CHAPTER-1
INTRODUCTION AND REVIEW OF LITERATURE

1.1 Introduction

Characteristically, the life of any individual is regulated by the developmental changes occurring in the body at the cellular level. Once growth and development begins during infancy, it continues throughout the other stages of life that follow, namely childhood, adolescence and adulthood. These progressive changes ultimately lead to the process of Ageing. The universally accepted ultimate notion of growth and development is the concept of Ageing, i.e., the process of physical, emotional, psychological and social change associated with passage of time. In a broader sense, it is the continuous and irreversible decline in the efficiency of various physiological processes once the reproductive phase of life is over (Balcombe & Sinclair, 2001). Thus, the hallmark of aging is the loss of physiological adaptability with the fleeting time.

Websters (1983) defined ‘Ageing’ as becoming old with showing the effects or characteristics of increasing age. Ageing is a naturally occurring post-developmental process which is progressive, involves impaired functioning inferring to loss of adaptive response to stress and growing risk of age-related disease (Johnson et al. 1995; Kirkwood, 1995). Therefore, ageing communally encompasses the progressive changes that augment risk of infirmity, disease and death. It thus directs towards the rapidly growing critical issue of socio-economical and biomedical concern to be investigated further with precision.

Finch (1990) defined ageing as ‘the age related changes in an organism that adversely affect its vitality and function, but most importantly, increase the mortality rate as a function of time (such that) senility represents the end stage of senescence, when mortality risk is approaching 100%’. Masoro (1995) proposed ageing as ‘deteriorative changes with time during post maturational life that underlie an increasing vulnerability to challenge, thereby decreasing the ability of organism to survive’.
However, Strehler (1982) suggested fundamental age-related changes must meet the four necessary conditions that follow: (i) must be deleterious i.e. must reduce function, (ii) must be progressive i.e. must take place gradually, (iii) must be intrinsic i.e. must not be the result of a modifiable environmental agent, (iv) must be universal i.e. all members of a species should show such gradual deficit with advancing age. Although these changes are subjective in nature and may vary among individuals, they usually trigger at different times in different individuals. The rate at which these changes occur and how they impact an individual depends on a number of factors like genes, environment, health status, stress, physical activity, and diet. Due to this, no two people age in exactly the same way or at the same rate.

The science which involves dealing with this process of ageing and all aspects -biological, sociological and historical- of the problems of the aged is called GERONTOLOGY. The goal of gerontologist is to extend the productive years of one’s life at the expense of the unproductive years of life and to enable one to age graciously with a minimum of mental and physical disabilities (Makinodan, 1977).

Yet another term colloquially and scientifically interchanged with ageing is SENESCENCE, i.e., the process of becoming old; the phase from maturity to death characterized by the accumulation of metabolic products and decreased probability of reproduction and survival (Websters, 1977; Rose, 1991). It is a stage of disabilities due to the defects in the processes of growth and of replacement of damaged cells. The number of cells decreases with advancing age, leaving fewer functional cells in the body due to slower rate at which cells multiply and replace lost cells, hence affecting the process of apoptosis that normally leads to a programmed cell death. It is the time dependent accumulation of damage at the molecular level that begins at fertilization and is eventually expressed as non-specific vulnerability, impaired function, disease and ultimately death. Its rate is influenced by a combination of stochastic events, genetic makeup, cell type, personal behaviour and environment.

Senescence refers to the biological process by which organisms become less capable of maintaining homeostasis with increasing time, in other words, it is a progressive degeneration following a period of development and attainment of
maximum reproductive potential that leads to an increased probability of mortality, a process usually shown by living organisms (Harper & Crews, 2000). It leads to a formulation of another branch of medicinal science that deals with the problems and diseases of old age and aging individuals known as GERIATRICS. It usually aims to study the diseases associated with aging population and undertake the medical care of the older person.

Although etiology of ageing is important to understand, but it is equally important to differentiate the normal physiological changes from those associated with disease (Lata & Walia, 2007). A significant amount of normal biological variability in adulthood, including risk of several diseases, has its origin in the span encompassed by the prenatal period and approximately the first two decades of life (Malina et al. 2004). However, Finch in 1994, highlighted the difference in various physiological processes with increasing age, that not all aspects decline with age, some show stability, whereas others may show age-related enhancement. Thus, before reviewing the changes, it is necessary to understand what constitutes a physiological parameter that shows ‘senescent’ change as opposed to ‘age-related’ changes. Arking (1998) enumerated five characteristics that must be met for an observed age-related change to be regarded as an aspect of senescence. The phenomenon must be cumulative, universal, progressive, intrinsic, and deleterious (CUPID) within the populations. Unfortunately, numerous well documented age-related changes in humans appear to be senescent alterations which are not universal and there seems to be an exception to every condition and trend (Harper & Crews, 2000).

Irrespective of any gender specifications, many somatic changes occur in the elderly over the years. Postural alterations are inferred from loss of muscles (sarcopenia), bone mass, physical instability and frailty; shrinkage in skin layers and loss of subcutaneous fat confound skinfold and other measurements; contractures and loss of cognitive function (Rexhepi et al. 2011). However, the age related changes can be better understood by glazing upon the various physiologic functions that usually decline in function with age advancements (Lata & Walia, 2007):
Introduction and Review of Literature

a) **Cardio-vascular system**- Normal atrophy of heart muscles, loss of elasticity in artery walls, intra-artery deposits lead to decrease cardiac output and impaired blood pressure response to standing, volume depletion and heart blocks (Terman & Brunk, 2005).

b) **Respiratory system**- Reduced elasticity and reduced cilia activity leads to decreased stamina with shortness of breath and fatigue (Levin et al. 2007).

c) **Skin changes**- Loosening of skin and development of wrinkles due to reduced elasticity and loss of fat layers and oil glands. There is also easily marked presence of “age spots” with deposits of melanin pigment. Skin reduces the sensitivity to sensations like heat, cold and injury (Calleja-Agus et al. 2007).

d) **Gastro-intestinal system**- Reduction in the production of hydrochloric acid, digestive enzymes and saliva leads to impaired swallowing and delayed emptying of stomach. In extreme cases the impaired food absorption may lead to malnutrition (Newton, 2005).

e) **Metabolic system**- This system is responsible to convert food into energy and after age of 25, everyone experiences an approximate 1% decrease per year in metabolic rate. Thus, the food is being less well absorbed and less utilized (Vaughan et al. 1991).

f) **Reproductive system**- In women, atrophy of ovarian, vaginal, and uterine tissues occur along with reduced production of vaginal fluids. In men, prostate enlarges and sperm production decreases (Nusbaum et al. 2005).

g) **Sensory system**- The decrease in pupil size reduces the response to light and thus, enhanced amount of illumination is required by the older people. Thickening of eye lens leads to light diffraction, increased glare sensitivity, decreased depth perception and difficulty distinguishing colours (Ganong, 2003; Jaul, 2006). Hearing impairment is a result of decrease in sensitivity to high frequency tones and decreased discrimination of similar pitches (Cook & Hawkins, 2006; Jaul, 2006). The tasting ability also declines after the age of
80 due to reduction in number of taste buds. Few individuals also experience reduced smell sense due to blockage or disease of olfactory receptors of upper sinus (Parker & Chapman, 2004).

h) **Cognitive changes**- Over time, the reduced efficiency of nerve transmission affect response time and coordination. They further affect sleeping pattern by decreasing length of total sleep time and rapid eye movement (REM) sleep (Prinz, 2004). Besides sleep impairment, intelligence, learning and memory retention of elderly is also declined with time.

i) **Immune system**- There is decreased ability to detect foreign molecules and increased frequency of autoimmune responses as a result of decreased capacity to promote full differentiation of lymphocytes (Arking, 1998).

j) **Musculo-skeletal system**- A generalised atrophy of muscles accompanied by a replacement of some muscle tissue by fat deposits results in loss of muscle tone and strength (Dirks et al. 2006). The bones of individuals lose calcium and become less dense leading to postural changes, reduction in height and marked changes in joints. These bone alterations may lead to chronic inflammations in elderly (Goldspink, 2005).

1.1.1. **BODY COMPOSITION**

Ageing is normally a complex gradual process which is associated with a number of changes in the body composition, physique, and morphological features. Body cell mass, skeletal muscle mass, organ mass, and fat free mass all decline with age. This decrease is associated with declining resting energy expenditure and heat production. It is important to note that the process of aging does not usually proceed at a uniform rate throughout the entire body. One system may age quickly, while another remains relatively unaffected. For example, a person may have a significant loss of vision or hearing while the functioning of cardiovascular and respiratory systems are not impaired. It can be well derived from the number of changes occurring in the human body that there are considerable differences that are related with specific gender and might take place in an organised manner in association with certain marked conditions.
approaching senescence. To conclude there is degeneration witnessed among all physiologic functions to varying degrees in almost both the sexes.

The other important component in body composition that changes variably is fat mass. Total body fat mass increases slowly with age during adulthood. In an analysis of Fels data, Siervogel and colleagues (1998) estimated the rate of increase in total body fat to be $0.57$ kg/yr between ages 18 to 45 years and $0.37$ kg/yr between ages 45 to 65 years in men, suggesting deceleration in the rate of increase with age. In women, these rates of increase were $0.44$ kg/yr and $0.52$ kg/yr between ages 18 to 45 years and 45 to 66 years, respectively indicating no deceleration over the same age intervals. All groups reached a maximum of fat mass between 50 to 60 years, during which a little or no change takes place. However the fat mass decreased after the age of 60 years in all groups (Baumgartner, 2005).

