Malnutrition is no stranger in any part of the globe and it is one of the greatest health problems in the world today. Malnutrition is defined as "a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients" and thus comprises of undernutrition (or protein-energy malnutrition; PEM), overnutrition, imbalance of nutrients and specific deficiency of nutrients (Park and Park, 1989). Undernutrition is the most widespread form of malnutrition and according to current estimates undernutrition in its varying forms has affected about one-fourth of the world population. The basic etiological factor of undernutrition is inadequate diet probably both in quantity and quality. It can occur as a primary event in previously healthy individuals as in famine, or it may occur as a secondary result of injury or disease. In recent years, fasting in obese patients has become a corrective manipulation. The most affected victims of undernutrition are usually women and children who have no say or voice in the matter. As a result, undernutrition is the leading cause of mortality and morbidity under five years of age throughout the world and it is estimated that over 150 million children are suffering from undernutrition (UNICEF Policy Review, 1991).
EFFECTS OF UNDERNUTRITION ON BODY SYSTEMS

General appearance and body weight:

'Haggard faced lean body' is the classical description of chronically undernourished people. The loss in body weight is progressive and generally is greatest at the beginning of undernutrition. Among the various organs, pancreas, spleen, liver, kidney, genitals, gastrointestinal tract and muscles show greater loss of weight.

Body composition:

The disproportionate loss of fat, increase in extracellular fluid volume, lesser loss of lean body mass and probably little or no reduction in bone mineral are the important changes in the overall body composition. There is relative preservation of body proteins and Golden et al (1977) have shown that the whole body protein breakdown is reduced to the extent of forty percent in severely undernourished children.

Digestive system:

As the gut is one of the most active organs metabolically it loses its mass substantially during undernutrition (Firmansyah et al, 1989). Gastric emptying and intestinal transit time are prolonged. In undernutrition, there is insufficient production of digestive enzymes, flattening of the villi and a reduction in absorptive surface area leading to impaired intestinal absorption of nutrients (Firmansyah et al, 1989). In addition, altered
mucosal functions and enzyme activity of small intestine have also been reported (Levenson and Seifter, 1983). Acinar atrophy, fibrosis of pancreas and decrease in liver fat and liver protein are seen in severely undernourished individuals.

**Endocrine system:**

Food deprivation causes major changes in almost all hormones. In prolonged undernutrition the islet cell volume is diminished resulting in decreased insulin level. Plasma glucagon level in the early stage of undernutrition is increased and during prolonged undernutrition it is decreased to pre-fast levels (Levenson and Seifter, 1983). Severe reduction in food intake causes decrease in the secretion of growth hormone (GH), thyroid stimulating hormone (TSH), follicle stimulating hormone (FSH), luteinizing hormone (LH) and prolactin (Campbell et al, 1977). The reduction in the secretion of GH is usually preceded by a rise in the early days of starvation (Owen et al, 1969). In undernourished individuals free T4 level is increased, and T3 level is decreased (Chopra and Smith, 1975). As relevant to the muscle physiology, it has been suggested that the decrease in T3 during undernutrition spares muscle proteins.

In protein-calorie malnutrition cortisol level is increased (Smith et al, 1975) and the plasma norepinephrine level is decreased. Regarding the responses of sex hormones to undernutrition there is paucity of studies in humans. In experimental
animals, decreased levels of serum prolactin are observed in fasting (McAtee and Trenkle, 1971). In semistarvation, the levels of LH and testosterone are decreased in female and male rats respectively.

Cardiovascular and Respiratory Systems:

In undernourished patients, diaphragm muscle mass is reduced by about 43% (Arora and Rochester, 1982a), maximum inspiratory and expiratory mouth pressures were reduced by 63% and maximum voluntary ventilation (MVV) was decreased by 59% (Arora and Rochester, 1982b). In animal studies, undernutrition has resulted in a decrease in cross sectional area of both slow and fast muscle fibres and twitch and tetanic tensions of diaphragm (Lewis et al, 1986). In cardiovascular system, decreased heart size, myofibrillar destruction, cardiac atrophy, bradycardia, ventricular dysfunction, decreased cardiac output, hypotension and diminished exercise capacity are the usual observations in undernutrition (Schocken et al, 1989; Levenson and Seifter, 1983).

