

## **Aging of the population: mechanisms and impact**

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### **Introduction**

There is an unprecedented interest among scientists regarding the mechanisms of aging and problems related to aging. "Adding life to year, not just more years to life" the words of Gerontological society of America, needs to be reviewed since scientists believe that many years of quality life can be added to the existing life now. The mechanisms of aging are becoming clearer and attempts are being made to reverse the process of aging in a new area of modern medicine known as the Longevity medicine. Numerous medical and socio-economical problems have arisen as a result of population aging and these are the major area of concern to many people and organizations dealing with policy planning at global and national levels.

### **What is aging?**

For most of us aging means growing old and it is considered an inevitable process. However no uniformly acceptable definition has been found so far to describe the process of aging. Aging is not simply a passage of years, graying of hairs or wrinkling of skin but appears to be a more complex concept.

Although twenty year olds look old to four year olds, no one would describe twenty year olds as senescent or disabled because of their age. The same is applied to forty year olds, healthy sixty, seventy or eighty year olds. Although there are many debilitated elderly around us, majority of elderly are neither senescent nor disabled.

The beginning of the old age has been addressed by many writers and scholars over the

centuries. Most have located the beginning of the old age around age sixty, although some though it started around age forty. Two major factors appear to influence the beginning of old age. The interaction between individual and the society such as individual's relationship with society (external factors) and ability to perform tasks (internal factors) are taken in to consideration in deciding this critical age. However with the rise of formal retirement age, less emphasis has been placed on the individual's ability and more on the chronological age.

At present the beginning of old age more depends on the external factors such as government and economic definitions and become based on chronological age<sup>1</sup>.

### **Aging of the global population**

Life in 21 century is predicated to be a healthier and longer for many peoples. Recent advances in diagnostic technology and treatment methodology have resulted not only in adding more years to the life, but also improving the quality of the life in late years. Prevention of non-communicable diseases and improved rehabilitation programs have largely contributed to these trends. Figures published by WHO recently demonstrate the "Aging of the global population," which has attracted the focus of many people and organizations.

WHO predicts the life expectancy at birth, which is now 66 years to reach 73 years by 2025. By the year 2025, 26 countries will have a life expectancy at birth of above 80 years. As a result many countries will have more centenarians in years to come. France is predicated to have 150000 centenarians by the year 2025, compared to only 200 in 1950.

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An exponential rise in world population will be seen in future years. It will increase by nearly 80 million people per year to reach 8 billion compared to 5.8 billion in 1997. However no uniform rate of growth will be seen in all age groups. In the next 25 years, the population aged 65 and above is likely to grow by 88%, compared to an increase of 45% in the working age population. The population under 5 will grow by just 0.25% annually between 1995 - 2025<sup>2</sup>.

### **National population**

Keeping with global changes, Sri Lanka's population too will undergo major changes in its age structure in the future. Comparison of age structure of the population in 1991 and 2041 clearly demonstrate the aging of the Sri Lanka's population. The life expectancy at birth has shown a steady improvement in Sri Lanka. Between 1950 to 1992 the life expectancy at birth has increased from 32 to 71 for males and 30 to 74 for females. It will further increase to reach 76 for males and 82 for females in 2041.

Segment of population aged 60 and above has shown steady increase in the past and will continue to grow in future. It has grown from 5% in 1946 to 8% in 1991. It will continue to grow to 15% by 2016 and further increase to 28% by the end of 2041<sup>3</sup>.

### **Theories of aging**

Scientists continually pursue the puzzle that will provide a clear picture of the physical process of aging. Many theories have been suggested, but none are able to explain the secret of aging adequately. Many have attempted to explain the phenomena of physical aging at cellular level to describe cell characteristics associated with aging such as mechanical failure, damage, depletion of reserves, changes in structure and accumulation of metabolites. However these theories only provide clues to aging and they are not absolutes written in stones.

Current theories can, in general be separated into two groups<sup>4</sup>.

#### **DNA damage theories**

These theories explain aging as a result of accumulated damage to DNA, which in turn inhibits cells' ability to divide, function and express the appropriate genes. This leads to cell death and overall aging of the organism.

##### *DNA damage/ repair theory*

DNA damage occurs continuously in cells of living organisms. Most of these are repaired by a repair mechanism within the cell but some accumulate, as the DNA polymerases and other repair mechanisms cannot repair as fast as they are damaged. These accumulated DNA damages probably interfere with RNA transcription and impair the cells' ability to function in normal manner. Many agents can damage DNA, but most damage is caused by oxidative stress.

##### *The free radical / oxidative theory*

This perhaps the most respected and well studied theory, rests on the fact the oxidants induce a variety of biochemical changes in target cells. Hydrogen peroxide is considered one of the major oxidant damaging human cell. If the concentration of oxidant is high enough, the ensuing damage will lead to total cell death and, therefore, these alterations will not be passed on to future generations. If cells are exposed to sub-lethal concentration of oxidants, the ensuing injury could cause permanent and transmissible cellular damage, which can be transmitted to future generations.

##### *Mitochondrial DNA theory*

The mitochondria, which are the energy producing bodies within the cells, have their own genome (mtDNA). This mtDNA is continuously

exposed to the by-products of respiration and in danger in getting damaged due to these highly reactive oxidative products. Unlike nuclear DNA, mtDNA lacks an effective repair mechanism and is unable to withstand the injuries inflicted by these by-products. Thus, the cell loses its ability to produce energy and gradually dies.

