the contractile speed of muscle in animal is increased 20% by raising the temperature 2°C.

6. **Body Type:** It is seen that Obese people tend to lack speed.
Meso ectomorphs (medium stature) type of persons have better speed, however, individual exception have been seen in this regard too.

7. **Strength**: Chui (1964), Clarke and Henery (1961), Colgate (1966), Smith and Dintiman (1964) indicate strong relationship between strength gain and gain in speed of movement. Moreover, as the resistance increases strength is needed to overcome resistances at a faster rate. It is also believed that strength, speed have mild relation where resistance is very light.

8. **Flexibility**: It is known that restricted flexibility especially in the hip region, can retard running speed, because it increases the resistance provided by the antagonistic muscle.

9. **Body Mechanic and Running Speed**: Photographic analysis have shown that efficient spring running is characterised by a high knee lift, long running stride, and placement of feet on a line beneath the runners C.G. It is so important that propelling forces be directed properly and efficiently specially the leg movement should be straight forward and backward, the arms and shoulder movement should be directed to pull the body in desired direction.

10. Co-ordination of movement is also an important factor in speed. The speed retard in unco-ordinated movements. Co-ordination of limbs contribute to spead.

11. **Endurance**: Endurance is defined as resistance to fatigue and quick recovery after fatigue. It is the ability to persist in strenuous activity.
Endurance is one of the most important component of physical fitness. It is needed in almost all the activities of games and sports. Endurance has been recognised as important factor of physical fitness.

**HOW TO INCREASE ENDURANCE**

The method of progressive over load is applicable to increase endurance. Over load for endurance means working the organisation beyond previous endurance level. Endurance is generally divided in two form. The muscle endurance and the cardiovascular endurance.

**MUSCLE ENDURANCE**

It has been established that strength contribute to muscle endurance. There is a very high co-relation between strength and muscle endurance. Muscle endurance depends upon the quality of muscle, extensiveness of their capillary bed and the nerve mechanism supplying them.

Since increasing strength is an effective method of increasing muscle endurance hence the strength building method can also be applied to increase endurance, i.e., heavy resistance with few repetitions. However, if one desire to increase endurance without increasing strength, then the programme must be altered to emphasize endurance without strength. Muscle endurance can also be increased with any exercise which result in overloading either by weight training or general exercises like calisthenic exercises, regular sports participation manual labour, jogging and walking.

It is generally agreed that 20 to 30 RMS with three sets, i.e., light
weight with more repetition will increase muscle endurance at a fast rate and will affect strength and muscle size very little.

CARDIOVASCULAR ENDURANCE

Cardiovascular endurance refers to the ability of the circulatory system to provide oxygen to the cell in order to support the oxidative process of energy production and to remove the waste product of metabolism. The primary objective of cardiovascular endurance training is to improve the circulation to the working muscles.

Cardiovascular training can be divided into two main categories: 1. Aerobic training and Anaerobic training.

1. **Aerobic Training**: Aerobic training refers to the training system when oxygen to body cell is adequate. The ability of the body to supply oxygen to cell is key to cardiovascular endurance. When adequate oxygen is not available in the cells, energy production shifts to aerobic (absence of oxygen) process. The anaerobic process produces insufficient ATP (energy) and it produces the lactic acid which results in fatigue. It is evident that with a better oxygen supply an individual work longer and at a faster rate. The better oxygen supply to the cell be attained through aerobic training.

Thus, the purpose of the aerobic training is to increase the ability of the oxygen transport system (cardiovascular system) and it results in more oxygen uptake, and in turn a better oxygen supply to cells.

The aerobic endurance can be developed by working continuously
for long period of time such as cross-country running, long distance swimming. Interval training is considered to be the best method to develop cardiovascular endurance. Interval training involves series of work and with a short rest interval in between the efforts (work out). Astrand and Rodahl (1970) found that a work-load which could be tolerated continuously for 9 minutes could be carried on for an hour when done intermittently (in interval training). This means that much more work can be done using interval training than continuous training. For more using effective results from interval-training, intensity must be increased as endurance is gained so that over-load may be applied continuously. In other words when an athlete becomes better conditioned he must do more work in order to gain additional endurance. The Interval training can be adjusted in four different ways.

1. The number of repetition can be increased.

2. Duration of time can be increased.

3. Intensity can be increased.

4. The rest interval can be reduced.

A workout of 3 to 5 minutes is generally recommended. The number of repetitions, intensity, Rest Interval are adjusted according to the level of conditioning. An individual should not feel fatigued at the end of the workout.

Heart rate is used as a criterion for determining the optimal training load. It should be maintained at a rate of within 10 beat of maximum heart
rate during each 3 to 5 minutes workout. The rest interval should be equal or less than the repetition (workout). Copper (1968) suggested that the rate should be above 150 beats per minutes for at least 5 minutes will produce gain in aerobic endurance.

2. Anaerobic Training: Anaerobic endurance refer to the effectiveness of the body process which provide energy for muscular contraction in the absence of oxygen or when sufficient oxygen is not available to produce enough energy aerobically. Anaerobic endurance is very important in activities requiring maximum effort for a short period such as 100 metres, 200 metres, 400 metres sprints or in activities such as basketball, football, which requires short burst of vigorous activity.

