

Review Article

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Aging and Cardiovascular Diseases

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Abstract

Aging; It is a physiological period that includes the whole of the irreversible, functional and structural changes that occur over time at the system, tissue and cell level of the organism. Globally, the population aged 65 and over was 703 million in 2019, with the East and Southeast Asia region hosting the largest number of seniors (261 million). It is predicted that 80% of the elderly will live in middle- and low-income countries by 2050. While the population aged 65 and over in Turkey was 6 million 651 thousand 503 people in 2016, it increased by 24.0% in the last five years and reached 8 million 245 thousand 124 people in 2021. While the proportion of the elderly population in the total population was 8.3% in 2016, it increased to 9.7% in 2021. After the age of 60, there is an increase in fat ratio and a decrease in muscle weight, different in men and women. The decrease in joint flexibility, muscle mass and calcium level in the bones in the human body makes it difficult for the person to perform daily life activities. In a review published in 2016, it was stated that regular physical exercise reduces the risk of major cardiovascular and metabolic diseases, cognitive loss, obesity and falls in advanced age. According to the Centers for Disease Control and Prevention (CDC), noncommunicable diseases significantly restrict the activities of daily living of 39 percent of individuals aged 65 and over.

Keywords: Aging, cardiovascular diseases, chronic diseases

INTRODUCTION

Aging; It is a physiological period that includes the whole of the irreversible, functional and structural changes that occur over time at the system, tissue and cell level of the organism. The aging process begins with birth, and all kinds of organisms age by undergoing many changes from birth to death. Aging is not a constant process and varies between individuals. The last part of this process is called old age. The onset of old age reveals individual differences from society to society and even within the same society over the years, according to education level, gender, physiological and economic conditions, and psychological age [1].

According to the World Health Organization (WHO), old age; It was expressed as increasing disability and being more dependent on others, and the old age limit was determined as 65 years. According to WHO, the scientific

40 classification of old age is:

- 41 • Early (Young) Age: 65-74 years
- 42 • Middle Age: 75-84 years old
- 43 • Advanced Age: 85 years and above [1].

44 The increase in the life process in the last century is one of the most important results of social progress. Some of
45 the reasons that affect the progress of the life process are the mutual relations of factors such as technological and
46 medical developments, increasing educational opportunities, healthy nutrition, and improving working conditions.
47 Therefore, the fact that old age has become a social problem in societies is based on the progress that has
48 emerged in the process of urbanization and industrialization. However, the increase in the ratio and number of
49 elderly individuals in the total population also causes differentiation in the role and position of the elderly in
50 society [2].

51 The words “old age” and “age”; It is expressed in sociological, psychological and biological dimensions and
52 takes shape according to the principles and values put forward by the society. Old age is defined as “A person is
53 as old as they feel, or as old as they think, even at the age at which their arteries are based”. The aging process, on
54 the other hand, varies according to genetic factors, the effect of diseases, the emotional state of the person,
55 environmental conditions, technological and scientific advances in the field of health [2].

56 According to the World Health Organization, the term elderly; It is meant for people over the age of 65. But
57 gerontology; He says that the aging process emerges from processes that are too complex to easily say that this
58 person is old. According to Gerontology, old age is only a social design and designs can differ according to need
59 and situation [2].

60 The words "age" and "old age" are a natural process that contains different problems in terms of chronological,
61 biological, social, cultural and historical aspects. A common definition of old age that is accepted by everyone
62 has not been expressed. Old age is a word that refers to the subjective aspect that changes according to social
63 development, age and region and differentiates according to the individual's psychological, social and health
64 status (Kalaycı, 2015). The concept of aging, which is based on these changes by WHO, is a biological stage that
65 occurs beyond the control of the person and his ability to adapt to environmental factors decreases [2]. Old age is
66 a normal period in which there are chronological, social and biological changes that include all of the irreversible
67 changes in the mental and physiological states of people [3,4].

