



## Concept of endurance and flexibility in relation to physical fitness

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### Abstract

Exercise and physical activity fall into four basic categories as endurance, strength, balance, and flexibility. The physical fitness has main ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and respond to emergencies. Physical fitness includes a number of components consisting of cardio-respiratory endurance (aerobic power), skeletal muscle endurance, skeletal muscle strength, skeletal muscle power, flexibility, balance, speed of movement, reaction time, and body composition. A health- and performance related component of physical fitness that is the range of motion possible at a joint. Flexibility is specific to each joint and depends on a number of specific variables, including but not limited to the tightness of specific ligaments and tendons. Flexibility exercises enhance the ability of a joint to move through its full range of motion.

**Keywords:** Endurance, Flexibility, Stretchability, Physical fitness

### 1. Introduction

Endurance is directly or indirectly of high importance in all sports. It is however not easy to define endurance. Endurance is the capacity for protracted work and is a measure of the ability to stave off fatigue. Barrow and McGee (1973) <sup>[1]</sup> define Endurance is the result of a physiologic capacity of the individual to sustain movement over a period of time. Nabatnikowa (1976) <sup>[6]</sup> brings this into focus by presenting definitions of endurance given by several experts. Disagreement among experts is much more regarding the definition of different types of endurance e.g. special endurance, speed endurance, strength etc. But there is agreement regarding the following aspects of endurance. Endurance activities have been found to be of high value for maintenance of good organic health, for increasing the general resistance against infection and for cure and treatment of various diseases and metabolic disorders. It relates to doing work for a long time or period, working under fatigue conditions and involves a large number of muscles to enhance work efficiency. The term stamina is sometimes used synonymously and interchangeably with endurance. In military settings, endurance is considered the ability of a force to sustain high levels of combat potential relative to its opponent over the duration of a campaign.

#### 1.1 Types of Endurance

Endurance performances are of different nature in different sports. These can be divided into various groups according to the dominant similarities in endurance ability is required. The formation of groups and thereby classification according to Nature of Activity. This Classification is based on the type of activity for which endurance is needed. From this aspect, endurance is of the following three types.

#### 1.2 Basic Endurance

Basic endurance, as it depends on the aerobic process, forms the basis of all types of endurance. Without a sufficient level

of basic endurance, other types of endurance are difficult to improve. It, however, should not be confused with local muscular endurance, which is the ability to do part body movements against resistance under conditions of fatigue. Local muscular endurance is a special form of strength endurance.

#### (A) General Endurance

#### (B) Specific Endurance

#### (C) Short Time Endurance

This endurance ability is needed for cyclic activities lasting from about 45 seconds to two minutes. The 80m run in track and field is a typical example of short time endurance activity. In short time endurance activities the energy is produced by a combination of glycolysis and oxidation. The contribution of alactacid mechanism is insignificant. The contribution of glycolytic process to energy production is significantly more than that of oxidation. As a result short time endurance activities result in high amount of lactic acid concentrations in the muscles and blood. Because of comparatively longer duration of activity the lactate values can exceed those found in speed endurance activities. Short time endurance depends to a significant extent on speed endurance and strength endurance (Basset and Howley, 2000) <sup>[2]</sup>.

#### 1.3 Medium Time Endurance

This ability is required for cyclic activities lasting from 2-11 minutes. Typical examples of cycle activities requiring medium time endurance are 1500m and 3000m in track and field and 100m in rowing. The energy production for activities of this duration is achieved by a combination of glycolysis and oxidation. The activities of this duration is achieved by a combination of glycolysis and oxidation. The activities lasting for about 3 min. 40 sec. are the activities in which contribution of glycolysis and oxidation is nearly equal. But for longer duration activities the contribution of

glycolysis steadily decreases. The contribution of alactacid metabolism is practically nil. For oxidation the source of energy is muscle glycogen which due to limited duration of activity cannot be depleted to significant extent and as a result is not a limiting factor for performance. Due to involvement of glycolysis in medium time endurance activities, lasting up to eleven minutes, high concentrations of lactic acid are produced.

#### 1.4 Long Time Endurance

The long time endurance is needed for cyclic activities lasting more than eleven minutes. The energy production is achieved mainly from oxidation of glycogen. For activities lasting up to 30 minutes significant amount of energy production is achieved through glycolysis. But for longer duration activities the contribution of glycolysis is very less for marathon run nearly the total amount of energy required by oxidation. There is, however, one significant change in energy production. For (fat metabolism) increase in the duration of activity. Depending on the nature of energy production as a result of duration of activity long time endurance can be divided into three types as given below in tabular form.