Longitudinal data from New Mexico Aging Process Study suggested that total body fat remained stable in elderly men and women over a 3-year period but decreased significantly over long periods of follow-up. Adipose tissue distribution also demonstrated distinct patterns of change with age and marked sexual dimorphism. Heitmann (1991) described changes in waist hip ratio from 35-65 years of age in Danish population sample. The former demonstrated an increase with age in men up to 55 years; while this increase in women was found to take place after 55 years. The main molecular components in fat free mass are water, protein, osseous and non-osseous mineral and glycogen, which are known well to vary systematically with age. Overall body weight also demonstrates a significant change with the age advancements. Most men experience an increase in body weight until their mid- to late-fifties when weight begins to decrease. The rate of weight loss is faster in the sixth and seventh decades of life. In women, body weight usually increases until the late sixties then decreases through rest of life. The rate of decrease typically occurs at a slower rate in women than in men.

Fat mass is believed to increase with increasing age as a result of reduced energy expenditure, whereas body lean mass is believed to decline as a result of reduced mechanical stress due to an increasingly sedentary lifestyle (Aloia et al.
Subcutaneous adipose tissue distribution is conventionally referred as “fat patterning” to distinguish it from the accumulation of internal adipose tissue, particularly visceral adipose tissue (Bouchard & Johnston, 1988). An android fat pattern in adults of either sex is associated with a spectrum of metabolic risk factors for chronic disease, including hypercortisolism, hypercholesterolemia, hypertension and insulin resistance (Seidell et al. 1989) and with behavioural and psychological risk factors such as low physical activity, smoking, alcohol intake and depression and anger (Mueller et al. 2001). Ley et al. (1992) concluded that menopause also affected the fat distribution as observed in more android fat and less gynoid fat in postmenopausal women compared with premenopausal women. Therefore, measuring the fat distribution pattern is as important as measuring the amount of fat.

The most prevalent serious public health problem derived from imbalance in body composition is obesity, a complex nutritional disorder among prosperous communities as a result from incorrect energy balance leading to an increased storage of energy mainly fat. The prevalence of obesity is increasing at a rather alarming rate. Presently, it is estimated that 250 million people world-wide are affected by obesity equivalent to 7% of adult populations. A WHO report presented obesity to be regarded as a serious ailment that threatens global well-being (WHO, 2000). Obesity is defined as an excessively high amount of fat or adipose tissue in relation to lean body mass (Stunkard & Wadden, 1993). The amount of excess fat, its distribution within body and associated health consequences vary considerably between obese individuals (Bhadra et al. 2009).

The etiology of obesity is complex since it is a resultant from multi factors combined together in any given environmental changes. The epidemiological trends associated with obesity infer large role of socio-cultural factors, environmental factors (like nutrition, stress, exercise, etc.), and inherited factors. It is indeed a great threat in society with increased rates of morbidity and mortality. Therefore, there is an increased and immediate need for estimation of prevalence of obesity among different sections of society to combat its raising prevalence.
Introduction and Review of Literature

Conventionally, anthropometric methods met the need of estimating the body fat and distribution of fat in populations, with height and weight used as primary measurements for the same. Later, the use of sophisticated techniques like bio-electric impedance analysis (BIA), magnetic resonance imaging (MRI), dual-energy x-ray absorptiometry (DEXA), isotope dilution, computed tomography (CT), hydrometry, ultrasound, etc. in conjunction with anthropometric techniques improved the estimation of body composition among different compartments or in more precise divisions of fat mass, fat free mass, visceral fat, skeletal mass, and muscle mass. The most often used anthropometric index for determination of generalised obesity is Body mass index (BMI), calculated as weight in kilograms divided by height in metres squared. To assess the contribution of fat mass and fat free mass towards BMI, Fat mass index (FMI) and fat free mass index (FFMI) are being used. The other anthropometric indices include the measures of central obesity particularly that involve the measurements of body circumferences and skinfolds. These indices include waist hip ratio (WHR), waist height ratio (WHI), conicity index (CI), A Body shape index (ABSI) and body adiposity index (BAI). The modification or approved use of new indices in combination with the conventional indices is a result from shifted interest towards the use of body circumferences and various ratios.

An enormous volume of work has subsequently been published on the epidemiology of fat distribution including the age changes over life span in diverse populations (Casey et al. 1994; Molarius et al. 1999; Douchi et al. 2000; Ijuin et al. 2002; Li et al. 2004). However, in lieu of reference data on different population and less consistency observed in different research designs throughout world among body composition investigations, WHO proposed BMI to be most useful and population based measure of obesity (WHO, 1995). The WHO BMI classifications of overweight and obesity are intended for international use and in turn international comparisons. A WHO expert consultation after much debate on recommended BMI cut-off points among Asian populations for determination of overweight and obesity proposed population-specific cut-off due to increased risk of diseases related with increased fat among Asians. The additional trigger points for public health action were identified as 23 kg/m² or higher representing increased risk and 27.5 kg/m² or higher as
representing high risk. The suggested categories are as follows: less than 18.5 kg/m² (underweight); 18.5-23 kg/m² (increasing but acceptable risk); 23-27.5 kg/m² (increased risk); and 27.5 kg/m² or higher, (high risk) (WHO, 2004).

1.1.2. MENOPAUSE

It is well evident by reproductive changes witnessed among men and women; that men usually experience a reduced functional change with age while women come across multiple changes that follow the end of their fertility period. There is an observed hasty advancement in degeneration among women after the attainment of menopause or menstruation cessation. It is regarded as the important landmark in reproductive life of women which brings about an end to the secretion of female sex hormones in them and modifies the internal atmosphere of their body. It is defined by the last menstrual period in a women’s life and is identified retrospectively since a woman is considered to have reached menopause twelve months after her last menstrual period.

Menopause may interact with or accelerate event of normal ageing. Since the consequences of ovarian estradiol decline are widespread due to the fact that normal functioning of many other tissues is dependent on availability of this hormone. It not only governs the components of reproductive system and secondary sex characteristics but also non-reproductive organs such as skin, skeleton, and cardiovascular system by hormone-induced gene activities. It controls the biological markers of ovarian ageing in women that include: (i) progressive decrease in fecundity rates; (ii) menstrual irregularities (including increased number of anovulatory cycles or those with luteal phase defects); (iii) changes in circulating levels of sex steroids, inhibin and pituitary gonadotrophins; (iv) neuroendocrine changes of thermoregulation, sleep, mood and behaviour (Vaidya, 1996).

The period before menopause is usually characterised by progressive shorter menstrual cycles leading to anovulatory and irregular cycles which are often followed by prolonged and heavy bleeding episodes. This transitional phase is termed as perimenopause. The different endocrine changes in reproductive transition (Menarche to
Menopause) of females are denoted by pre-menopause, peri-menopause and post-menopause terms, respectively. There occur few symptoms that are manifested during the different reproductive transitional phases. However, their severity and prevalence may vary among different ethnic populations and within individuals of same population. These symptoms primarily include those related with vasomotor instability, urinary symptoms and psychosomatic changes. Sagdeo & Arora (2011) enlisted symptoms that may vary at individual levels like hot flushes and night sweats, heart discomfort, sleep problems, depression, irritability, anxiety, weight changes, physical and mental exhaustion, joint and muscular discomfort, bladder problems, dryness of vagina & sexual problems among rural and urban menopausal women from Nagpur. There exists great diversity in the symptoms’ nature and frequency across countries, even in same cultures (Indira & Murthy, 1980; Bagga, 2004; Sharma et al. 2007).

Natural menopause also contributes to changes in body composition (Panotopoulos et al. 1996), body fat distribution (Panotopoulos et al. 1996; Tremollieres et al. 1996; Poehlman & Tchernof, 1998), and decreased physical energy expenditure (Poehlman & Tchernof, 1998). The menopausal transition phases witness significant changes in woman’s body weight or body composition in total, which are associated with the endocrine changes controlling the metabolic activities in her body. In women this increase in body composition is believed to be a result from increased contribution of subcutaneous adipose tissue to total body weight with increasing age. Researchers conclude that deposition of internal fat, principally in later ages of maturity leads to fattening of female body, is also an important component in the complex phenomenon of ageing in women. Knowledge concerning changes in body composition has relevance in evaluation of the major components of the body fat and lean body mass as it provides valuable information in a wide range of biomedical contexts particularly related to ageing and illness (Bagga, 2010).

1.1.3. BONE MINERAL DENSITY AND OSTEOPOROSIS

Bone density increases through the growth years, reaching a peak in the late twenties, stably maintained till 30s and deteriorates beyond that. Peak bone mass is the
maximum bone mass accumulated at early adulthood, generally by 20 years of age. Peak bone mass determines the strength of bone in later life. Factors influencing peak bone mass include body size, genetic influence and factors that hinder bone mass accumulation such as low calcium, malnutrition, inability to weight-bear, corticosteroid usage and hypogonadism (Prentice, 2004). The Saskatchewan Pediatric bone mineral accrual study noted that 26-39% of total body bone accretion occurs in the 2 years surrounding peak bone accretion (Bailey et al. 1999; Baxter-Jones et al. 2011; Zemel, 2012). It is widely held belief that bone accretion during childhood is a major determinant of bone health later in life.

An important public health issue related with female ageing in current scenario is the Post-menopausal osteoporosis, i.e., the disease associated with the alteration in bone mineral density (BMD) among elderly females after attainment of menopause or menstrual cessation. The age changes in bone mineral content and further changes in strength of bone leads to development of fragility in skeletal bones and thus, increases the risk of fractures in the elderly. Clinically, postmenopausal women with low body weight, low percentage body fat or low body mass index are at increased risk of low bone mass and rapid bone loss, both of which are independent contributing factors to postmenopausal osteoporosis (Ravn et al., 1999).