Anaerobic endurance training consist of repeated short workout with maximum effort followed by brief rest period between workouts. Anstrand and Rodhal (1970) indicate that workout of about one minute in length is most effective type of endurance. 4 or 5 workout of Interval training results in high level of lactic acid in the blood which means greater rise of anaerobic mechanism in cell. Well trained athletes are able to tolerate higher level of lactic acid than less trained or untrained. This means anaerobic training would be of great value athletes involved in vigorous short duration activity.

METHODS OR TYPES OF ENDURANCE TRAINING

1. Repetition of Sprint: This system involves repetition of short sprint. The running is at maximum speed, distance is shorter. This method is good for preparation of competition.
2. **Continuous Slow Running**: It refers to running long distance at a lower speed. The distance is generally equal to the distance one wants to compete for. For example, an athlete of 1500 metres should run 1500 metres, 3 to 5 times.

3. **Continuous Fast Running**: The speed of run is faster and faster in contrast to continuous slow running. The distance is also slower. This process develops aerobic endurance.

4. **Slow Interval**: In this process, the speed is faster than in continuous fast running. It prepared the athlete for a more intensive effort. The heart beat is generally 180 beat per minute. This process develops aerobic endurance. Distance is generally 80 meters to 400 metres.

5. **Fast Interval**: Fast interval develop anaerobic endurance or speed endurance. It is used after attaining aerobic endurance. The heart beat is 180 beat per minute during the work phase.

6. **Repetition Running**: This process involves repetition of comparatively longer distance with complete recovery after each effort. Distance is generally 800 to 3000 mts.

7. **Speed Play**: Speed play is form of training which involves fast slow running, sprinting, walking, continuous fast running etc. This is also known as Fartlek training.

8. **Interval Sprinting**: It is a method of training where an athlete sprint 50 mts jog 100 mts. and so on depending upon his conditioning.
9. **Acceleration Sprinting**: It is gradual acceleration from jogging to striding and then to sprinting. For example, 25 yards jogging, 50 metres striding and then sprint 50 metres followed by 50 metres walk jogg.

**FACTORS INFLUENCING ENDURANCE**

Factors relating to endurance also influence endurance. These are as follows:-

1. **Rate of Movement or Pace**: Walking, running, swimming, stopping, starting, accelerating, decelerating are concerned with use of energy. The most economical pace is an even rate over the entire distance. For example, a 4 minutes mile should consist of 60 seconds quarters. The idea of even pace also has strong application to long duration games such as basketball, soccer, tennis or handball.

2. **Skill**: Certain amount of energy is wasted in uncoordinated movements. A skilled individual waste less energy. For example, an unskilled swimmer shall use more than five times as much energy as a skilled person in swimming on the same distance.

3. **Strength**: Strength also influence endurance. The weaker fibres get fatigued earlier than the stronger fibres.

4. **Age**: Endurance increase with age upto a certain point after which endurance decreases as age increase. Morehouse and Miler (1967) state that the ability of boys to perform endurance activities increases upto the age of about 20 years (with training endurance will still increase more)
endurance reaches its peak as soon physical maturaion is achieved. The maximum strength remains constant from three to five year a and then begin to decline gradually. Stroke vol. in children is lesser hence less endurance. Endurance increases as stroke vol. increases.

5. **Sex**: Studies show that upto the beginning of puberty, girls are about equal to boys in endurance. Women reach at maximum endurance in early twenty years of age while men continue to increase up late twenties. Endurance of women in strenuous activity is lesser than man. Morehouse and Miller (1967) pointed out that the adult women have only one half of the endurance of adult men in running. Endurance in women is lesser than man because of smaller size, more rapid heartrate, smaller chest cavity, fewered blood cells.

**Body Type**: Morehouse and Miller (1967) claimed that people of moderate build have the greatest ability to sustain prolonged muscular effort. Sills and Everett (1953) in a study of the relationship between extreme body type and performance, found that measomorphs were only slightly better than ectomorphs in endurance tests and endomorphs were inferior to two other body types.

**Over Weight**: Fat lacks the ability to contract, therefore, it does not contribute to performance. The fat hinders performance in three ways.

(a) Fat adds dead weight and thereby increases resistance against movement.

(b) Fat within the muscle causes friction and contribute to inefficiency in muscle contraction.
(c) Fatty tissue places an over load on the circulatory system.

**Temperature:** Grose (1958) found that endurance is adversely affectedly extreme hot and cold temperature. According to clarke (1958) 80°F appears to be the optimal muscle temperature for endurance workout.

**PHYSIOLOGICAL ASPECT OF ENDURANCE**

**Endurance Training Results in Following Changes in the Organism**

1. **Heart**: The heart becomes larger and more effective, as a pump. The muscle tissue which forms the walls of the heart respond to regular overload because as a result of endurance training these become larger and stronger. The increased size and strength of the heart causes a great stroke volume and more cardiac output. In turn this process results in slower resting heart rate and smaller increase in rate for a given level of work.

2. **Lungs**: Consistently over loading of the respiratory system increase the strength and endurance of the respiratory muscles and cause increase in the lungs volume and this allows a larger exchange of air per respiration. The expansion results in the development of more alveoli and hence more surface area where gases may be transferred to and from the circulatory system. This results in slower breathing rate during the rest and less increase in breathing rate during heavy work.