68 The concept of the elderly is expressed as the loss of the individual's physiological, psychological, physical and
69 mental strength [5]. Although the concept of old is used in the sense of "older", it also means an experienced or
70 experienced, mature person in the society [6]. From the ancient times of history to the present, many definitions

71 have been introduced to the concept of the elderly from different angles. However, from what age an individual
72 will be described as "old" is among the topics discussed. Based on the statements of OECD (1992), when the
73 word elderly is mentioned, it is understood that "people aged 65 and over, consisting of a heterogeneous group
74 whose behaviors and needs change" [7]. While the United Nations expresses the age of 60 and over as old, many
75 developed countries take the age of 65 as a reference. WHO chronologically defines people aged 65 and over as
76 "elderly". Since there is a consensus on the definition of elderly by the WHO with the chronological age variable,
77 65 years and over are defined as "elderly" [8,9].

78 Today, people aged 65 and over are categorized as "elderly" across the world. Accordingly, it is seen that first of
79 all, the qualification of the elderly is realized on the basis of chronological age. In this context, there is a
80 consensus on the definition of people who have left 65 years behind as old. However, chronological age does not
81 provide sufficient information for the definition of the elderly today. The age to be considered "old" in every
82 period and society may differ, and the age at which this agreed "age" is may change over time and from society to
83 society. This indicates that age is not only a chronological order, but also a cultural and social concept in this
84 context [7,9].

85 Senile; It is considered as one of the life periods of the individual such as infancy, childhood, adolescence and
86 youth. It is seen as the synthesis of all periods throughout life. It is expressed as the last stage of human life and
87 the advanced aging stage of the person [10]. Aging is a form of being old in the word meaning, showing the
88 actions of advanced age. In terms of biological functions, it is the transformation and change in the time period
89 until death after reaching adult status [8,9].

90 Old age is a period that indicates the differentiation of the mental and physical structure of the person and the
91 decrease in the existing mental and physical capacities. It is also the period when the quality of life declines with
92 the change in social and economic conditions. It refers to a period in which individuals lose their independence
93 and experience losses in their living spaces. Thus, it is seen as a fixed and stagnant period of life in which
94 individuals become dependent on their environment [7,11]. Aging is generally accepted as a life period in which
95 problems such as cognitive and physical decline, abandonment of the productive role, loss of health, change in
96 the social position of the individual, differentiation of interpersonal relations are experienced [11]. However,
97 although old age is perceived as a negative period due to some regressions, diseases, inadequacies and problems,
98 it is actually related to how the previous periods of life were spent as a synthesis of other periods. For this reason,
99 old age is not just a period of getting older, but a result of all life [9,12].

100 **ELDERLY POPULATION IN THE WORLD AND IN TURKEY**

101 Since the middle of the 21st century, the improvement in living standards along with the decrease in birth rate all

102 over the world, especially in developed countries, causes the prolongation of human life and the rapid increase in
103 the number of elderly individuals [2].

104 According to WHO data, while people live longer today, every country in the world is experiencing a growth in
105 the proportion of the elderly in the population. The population aging rate is much faster than in the past. The
106 number and proportion of the population aged 60 and over is gradually increasing. The number of individuals
107 aged 60 and over was 1 billion in 2019, and by 2030, 1 out of every 6 people in the world will be aged 60 and
108 over (1.4 billion), and by 2050 the world population aged 60 and over will double (2.1 billion) is estimated. The
109 number of individuals aged 80 and over is expected to triple between 2020 and 2050, reaching 426 million. This
110 increase is occurring at an unprecedented rate and will accelerate in the coming decades, especially in developing
111 countries [13].

112 Also globally, the population aged 65 and over in 2019 was 703 million, with the East and Southeast Asia region
113 hosting the largest number of seniors (261 million). It is predicted that 80% of the elderly will live in middle- and
114 low-income countries by 2050 [13].

115 While the population aged 65 and over in Turkey was 6 million 651 thousand 503 people in 2016, it increased by
116 24.0% in the last five years and reached 8 million 245 thousand 124 people in 2021. While the proportion of the
117 elderly population in the total population was 8.3% in 2016, it increased to 9.7% in 2021. In 2021, 44.3% of the
118 elderly population was male and 55.7% was female. According to population estimates, it is predicted that the
119 proportion of the elderly population will be 11.0% in 2025, 12.9% in 2030, 16.3% in 2040, 22.6% in 2060 and
120 25.6% in 2080. When the elderly population is analyzed by age group, it is seen that 61.5% of the elderly
121 population is in the 65-74 age group, 30.2% is in the 75-84 age group, and 8.2% is in the 85 and over age group.
122 In 2021, 64.7% were in the 65-74 age group, 27.3% were in the 75-84 age group, and 8.0% were in the 85 and
123 over age group. The fact that the proportion of the elderly population in the total population exceeds 10.0%
124 indicates the aging of the population. The elderly population in Turkey has increased at a higher rate than the
125 population in other age groups [14].