#### 1.5 Speed endurance

It is the ability to do sports movements with high speed under conditions of fatigue. Speed endurance is a combination of speed and abilities. It is of a different nature in cyclic and non-cyclic sports. In cyclic sports the speed endurance is required to continue movement with high speed in spite of rapid accumulation of fatigue during the activity. In non-cyclic sports the speed endurance is required to do movement again with maximum possible speed under considerably of fatigue e.g., repeated sprints in football speed endurance depends considerably on anaerobic capacity technique and psychic factors (Tanaka and Seals, 2008) <sup>[8]</sup>. It is the performance prerequisite to do motor actions under given conditions (movement tasks, external factors, individual prerequisite) in minimum of time. It is the ability to react effectively and quickly to a signal in sports, signals can be of different type e.g., visual, tactile, and acoustic. Depending on the degree of into simple and complex reaction ability.

#### 1.6 Movement Speed

It is the ability to do a single movement in minimum of time. Movement speed is of high relevance in acyclic sports. In cyclic sports it is important in the initial phase (e.g., start movement) or in some phase during the total period of cyclic activity e.g., turns in swimming and hurdle clearance in hurdle event (Holloszy and Coyle, 1984) <sup>[3]</sup>. In acyclic sports movement speed is very closely bound with technique and tactical action. Depending on the nature of the movement the ability of movement speed depends heavily on explosive and strength technique

#### 1.7 Acceleration ability

It is the ability to achieve high speed of locomotion from a stationary position or from a slow moving position. Acceleration ability depends to a great extent on explosive strength, technique and movement frequency. Performances in sprint events are determined to a great extent by acceleration ability. Acceleration ability is also of crucial

importance in all team games and racket sports where high running speeds are to be achieved over short distances.

#### 1.8 Locomotor ability

It is the ability to maintain maximum speed of locomotion for maximum possible duration or distance. Locomotor ability is important in only a few sports or event e.g., 100m and 200m in track and field, short sprints in track cycling and speed skating. In swimming, rowing etc., locomotor ability is not of much importance because all event last for more than 40sec. On the other hand in these sports speed endurance is of high importance. Locomotor ability depends to a great extent on mobility of the nervous system that allows for high movement frequency. It further depends on technique, ability to relax and explosive strength. The trainability of locomotor ability is very low.

#### 1.9 Flexibility

Flexibility is a motor ability, which is not clearly a conditional, or a co-ordinative ability. It depends partly on energy liberation processes and partly on the coordinative processes of the CNS (Meinel and Schnabel, 1987) <sup>[4]</sup>. In common, usage flexibility is often equated with stretch ability, elasticity, suppleness, mobility etc. But as a scientific term flexibility means much more than what is conveyed by any of these terms. Flexibility can be defined as the ability to execute movements with greater amplitude or range.

Stretchability and elasticity are the special qualities of the muscles and ligaments by which these can be stretched and can regain their normal length without any adverse effect on the concerned tissue. Suppleness denotes the ability of a muscle to remain in a state of low tension there by allowing for smooth and easy movements of the limbs. Mobility pertains to the degree of movement possible in different planes at a joint. Stretchability, elasticity, mobility and suppleness, therefore, are a part and parcel of flexibility as these represent different capacities, which enable the person to execute movements with greater amplitude.

#### 1.10 Types of Flexibility

##### (a) Passive Flexibility

The ability to do movements with greater amplitude with external help is called passive flexibility e.g., stretching exercise with the help of a partner (Vuori, 1998) <sup>[9]</sup>. The passive flexibility is always more than active flexibility and is largely determined by the joint structure and stretchability of the muscles and ligaments. Passive flexibility is the basis of active flexibility.

##### (b) Active Flexibility

The ability to do movement with greater amplitude without external help is called active flexibility e.g., stretching a joint by a sportsman himself without any external help. Active flexibility is always less than the passive flexibility and a large difference between the two indicates lack of muscle strength or co-ordination or both. Active flexibility is also of two types, static and dynamic. Static flexibility is required for movements done while the sportsman is standing, sitting or lying. Dynamic flexibility is required for executing movements with greater amplitude when the sportsman is moving. The dynamic flexibility is always less than static

flexibility and is heavily dependent on the motor coordination.

