ANTHROPOLOGY OF AGING

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Contents

Summary

Definitions of so-called older age are often based on a chronological age of 65 years and over, but some authors take the view that aging is a process which starts after the 30th year of life. Initially there are changes in organ functions, followed by anatomical changes. Some organs age faster, some slower. For example, kidneys decrease in size to one third, the lungs do not change, the liver shrinks a little and the prostate doubles. In some cross-sectional studies, muscle mass in men aged 65 is on average 12 kilos less than in the so-called middle age, and in women it is approximately 5 kilos less. In the heart the amount of connective tissue increases, lipofuscin is deposited in cardiac muscle, the strength of which is decreasing. In the respiratory tract the number of pathways and cilia decrease, along with the alveolar surface; muscles involved in breathing change, and lung elasticity is also diminished.

With regard to the previous body capacity, "physiological aging" can be divided into three types of elderly: the "older" elderly have the highest functional capacity of 2-3 MET (MET= metabolic unit, i.e. oxygen consumption of 3.5 ml/kg body mass in a minute), the "younger" elderly are the persons of older age having maximal functional capacity of 5-7 MET, while the "sport" elderly have a functional capacity of 9-10 MET, disregarding chronological age. The brain weight diminishes by approximately 7% compared to younger age. In the temporal gyrus and area striata, as much as 20 to 40% of cells are lost, vacuolar and neuroaxonal degeneration occurs, and lipofuscin is accumulated. Brain blood flow, which is 50-60 ml/min/100g of tissue in normal conditions, with increase of biological age decreases to about 40 ml/min/100 g of tissue. However, this is usually not a consequence of biological age but of disease. A chronological age of 65 for the onset of “elderhood” is a sociopolitical construct developed by social security systems and government organizations to decide an arbitrary age at which benefits should be paid. Thus, it neither a border nor do changes designating old age occur exactly at that "age border". The changes in the organism during the so-called aging are individual. So, the functional capacity of an organism, both physical and intellectual, must be evaluated individually, having in mind biological age.

1. Introduction

Chronological and biological ages are in growing incongruity. This is particularly true for certain developed countries. For example in Croatia more than 15.6% of inhabitants are currently aged 65 or more, with the assumption that by the year 2050 AD, more than 30% of the population will belong to this group. In the city of Zagreb, every sixth inhabitant is aged 65 or over, and in the period 1992 to 2002 more inhabitants died than were born.

Aging is mostly discussed on the basis of chronological age. A chronological age of 65 for the beginning of “elderhood” is a sociopolitical construct developed by social security systems and government organizations to decide an arbitrary age at which benefits should be paid. But, numerous questions are imposed here, such as: can we talk about so-called older age on the basis of the chronological age border of 65 years? Is there substantial proof for this? What criteria are there? Probably, genetic-evolutionary and direct environmental factors over the centuries are responsible for the changes observed in humans.

It is considered that in the Paleolithic era people lived approximately 18 years; old Egyptians lived about 29 years. Sometimes it is stated that at the time of Christ the average life expectancy was about 30 years, although there were some people of pretty advanced age. In the so-called new era, some 500 years ago, the average life span was about 35 years. At the beginning of the twentieth century, average life expectancy was about 50 years, and at the end of the century it approached 80 years. For example, in USA at the beginning of the twentieth century the population aged 65 or older for both genders was 4.1%, in France 8.1%, but two thirds of the way through the century in the USA the proportion had increased to 8.3%, in France 12% and in Croatia 10.8%. It was expected that at the turn of the millennium there would be about 11.4% of the global population belonging to older age groups, but the actual data is much higher. What definition leads to the so-called older life age? It is a matter of different approaches, but common to all of them has been the citing of chronological age. An age of 65 years is most often used for assessment of the so-called older age.

But, a more careful definition from the World Health Organization regards older age as the range from 65 to 75 years, old age from 76 to 90 years, and very old age as the chronological age over 90 years.

Numerous changes occur in the human organism with advancing age, from decrease in material substrate quantity, making tissues less valuable, and often being replaced by still less valuable tissue. These changes are called atrophic or degenerative (the so-called "tissue wearing out processes").

Some authors claim that the end of an organism's life is the final course of events in increasing the entropy of a non-regulated system. In recent times the theory of apoptosis—programmed cell death—has been more widely accepted.

The highest somatic functional capacity in man is achieved at about the 30th year of life. According to some authors, the aging of the human body does not start at the age of 65, but after the 30th year. Some common criteria of aging are presented in Table1.

World Health Organization	60-75 elderly 76-90 old >90 very old
Often	60 >
Usual	65 >
Biological ages (by some authors)	30 >

Table 1. Some usual criteria of aging in years

Initially changes happen in organ functions, followed by morphological changes of particular organs. Some organs age faster, some slower. When evaluating the changes associated with advancing age, three types of changes can take place: changes of organs due to disease, changes of organs caused by organism aging (the so-called physiological aging), and the simultaneous changes in organs due to both disease and aging process. This text deals with the organ changes during physiological aging. The statement often met: *Senectus ipsa morbus est*, is incorrect.

Among the general changes which happen along with so-called aging, body mass grows with advancing age on account of fat tissue increase, but this normally decreases in highly advanced age.