Osteoporosis or ‘porous bone’ is defined as disease characterised by low bone mass and a micro-architectural deterioration of bone tissue leading to enhanced bone fragility, and a consequent increase risk of fracture (Christiansen & Riis, 1990). Osteoporosis, defined as a decrease in bone mass with no change in the chemical ratio of mineral to protein matrix (Schlenker, 1984), is not a disease entity separate from aging but is a more extreme version of the normal processes of bone loss. Osteoporosis disease is characterised by abnormalities in the amount and architectural arrangement of bone tissue that lead to impaired skeletal strength and an undue susceptibility to fracture (Melton et al. 1992). The condition has even been called the silent epidemic because postmenopausal bone loss itself causes hardly any symptom and becomes clinically apparent only when a fracture has occurred, by which time the disease has progressed considerably (Bhathena, 1996). The term ‘senile osteoporosis’
describes a true condition of atrophy in which there is quantitative reduction in the bone mass per unit mass of anatomical bone, and between youth and old age this loss may amount to about 15% of the weight of skeleton (Sinclair, 1989). Since the pathologic effects of osteoporosis are associated with loss of strength and subsequently susceptibility to fractures, the more bone mass one has as a young adult, the better off one will be as an aging adult (Arking, 1998).

Osteoporosis or bone fragility is one of the most common conditions among older adults. It may result in diminished height and cause curvature of the spine and the backache as vertebrae are eroded and compressed. It often causes a general reduction in the strength of bones, making them more easily fractured. There is significant morbidity and mortality associated with this disease and its relationship to fracture risk, as 20% of senior citizens who suffer a hip fracture will die within 1 year and others experience a downward spiral in mental and physical health. If osteoporosis has its origins in childhood, then understanding the factors affecting bone accretion in childhood may be the key to early prevention of this common, debilitating condition (Zemel, 2012). Threats to optimal bone mineral acquisition include malabsorption, inflammation, decreased physical activity, malnutrition, hypogonadism, delayed growth and maturation, altered body composition and some medications (Leonard & Zemel, 2002).

Secondary osteoporosis is associated with a number of medical disorders, including gastrointestinal diseases, hematologic disorders and hypogonadal states. Moreover, exposure to certain medications may contribute or exacerbate osteoporosis (NOF, 2010). Although body size inclusive measurements of total body weight, percentage weight change since twenty five years, lean mass, fat mass, body fat percentage, hip girth, and body mass index were associated with hip fracture risk, yet measurement of total body weight by itself was found to be sufficient for ascertaining hip fracture risk and was not improved by other attributes of body size and composition (Ensrud et al., 1997).

It is necessary to have a clear understanding of normal functions of skeletal system with age advancements. There is a continuous formation and resorption of bone tissue
that serves to replace the old matrix, which tends to become brittle, and remodels the
bones to better meet the changing structural requirements in growing adults. Bone
cells (osteoblasts) which are involved in new bone formation are found invariably on
advancing surfaces of growing bones while bone cells (osteoclasts) involved in bone
resorption are found in depressions on bone surfaces or cavities formed as a result of
erosion of bone surrounding cell. Despite dissimilar appearance, both cells represent
different functional states of the same cell type (Arking, 1998). The combined activity
of these two cells maintains the bone content in human body. Factors such as stress,
hormonal functioning and nutrition influence their functioning. Bone may be
subjected to two main stresses: gravity and functional forces derived. When bone is
subjected to heavy loads of prolonged time, body responds by deposition of increased
amount of collagen fibres and inorganic salts in the bone, while in absence of stress
salts may be withdrawn. Hormonal interactions elevate levels of parathormone in
body causing an increase in number and activity of osteoclasts, thus raising the blood
calcium level. On the other hand, calcitonin causes the decrease in bone resorption
activity and lowers blood calcium level, since it favours mineral deposition and
stimulates new bone formation. The balanced skeletal mass is maintained by these
hormonal interactions in normal individuals. A good nutrition in terms of a balanced
diet provides body with variety of essential substances like Vitamin D that assists
calcium across blood stream (Spence, 1989).

The major age related change in the skeletal system is the loss of calcium from bone.
At any given age, bone mass is greater in men than in women since the sex
differences in bone loss are dramatic. A male usually loses 12% of skeletal mass over
a period of 30-year since men generally do not begin to lose calcium from bones until
after the age of 60. However, over an equivalent time period women loses about 25%
of her bone mass, much of it in the years following menopause. As the number of
collagen fibres decreases, the bone matrix gradually comes to contain a greater
proportion of inorganic salts, even though it also loses calcium. The increased
percentage of mineral salts that occurs with aging is thought to be the reason that the
bones of elderly become brittle and fracture easily. When bone is incinerated the
collagen fibres contained in it are destroyed, and left ash is primarily composed of
Introduction and Review of Literature

mineral salts. The decreased ability of bone to withstand stress with increasing age is a result from combination of loss of mineral salts and collagen fibres, increased percentage of mineral salts in remaining bone, and increased porosity of bone due to failure to replace bone that has been resorbed (Spence, 1989).

Hormones and gender are synergistic in particular case of postmenopausal women. Estrogenic hormones tend to protect bone from stimulating effect of parathyroid hormone on osteoclasts. When estrogen levels decline at menopause, increased sensitivity of osteoclasts to parathyroid hormone, increase the process of bone resorption. Estrogens also affect the levels of calcium absorption and excretion. Thus dual effect of estrogens involves indirect suppression of remodelling and improved efficiency in utilization of dietary calcium. Quantitative measurements of the amount of bone resorption in postmenopausal women have shown a net daily loss of 38 mgs of bone mass in them. At this rate, an average female loses 1.5% of her bone per year (Schlenker, 1984). The intrinsic factor like gender and extrinsic factor such as diet and exercise amplify the exaggerations of normal aging process in skeletal system in the form of age related pathologies such as osteoporosis and arthritis. The former affecting the bones while the latter attacking the joints.

Osteoporotic fractures mainly occur at the wrist, spine and hip. The cause of osteoporosis is unknown. One likely factor is a long-term diet deficient in calcium. The level of calcium in the bone depends on balanced availability of calcium, phosphorous, magnesium and vitamin D. Vitamin D is critical for proper dietary calcium absorption from the intestine, while phosphorous and magnesium regulate the amount of calcium absorbed by the bones. However, excessive protein and fluorine can hinder calcium absorption (Kuruganti, 2012). Calcium deficiency may occur in older persons since calcium absorption by the intestines is hindered by an age-related decrease in the level of vitamin D in the blood. If sufficient amount of calcium is not obtained through diet, body attempts to attain adequate levels of calcium by bone resorption resulting in the weakened bone typical of osteoporosis (Spence, 1989). The loss of bone strength with age has been attributed to at least two different processes (Whitbourne, 1985). An increased porosity arising from the continuous bone
Introduction and Review of Literature

Remodelling reduces the structural strength of the bone. The remaining bone also becomes more brittle with age paradoxically via an increased mineralization of the remaining bone tissue. At the same time there may be a decrease in the thickness of the cortex of the long bones and the vertebral bodies, and Haversian canals often increase in diameter and become filled with fibrous or adipose tissue (Sinclair, 1989). As a result, the bone of an elderly person, when subjected to pressure, is more likely to snap and cause clean fractures which are less likely to get healed. A decrease in bone mass is a deleterious age-related change initially brought about by changes in certain intrinsic factors and strongly modulated by certain extrinsic factors, all of which interact in a complex cascade to reach the end point of this pathogenic pathway, namely osteoporosis. Here, the decreased bone mass is a precondition of the end point of osteoporosis (Arking, 1998).

There are several well established risk factors for osteoporosis but with no adequate sensitivity and specificity to enable identification of women at risk (Bhathena, 1996, Kuruganti, 2012). The risk factors for osteoporosis are numerous, many are intercorrelated and the relevance of risk factors differs between individuals. These include the race (Cacasians, Asians); sex (female); age (above 50 years); heredity (family history); build (underweight); nourishment (undernourished); diet (low calcium diet in growing years); vitamin deficiency (Vitamin D specific deficiency); fracture history (previous fragile fractures, family history of fractures); poor visual acuity; low bone mineral density; bone turnover (high); parity (Nulliparity); estrogen status (secondary amenorrhoea); menopause (premature menopause, early oophorectomy); neuromuscular disorder; physical activity (disease leading to prolonged immobilization); drugs (corticosteroid therapy, exuberant thyroid replacement therapy); lifestyle (sedentary lifestyle, excessive smoking, high intake of alcohol); associated disease (Rheumatoid arthritis) (Kanis, 2002; Melton and Riggs, 2003).

1.1.4. Diagnosis of Osteoporosis:

Osteoporosis is often asymptomatic until a bone fractures, then an X-ray and bone density measurement confirms the diagnosis. When the bones begin to lose their density, and become-more-than-normal porous, they are more easily compressed-
making them more likely to crack (Hip fracture) or collapse (spinal fracture). The loss of BMD occurs on a scale such that the first-level of BMD loss is known as osteopenia or a low BMD, which if undetected or untreated, proceeds to osteoporosis. Clinically, calculations of bone mineral density or content are frequently used to aid diagnosis and density criteria have been produced by World Health Organisation (WHO, 1994).

Researches worldwide demonstrate that there occurs a wide range of figures for bone mass of individuals at which the osteoporotic fractures occur (Ross et al. 1990). There exists evidence that the link between density of bone and osteoporotic fracture is considerably poor (Cummings, 1987; Pødenphant et al. 1987; Chappard et al. 1988; Ross et al. 1990) however, there is significant opinion to consider the importance of trabecular structure of the bone important in the occurrence of osteoporosis-related fractures (Mosekilde et al. 1987; Jensen et al. 1990; Beck et al. 1993; Lees et al. 1993; Mays et al. 1998). In addition, while there is a relationship between bone mineral density and fracture risk, the extent of any change in bone mineral density does not necessarily predict the extent of change in fracture risk (Prentice, 2004). Nonetheless, bone mineral density is the best current predictor of future fracture risk (Walker-Bone et al 2001).