3. **Capillaries**: As a result of endurance training capillary begin
the lungs and trained muscle increase significantly. The increased capillaries allows greater exchange of gasses between lungs and blood, muscle and the blood.

4. **Blood**: Blood volume also increase in proportion to the increase in capillaries. Carlsten and Grmnb by (1966) found that adult men who were well conditioned had about 20% more blood than those who were poorly conditioned. As a result of endurance training, the composition of the blood changes i.e., more red corpuscles and less water contents, and this process increase the blood viscosity and its carrying capacity.

5. **Blood Pressure**: With the endurance training, a near resting level of blood pressure is maintained under condition of moderate work. The rapid return of resting pressure is a further indication of good condition.

6. **Increased Efficiency**: Extensive endurance training brings increased neuromuscular efficiency, i.e., less energy is spent to accomplish a given work. This is accounted for—

(a) More efficient transmission of nerve impulses.

(b) Less resistance from antagonistic muscles.

(c) Less wasted motion.

(d) Less fatty tissue in muscles.

(e) More efficiency in contraction of the muscles.

**AGILITY**

Agility is also represented by the term mobility and swiftness. Agility is ability of the body to change direction of the body and its parts rapidly
and skilfully. Agility is combination of several athletic traits such as strength speed, reaction time, power and co-ordination. It is demonstrated in movements such dodging, zig zag running, changing body position quickly or stopping and starting again.

Agility is very important in all the activities which involves quick changes of the body position such as in basketball, tennis, badminton, volleyball, football, baseball, gymnastics, diving, track and field events, swimming etc. An individual can be called agile when his physical performance are fluent and economical. Agility is thus fundamental to good performance.

**Types of Agility:**

1. General
2. Specific

Specific agility: It is rapid movement of hands and arms as in playing piano and back hand in badminton.

**HOW TO INCREASE AGILITY**

Agility can be improved by increasing the components of fitness, equilibrium and co-ordination are the most important factors out of these. Thus for increasing agility, fitness components like strength, power, flexibility reaction time should be improved. Special attention to be given to practice specific movement several time. Some of the exercises to develop agility are given below:-
1. Zig Zag Running in figure of 8.

2. Asymmetric exercise while marching

3. Astride jump Forward and backward.

4. Turning to side, back, from time to time.

5. Side running, back running.

6. Hopping Runs.

7. Inclined Walking.


10. Spring Board Exercises.

FACTORS INFLUENCING AGILITY

1. Somatotype: Obese tall and lanky people tend to lack agility. People of medium height who are well muscled are found to be more agile. Mesomorphs and meso ectomorphs are more agile. However, there are exceptions also.

2. Age and Sex: Boys are found to be slightly more agile than girls upto the stage of puberty but later boys tend to become more agile than girls. Agility increases upto the age of 12 years.

3. Over Weight: Individuals with over weight are also less agile.

4. Fatigue: Fatigue too hinders agility. A fatigued individual tends to lack movements of agility.
Donald R. Hilsendager, Malcolm H. Strowand Kemeth J. Ackerman studied whether exercise designed specially to develop strength and speed were as effective for improving agility as exercises designed specifically to develop agility. 31 tests were conducted before and after participating in the six week programme and the data was anlaysed by the analysis of covarian technique. The study concluded that agility can best be developed in programme designed specifically for that purpose.

Wendell Liemohn and Dennis R. Knapezyk. conducted a study on the analysis of Cratty’s Locomotor agility test. The study investigated the sub-test items included in Cratty’s Locomotor Agility Test. The research indicated a higher correlation coefficient with more psychomotor cognitive variable.

FLEXIBILITY

Flexibility is expressed by range of motion in a joint or more than one joints and the movement of joints depends upon flexibility. Lack of flexibility results in improper movement. Hence, flexibility is of great importance in games and sports and even in our daily physical activities. In-activity results in loss of flexibility. Flexibility is influenced by three factors:-

1. Bone structure of the points; for example, the joint of elbow and knee. Because of the bone structure the joint cannot extend beyond 180°.

2. The amount of bulk surrounding the joint. For example, elbow joint and biceps muscle. If biceps muscle is bulky, it will restrict the movement of elbow joint.
3. The extensibility of ligaments, tendons, muscles, for example, flexion of hip and back muscle by touching palm on the ground.

TYPE OF FLEXIBILITY

1. Passive: It is demonstrated by the range of movement that occurs in a joint when the muscles relaxed and body parts are moved by another person.

2. Dynamic: It is demonstrated by the range of movement that occurs in a joint as a result of contraction of the muscles which control the joints. This type of flexibility is more important.

HOW TO INCREASE FLEXIBILITY

Devries (1962) found that slow stretching exercises are most effective for immediate improvement in flexibility. In the long range programme of the development of flexibility, two types of exercises have been recommended, (i.e., 1) Ballistic (Bobbing); and ii) Slow tension (Static stretching).

Flexibility can be increased by both the methods but the tension method is more effective. The ballistic method gives soreness to muscles.

The general procedure recommended for improving flexibility is to do the movement slowly until the connective tissues stretches. This position is maintained for 8 to 10 seconds. This process is repeated 5 to 6 times for each exercise. The best results are possible when stretching exercises are done daily. Dynamic stretching is performed than static stretching exercises.
FACTORS INFLUENCING FLEXIBILITY

Following factors influence the flexibility:

1. **Age and Sex**: Boxton, Kirchner, Glines (1957) states that the greatest flexibility is achieved during early elementary school years until 12 years of age. Kirchner and Glines (1957) explained that an elementary school level girls are more flexible than boys and this differences continues through out life.

