Human Aging

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If aging is central to the human condition, are there identifiable aging events that all people experience? The answer is "yes," but some caution should be exercised here as the list of common aging events, presented below, and exceptions to them continues to expand as our understanding of the complexities of senescence increases. Further, some universal physiological changes in their more extreme forms are classified as diseases, such as, osteoporosis and BPH (benign prostatic hyperplasia or enlarged prostate gland). *Universal Aging* refers to the inevitable physiological changes that humans encounter as they age, assuming a normal life expectancy. Here is a general list of "universal" aging events. Because they occur slowly at the tissue, organ, or systemic level, over a period of years, many of these events are indiscernible and often go unnoticed:

21 Universal Aging Events

- **graying and thinning of hair**, gradual and progressive over a 15 year period typically beginning in the late 20s or early 30s (Commo, Gaillard & Bernard, 2004).

- **changes in skin elasticity and texture** beginning in the mid-20s, and decline in dermal vasculature resulting in change in skin pallor, decreased inflammatory response and clearance of foreign substances, delayed wound healing, decreased sweating, and compromised thermoregulation (Kart, Metress, & Metress, 1992).

- **loss in height** due to joint compression and posture change, beginning at about age 30 and accelerating with age resulting in a 1.2 inch loss for women and a 1.9 inch loss for men by age 70 (Bord-Hoffman & Donius, 2005).

- **progressive decline in overall flexibility** with age due to less elasticity in ligaments and connective tissues between bones, loss of muscle mass and muscle fibers, and tissue dehydration (American Academy of Orthopaedic Surgeons, 2007).

- **muscle mass loss** (sarcopenia), about 10 percent per decade after age 45 (Janssen & Ross, 2005).

- **degeneration of the aging eye**, beginning after age 40: reduced elasticity of the lens resulting in inability to perceive small detail (presbyopia): increased lens thickning, opacity, and yellowing resulting in loss of visual acuity, peripheral, low light and night vision, decreased color clarity perception (senile cataracts) (Kline & Scialfa, 1996; Kart, Metress, & Metress, 1992).

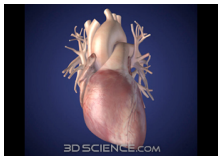
- **progressive degeneration of the auditory nerves and structures of the inner ear** after age 50, along with excessive build-up of cerumen, resulting in hearing capacity decline, particularly higher frequencies, and decreased signal detection capability (Kart, Metress, & Metress, 1992).

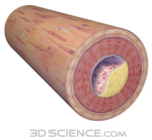
- **lung capacity decline** starting at age 20, dropping about 5 percent in functional ability per decade. There are four major changes associated with aging: 1) a decline in elasticity of the bony thorax, 2)

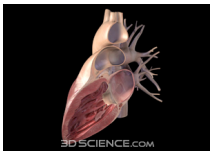
a loss of muscle mass with weakening of the muscles of respiration and reduced mechanical advantage, 3) a decrease in alveolar gas exchange surface and 4) a decrease in central nervous system responsiveness, which have anatomical, mechanical and functional consequences (Ross, 2009).

• **kidney efficiency decline** at about 4 percent per decade beginning at age 30, including decreased blood flow, glomerular filtration rate, mass and weight (Núñez, Cameron & Oreopoulos, 2008).

• **bone density loss** beginning after age 30 due to incremental metabolism changes, becoming problematic (osteoporosis) after age 50 in certain higher risk individuals, including post-menopausal Caucasian and Asian women, thin and small body-framed individuals, genetically predisposed, and persons whose lifestyle factors are unhealthy (e.g., poor diet, smoking, lack of exercise) (Raisz, 2008).







• **cardiovascular aging** in terms of decline in maximum heart pumping rate, oxygen extraction, and aerobic capacity resulting from arterial stiffening, vasoconstriction, elevated systolic blood pressure and increased pulse pressure, thickening of the left ventricle wall, reduced diastolic filling rate (with filling slowing after age 20 and reaching 50% loss by 80), impaired cardiac reserve, alterations in heart rate rhythm (i.e., decline in beat-to-beat fluctuation with aging), and prolonged cardiac action potential (Webb & Inscho, 2005).