126 In Turkey, which is in the process of "demographic transformation", which is called the global aging process, the
127 age group of the population has changed with the decrease in the fertility and mortality rates, the developments in
128 the field of health, the increase in the welfare level, life expectancy at birth and the standard of living. While the
129 ratio of young people and children in the total population has decreased, the ratio of the elderly in the total
130 population has increased. Although Turkey still has a young population structure compared to countries with a
131 proportionally elderly population structure, the elderly population is considerably higher in numbers [14].

132 The median age, which is one of the indicators giving information about the aging of the population, was 31.4 in

133 2016 and became 33.1 in 2021. According to population estimates, the median age is expected to be 34.1 in 2025,
134 35.6 in 2030, 38.5 in 2040, 42.3 in 2060 and 45.0 in 2080 [14].

135 While the elderly dependency ratio, which represents the number of elderly people per hundred people of
136 working age, was 12.3% in 2016, this rate increased to 14.3% in 2021 [14]. According to population estimates, it
137 is predicted that the level of elderly dependency will be 16.4% in 2025, 19.6% in 2030, 25.3% in 2040, 37.5% in
138 2060 and 43.6% in 2080 [14]. While the first three countries with the highest proportion of elderly population
139 were Monaco with 34.3%, Japan with 28.8% and Italy with 22.8%, Turkey ranked 68th among 167 countries [14].
140 According to the United Nations world population estimates, life expectancy at birth for the period 2020-2025 is
141 73.2 years, 70.8 years for men and 75.6 years for women worldwide [14].

142 In Turkey, in 2021, 6 million 112 thousand 760 out of a total of 25 million 329 thousand 833 households have a
143 minimum individual aged 65 and over, defined as the elderly population. In other words, it was seen that 24.1%
144 of the households lived at least one elderly person. Elderly individuals living alone constitute 1 million 561
145 thousand 398 of 6 million 112 thousand 760 households with at least one elderly person [14]. The rate of
146 illiteracy among the elderly population decreased from 20.8% in 2016 to 15.6% in 2020. The rate of illiterate
147 elderly women was on average 5 times higher than the rate of older men in 2020 [14]. When the elderly
148 population is analyzed by education level, the rate of those who graduated from primary school in 2020 is 46.1%,
149 the rate of those who graduated from secondary school or equivalent school / primary school is 7.9%, the rate of
150 those who graduated from high school or equivalent school is 8.0%. the rate of graduates is 7.4%. It has been
151 observed that the ratio of the elderly male population is higher than the elderly female population at all completed
152 education levels [14].

153 According to the findings of the living conditions and income study, while the poverty rate was 21.2% for Turkey
154 in 2016, it became 21.9% in 2020. While this rate was 16.0% in 2016 for the elderly population, it became 16.7%
155 in 2020 [14]. According to the findings of the household information technologies usage study, while the rate of
156 people aged 65-74 using the internet was 8.8% in 2016, this rate increased to 32.5% in 2021 [14].

157 **PHYSIOLOGICAL CHANGES DUE TO AGING**

158 During the aging period, some changes occur in elderly individuals. These generally consist of psychological,
159 physical, social and economic changes and affect the life of the elderly individual. In this context, when we look
160 at the physiological changes, after the age of 60, there is an increase in fat ratio and a decrease in muscle weight,
161 different in men and women. The decrease in joint flexibility, calcium level in bones and muscle mass in the
162 human body makes it difficult for the person to perform daily life activities. For this reason, the level of physical
163 activity of people decreases. Loss of muscles and bones causes an increase in the risk of fracture, shortening of

164 the neck, tooth loss, thinning of the subcutaneous fat layer, humpbacks and curvatures in the legs. With aging,
165 decreases occur in heart beat volume, heart function, oxygen consumption and beat rate [2].