2. **Temperature**: Wright and Johns (1960) found that warming a body region to 113°F, flexibility increases by 20% while calling to 65°F results in decrease of 10 to 20%. It is also believed that increased body temperature through exercise increase flexibility. Further, it is believed that increased flexibility will reduces chances of injury to the tissues.

3. **Weight Training**: Massey and Chandet (1956) indicated that weight training tends to increase flexibility in the body region.

4. **Body Type**: It is seen that there is more flexibility in the neck, hip, trunk region. Harvey and scott (1967) and Lauback and Mcconvilve (1966) indicated that body fat, as measured by skin fold calipers, shows a negative correlation with flexibility. The amount of muscle tissue is apparently un-related to flexibility unless muscle bulk actually interferes with completion of the movement. There is no relation between flexibility and length of the arms, legs and trunk.

5. **Activity Level**: Complete inactivity, resulting loss of flexibility.
Inactivity may also cause accumulation of body fat which also restrict flexibility, whereas regular activity tends to maintain normal flexibility.

Margaret L-Harris investigated the structure of certain measures of flexibility measures, single joint action and composite, were used. Fifty three variables 38 joint action, 13 composite and two anthropometric measures were administered. The major conclusion is that there is no evidence that flexibility exists as a single general characteristics of the human body. Thus, no one composite test or no one characteristics of an individual can give a satisfactory index of the flexibility characteristics of an individual.
CHAPTER - II A

EXERCISE AND PHYSICAL FITNESS

It is obvious now that exercise of almost any kind, suitable in degree and duration for the particular individual concerned, can and does play a useful role in the maintenance of both physical and mental health. The few who vigorously oppose exercise are becoming less vocal now. At one time, of course, they were convinced that exercise is not useful for physical fitness rather some of them pleaded that too much involvement in physical activities might harm the heart. But these views are never supported by scientific evidence.

On the other hand, scientists have based their research on scientific evidence and claim numerous benefits of regular exercise.

The benefits of exercise are divide in physiological, psychological and sociological categories.

PHYSIOLOGICAL BENEFITS

Circulatory:

1. There is little doubt that regular and moderate exercise will reduce the resting heart rate. The more vigorous the regular exercise, the greater the heart rate reduction. It means that the heart rests more often and there is evidence that the total work is decreased and that efficiency is increased. Thus, exercise ensure more rest for the heart.

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2. The increased blood pressure associated with exercise ensures a healthier vascular system. The exercise increase the rate of blood circulation per second.

3. Steinhaus cities considerable evidence that the regular exercise can cause cardiac muscle hypertrophy, this should mean a stronger heart. The claim that regular exercise causes increased coronary circulation is probably based on Eckstein classic work which indicate that after blockage or occlusion of one of the main coronary arteries, regular exercise thus promotes the development or opening up of collateral or additional pathways, that bypass the occlusion. There are also evidences that there is an increase in cardiac muscle capillarization due to exercise.

4. Though there are some contradictory studies, but there are evidences in support of the claim that regular exercise does increase red blood cell, hemoglobin and total blood volume. With this change on of the obvious benefits, is the increased oxygen carrying capacity of the blood. There is also a perfect positive correlation between the total hemoglobin and maximum oxygen intake.

5. There are number of studies which indicate that people involved in the more active occupation suffers less ischemic heart disease than those inedentary occupation.

**NEUROMUSCULAR BENEFITS**

1. Electromyographic studies indicates that as one develop highly skilled movement the sequence of motor units also becomes well established.
Practice of a particular movement can and usually result in better neural control. Exercise thus, develop better nervous control of muscle function which resulting better co-ordination.

The training also increase muscle capillarization and fiber hypertrophy that result in increased strength and muscular endurance.

2. The regular exercise involving some exercises of specific general motor ability also improves motor ability. Endurance and strength exercise do not improve motor abilities. It is seen that inactivity leads to indigestion and weaken the digestive systems.

**BASIC GUIDELINES FOR PHYSICAL FITNESS**

The physical conditioning procedure always involves following four factors:

1. Intensity
2. Duration
3. Frequency
4. Density or recovery phase.
5. Type of exercise.

1. **Intensity:**

The term intensity implies that how hard should be the work out. It is agreed that in order to improve in cardiorespiratory and muscular fitness a “vigorous over load” is necessary in all conditioning programme. The
heartrate increases during exercises with energy requirement as indicated by oxygen uptake, hence, heart rate has been used as a simple measure for estimating physiological stress on the body. Karvonen a Finnish researcher in 1957 found that for better cardiorespiratory fitness heart rate during exercise must be raised by approximately 60% of the difference between the resting and maximal heart rate. Recent researches have established an increase in heart rate equal to 75% of the difference between resting and maximal heart rate as a reasonable intensity. Calculations of a training heart rate (target heart rate) is quite simple. Take a difference between the maximal and resting heart rate, multiply it by 0.75 and add the result to resting heart rate. This will be 75% heartrate reserve. The well trained athlete can even work efficiently at an intensity of 85% of heart rate (HR) reserve. Budd Getchell has rprescribed the following formula for calculating target heart rate.