### 1.11 Factors determining Flexibility

The amplitude with which a movement can be done depends on several factors, which are anatomical, physical and coordinative in nature. In addition, there are several factors, which can influence flexibility to a considerable extent. The factors determining flexibility are –

#### 1) Anatomical structure of the joint.

A joint consists of two or more bone ends joined together by ligaments. The bone ends are in physical contact with each other. The manner in which the non-ends are joined basically decides the type and extent of movements possible at the joint. Ball and socket type joints e.g., shoulder and hip allow for greater mobility at these joints. On the other hand, in a hinge joint e.g., knee and elbow only flexion and extension is possible. The anatomical structure of a joint is genetically determined and there are very less individual differences. It is practically untrainable during adulthood. But perhaps during childhood the anatomical structure of a joint can be affected by long-term training to some extent.

#### 2) Ligaments of the joint

In a joint the bone ends are jointed together by ligaments, which are thick bands of connective tissue. They allow the movement to take place at a joint while keeping the bone ends together. The length and arrangement of ligaments as well their elasticity primarily determine in which direction the movement can take place and to what extent. The ligaments, being connective tissues, cannot be stretched like muscles but these have some degree of elasticity. By long term training the thickness, strength and elasticity of the ligaments can be increased to some extent. But the length of the ligaments cannot be changed by training.

### 1.12 Benefits of Flexibility

Several benefits can be gained from flexibility development: Enhanced ability to move freely and easily and to perform activities such as bending down to tie your shoes, scratching your back, and turning to look back as you are driving. Decreased aches and pains. Tight, inflexible muscles pull unevenly across joints, causing skeletal misalignment, poor posture, unnecessary fatigue, and muscle and joint pain. Stretching can alleviate these problems (Mikkelsen *et al.* 2006) [5].

### 1.13 Possible decreased risk of injury

When tight muscles restrict the natural range of motion of a joint, the slightest unusual twist can cause a strain or pull, such as a strained hamstring. Inflexibility also is a precipitating factor in overuse injuries such as tendinitis, because inelastic muscles transfer excessive stress to even less pliable connective tissue. Some research indicates that the importance of stretching in injury prevention may vary depending on the type of activity to follow. It may be more important in activities involving vigorous jumping and bouncing (like soccer or basketball) in which the muscle-tendon unit undergoes high-intensity stretch-shortening cycles. It may be less important in activities with limited demands for stretch-shortening cycles (e.g., jogging,

walking). While the effects of stretching in injury prevention are controversial and research has generally not shown that stretching before exercise decreases risk of injury, a long-term flexibility program designed to alleviate muscle tightness and imbalance can offer benefits. Excessively tight areas, identified by flexibility assessment, can be corrected and adequate flexibility restored for sports and daily activities (Mikkelsen *et al.* 1996) [7]. Many rehabilitation professionals would agree that injury resistance is best enhanced by including in your weekly workouts exercises designed to enhance both flexibility and strength as part of a balanced muscular fitness program.

### 1.14 Recovery from injury

Athletic trainers and physical therapists commonly utilize stretching in injury rehabilitation programs. Research has shown that gentle stretching in a pain-free range of motion is important in shortening the rehabilitation period after injury. This enables a person to more quickly regain normal range of motion and return to activity.

### 1.15 Enhanced athletic performance

In racquetball, golf, tennis, volleyball, and swimming, greater range of motion and ability to apply force through that range of motion can confer a winning edge. However, research indicates that stretching routines preceding strength-dependent activities appear to decrease subsequent performance. Therefore, it may be best to minimize stretching prior to competitive events and to delay stretching for flexibility until after strength-building exercise sessions.

### 1.16 Reversal of age-related flexibility declines

We tend to lose flexibility as we age, partly due to age-related changes in connective tissue and muscle, partly due to decreasing levels of activity. A regular stretching program can improve flexibility at any age.

### 1.17 Improved posture, appearance

We look and feel better when we carry ourselves tall with shoulders back, chest high, and back straight. Unfortunately, over time, we may tend to “sag into gravity” and develop a “hunched over” appearance with rounded shoulders, forward head, and sagging abdominals. Muscle tightness across the chest, hamstrings, and lower back coupled with weakness of opposing muscles can contribute to and perpetuate poor postural habits. Over time, poor posture tends to worsen and becomes harder to self-correct as muscle imbalances increase. Stretching to correct shortened muscles, along with strengthening the weak opposing muscles.

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