Although available technologies measuring central (spine and hip) and peripheral skeletal sites (forearm, heel, fingers) provide site-specific and global (overall risk at any skeletal site) assessment of future fracture risk, Dual-energy x-ray absorptiometry (DEXA) of hip is regarded as the gold standard for the diagnosis of osteoporosis using WHO criteria (ACCME, 2004). Dual-energy x-ray absorptiometry (DXA) measurement of the hip and spine is the technology now used to establish or confirm a diagnosis of osteoporosis, predict future fracture risk and monitor patients by performing serial assessments (Kanis et al. 1994). Areal BMD is expressed in absolute terms of grams of mineral per square centimeter scanned (g/cm²) and as a relationship to two norms: compared to the expected BMD for the patient’s age and sex (Z-score), or compared to “young normal” adults of the same sex (T-score). The difference between the patient’s score and the norm is expressed in standard
deviations (SD) above or below the mean. Usually, 1 SD equals 10 to 15 percent of the BMD value in g/cm². Depending upon the skeletal site, a decline in BMD expressed in absolute terms (g/cm²) or in standard deviations (T-scores or Z-scores) begins during young adulthood, accelerates in women at menopause and continues to progress in postmenopausal women and men age 50 and older. The BMD diagnosis of normal, low bone mass, osteoporosis and severe or established osteoporosis is based on the WHO diagnostic classification (NOF, 2010). The World Health Organization has established these definitions based on BMD measurement at the spine, hip or forearm by DXA devices. The individuals who have BMD within 1SD of a “young normal” adult (i.e. T-score at -1.0 and above) are characterised as ‘Normal’; the individuals with BMD between 1.0 and 2.5 SD below that of a “young normal” adult (i.e. T-score between -1.0 and -2.5) are ‘Osteopenic’ with low bone mass; the individuals with BMD equal to 2.5 SD or more below that of a “young normal” adult (i.e. T-score at or below -2.5) are ‘Osteoporotic’; and the individuals with BMD 2.5 SD or more below the “young normal adult mean” (i.e. T-score at or below -2.5) in the presence of one or more fragility fractures are affected from ‘Severe Osteoporosis’ or ‘established osteoporosis’ (Kanis et al. 1994).

Besides DEXA, there exist the following bone mass measurement technologies that are capable of predicting both site-specific and overall fracture risk. When performed according to accepted standards, these densitometric techniques are accurate and highly reproducible (ISCD, 2008).

a) Peripheral dual-energy x-ray absorptiometry (pDXA) measures areal bone density of the forearm, finger or heel. Measurement by validated pDXA devices can be used to assess vertebral and overall fracture risk in postmenopausal women. There is lack of sufficient evidence for fracture prediction in men. pDXA is associated with exposure to trivial amounts of radiation. pDXA is not appropriate for monitoring BMD after treatment.

b) CT-based absorptiometry. Quantitative computed tomography (QCT) measures volumetric trabecular and cortical bone density at the spine and hip, whereas peripheral QCT (pQCT) measures the same at the forearm or tibia.
In postmenopausal women, QCT measurement of spine trabecular BMD can predict vertebral fractures whereas pQCT of the forearm at the ultra distal radius predicts hip, but not vertebral fractures. There is lack of sufficient evidence for fracture prediction in men. QCT and pQCT are associated with greater amounts of radiation exposure than central DXA or pDXA. In fact, QCT is the only technique that can distinguish between cortical and cancellous bone.

c) **Quantitative ultrasound densitometry (QUS)** does not measure BMD directly but rather speed of sound (SOS) and/or broadband ultrasound attenuation (BUA) at the heel, tibia, patella and other peripheral skeletal sites. A composite parameter using SOS and BUA may be used clinically. Validated heel QUS devices predict fractures in postmenopausal women (vertebral, hip and overall fracture risk) and in men 65 and older (hip and non-vertebral fractures). QUS is not associated with any radiation exposure. Two parameters of ultrasonography are investigated: velocity, which depends on elasticity and density, and attenuation, which results from scattering and absorption. Bone ultrasonography measurements may reflect parameters of bone structure and strength that are independent of BMD. The speed of sound transmission is thought to be a function of both the bone density and bone microarchitecture (ACCME, 2004).

d) **Radiographic Absorptiometry (RA)** technique is a quantitative assessment of the metacarpals and phalanges based on a plain radiograph. Recently, digital imaging software allows BMD reports to be calculated from hand X-rays scanned into computer or works with digital x-ray equipment.

However, t-scores cannot be used, for diagnosis, interchangeably with different techniques or be based on measurements taken from different sites, since the same T score derived from different sites and with different techniques yields different information on fracture risk. Reasons for this variation include differences in the gradient of risk for techniques to predict fracture, discrepancies in the population SDs and differences in the apparent rates of bone loss with age (Faulkner *et al.* 1999; Kanis
& Glüer, 2000). A further difficulty is that the intersite correlations, though usually significant, are inadequate for prediction, giving rise to misclassification (Arlot et al. 1997; Grampp et al. 1997) because of biological variation in BMD and technical errors of accuracy. For diagnosis, measurement at the hip is the gold standard, in terms of site, since it has the highest predictive value for hip fracture (Marshall et al. 1996), which is the most severe complication of osteoporosis and predicts risk of all fractures as well as other techniques. The normal reference range to be used should be taken from appropriate populations. Small differences between ranges have a large effect on the number of individuals with BMD below a diagnostic threshold (Kanis, 2002).

Although, DEXA scan is regarded as a ‘gold standard’ for measurement of BMD or future fracture risks, its use in field for screening a population is restricted because of its high cost, high maintenance and higher technique specificity and its use in the field. The present study therefore, was conducted using ultrasound based densitometer (McCue C.U.B.A. Clinical) which works on the principle of BUA for future fracture risk assessment. The most widely assessed methods are broad-band ultrasound attenuation and speed of sound (or ultrasound velocity) at the heel since these techniques do not involve ionising radiation and provide information with respect to the structural organisation of bone in addition to bone mass, there is much interest in their use. For reasons outlined below, these techniques cannot be used to diagnose osteoporosis, but evidence (Porter et al. 1990; Glüer, 1997; Gregg et al. 1997; Hans et al. 1996) lends support to their use for the assessment of fracture risk in elderly women (Kanis, 2002). Results of most studies suggest that measurements of broad band ultrasound attenuation or speed of sound are associated with a 1.5-fold to 2.0-fold increase in risk for each SD reduction in BMD (Glüer, 1997). Findings of some, but not all, studies suggest that ultrasound might measure some aspects of skeletal status and fragility that cannot be measured with absorptiometric techniques alone (Ross et al. 1995; Hans et al. 1996; Heaney & Kanis, 1996). However, there exists a difference of discrimination using DEXA measures and ultrasound measures for osteoporotic patients since -2.0 SD T-score in ultrasound have been found to have discriminating ability of 90% (Greenspan et al., 1997).
The clinical significance of osteoporosis rests with the fractures that arise as a consequence of the condition, and their attendant morbidity and mortality. Low bone mass is an important component at the risk of fracture, but other abnormalities may arise in the skeleton that contribute to skeletal fragility. Thus, there is a need for distinction to be made between diagnosis of osteoporosis and assessment of risk, which in turn implies a distinction between diagnostic and intervention thresholds (Kanis, 2002). Thus, there are additional fracture risk assessment tools that may help in this distinction to an extent namely FRAX tool and Osteoporosis self-assessment tool for Asians (OSTA).

The FRAX tool, developed by the World Health Organization and the National Osteoporosis Foundation, is one of the most widely used instruments to predict risk for fractures. The USPSTF (U.S. Preventive Services Task Force) used the FRAX (Fracture Risk Assessment) tool to estimate 10-year risk for fractures because this tool relies on easily obtainable clinical information, such as age, body mass index (BMI), parental fracture history, and tobacco and alcohol use (USPSTF, 2011). The FRAX tool includes a publicly available risk calculator that determines which individuals would exceed the baseline risk threshold for fractures on the basis of their age or other risk factors (such as low BMI, parental history of hip fracture, smoking status, and daily alcohol use). Considering a 65-year-old white woman who has no other risk factors to be the baseline risk case (a 10-year risk for any osteoporotic fracture of 9.3%), women as young as 50 years may have a 10-year risk for any osteoporotic fracture of 9.3% or greater, depending on the type and number of risk factors present (Nelson et al. 2010).

The Osteoporosis Self-Assessment Tools for Asians (OSTA) is based on age and body weight and has been found to be a good and simple tool with high sensitivity and acceptable specificity for the identification of women at risk of osteoporosis. A good screening tool may be helpful for patients as well as for physicians with limited professional experience as an aid for identifying when additional attention is needed and for selecting the most appropriate therapy. Several studies show that OSTA is an effective method for identifying people at low risk of osteoporosis (Park et al. 2003;
Yang et al. 2004). The OSTA index may be a simple and effective clinical risk assessment tool for identifying the risk of osteoporosis as defined by DXA according to the WHO diagnostic criteria, and it may be a useful tool for identifying new painful vertebral fractures (Yang et al. 2013).

In order to have a clear understanding about the aging process and the status of bone mineral density (estimated with the help of speed of sound (SOS) and/or broadband ultrasound attenuation (BUA) using Quantitative ultrasound densitometry), it is necessary to validate the existing knowledge by undertaking studies on females with respect to these important aspects, which have vital implications in the later life. Since female health has many remarkable events associated with aging, therefore, the present study has been undertaken to ascertain age related changes in body composition and bone mineral density along with the factors affecting these changes among rural and urban Bania females of District Panchkula.