\[ 200 \text{ minus individual age} = \text{maximum heartrate} \]

\[ Mx \text{ H.R.} - \text{Sitting H.Rate} = \text{Hearts reserve} \]

\[ H.R. \text{ Reserve} \times 0.75 + \text{Sitting heart rate} = \text{Target Heart Rate a 75% Heart rate reserve.} \]

An overload ranging from 60% H.R. Reserve to 85% H.R. Reserve has been estimated as reasonable. In general, for young adult a training heart rate is in the range of 150 to 170 beat per minute and for older adult a heart rate of 130 to 140 beats per minute, may be reasonable.
2. **Duration:**

The term duration here means that how long the workout to be done. The duration of exercise is directly related to the intensity of the activity. The more the level of the intensity of exercise the lesser will be the duration of exercise and vice-versa. In general, an exercise session of 30 minutes is sufficient to produce significant fitness changes. In the beginning, it is difficult to perform exercise for 30 minutes, so at start the duration may be 15 to 20 minutes. Normally, recovery period corresponding to the intensity and duration of exercise is also included in the conditioning programme.

3. **Frequency:**

How often the work-out to be done. It has been found that daily work out are not necessary to improve one’s cardiorespiratory fitness. Above average physical fitness can be attained with regular work out generally four times per week. This is based on the assumption that conditioning work-out is at 75% H.R. Reserve intensity for a period of 30 minutes.

A regular frequency of exercise is necessary for adequate level of physical fitness. This fitness programme should be considered as a way of life. Regular and controlled exercise during the week will give you abundant energy.

4. **Density or Recovery phase:**

The activities which are low in intensity and short in duration results in a lower level of fitness improvement. For instance golf, bowling, archery,
softball do little to develop or maintain physical fitness. These activities are for fun. The vigorous continuous and rhythmic activities such as brisk walking, running, cycling, swimming, rowing cross-country are excellent for development of the entire body.

The inactive person should avoid competitive sports requiring sudden burst of energy and quick movement. The older one’s should also avoid these types of activities.

In general, the activities that require short burst of speed and quick movements do little to improve cardiovascular efficiency. Weight training programme have produced meaningful result in the development of muscular endurance. These activities, too, have little effect on cardio-vascular fitness. The reason being that movement is restricted to a specific area of the body and activity is intermittent. However, weight training is very beneficial in developing muscle strength and muscle endurance.

VARYING INTENSITY, DURATION AND FREQUENCY

Training depends upon individual to individual. Age, weight, medical limitation influence the principle of the training in intensity, duration, frequency etc. If the intensity is lesser the duration of exercise shall increase. Like-wise frequency of training is also influenced and recovery will be lesser. Generally, 5 days per week training programme results is greater improvement. However, for beginners four days per week exercise programme is recommended.
Setting up a programme of exercise is a complex task. Age, sex, present level of fitness, facilities, nature of job etc. will influence the programme. The programme is based on the aforesaid principles.

THREE SEGMENT WORKOUT

Physical fitness consists of three essential parts:

1. Warm up

2. Conditioning period

3. Cool down.

1. The Warm up: Proper warming up before each work out is a wise habit. Warming up is a precaution against injuries and muscle soreness. It stimulates the heart and lungs and increase the blood flow. Complete warm up will stretch the muscle and tendons for ensuing activity. It also contributes for mental preparation for the ensuing activity.

Warm up also varies from individual to individual and is influenced by the nature of the activity, weather-conditions, etc.

2. Main Conditioning Work Out: After sufficient warming up, the individual is ready for the main conditioning work out. Recommended conditioning work out are running, swimming, cycling and other continuous activities. Other advance method includes weight training, interval training, circuit training, Factlek etc. The appropriate intensity of exercise should be 75% H.R. Reserve. The training programme is modified as the fitness level increase. The duration of the work out is so that one can feel fully

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recovered within an hour of rest period after the completion period. At the start the duration may be 20 minutes and is gradually increased.

3. **Cool down:** Cool down is a tapering off period after completion of the main work out. It is best accomplished by a continuation of activities at a lowered intensity. In other words, keep moving, walking is most common mean of the cool down process.

   The reason for cooling down is to allow the muscles to assist in pumping the blood from the extremities back to the heart. If the activities are stopped abruptly your heart will continue sending extra blood to the muscles for a few minutes. Since the muscles are not contracting and helping to propel the blood back to central circulation, blood may pool in muscle. Hence, it is recommended to keep on moving before you go for shower. Generally, 5 minutes recovery period is sufficient under normal conditions. The heart rate at the end of cool down be less than 100 beats per minute.

   The following suggestions will be useful in deriving the maximum enjoyment and benefit from exercise.

1. A programme of exercise should be started at an early age and be continued through out life with adjustment from time to time as life advances and needs, interests and capabilities changes.

2. Exercises from 30 minutes to an hour is prescribed for an individual.

3. Individual interest be kept in mind while prescribing exercises.
4. Hard, fast, sustained or highly competitive games and sports should not be played by persons of any age unless these persons have attained an appropriate state of fitness through systematic training.

5. A periodical medical examination is essential aspect from fitness and exercises.

6. Person with weaker fitness should not follow the exercise programme of those who are fit and doing regular exercises.

7. Age is an important consideration for an exercise programme.

8. Careful preparation and maintenance of playing field and other arenas of sports are essential to reduce the chances of injury and individual will enjoy the exercises on a better maintained ground.