166 Hardening of the chest wall, loss of flexibility of the lung tissues and decrease in respiratory muscle strength
167 cause changes in respiratory functions. The decrease in the effectiveness of insulin, which is important in the
168 regulation of blood glucose, leads to "type 2" diabetes. Insulin resistance occurs as a result of an increase in
169 adipose tissue and a decrease in physical activity. There is also a decrease in the metabolic rate of the brain. As a
170 result of the decrease in basal metabolic rate, calorie requirement and total energy expenditure decrease. As a
171 result of the decrease in the flexibility of the lenses, loss of close focusing, decrease in depth perception, color
172 discrimination and visual acuity occur in the eyes. Falls occur in unsafe environments, such as slippery floors,
173 due to problems related to the nervous system, balance and vision in the elderly. In the elderly, injuries such as
174 bone fractures, painful soft tissue damage and cerebral hemorrhage come to the fore as a result of falling. In old
175 age, the proliferation of immune cells decreases and the body's resistance to micro-organisms decreases. Aging
176 has no effect on the male and female reproductive systems. As a result of the decrease in hormone levels in older
177 women, the ovaries and uterus become smaller in terms of their function and structure. Dryness and thinning of
178 the vaginal tissue are noticeable. Nipple sensitivity decreases and breasts are hard. These changes experienced by
179 women do not have a negative effect on sexual act. Although men's reproductive system changes also occur, they
180 have the opportunity to have children until they die. In addition, as a result of the decrease in hormone production,
181 changes in sperm quality and number, decrease in seminal fluid, shrinkage in testicles and penis and enlargement
182 in prostate occur [2].

183 Some age-related changes include a gradual decline in physiological aging-related function. With aging,
184 physiological changes occur in senses such as gastrointestinal system, respiratory system, neurological system,
185 cardiovascular system, excretory system, immune system, endocrine system, musculoskeletal system, vision, skin,
186 taste, smell and hearing. Elderly people often have multiple chronic systemic diseases and are taking multiple
187 medications. With age, psychomotor decline, loss of function in organs and tissues, and therefore, limitation in
188 daily activities and increase in accident rates, more serious and frequent infections are expected conditions. These
189 changes due to aging affect the daily life activity, addiction status, communication with the environment and
190 working life of the individual [15].

191 Physical and physiological changes that occur with aging cause failure in social relations due to depressive mood,
192 deterioration in cognitive functions and limitation in daily living activities [3,4,16]. Physiological changes occur
193 in many body systems during the aging process. These changes affect the individual's addiction status,
194 communication with the environment, daily life and working life [4,17].

AGING AND CARDIOVASCULAR DISEASES

According to TUIK death and cause of death statistics, 37.6% of the elderly who died in 2021 died due to circulatory system diseases. The cardiovascular system is the most important system that affects mortality and morbidity due to cell loss in the conduction and muscle system in old age. Depending on the genetic background and age, the heart's ability to pump blood decreases, the myocardium loses its flexibility, and the heart valves thicken and increase in diameter. Due to arteriosclerosis, the thickness of blood vessels increases while their elasticity decreases. Functional and structural changes in the cardiovascular system in old age increase the risk of coronary artery disease, heart diseases, heart failure, venous thrombosis and hypertension. Healthcare professionals should be aware of these physiological changes that affect the quality of life of elderly people [18].

With aging, some changes occur in the cardiovascular system without the presence of morbidity. With aging, cardiac output and stroke volume decrease and the risk of postural hypotension increases. The vessel walls thicken and decrease in their elasticity. With advancing age, a continuous rise in systolic blood pressure occurs as a result of the hardening of the vessels and the decrease in their elasticity. At the age of 60 and beyond, there is either a slight decrease or no change in diastolic blood pressure. With the accumulation of calcium minerals in the heart, the valves in the heart thicken and murmurs appear. With the decrease in the response to beta-adrenergic stimuli in smooth muscles, cardiac output also decreases during exercise [15,19]. Important problems that can be seen as a result of physiological changes that occur with aging; heart failure, arrhythmia, and cardiac hypertrophy. In this context; The risk of cardiovascular disease increases with the existence of other associations such as age-related diabetes, obesity and hypertension. With increasing age, heart failure, heart valve problems, arrhythmias and coronary artery diseases also increase. For this reason, there is a need to know the changes that occur with aging [20].