1.2. Review of Literature

The increased proportion of the elderly in the living populations not only directs towards the increased longevity over past 40 years but also gives a more appreciable picture of improved medical facilities, better living conditions and maintenance of elderly in the society. This has indeed resulted in the need for increasing funding of research on aging in many nations pertaining to growth and developmental changes among the different ethnic and racial groups throughout the world. The said research interests range from the cellular and molecular basis of aging to the evolutionary biology of senescence, and from the epidemiology of aging to personal and social changes with aging (Harper & Crews, 2000). These gerontological researches attract scientists from different disciplines to give a complete surviving picture in the society. With the knowledge that varying lifestyles and dietary patterns can influence the aging process and indeed have some major public health implications, the most interested scientists are primarily the physical anthropologists. Also, their ability to see problems from an evolutionary perspective directs towards their significant contribution on evolution of life span (Bagga, 2010).
Aging is a mosaic process at both the population and individual levels, i.e., not all members of a population age in exactly the same way; not all the organs and tissues of one individual age at the same rate. In addition to knowledge of aging and prevalent degenerative changes is the importance of the concept of feminisation of ageing, i.e., extension of life span of women outliving men in old ages among industrialised nations. This is a biological reality that women live longer despite similar socio-economic profiles, nutrition and other cultural variables, suggesting towards better longevity of female species (Pifer & Bronte, 1986; Bagga, 2003). Recently, proposed ‘grand mothering hypotheses’ suggests that the question of female longevity may have deeper evolutionary significance than we are aware (Lahdenperä et al., 2004). Developments in evolutionary life history theory suggest that, instead of help for older members of the population, it is help from postmenopausal grandmothers that accounts or age structures of human societies (Hawkes, 1998).

1.2.1. BODY COMPOSITION:

Body composition changes attributable to aging are characterized by a progressive reduction in fat free mass and an increase in fat mass (Baumgartner et al., 1995; Zamboni et al., 2003). Both these age-related body composition changes seem to be independently associated with an increased risk of functional limitation (Janssen et al., 2002; Sternfeld et al., 2002). In addition to the increase in the proportion of fat to lean body mass with increasing age, the researchers realise that there is a tendency for the fat to be redistributed (Borkan, 1983; Enzi et al. 1986; Kapoor, 2000; Bagga & Sakurkar, 2003). Fat redistributes centrally, with increases in waist circumference thought to reflect increases in visceral fat with age (Borkan et al., 1985). Even if weight is stable, people tend to become fatter with age as muscle mass diminishes and is replaced by fat (Gallagher et al., 2000). The remaining muscle may be infiltrated by fat (Goodpaster et al., 2000). There is a loss of bone mass from a peak in the early 20s. From these changes have come important hypotheses regarding the contribution of each of these components of body composition to health. Data on body composition allow a more direct assessment of the contribution to health of fat and lean body mass.
Total body fat mass increases slowly with age during adulthood. In an analysis of Fels data, Siervogel and colleagues (1998) estimated the rate of increase in total body fat to be 0.44 kg/yr and 0.52 kg/yr between ages 18 to 45 years and 45 to 66 years, respectively among women, indicating no deceleration over the age intervals. All groups reached a maximum of fat mass between 50 to 60 years, during which a little or no change takes place. However the fat mass decreased after the age of 60 years in all groups (Baumgartner, 2005). Longitudinal data from New Mexico Aging Process Study suggested that total body fat remained stable in elderly women over a 3-year period but decreased significantly over long periods of follow-up. Adipose tissue distribution also demonstrated distinct patterns of change with age. Heitmann (1991) described changes in waist hip ratio from 35-65 years of age in Danish population sample. The former demonstrated an increase in this ratio with age in women after 55 years. The main molecular components in fat free mass are water, protein, osseous and non-osseous mineral and glycogen, which are known well to vary systematically with age. Overall body weight also demonstrates a significant change with the age advancements. In women, body weight usually increases until the late sixties then decreases through rest of life.

Numerous studies have investigated the age trends among elderly populations in particular context with body composition. These include the studies among elderly persons from Taiwan (Chiu et al. 2000); adult residents from East Angelia, England (Bose, 2002); Cohort from Sonoma California (Sternfeld et al. 2002); Asian Indian adults (Snehalatha et al. 2003); Elderly population of Santiago, Chile (Santos et al. 2004); Elderly Indian population (Reddy et al. 2004); Adults from Salvador- Bahia (Pitanga & Lessa, 2005); Population from Rural Wardha (Deshmukh et al. 2006); Subjects from United Kingdom (Price et al. 2006); Tribal populations from Keonjhar, Orissa (Bose et al. 2007); Swedish old people (Carlsson et al. 2009); 75 yr old men and women from Göteborg, Sweden (Dey et al. 2009); Bishnupriya Manipuris of Cachar district of Assam (Das & Roy, 2010); Kosovo population (Rexhepi et al. 2011); Urban South Indian adult men and women (Rao et al. 2012); Spanish Caucasians adult workers (Bennasar-Veny et al. 2013); Sri Lankan adults
Introduction and Review of Literature

(Ranasinghe et al. 2013); Outpatient clinic patients of Geriatric service hospital, Rio (Leite et al. 2014); middle-aged and older US adults (Stenhom et al. 2014).

Yet another group of researchers studied body composition, somatotypes and fat patterning particularly among the elderly females to highlight the age changes in these important aspects (Sidhu et al., 1975; Singh, 1978; Singal, 1979; Banerjee & Sen, 1984; Singal and Sidhu, 1982, 1984; Sidhu & Sidhu, 1987; Majumdar et al., 1990; Luoto et al. 1994; Kaur, 1995; Sharma, 1995; Gangopadhyay & Gangopadhyay, 1996; Hussain, 1997; Bagga, 1997; Tyagi & Kapoor, 1999; Bagga and Sakurkar, 2003; Tungdim & Kapoor, 2003; Bose et al. 2003; Bose & Chaudhari, 2003; Ghosh, 2004; Tyagi et al., 2005; Bose et al. 2007; Bisai et al. 2009; Kaur & Talwar, 2009, 2011; Mohan et al. 2011; Das et al. 2012). An increase in weight up to a middle age group of 40-44 years in Jat Sikhs and scheduled caste females of Punjab and at 45-49 years among Banias was reported followed by a decline in the later age groups (Singal & Sidhu, 1982, 1984); Sikh and Hindu Harijan females (Sidhu & Sidhu, 1987), Maharashtrian Brahmin females (Bagga, 1997); Rural and Urban Kunbi females (Hussain, 1997); High altitude females (Tyagi & Kapoor, 1999); Jat Sikh females (Singal et al., 1999). Weight is composed of fat and lean body mass/fat free mass and change in weight is attributable to change in anyone of the components. Thus, studies have been reported with special context to body fat (Singal & Sidhu, 1982) and fat free mass (Sidhu & Sidhu, 1987), emphasising the usual trend noticed with the increase in age.

Body composition and fat patterning are under the influence of genetic factors and can be modulated by age, sex, nutrition and several cultural and socio-economic factors present in the environment. Mueller & Reid (1979) suggested that environmental factors such as nutrition, stress and exercise have significant effect on subcutaneous fatness. Studies on body composition assessment, fat distribution patterns and its associated factors include Denmark study on postmenopausal women (Wang et al. 1994); California cohort study (Sternfeld et al. 2002); Urban elderly females from Delhi (Tyagi et al. 2005); Elderly senior citizens from old age homes (Tyagi, 2007); tribal populations of Keonjhar, Orissa (Bose et al. 2007); old aged
people from residential care facilities of Northern Sweden (Carlsson et al. 2009); NORA cohort in Sweden (Dey et al. 2009); Brahmin females of Punjab (Kaur & Talwar, 2009); South Indian females (Mohan et al. 2011); Jat females of Haryana (Kaur & Talwar, 2011); sedentary adult Indian women (Kaur et al. 2012). There are various ways to study the distribution of body fat, for example (i) by centripetal fat ratio or trunk–extremity ratio, (ii) by combining waist/hip ratio and skinfold ratios (Fiori et al., 2000), (iii) by principal component analysis on a set of skinfolds (Mueller and Reid, 1979; Ramirez and Mueller, 1980), (iv) from the residual of the regression of each log transformed skinfold on the mean log transformed fatness, which in human females is linked to fertility (Brown and Konner, 1987; Norgan, 1997), female ovarian function being particularly sensitive to energy balance and energy flux (Ellison, 2003).

Frailty and sarcopenia are the advanced stages of progressive age-related body composition changes. Systematic and continuous losses of muscle mass with age (known as sarcopenia), increases in body fat up through the seventh decade and decreases in body fat thereafter are well recognized age-related changes in body composition (Borkan & Noris, 1977; Muller et al. 1995; Morley, 1997). These age-related changes are associated with increased risk of morbidity, functional impairment and mortality, and they constitute important public health problems (Stookey et al. 2001; Chang et al. 2012). Thus, advanced age alters the body composition not only by changing the amounts of fat mass and fat free mass but also by redistribution of fat which has vital health implications among elderly people (Cheryl & Lyder, 2001).

Nutritional status and impaired functional ability among the elderly, especially from poorer sections of the developing countries, must receive attention. Research results have shown a relationship between health and nutritional status in the elderly (Launer et al. 1994; Visser et al. 1994). Body fat content and its distribution are helpful in assessing the risks for cardiovascular disease (Lowik et al. 1991), hypertension (Gillum, 1987), diabetes (Gillum, 1987) and dislipidaemia (Chumlea et al. 1992; Reddy et al. 1998). Therefore, information on body composition is essential in delineating the nutrition and health relationship (Chumlea & Baumgartner, 1989).
Higher adiposity values and related morbidity in particular context with obesity has been reported among older Bengalee Hindu women of Calcutta (Bose & Chaudhari, 2001; Bhadra et al. 2005); Bengalee adults of Kolkata Metropolitan Area (Bhadra et al. 2009); Urban Kanpur (Singh et al. 2010); Working premenopausal and postmenopausal women of Jalandhar District (Khokhar et al. 2010); premenopausal and postmenopausal working women of Raipur District (Singh et al. 2012); Geelong Osteoporosis study (Pasco et al. 2012).