YOGA AND FITNESS

Fitness through yoga is not a new aspect of the study. In Indian culture yoga has been recognised as a single device for achieving physical fitness and spiritual values. Yoga is prescriptive style of life for self actulization. Maslow stated self actualization is development of all faculties of the man to the highest level of expression in intellectual, social, emotional and physical aspect of living, maximum possible unfolding or inherent potential. Exercising the body in various postural holding, a variety of voluntary controlled breathing practices and certain main pollutions of body functions from predominantly visual aspect of yoga and most often treated as synonymous with yoga in its entirety.
There is a need for research in yoga to establish its beneficial and effective role in human life. Though some research has been done but these are not enough to solve the controversy of the subject. Allan J. Ryan (2) remarked that yoga can be effective means of improving flexibility, but it hardly makes any contribution for improving muscular strength and cardiovascular endurance but his statement cannot be taken for guarantee. For example, Bhujanga Asana promote spine flexibility but this is not possible without strengthening the lower back muscle in holding this position.

A survey done by Robin Monro reveals that half a million people, i.e., about 1% of the population in U.K. are actively interested in Yoga. Over 90% of them believed Yoga to have increased their energy level and working capacity and over 50% believed Yoga to have lowered their consumption of medicine and their susceptibility to cold and flu. A physical fitness survey in U.S.A. reveals that yogic exercises were least popular yet 12.8% resorted to these. Dr. V.S.S.M. Rao remarked that yoga has potential to develop, physical fitness as a whole. He hold that all the 8 steps of Patangali Yoga namely: Yama, Niyama, Asana, Pranayama, Prathayhara, Dharna, Dhyana and Smadhi have application in the promotion of health. Dr. Rao hold that physical fitness is essential stress management and through yoga these can be managed with ease.

Gharote. S. has described how yoga could be gain fully employed in the promotion of physical fitness. Bandopadhya evaluated the effect of Halasana in comparison with abdominal curles. Halsana is found to be effective in reducing abdominal girth and subcutaneous fat and developing
abdominal strength as the popular physical fitness exercise known as abdominal curl.

Ganguly and Gharote claim that yoga training for 8 months improves significantly the scores made in Harvard Step test.

**PSYCHOLOGICAL ASPECT OF FITNESS**

In the modern concept physical fitness means fitness of both body and mind. Physical fitness is, thus, one aspect of the total fitness. The new concept of fitness includes the mental aspect. Mental fitness reflect emotional stability and mental efficiency. This is also termed as psychological aspect of fitness.

**PSYCHOLOGICAL BENEFIT OF EXERCISES**

Being fit gives an overall feeling of well being. It boost self image and help developing a positive approach. Engaging in activity of sports and exercise provides an excellent relief and relaxation for mind. Studies indicate that people who do physical exercises regularly feel less tired, are more disciplined and more relaxed, more productive at work, more satisfied with their look and self confident. Dr. Ronald, Lawrence founder and former president of American Medical Joggers Association indicated that running improves total human well being, one sleep better, but need less sleep, sex life is picked up, one can better cope with stress and improves work productivity. Dr. Lawrence hold whether the benefits are physical or mental, vigorous activity strengthens the whole quality of life.
Dr. George Sheehan, Cardiologist, runner and author of several books on running asserts that it is a psychological rather than the physiology of fitness that is important. According to Sheehan "play provides physical grace, psychological ease and personal integrity. One who plays is fulfilling himself and becoming a complete person". He believes that exercise must be play or it will do little good". People who do physical exercise regularly feel more alive. Dr. Thaddens Kostrubala, a San Diego psychiatrist, has had observed remarkable results treating his patient by having them run. This form of therapy found mental effect on them. Depression was eased, medication abandoned, smoking and drinking reduced or eliminated and overall well being improved. Dr. Kostrubala suggests that vigorous activity such as running causes some body chemistry reaction that helps to restore emotional stability.

Recently a study was reported in New England Medical Journal. The study is based on the research conducted at Massachusstts General Hospital in Boston. A small group of women who spent two months bicycling and jogging experienced dramatic increased in the betaendorphine in their blood. Endorphin is an opium like substance produced by the brain and pituitary gland that helps the body resist pain.

The sports, dance and swimming exercises are used extensively in rehabilitation of psychiatric patient. Dr. E.M. Layman remarked, "individually prescribed physical exercise as an adjunctive therapy may result in behavioural improvement in psychiatric patient who do not respond well to other therapy and exercise help some patients to profit more from other therapy."
Regular exercise causes a general feeling of well being. The circlo-
respiratory fitness and efficiency of daily living is closely related to improved
work capacity and this feeling of well being in the human being as his
desire is fulfilled.

DISCHARGE FATIGUE

Physical exercise can divert the mind into fresh channel and provide
emotional outlet for cares and worries that may be associated with daily
life, thus, discharge tension and promote relaxation to a great extent.

EXERCISE DEVELOP PERSONALITY

It is claimed that physical activities develop personality. There are
wonderful opportunity in competition and physical education for positive
personality growth but the benefits actually derived are more dependent
upon the individual's response than upon the activities.

Exercise improves resistance to emotional stress through
competition. Sports activities improve leadership qualities, emotional balance,
courage, confidence, will power, determination, etc.