Thus, for example, in some cross-sectional studies, in younger age men fat tissue amounts to about 15% of body mass, and at the age of 75 it is 36%. In young women it is about 33%, while at the age of 75 it is 45%, on average.

Cross-sectional comparisons (discounting change over life span) of middle and older ages show that the total amount of water in the body is reduced by about 10-15%. The human body contains more water outside than within cells, i.e. there is greater plasma volume. The ratio of these parameters in middle age is about 2:1, but it reduces in older age.

2. Skin and epidermal tissue

The skin changes with age. The germinative epidermal layer diminishes and the number of germination cells is reduced. Also, the number of sebaceous and sweat glands becomes smaller; the skin becomes thin, its elasticity is lost and it wrinkles, especially on the face. The epidermal fat tissue is reduced, and the skin loses some of its thermal insulation properties.

The quantity of subcutaneous tissue decreases, the skin itself becomes thinner, sweat glands undergo atrophy, and sweating is lower. The blood perfusion of the skin diminishes, both due to changes in blood vessels and to decrease in heart output. Thermoregulation changes, due to the above-mentioned factors, but also as a result of changes in the central nervous system. The result is a weakening of the ability to emit heat and to maintain body temperature.

Nails grow more slowly, they become blunt and yellowish, and the content of calcium declines. Hair is lost from the scalp, armpits and other places.

3. Supportive tissues

The supportive basis of the connective tissue changes and the water content reduces, while the amount of solid tissue grows. The latter consist of polymers condensing in old age. Collagen fibers become both larger and more numerous, their fusibility decreases, and their structure becomes more solid. However, their mechanical properties become aggravated. Consequently, more strength is needed for adequate extension, while return to the initial length is slower. In very advanced age, however, the collagenase enzyme concentration is increased, causing less expressed collagen inelasticity. With age, elastin fibers lose water, become intense yellow, hard and stiff. This is especially observable in stress, when they break and become fragmented. They are sometimes replaced by collagen fibers. With advancing age emerges a substance with properties in between collagen and elastin—the so-called pseudo-elastin. Its structure comprises an amorphous substance sheath around collagen.

The hyaline cartilage dehydrates through the years, and turns into fibro-cartilage. The joint cartilage becomes yellow, loses elastic properties, and in more mechanically loaded sites, e.g. the knee meniscus, it becomes thinner. The cartilage can completely "ossify" due to calcifications. The skin loses elasticity, the joints become stiffer due to fibrous tissue and the rib cartilages lose elasticity, and stiffen. The intervertebral discs harden due to the restricted water content.

4. Muscle mass

The muscle mass in men in so-called middle age in some cross-sectional studies, is about 12 kg higher than at the age of about 65 years, and in middle aged women about 5 kg higher than at the age of 65. The pigment lipofuscin is accumulated in muscle cells (called the "aging pigment"), the quantity of fats increases, some of the muscle cells deteriorate and are replaced by connective tissue. An attempt to regenerate myocytes is the synthesis of proteins in their peripheral parts, lessening the ATP content, decreasing the ratio of ATP and ADP, and diminishing the quantity of glycogen and creatinine phosphates. Simultaneously, but to a lesser degree, motoneurons are being lost. The amount of spontaneous neurotransmitter release decreases, although membrane potentials do not change with advancing age. In some studies, working capacity, i.e. use of large muscle groups over longer periods of time, in older age is approximately one third lower than that of middle aged persons.

5. Bones

Bones also undergo numerous changes, particularly in women after menopause. The mineral content of bones subsides for about 10% with advancing age. In long bones remodeling occurs. The outer bone diameter is increased, the bone mass becomes thinner, and the resulting space is filled with fat and fibrous tissue. The bone cortex becomes thinner with the increasing inclination towards fractures. This loss of mineral content is particularly pronounced in women after menopause. Consequently, the frequency of bone fractures is several times greater in women than in men.

Data show that each fifth woman aged about 80 yrs experiences the thigh-bone fracture. Naturally, many factors are responsible for that, from the imbalance of osteoblastic and osteoclastic activities (particularly in post-menopause) to the change in the relation of parathromones and calcitonin. The latter happens due to the changes in the estrogen quantity, because the calcitonin excretion is under direct influence of the estrogen rate in the blood flow.

The consequence is the larger quantity of parathormone which directly influences the bones and the increased excretion of minerals through kidneys. Besides, in the elderly the decreased concentration of hydroxylated D_3 vitamin is observed, leading towards reduced calcium absorption through the small intestines membrane which causes an increased calcium release from the bones in order to achieve the adequate calcium level in blood.

6. Teeth and oral cavity

By some studies, about the half of people at the age of 65 have no more teeth. The loss of teeth will of course, besides the chronological age, depend upon the mouth cavity hygiene, but also upon other concomitant diseases.Dentin decreases with age, odontoblasts increase their activity and degenerate, dentin becomes turbid and hypohydrated. The tooth pulp is almost filled in, partly by the altered odontoblasts. The amount of cemented substance is decreasing, and the changes in bones are characterized by the mineral loss and bone matrix resorption.Changes in blood vessels and nerves of the oral cavity occur as well, the blood flow through the salivary glands subsides, leading to the reduced mucin secretion.

The tongue is prone to atrophy, while the sense of taste can be lost up to 70%.

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Biographical Sketches

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