Anthropometry is an essential tool in geriatric nutritional assessment used to evaluate underweight and obesity conditions, which are both important risk factors for severe diseases and disability among the elderly (Jensen & Rogers, 1998; Visser et al. 1998). Anthropometric characteristics provide a better understanding of the growth process by describing changes in the body size and morphology through ages. It is also well documented that all anthropometric characteristics do not reach a peak stage simultaneously or at same rate (Das & Roy, 2010). The main measurements obtained on elderly populations include the weight, height, girths and skin folds (Menezes & Marucci, 2005). The accumulation of body fat is usually located in the area of the trunk and visceral sites. Since, the overweight and obesity conditions increase the risk of cardiovascular and chronic diseases, it becomes necessary to point the markers of obesity and adiposity. This is primarily done by body mass index and waist circumferences (Janssen et al. 2004).

However, for the elderly population, BMI is known as an inappropriate measure of body fat and is limited in its predictive ability for mortality (Calle et al. 1999; Visscher et al. 2001) due to three reasons: (i) it does not differentiate between fat and lean body mass, and the latter is progressively lost with increasing age (Bales & Ritchie, 2002; Price et al. 2006); (ii) height measurement is unreliable due to shrinkage and vertebral collapse (Price et al. 2006); (iii) height and weight information is often recalled and self-reported rather than measured, causing spurious and inaccurate BMI estimates in the elderly (Chang et al. 2012).

Anthropometric measurements include a longitudinal dimension, transversal dimension, the body mass index (BMI, derived from the ratio of the height and weight
of the respondents), body fat percentage (obtained by an indirect method of measurement), waist circumference (WC) and waist-to-hip ratio (WHR). Measures such as the BMI are good for the assessment of excessive weight or obesity, while WC and WHR are good indicators of abdominal fat (Milanovic et al. 2011). Waist size is a marker of abdominal fat depots. Different studies used different sets of measurements of body fat distribution to look at the relationship between mortality and body fat distribution in different samples of old subjects (Chang et al. 2012). In analysing a finding from Iowa Women’s Health Study, WHR was claimed to be best anthropometric predictor in women (Folsom et al. 2000). In yet another study among all Asian elderly ranging 65-98 years in age, Han et al. (2010) argued that lean body mass should be the best predictor of mortality in Asians. Further, in a cardiovascular health study, Janssen & Ross (2005) found that after controlling for both WC and BMI, BMI was negative predictor, whereas WC was a positive predictor.

Recently, Bergman et al. (2011) proposed a better index of body adiposity, i.e., Body adiposity index or BAI that can be used to reflect % body fat or adult men and women of differing ethnicities without numerical correction. It can also be used in clinical setting even in remote locations with very limited access to reliable scales. BAI was found to be better adiposity assessment parameter in postmenopausal Caucasians compared to African American & Filipina women (Djibo et al. 2015). However, in a study by Banik & Das (2015) among three endogamous groups of South Bengal, comparison of BMI and BAI inferred BMI to be better related to PBF than BAI. Still another anthropometric measure, named A Body shape Index (ABSI), has been derived by Krakauer & Krakauer (2012) from waist circumference which is independent of BMI and is said to be a better index than using either WC or BMI independently (Sharma et al. 2014).

A review on the use of different anthropometric indices for estimation of body fat and related clinical risk concluded that there is limited knowledge with respect to universal index or a combination of two indices applicable across ethnic population groups, or gender specific, or clinical risk specific (Bose, 2001; WHO, 2004; Pitanga & Lessa, 2005; Deshmukh et al. 2006; Shuger et al. 2008; Nyamdorj (Decoda study
Introduction and Review of Literature

group), 2008; Bergman et al. 2011; Peltz et al. 2010; American Medical Association, 2011; Rao et al. 2012; Shidfar et al. 2012; Krakauer & Krakauer, 2012; Bennasar-Veny et al. 2013; Ranasinghe et al. 2013; Lutoslawska et al. 2014; Gupta & Kapoor, 2014; Sharma et al. 2014; Djibo et al. 2015; Sung et al. 2014; Fu et al. 2014; Meredith & Madden, 2014; Banik & Das, 2015). Therefore, it is suggested to validate the adiposity using conventional and derived indices in collaboration or combination of more than two indices to portray complete and comprehensive characteristics of body composition in a population.

Age increased blood pressure is a common trend witnessed among elderly males as well females. Pereira et al. (2009) reported that the prevalence of high blood pressure in low and middle-income countries is coming at par with high income countries. The prevalence of hypertension varies considerably from one region of India to another. Kaur (2012) reported age related trends in blood pressure among rural and urban Jat Women of Haryana and found that urban females showed significantly greater blood pressure and pulse rate as compared to rural Jat women. Gupta and Kapoor (2012) studied blood pressure levels and their association with different indices of body fat in adult Bania (25-60) years in Delhi. Rana and Sidhu (2012) studied relationship of percent body fat with blood pressure among young adult females of Amritsar and concluded that PBF measured by BIA was not a good predictor of high BP. Many factors are considered determinant for increased blood pressure such as age, sex, salt intake, obesity, sedentary lifestyle, alcohol consumption, smoking, genetic factors and dietary habits.

1.2.2. MENOPAUSE:

A large body of data exist on physiological and morphological changes among the elderly populations of different regions of the world. In particular context with females, and increasing life expectancy, menopause is an increasingly important aspect of women’s health (Ayatollahi et al., 2005). Reproductive senescence among women is universal and it must not be conceptualised that menopause is an invariant biological transformation, since biology and culture have an endless feedback relationship of continuous exchange which is potential subject to variation (Walfish et
al., 1984; Yeh, 1989; Lock, 1998). The age at which natural menopause occurs is
between 45 and 55 years for women worldwide. Also there are numerous bio-social
factors which influence the age at menopause among different populations.

Recent studies have shown that variation in age at menopause is associated with
several factors such as genetics, reproductive, socio-demographic, and certain
behavioural influences (Boldsen & Jeune, 1990; Luoto et al., 1994; Garrido-Latore et
al., 1996; Bromberger et al., 1997; Spitzer, 1999; Edwards, 1999; Kamau, 1999;
George, 2000; Kangas, 2000). Smoking is significantly associated with earlier age at
menopause (Mckinlay et al., 1972; Jick et al., 1977; Lindquist & Bengtsson, 1979;
Kaufman et al., 1980; Neri et al., 1982; Willett et al., 1983; Prazzini et al., 1992;
weight is also predictive, with lean smokers having the highest risk of early
menopause (Willett et al., 1983). Other common factors associated with early
menopause include marital status i.e. married women report a later age at menopause
than do single women (Brand & Lehert, 1978; Neri et al., 1982; OlaOlorum &
Lawoyin, 2009). Women of higher income status have also demonstrated a later age
at menopause than do women with lower incomes (Luoto et al., 1994; Randhawa et
al., 1987; Stanford et al., 1987; Sethi et al., 1996). Most studies have also
demonstrated relations between menopause and months spent breast feeding
(Goodman et al., 1978), miscarriages (Neri et al., 1982; Whelan et al., 1990),
abortions (Neri et al., 1982; Biela, 2002) and use of oral contraceptives (Brand &
Lehert, 1978; Biela, 2002; Palmer et al. 2003; OlaOlorum & Lawoyin, 2009).

Many studies report earlier mean age at menopause in thinner women than in heavier
women (Brand & Lehert, 1978; Lindquist & Bengtsson, 1979; Sherman et al., 1981;
Neri et al., 1982; Willett et al., 1983; Karim et al., 1985; Beall, 1987). Nutritional
status (Osteria, 1983; Riley, 1994; Simondon et al., 1997), seasonality (Boldsen,
1992), physical activity (Malina, 1983) and altitude level (Beall, 1983; Kapoor &
Kapoor, 1986; Gonzales & Villena, 1996) have shown to be remarkably associated
with the age at menopause and age at menarche.
Studies also demonstrated a significant difference within populations residing in urban and rural areas with respect to their lifestyles. There is an economic imbalance between the poor, middle class, affluent and the multicultural, multi-ethnic, multi-religious composition of the population. Average age of menopause is somewhat lower in rural population than urban population (Sharma et al., 2007; Cho et al., 2008; Puri, 2008; Kaur & Talwar, 2009; Sagdeo & Arora, 2011). Numerous surveys have been conducted to estimate age at menopause in different parts of India (Sen, 1953; Rakshit, 1962; Ghosh and Kumari, 1973; Kar & Mahato, 1975; Talukdar, 1977; Singal and Sidhu, 1982; Banerjee & Banerjee, 1988; Chatterjee, 1994; Mastana, 1996; Sethi et al. 1996; Talwar and Pande, 2004; Sharma et al. 2005, Pathak & Parashar, 2010).

It has been concluded from a number of studies that early menopause may be a risk factor for earlier mortality from diseases related to decreased estrogen levels and may promote increased incidence of osteoporosis, heart diseases, diabetes, hypertension, breast cancer, osteoarthritis, and auto-immune diseases (Mathews et al., 1989; Holm & Penckofer, 1992; Sowers & la Pietra, 1995; Van der Schouw et al., 1996; Adler, 2000). With the advent of modernisation and industrialisation there has been an increase in the age at menopause as compared to the earlier studies reported by various researchers. In the light of above it would be appropriate to undertake studies on regional populations to see the magnitude of change in age at menopause and to ascertain changes in this age among rural-urban settings as well as among women from different socio-economic status.