EMOTIONS AND PHYSICAL FITNESS

Wells (1958) and Breen (1959) found physical fitness to be negatively
related to characteristic such as anxiety, tension, emotionality. Scheelz
(1961) found significant superiority in the self concept in high school girls
of high physical fitness as compared with girls of low fitness. Cureton
(1963) found that a programme of physical fitness helped adult men to
make more friends and resulted in disappearance of tension as well as appearance of greater mental physical energy.

McFarland and Huddleston (1936) found mental patient to have lower fitness than normal or athletes. Rossenbery and Rice (1964) reported Schezopbermic patient to be lower in fitness than neurotic or non-patient group. Johndon (1966) also found positive relation between fitness and mental health.

MOTIVATION AND PHYSICAL FITNESS

The motivates behind the physical fitness can be enumerated as below:-

1. The individual wants to appear youthful and attractive.

2. Being afraid of diseases.

3. There is a desire to be more vigorous and vital.

4. Because of profitness.

5. The need for relaxation.

6. To express their competitive urge.

PERSONALITY AND PHYSICAL FITNESS

Aliport (1961) defined personality as the dynamic organisation within the individuals of those psychophysical systems that determine his unique adjustment to his environment. "This definition put emphasis on physical and psychological characteristics in an individual. For a total development
of an individual personality, it is essential that he should be physically fitter, mentally alert, emotionally matured and socially adjusted. Personality in other words is total fitness and physical fitness is a base for developing a comprehensive personality.

PHYSICAL FITNESS AND INTELLIGENCE

The human physiological and anatomical system is closely related with physical fitness. On the other hand, intelligence level is closely related with physiological and anatomical system. The intellectual process is more effective and more efficient in an individual who is physically fit. On the other hand, a person who fatigues earlier and easily to a certain a degree is handicapped in his attempt to achieve his potential in all aspects of his life. Oxendine (1968) reviewed studies favouring a positive relationship between intelligence and motor performance and also those showing no relationship. The review indicate low positive correlation. No study reported a negative correlation between intelligence and ability to learn skill. Hart Marrial and Clayton shy (1964) obtained a significant but low correlation of 0.496 between the scores on physical fitness index and cumulative grade point of sixty sophomore women at Springfield college. Robert Webres (1963) in his study of 264 freshmen at the University of Iowa reported a correlation of 0.41 between physical fitness scores and grade point average.

Physical fitness also helps in increasing the self concept of a man. The increase in self-confidence self esteem and self-realisation through vigorous physical activities are related with physical fitness. With increased
physical fitness there will be increased zest for living, greater productivity in work and results in the self-fulfilment.

**SOCIO-ECONOMIC ASPECT OF PHYSICAL FITNESS**

Man is, by nature, a social animal. Human behaviour is, thus, influenced by social and psychological factors. Importance of physical fitness cannot be denied, the primitive man’s very survival depends on physical fitness. Individual’s activities vary with occupation, socio-economic status, class affiliation, age and other personal factors. For instance, physical fitness for a business-man, industrial worker, a fisherman, sportsman of different level vary from each other.

With the coming in of the modern technology, the concept of physical fitness has undergone a change. This changing life style has brought new situations. The complex and highly competitive society of today imposes numerous strains on the man. The higher he rises in the social hierarchy, heavier are his needs and responsibilities. Thus, it has become difficult to stay at the top in the society. In the absence of complete physical fitness an individual is likely to fail in the life. Thus physical fitness is quite an important factor from social angle also. Much of the studies in physical fitness have not touched the social aspect. There is a need to socialise the programme of physical fitness in the masses. Since most of the people are not likely to aspire or reach elite levels of physical fitness. Research and efforts should shift attention from elite to general level. It is now more essential as the society is on-going a continuous change. Physical fitness
is not only for the young but is also a must for a middle aged or even the elders.

Socio-economic factors will influence fitness-consciousness and achievement of the individual. Social objectives may vary from higher productivity, military preparedness, national defence etc. The class, affiliation, self image and pursuit of happiness motivates for physical fitness. Researchers have reported that (Yiannakis in U.K.) lower class emphasis sports of strength and toughness and envolves physical contacts while upper class like the sports where brain work is needed.

In the social aspect many individual wish to look smart and beautiful and fitness contributes towards these social aspects. Thus, physical fitness has social dimension beyond physical parameters.

NUTRITION AND FITNESS

Influence on the development of strong and healthy body is greatest during growing years. A primary cause of interruption of the normal growth cycle of children is nutritive deficiency. According to Lusk, nutrition is sum process concerned with growth maintenance and repair of the living body as a whole or of its constituent parts. Nutrition deals with individual cell of body. Nutrition, therefore, is essential within the body that enable the cell to carry on their proper functioning.

Obviously, good nutrition implies that everything is running smoothly. Adequate food is supplied to every individual cell for its proper functioning. Poor nutrition implies that some breakdown is occurring in this normal
sequence of events. The food supply may be limited in amount or lacking in particular constituent required by body cells. When a body part is not receiving the kind of amount of the essential nutrient it needs, it is malnourished malnutrition cause retardation in growth. It has been seen that physical fitness level goes down considerably in the absence of adequate diet. Thus, a balance diet is essential for fitness. As individual differs so the individual enzyme system. Thus, the food and diet may also differ in individual case. But the component of food must be available in adequate quantity in one’s diet.