• **decreased sensitivity in touch** (tactile threshold, thermal pain threshold, vibration sense, and spatial acuity) in older adults with functional implications for speech, hand grip, and postural stability (Wickremaratchi & Llewelyn, 2006).

• **gastrointestinal changes** related to aging (Kart, Metress, & Metress, 1992):

mouth: decline in salivary flow, smell, and taste after age 60 (of the four basic tastes, salty, bitter, and sour decline with age but sweet does not) (Schiffman, 1997);

esophagus: common with advancing age are reductions in contractions and tension in upper esophageal sphincter, and which may be indicative of more serious disorders, are difficulty with swallowing, substernal pain, heartburn, belching, and general discomfort; anatomical changes to the larynx that result in voice change, apparently more extensive in males (Linville, 2004).

stomach: changes in gastric mucosa initially affecting acidity level and fat digestion, then a decline in pepsinogen production necessary for protein digestion, followed by a decline in mucin production, collectively resulting in impaired digestion and nutrient absorption;

small intestine: decrease in size and permeability of capillary bed and, after age 40, decline in pancreatic enzymes being secreted into the small intestine contributing to malabsorption of nutrients (including fat and carbohydrates) and maldigestion, including lactose intolerance and bloating;

gallbladder: after age 60 decline in ability to empty the gallbladder and a change in the physical composition of the bile (thicker, richer in cholesterol, volume reduction) resulting in increased incidence of gallstones for adults 50-60 years in age (25-30 percent) and over age 80 (55 percent);

liver: decreased storage capacity and blood flow with age and after age 70 a decline in weight (from 2.5 percent of body weight to 1.6 percent) resulting in a slight reduction in ability to synthesize protein but in minimal decline in liver function (Jourdan, Vaubourdolle, Cynober & Aussel, 2004; Kitani, 2002);

pancreas: both structural and enzymatic changes after age 40 including age-related reduction of trypsin (proteolytic enzyme important in protean synthesis) and reduced alveolar cell generation, adipose and amyloid infilteration, and obstruction of the pancreatic ducts.

- **loss of reproductive capacity and sexual vitality** (Johnson, 2007):
  women: fertility is highest in the 20s, declining slowly to about age 35 and more rapidly thereafter culminating in menopause (final menstrual period) at a mean U.S. age of 52; physical, functional, and emotional changes, driven by ovarian transformation, including estrogen reduction (e.g., hot flashes and night sweats, bone density loss), changes in blood lipid levels (increased risk of heart disease), reduction in the size of the uterus and breasts, reduction in vaginal lubrication and rise in vaginal pH, loss of libido, and general discomfort, depression, anxiety, and mental confusion.
  men: There is current uncertainty regarding the exact causes of male reproductive decline with age with fertile spermatozoa being produced in most men throughout life; after age 20 semen volume and motility decline along with the quality and quantity of spermatozoa; decline in testosterone production, loss of libido, erectile dysfunction, and orgasm failure are more frequent after age 40, and are exacerbated by diabetes, high blood pressure medications, smoking, and neurodegeneration; enlargement of the prostate (benign prostatic hyperplasia) is common in half of all men in their 60s and as many as 90 percent in their 70s and 80s resulting in obstruction of the urethra and gradual loss of bladder function (National Kidney Information Clearinghouse, 2006).

- **changes in specific brain density and weight**, about 5-10 percent reduction between the ages of 50 and 90, select neuron death primarily in the frontal lobes and parts of the brain related to movement (cerebellum and basal ganglia), widening of brain surface grooves and shrinkage of the convolutions, 25 percent reduction in overall brain electrical activity, probably related to decreased blood flow as we age, increase in neurofibriallary tangles, formation of senile plaques, and reduction in the amount specific neurotransmitters, and degradation of the mylean sheath (i.e., white matter) around neurons; while all healthy adults experience some cognitive decline, including minor memory problems and decreased reaction time in the processing of complex information, there is enormous variability among healthy adults and the underlying causes and differential rates of cognitive aging are not clearly understood (Glisky, 2007; Whalley, 2001; Guttman, 2001).

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