Excretory system:

The kidney shows normal function for a long time in undernutrition despite their high metabolic requirement, possibly by the very high blood supply. The effective renal plasma flow did not show any significant change during 38 days fasting in
human subjects (Owen et al, 1969). Due to the decreased amounts of urea in the renal medulla the concentrating ability of the kidney is decreased leading to polyurea in undernutrition.

Changes in the nervous system:
Effects of undernutrition depends upon its severity, duration and time of occurrence in life. For instance, during growth spurt when the nervous system is rapidly developing, brain, spinal cord and the peripheral nerves are highly susceptible to nutritional deficit. Human brain is vulnerable in the period of brain growth spurt, which is from the 14th week of gestation to 3-4 years of age and the peripheral nerves are vulnerable from 14th week of gestation to several years.

Effects on brain:
Pereira et al (1979) have observed that the head circumference is less in undernourished individuals. Cerebellum is more affected than the rest of the brain (Dobbing and Smart, 1974) where chromatolysis, altered proportion between neurons and glial cells, disturbed arrangement of Purkinje cells and reduced amount of DNA are observed in undernutrition. Early postnatal undernutrition produced brain hypomyelination. A spectrum of metabolic derangements have also been reported in undernutrition. Dobbing and Smart (1974) and others have reported altered activity of various enzymes like glutamate
dehydrogenase, acetylcholinesterase and glutamic acid decarboxylase in undernourished brain. The brain content of acetylcholine has been reported to be increased in undernourished rats (Venkataraman et al., 1984). Poor neurointegrative functions and deficit in mental development have also been reported in undernourished individuals (Galler et al., 1985; Grantham-McGregor et al., 1980; Tizard, 1974).

Effects on the peripheral nerves:

Chopra et al (1986), Chopra and Dhand (1988) and others have observed axonal degeneration in distal parts of long axon, segmental demyelination, myelin disintegration, infolding of myelin sheath, shrinkage of axon, reduction in the diameter of the myelinated nerve fibres and shorter internodes, in the undernourished individuals. Biochemical studies have revealed that the contents of total lipids, phospholipids and cholesterol in the nerves, are reduced due to undernutrition. Functionally, reduction in conduction velocities, increase in terminal latencies of motor nerves have been reported (Veera Raghava Reddy, 1985).

Effects on skeletal muscle:

In undernourished children and experimental animals various studies have shown that there are fibrillation potentials and decreased muscle fibre diameter (Copinath et al, 1983). Enzyme studies have revealed that the activity of glycolytic enzymes
are increased and the enzymes of aerobic metabolism are reduced. Skeletal muscles in undernutrition seem to be directly affected by energy deficiency. But some changes like fibrillation, muscle fibre atrophy and delayed differentiation may also be secondary to peripheral nerve lesions. In parallel to these structural and biochemical changes, alterations in the contractile functions have been described. Reduction in muscle force, altered endurance time and relaxation rate are the main manifestations of undernutrition (Brough et al, 1986; Lopes et al, 1982; Russell et al, 1984). Clinically, muscle wasting, hypotonia and altered deep reflexes have been reported due to undernutrition (Chopra et al, 1986).

Interestingly, undernutrition to the extent of semistarvation during most of one's life span is shown to increase the longevity and to retard age associated changes in most physiological processes and age associated disease processes (Harper, 1982; Masoro, 1992; Ross, 1961). The subsequent studies have shown the associated structural alterations in the skeletal muscles (Boreham et al, 1988). On the contrary, no detailed study is available, to describe the resulting changes in the contractile functions of skeletal muscles by semistarvation, of long duration from the weaning period through the growth period to the early adulthood.
Besides, no detailed study is available to describe the changes due to prolonged semistarvation in the contractile functions of smooth muscles, particularly of gastrointestinal (GI) system, a system the malfunction of which may result in further malnutrition.

It is commonly seen that in society, those who suffer from undernutrition usually have to do severe manual labour. Most of the earlier experimental works have not combined forced physical activity with undernutrition and experimental animals with undernutrition are known to reduce their physical activity as an adaptive process. Thus, no detailed study is available to describe the combined effects of undernutrition and forced physical activity on contractile functions of skeletal and smooth muscles.