1.2.3. MENOPAUSAL SYMPTOMS:

Numerous physical and psychological symptoms have been attributed to hormonal changes of menopause. The prevalence of menopausal symptoms varies widely not only among individuals of the same population but also between different ethnic populations (Sharma et al. 2007). Even there is a great diversity in nature of symptom and frequencies across countries, even in same cultures (Robinson, 1996; Obermeyer, 2000). These symptoms have been considered as atypical as their presence may not only be limited to the menopausal transitional phase. The expression, magnitude and
frequency of these atypical symptoms may vary from one woman to another and possibly be influenced by factors not clearly defined (Kuh et al. 1997). The rate of symptoms displayed an increasing trend from one menopausal stage to the next. The frequency of menopausal symptoms may differ depending upon the female population under study in terms of hormonal status (pre-, peri-, or postmenopausal), health status, socio-economical background, etc. (Chedraui et al. 2007). Still another study enumerated factors like early age at menopause, individual perception of menopause, genetic and racial differences and reproductive parameters like parity (Nusrat et al. 2008). The studies undertaken to ascertain the correlation between age at natural menopause and symptomatology of menopause suggest a varying trend (Bagga, 2004; Shah et al. 2004; Pathak & Prashar, 2010). The early symptoms are oligomenorrhoea, menorrhagia (Baghla & Sharma, 2008), hot flushes (Freedman, 1990; Guthrie, 1996; McKinlay, 1974), Insomnia (Hunter, 1990; Vaidya & Pandey, 2003), mood changes (Hunter, 1990; Spinelli, 2000). The intermediate symptoms are skin and vaginal atrophy, stress incontinence (Agwu et al. 2008) followed by late effects or osteoporosis, coronary heart diseases, Alzheimer’s diseases, Diabetes and Arthritis (Sagdeo & Arora, 2011). It is commonly believed that Asian women have a lower prevalence of menopausal symptoms than Western women (Loh, 2007). Sharma et al. (2007) investigated the frequency and prevalence of menopausal symptoms with a 30-item checklist derived from Green (1976) and Neugarten & Kraines checklist (1965) among urban women from Jammu and inferred that fatigue & lack of energy, headache, hot flushes, cold sweats, cold hand & feet and weight gain were the most frequently complained menopausal symptoms in them. Overall, vasomotor symptoms were the most prevalent.

1.2.4. BONE MINERAL DENSITY

Body cell mass, skeletal muscle mass, organ mass, and fat free mass all decline with age. This decrease is associated with declining resting energy expenditure and heat production. Stature frequently declines (0.5 to 1.5 per decade) with age (Baumgartner et al. 1995) owing to decrements in the height of the vertebral bodies and shrinkage of inter-vertebral disc spaces. Bone mineral density (BMD) increases through growth
years, reaching a peak in the late twenties. After the age of 35, healthy men and women lose bone mass at the rate of 0.3-0.4 percent per year. After menopause, women lose bone mass at a far greater rate, about 3-5 percent per year, showing a tenfold increase. The accelerated period of bone loss generally lasts for 6-10 years, after which the loss continues at a much slower rate (Bhathena, 1996).

The rate of decrease accelerates in women in relation to declining levels of circulating estrogens after menopause (Blunt et al. 1994). Since, low BMD is associated with increased risk of fragility fractures in the elderly (IOF, 2009); therefore, BMD is an important determinant of morbidity and mortality in postmenopausal women and elderly males (Trombetti et al. 2002; Kanis et al. 2003; Johnell & Kanis, 2006; IOF, 2009).

Previous studies have identified several risk factors associated with decreased BMD including aging and menopause in females (Tsai et al. 1996; Tsai & Tai, 1997) and body weight & height (Tsai et al. 1996, 1997). The reduction in the physical activity also decreases bone mineral density (BMD) through reduced mechanical stress from muscle action (Seo et al. 1996). It directs towards the bone mineral loss attributable to age- and menopause- related decline in physical activity (Hill et al. 1995). Several longitudinal studies indicate towards the beneficial effect of physical exercise on BMD especially among postmenopausal women (Bennel et al. 1997; Ebrahim et al. 1997; Nishimura et al. 1997; Kronhed and Moller, 1998; Douchi et al. 2000).

Menopause may interact with or accelerate event of normal ageing. Since after menopause, the calcium required in the body is resorbed from the bones. Some women may lose as much as 30% of their bone mass between the ages of 50 to 70. It results in reduction of bone mineral density in the bones which makes the bones comparatively weaker and more prone to fractural risks. This clinical condition of reduced bone density is called OSTEOPOROSIS, which is characterised by low bone mass, deteriorating bone tissue and disruption in bone architecture. The process of osteoporosis, a systematic rather than localised increase in soft tissue at the expense of mineralised tissue, is an abnormality in itself (Schwartz, 1995).
Postmenopausal osteoporosis is an important public health problem in developed countries. There are many factors that affect bone mineral density (BMD). It is well known that obese women have elevated BMD (Dawson-Hughes et al. 1987; Ribot et al. 1987; Hassager & Christiansen, 1989; Shiraki et al. 1991). Factors that affect BMD do not generally influence BMD throughout all the stages of life cycle. Some factors have strong impact on BMD during a certain period of the life cycle, and then have a reduced impact on BMD at other stages of life cycle and lean body mass was significant determinant of BMD in premenopausal women, while body fat mass is a significant determinant in postmenopausal women (Ijuin et al. 2002).

Perimenopause, the transition into menopause marks the beginning of accelerated bone loss (Perrone et al. 1995; Prior, 1998). Studies found that lean mass positively influences the femoral BMD (Aloia et al. 1995; Salamone et al. 1995; Li et al. 2004) reflecting towards genetic association between higher peak BMD and higher lean mass or a physically active life style, which increases both bone and muscle mass (Chen et al. 1997). There exists considerable evidence that genetic factors play an important role in determination of bone mass throughout life (Dequeker et al. 1987; Pocock et al. 1987; Slemenda et al. 1991; Flicker et al. 1995; Arden et al. 1996; Nguyen et al. 1998; Howard et al. 1998). Other risk factors enumerated by other researchers include menopausal status, body mass index, maternal fracture history, exercise, previous use of hormonal replacement therapy (HRT) and fracture history (Miller et al. 1995; Compston et al. 1995; Torgerson et al. 1995).

In general, osteoporosis is an affliction of the aged (although it can occur in younger individuals) that affects the spongy bone, first and especially, of the ribs, vertebrae, os coxae, and femoral neck. With advancing age, the bones of the extremities can become involved. Cortical bone thickness and density of trabeculae and transverse plates become reduced. Affected bone continues to lose calcium and phosphate in spite of the fact that diet, as well as vitamin and mineral intake and serum levels, may be normal. Hypercortisonism is known to cause osteoporosis. Other specific causes are less clearly delineated, although diets deficient in calcium, nutrition or disease
related weight loss, castration, and hyperthyroidism appear to exacerbate extant osteoporosis (Schwartz, 1995).

The cause of osteoporosis is unknown, but it appears to be the result of reduced activity of the osteoblasts. Other factors which have been considered as contributing to a loss of bone density include low body weight, cigarette smoking, alcohol consumption, inadequate calcium intake and lack of regular exercise. Bone rarefaction of a less marked degree may simply be a feature of the normal ageing process, and attributable to an intrinsic deterioration of the performance of the osteoblasts (Sinclair, 1989). Clinically, postmenopausal women with low body weight, low percentage body fat or low body mass index are at increased risk of low bone mass and rapid bone loss, both of which are independent contributing factors to postmenopausal osteoporosis (Ravn et al., 1999). Secondary osteoporosis is associated with a number of medical disorders, including gastrointestinal diseases, hematologic disorders and hypogonadal states. Moreover, exposure to certain medications may contribute or exacerbate osteoporosis (NOF, 2003). Although body size inclusive measurements of total body weight, % weight change since 25 years, lean mass, fat mass, body fat %, hip girth, and body mass index were associated with hip fracture risk, measurement of total body weight by itself was found to be sufficient for ascertaining hip fracture risk and was not improved by other attributes of body size and composition (Ensrud et al., 1997).

The internationally agreed description of osteoporosis is: ‘A systematic skeletal disease characterised by low bone mass and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility and susceptibility to fracture’ (CDC, 1993). In 1994, World Health Organisation (WHO) published diagnostic criteria for osteoporosis in postmenopausal women, intended primarily for descriptive epidemiology (Kanis et al., 1994; WHO, 1994). These criteria have since been widely accepted and are commonly used to provide intervention thresholds, treatment and inclusion criteria for drug trials, and a basis for health technology assessments (Kanis et al., 2008).
The incidence of osteoporosis is best measured indirectly, as the incidence of fractures attributed to the condition, while prevalence is best measured by the frequency of reduced BMD or numbers of those with vertebral deformity (Woolf & Pfleger, 2003). Prevalence of osteoporosis in developing and less developed countries is not well known due to the lack of sufficient studies in these populations. But, the ethnic differences in BMD are well known. Blacks have greater BMD than Caucasians. Hispanics are similar to Caucasians while Asians have the lowest BMD (Handa et al., 2008). In general, BMD is lower in Asians than in Caucasians possibly due to the smaller body size of Asians (Ross et al. 1996; Marquez et al. 2001). In a cohort study by Barrett-Connor et al. (2005), all groups showed a decline in T scores with increasing age. Ethnic differences in BMD were strongly influenced by body weight. Fracture rates were lowest in black and Asian women within each age group, whereas white and Hispanic women had the highest fracture rates, suggesting the ethnicity influences fracture risk too.