The total daily calorie requirement for an active man ranges from 3000 to 7000 Calories, depending upon his size, condition and the amount of work he performs. Harder the physical work, more the calories are needed. If an individual eat lesser than the required he will burn his body tissues to make up the deficit and he will feel fatigued and staledness sooner. If one consumes more food than needed he will build up fatty tissues. A good diet, thus, possess following elements:

1. **Carbohydrate**: Carbohydrate are complex organic compounds made up of elements- carbon, hydrogen and oxygen. During the process of digestion, the carbohydrates are converted to glucose prior to their use by the body. Glucose is metabolised in the body as source of energy. Some of the carbohydrate may be converted to fat and the intermediate product of its break down may be aminated to from Amino Acid. Thus, in the process of digestion carbohydrates are converted into glucose. Glucose
is absorbed in the blood and used by the organism mainly as source of energy. If more carbohydrates than the organism are used, the surplus carbohydrates are transformed into fat. This is why that if no physical work is done and more sweets are consumed, it leads to obesity and impedes the work of heart.

Main source of the carbohydrates are grain and cereals products, corn, potatoes, beans, rice, banana, grapes juice, honey, jam, jelly, dry fruits.

2. Fats: Fats are glyceryl ester of fatty acid, but it is generally used as chemical compound insoluble but soluble in fat solvent.

Fat has extremely high energy value: 1 gm fat produces 9.3 calories. Its burning of course, requires more oxygen. The prime value of fat is that it contains fat soluable vitamin A, D, E, and K and the essential fatty acid. Too much fat leads to formation of high cholesterol level. But exclusion of fats from diet is not recommended although it is possible to exist without fat. Fat is found in certain meat, certain fish, nuts, almonds, peanuts, vegetable oils, butter, milk and ghee.

3. Proteins: Protein is needed mainly for building new body tissues. Protein food breaks down to form amino acid and these acid from the body tissues. It is found in meat, fish, milk, cheese, soyabean and pulses.

These are highly complex organic compounds containing carbon,
hydrogen, oxygen, nitrogen. The importance of proteins are in the provision of essential amino acids (phenylalanine, methionine, tryptophan) which is essential for health existence.

Morehouse and Miller (1971) made the following generalization for proportion of food stuff.

FOR LONG DISTANCE EVENTS

a) 700 gm carbohydrate.

b) 100 to 300 gm fat.

c) 100 gm protein.

FOR SPEED AND POWER EVENTS

a) 350 to 411 gm of carbohydrate

b) 100 to 300 gm fats.

c) 200 gm protein.

Best and Taylor (1966) recommended following for athletes:

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<table>
<thead>
<tr>
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<tr>
<td>carbohydrates</td>
<td>300 grams</td>
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<tr>
<td>fat</td>
<td>133 grams</td>
</tr>
<tr>
<td>proteins</td>
<td>70 grams</td>
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The approximate percentage is:

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<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>carbohydrate</td>
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</tr>
<tr>
<td>fats</td>
<td>20%</td>
</tr>
<tr>
<td>proteins</td>
<td>15%</td>
</tr>
</tbody>
</table>

(76)
For Olympics Abrahams (1948) reported that athletes needed
7000 Calories

- carbohydrates: 800 grams
- fats: 270 grams
- proteins: 320 grams

The correct proportion of carbohydrates, fats and proteins has been
a matter of debate for long time. It is, however, known that human organism
prefers to burn carbohydrate for energy during muscular activity, although
it is also capable of utilising fats. The fat is quite a good source of energy
yet it cannot replace carbohydrate as source of energy. The role of protein
as a source of energy is not highly significant as compared with that of fat
and carbohydrate. But the amino acids found in protein are essential for
healthy existence.

After various experiment and trials it has been found that average
daily caloric requirement of an adult man doing light work is 3000 calories.
If the daily requirement is not available the individual will, loose weight and
vice-versa. Thus, weight is a general guide to judge the adequacy of a diet.
A balance diet generally consists of:

- 100 grams proteins: 410 calories
- 100 grams fats: 930 calories
- 400 grams carbohydrates: 1640 calories

4. Water: Water is most important single constituent of the body
accounting for 70% of its weight. It is constantly being lost from the body in
the form of urine, sweat, faces etc. The lost water must be replaced for maintaining normal health.

5. Salt: Sodium chloride or common salt is most important mineral constituent in the body and a daily minimal intake of about 2 grams is necessary. It is needed in case of heavy exercises. The effect of salt loss is the one set of painful muscular cramps which are wide spread throughout the body. In addition to salt, potassium, calcium phosphate and iron and other element required in the diet are cobalt and manganese.

Other vital dietary constituent are the vitamins. They are substance of varied chemical nature and properties which do not contribute to energy liberation in the body but are necessary for its liberation. Vitamins are present in different food stuffs as per details below:-

Vitamin-A is found in milk, egg, liver.
Vitamin-B₁ is found in cereals, pulses, yeast.
Vitamin-B₂ is found in meat, milk, whole meal.
Vitamin-C is found in fresh fruit, fresh green vegetables.
Vitamin-D is found in fish liver oil.
Vitamin-E is found in wheat grain and olive oil.
Vitamin-K is found in bacteria, syntheses and in green vegetables and cereals.