### *Radiation theory*

This theory is focused mainly on the radiation induced cell damage and appears to be limited to superficial skin. Studies have shown the ability of UVA, UVB and infrared radiation to damage the skin and connective tissue underneath. Exposure to radiation induces formation of free radicals, which can accelerate aging of the superficial tissues.

### **Build-in breakdown theories**

These theories suggest that the aging is a direct consequence of genetic programming. The process of aging is directly built into the genome and cellular structures in the form of a biological clock. The exact location of this biological clock is uncertain, but may be located in several systems such as pineal gland, immunological system or in genetic materials.

### *Disposable soma theory*

Soma or somatic cells are all the cells in the body except gametes and cells involved in gamete formation. This theory suggests that body invest its energy and other resources mainly for the maintenance of nuclear materials and cells linked to reproduction. Once the organism passes the critical age and ability to reproduce decline, there is simply no reason to keep the organism alive.

### *Genetic theory*

Experiments have shown that human cells will divide less than 100 times outside the body. Also there is an inverse correlation between the num-

ber of cell divisions and the age of the person from which the cells are taken. Senescent cells express highly abundant DNA synthesis inhibitory mRNA, which is not seen in young cells. This theory suggests that aging is predetermined, active in-built process but the exact onset of this process is not known.

### *Immunological theory*

The immune system in the human body peaks at puberty and gradually decline with advancing age. Thymus gland decay and T-cells lose their effectiveness with advancing age. This makes person susceptible to infections and auto-immune disorders and accelerate cell aging.

### **Anti-aging therapy**

Based on the knowledge of aging mechanisms many attempts have been made to prevent or retard the process of aging. Many pharmaceutical items are available without a prescription in many developed countries and people concerned have raised the question of safety of these items and economical implications of such treatment<sup>6</sup>. The list of drugs is long and some popular drugs is discussed briefly here.

### *Melatonin*

Melatonin is a hormone produced from tryptophan, via serotonin in the pineal gland. It is synthesised and secreted at night between 9 pm and 8 am. The control for the production of melatonin comes from the suprachiasmatic nucleus of the thalamus and retinally perceived light.

Melatonin was discovered almost 40 years ago and yet despite intensive research, its role in the human body is not certain. Its beneficial effect on sleep-timing disorders is well known<sup>6</sup>. Animal and in-vitro studies have shown many other beneficial effects of melatonin. It is one of the most powerful scavengers of free radicals and it easily penetrates the blood brain barrier<sup>7</sup>. In addition it has anti-mitotic and immunosupportive properties<sup>8</sup>.

These properties of melatonin are believed to be beneficial in retarding the process of aging, but studies to demonstrate this benefit in a larger group of people are lacking. Although the free and generalized use of melatonin as an anti-aging therapy can not be recommended it is available freely over the counter as a food supplement in many countries<sup>5</sup>.

### **Dehydroepiandrosteron (DHEA)**

DHES and its sulfate ester, DHEAS decline with age. This is mainly due to the declining testicular functions and relative increase in sex hormone binding globulin (SHBG) seen with advancing age. Relative androgen deficiency is likely to have adverse consequences on muscles, adipose tissue, bone, haemopoiesis, insulin sensitivity, mood and sexual functions and might be treated by an appropriate supplementation. Studies involving larger number of people to prove this point are lacking and free and generalized use of these compounds can not be recommended with the current knowledge<sup>9,10</sup>.

### **Other forms of treatment**

Many drugs are considered to be useful in slowing the process of aging but they all need confirmation by future trials. Anti-oxidants such as vitamin E and C and selenium, amino acids and nucleic acids (DNA and RNA) are all claimed to have anti-aging properties but their use is mainly based on theories of aging than convincing results of human studies.

### **The effects of population aging**

By 2025 there will be more than 800 million people over 65 in the world, and two-thirds of them in developing countries. Caring for this population will be the most challenging task in the next century. By 2030, a third of the population in the United Kingdom will be of pensionable age and last December government set up a royal commission to look into this<sup>11</sup>.

The problems resulting from population aging can be divided in to several aspects

1. Less number of people in adult working population resulting higher rate dependency.
2. High demand on health care systems by elderly.
3. High demand on social and welfare organizations by elderly.

The relative slow growth of adult working population will contribute to greater dependency on this segment of population. Their contributions for welfare activities in the forms of taxes and other contributions will go high.

Disease are common among elderly. Old age is not a cause but appears to be associated with diseases. Old age associates with certain amount of disabilities. When activities of daily living are impaired they need assistance of others. Social services and welfare organizations play a major role in assisting elderly in need, but the cost of maintaining these services are very high. In 1993 Sri Lanka had 130 elderly homes. The number of elderly homes in Sri Lanka is growing but most of them are struggling to provide even basic facilities and depend on individual donations for survival.

### **Summary**

An exponential rise of the elderly population is predicted all over the world and figures from Sri Lanka too indicates this trend. Disease and disabilities are common in this segment of population and it will cause enormous burden on health and social care services. Time has come to plan strategies to meet the most challenging problem of population aging, globally and nationally. The mechanism of aging is becoming clearer and attempts are being made to retard the process of aging. Proper guidelines to plan the early days of life in order to achieve a healthy and strong old age will be available soon.

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