Researchers have concluded that factors like urbanisation, parity, lactation, nutrition, occupational, activities, etc may influence bone density in developing countries (Cure-cure et al., 2002; Grimes & Wimalawansa, 2003; Shatrugna et al., 2005; Vu et al., 2005; Pongchaisikul et al., 2005,2006; Jang et al., 2006; Allali et al., 2007; Gu et al., 2007). Some studies have reported that bone health is better in rural populations, whereas others have conflicting results. In a cross-sectional study by Pongchaisikul et al. (2005) among Thai population, it was demonstrated that after adjusting for age and body weight, femoral neck BMD was significantly higher among the rural population in comparison with the urban group. This urban/rural difference became more pronounced after stratifying by sex, age group, and BMI category. In yet another study from Vietnam, Vu et al. (2005) it was observed that among the premenopausal women, prevalence of osteoporosis was higher in urban areas while in postmenopausal women higher prevalence was observed among the rural group. Other study by Gu et al. (2007) on Chinese population depicted significantly higher spine bone mineral content, BMD and bone area in urban group than their rural counterparts, even after controlling for body size.
Dargent-Molina et al. (2000) found factors most predictive for very low BMD among women aged 75 years and over to be low weight, history of fracture after the age of 50 years, slow gait, balance impairment, low grip strength and dependence of instrumental activities of daily living. Other factors likely to be important in developing countries are parity and lactation. Parity has been shown to have detrimental effects on bone density in studies from Korea, Vietnam, and Morocco (Vu et al., 2005; Jang et al., 2006; Allali et al., 2007). However, in a study from South America, osteopenia and osteoporosis were commoner in nulliparous women in comparison with multiparous Columbian women (Cure-cure et al., 2002). Lactation is associated with the loss of maternal calcium. Factors influencing BMD are duration and frequency of lactation, period of amenorrhea, and pre-pregnancy weight (Grimes & Wimalawansa, 2003). Nutrition is another factor that impacts bone mass. Many countries in the developing world have low calcium intake and also vitamin D deficiency (Handa et al., 2008).

In a study by Keramat et al. (2008), an effort was made to compare the risk factors of osteoporosis prevalent in India and Iran among the urban post menopausal women. It concluded that calcium supplementation and HRT were protective factor with steroid therapy as a risk factor among the Iranian women, while calcium supplementation for more than 1 year demonstrated a protective factor in Indian women. However, no significant difference in association of risk factors and osteoporosis was found among the two groups.

The fractures, sequel to osteoporosis condition, carry high mortality and morbidity among populations. This warranted good facility for screening and diagnosis of osteoporosis at an early stage. The various non-invasive methods involved in measurements of BMD include dual energy x-ray absorptiometry (DEXA), single x-ray absorptiometry (SXA), quantitative ultrasound (QUS) and quantitative computerized tomography (QCT). However, the DEXA scan is regarded as gold standard for BMD assessment (El-Desouki et al. 2005).

The previous studies have been conflicting and demonstrated that diagnosis of osteoporosis can vary depending upon which area of the body is screened (namely
lumbar spine, hip, forearm, heel), equipment and the reference data used (Boonen et al. 2005; Shankar et al. 2010; Anburajan et al. 2011; Vijay et al. 2011; Suman et al. 2013; Chin & Soelaiman, 2013). However, the use of T-score threshold of -2.5, as specified by WHO definition for osteoporotic condition, may be inappropriate for diagnosis of osteoporosis that uses BMD at skeletal sites other than the spine, hip or radius, or for use with other modalities such as quantitative ultrasound (QUS) or quantitative computed tomography (QCT) (Knapp et al. 2004).

The estimation of future fracture risks also raises the need for information on the changes in micro-architecture of the bone besides lowered BMD in osteoporotic conditions (Burston et al. 1998). This need has been recently combated by the technique of ultrasound that measures broadband ultrasound attenuation (BUA) to indicate the skeletal status in the trabecular bone (Langton et al. 1984). Quantitative ultrasound measurement of bone is increasingly now becoming a recognised method of determining bone quality (Hans et al. 1993; Kaufman & Einhorn, 1993; Glüer, 1997; Gregg et al. 1997; Njeh et al. 1997; Cook et al. 2005). In vitro studies have confirmed that BUA values obtained from the calcaneus correlate with the histomorphometric appearance of the trabecular system. Therefore, BUA helps in inferring the changes in both mineralisation and structure of the underlying bone (Gluer et al. 1993).

The use of peripheral techniques in BMD estimation has been used in many studies and among different populations throughout the world. These research studies include Population from Southern Maharashtra with heel ultra-densitometer (Rao et al. 2003); community-dwelling postmenopausal women with calcaneal ultrasound, metacarpal digital X-ray radiogrammetry and phalangeal radiographic absorptiometry (Boonen et al. 2005); Chinese mainland men & women with calcaneus quantitative ultrasound technique (Liu et al. 2006); Taiwan residents with quantitative ultrasonography (Yang et al. 2006); women from Southern region of Stockholm with DEXA and ultrasound DEXA-T (Salminen et al. 2006); Postmenopausal Caucasian women with quantitative ultrasound (Minnock et al. 2008); Pakistani adult women with quantitative ultrasonography (Fatima et al. 2009); Postmenopausal women from Lahore with
single X-ray absorptiometry (Hafeez et al. 2009); Postmenopausal women visiting police and services hospital, Peshawar (Zahoor & Ayub, 2010); Indian women and men with peripheral dual-energy X-ray absorptiometry (pDXA) (Anburajan et al. 2011); South Indian patients with pDXA (Snehalatha & Anburajan, 2011); Rural and urban Indian population with heel ultrasound bone densitometer (Samar et al. 2011); Urban Sengalese women with quantitative ultrasound (Ndongo et al. 2012); Australian men and women at Dubbo (Chan et al. 2012); Population study at Mangalore with pDEXA (Suman et al. 2013); South Indian population with ultrasound bone densitometry (Bharathi & Baby, 2014); elderly Indian population with ultrasound bone densitometry (Chowdhury, 2014).

Therefore it may be concluded that the disease burden of osteoporosis in developing countries is continuously increasing and the epidemiological information on osteoporosis and fragility fractures is sparse. However, parity, lactation, nutrition status, occupation, etc impact BMD in different ways that need to be further elucidated. Population specific normative data for bone density is lacking. Also studies on economic aspects of osteoporosis and its influence on quality of life in developing countries are needed.

**INDIAN SCENARIO:**

The population of India is expected to increase to 1367 million by 2020 and 1613 million by 2050; of which 9.8% (134 million) and 19.6% (315 million) respectively will be adults over 60 years (WPP, 2011). As per the Situation Analysis of the elderly in India (Central statistics Office, 2011), the grey population that accounted for 6.7% of total population in 1991 is expected to rise its share to more than 10% by the year 2021.

The most common osteoporotic condition among Indian females is postmenopausal osteoporosis since among other predisposing factors to osteoporosis; premature menopause is common in Indian scenario (Munshi & Kochhar, 2014). The limited data from India revealed the prevalence of postmenopausal osteoporosis from 25.8% to 62%; the risk based on age to be more than 40% from the age of 40 years and
introduction and review of literature

increases to 62% by age 60 and 80% by the age of 65 years (Cole et al., 2008; Makkar et al. 2008; Babu et al.2009; Unni et al. 2010).

Studies from different parts of India indicate a wide prevalence of Vitamin D deficiency in all age groups including neonates, infants, school children, pregnant/lactating women, adults and postmenopausal women (Harinarayan & Joshi, 2009; Teotia & Teotia, 2009; Agarwal et al. 2010; Kalra et al. 2011; Marwaha et al. 2011; Harinarayan et al. 2012; Singh, 2012). Also studies concluded that Indians have lower bone density than their North American and European counterparts and they tend to report osteoporotic fractures 10-20 years earlier in comparison with Caucasians directing to possible reasons of genetic, environmental and nutritional in origin (Vaidya & Shah, 2010; Singh et al. 2012; Meeta et al. 2013).

1.2.5. SIGNIFICANCE OF THE STUDY:

Ageing is associated with changes in body composition, including an increase and redistribution of adipose tissue along with a decrease in skeletal muscle, bone mass, agility, strength, physical work capacity and age related increasing trends of blood pressure, hypertension and obesity. The review of literature on the feminisation of aging in elderly population has raised the need of extensive researches related with female elderly populations to help maintaining the healthy aging among the majority gender dominating this section of society. Since female health has many remarkable events associated with aging, therefore, there is a need to address each of these events in a comprehensive manner to combat these problems with suitable timely interventions.

The beginning of reproductive cycle i.e. age at menarche followed by age at marriage, age at first born, parity, duration of breast feed and end of reproductive period i.e. age at menopause (natural or artificial) are the major events in a females’ life history which influence the later years of her life. These events not only influence the body composition of a female depending upon the nutrition, genetics, lifestyle and environmental factors but also modify the body physique and appearance by altering the associated hormonal secretions. These changes are associated with ovarian aging including progressively higher FSH concentrations and occurrence of the last menstrual period. Osteoporosis or bone fragility is one of the most common conditions among older adults. The condition has even been called the silent epidemic because its progression among post menopausal females becomes apparent only when
they suffer a fracture. Bone accretion during childhood is a major determinant of bone health later in life. Majority of populations in India at all age groups are suffering from Vitamin D deficiency. Therefore, highlighting the role of underlying factors affecting bone accretion is the need of the hour for its early prevention.

India is undergoing nutritional transition and facing burden of various metabolic diseases along with increased prevalence of osteoporosis because of marked changes in body composition. Therefore, it is necessary to ascertain the recent trends in body composition and bone accretion to see the magnitude of change. There exists scanty information on body composition and particularly on bone health of elderly females from various regional populations in India. Therefore, this study is an attempt to augment data on body composition and bone density of Bania females of District Panchkula. Moreover, it will be an earnest endeavour through this study to create awareness about risk of osteoporosis, its prevention, and highlight the role of physical activity and dietary habits related to healthy ageing.

AIMS AND OBJECTIVES OF THE STUDY:

The present study is undertaken to accomplish the following aims and objectives:-

- To study the age variations in body composition among rural and urban Bania females of Panchkula District.
- To ascertain age changes in bone density among the rural and urban Bania females.
- To determine the age at menarche and age at menopause among rural and urban Bania females.
- To compare changes in body composition and bone density among pre-menopausal, peri-menopausal and post-menopausal women.
- To enumerate the factors associated with osteoporosis.
- To create awareness among rural and urban females about the causes, consequences and prevention of osteoporosis.