Cardiovascular diseases are the leading cause of death in people aged 65 and over, and 80% of deaths from cardiovascular diseases occur in this age range. For this reason, it is important for healthcare professionals to interpret and understand the physiological changes that will reduce the quality of life in later life [21]. With age, stroke volume and cardiac output decrease and the risk of postural hypotension increases. The shadow of the heart is enlarged when looking at the chest X-ray. With aging, the elasticity of the vessel walls decreases and thickens. As a result of various calcifications in the heart, mitral and aortic valves are affected, causing sclerosis, murmurs and thickening of the heart valves. The response to beta-adrenergic stimulus in smooth muscles and thus cardiac output decreases during exercise.

Systolic blood pressure generally increases with advanced age, whereas diastolic blood pressure either tends to decrease slightly or does not change after 60 years of age. The main reason for this is the hardening of the arteries

226 due to the loss of flexibility of the great arteries. An increase in systolic blood pressure can cause hypotension and
227 impair left ventricular filling. Arrhythmias and ectopic beats are common, and the activity of baroreceptors
228 decreases, vasoconstriction occurs in the lower extremity veins, and the adipose tissue around the heart increases.
229 The blood flow to all organs decreases, the superficial veins of the skin become prominent and the veins dilate. A
230 serious decrease in physical activity capacity due to aging, hypertension, atrial fibrillation, atherosclerosis, valve
231 diseases, heart attack, venous thrombosis and heart failure occur. Appropriate exercises should be recommended
232 to elderly people according to their physical capacities, and the elderly should stay away from extreme fatigue,
233 stress and situations that cause tachycardia [15,22].

234 With aging, the number of cardiac output and cardiac beats decreases, the wall thickness increases, and the
235 vessels lose their flexibility. The fat layer surrounding the heart increases and the heart valves lose their elasticity
236 and become thicker. These changes, which occur with advancing age, significantly affect the function of the heart
237 and create an environment for the development of non-communicable diseases. Congestive heart failure,
238 hypertension, ischemic heart disease, coronary artery disease are common cardiovascular diseases in the elderly.
239 Due to these problems, circulation decreases, weakness, fatigue, edema, oxygen deficiency and adaptation to
240 different states become difficult [4,23].

241 **STUDIES ON AGING AND CARDIOVASCULAR DISEASES**

242 The physical capacities of individuals decrease with age, which limits the functional independence of the elderly
243 [24]. In a review published in 2016, it was stated that regular physical exercise reduces the risk of major
244 cardiovascular and metabolic diseases, cognitive loss, falls and obesity in advanced age [25]. In a study
245 conducted between November 2011 and July 2012 in elderly people living in 25 nursing homes affiliated to the
246 Ministry of Family and Social Policies, hypertension (60.3%), cardiovascular diseases (34.3%), rheumatic
247 diseases (29.8%) and diabetes mellitus. mellitus (29.4%) was determined as the most common diseases [26,27].
248 According to the Center for Disease Control and Prevention (CDC), non-communicable diseases mainly restrict
249 the daily activities of 39 percent of individuals aged 65 and over [28,29].

250 According to TBSA 2017 research data, high total cholesterol level (≥ 200 mg/dL) was determined in 42.2% of
251 men aged 65 and over and 57.4% of women. HDL-C levels are low in 36.5% of men and 43.6% of women (male:
252 < 40 mg/dL; female: < 50 mg/dL). High triglyceride levels in 15.1% of men and 17.2% of women (≥ 200 mg/dL);
253 low-density lipoprotein cholesterol (LDL-C) levels were found to be high (≥ 130 mg/dL) in 28.7% of men and
254 27.8% of women. High HbA1c levels (≥ 6.5 mg/dL) were found in 23.2% of men and 23.7% of women. 23.6% of
255 men and 28.7% of women had diabetes; 48.2% of men and 65.4% of women declared that they were diagnosed
256 with cardiovascular disease. The frequency of high fasting blood glucose (≥ 126 mg/dL) and impaired fasting

257 glucose (110-125 mg/dL) was in 21.3% and 25.3% of men and 17.0% and 27.1% of women, respectively [27].

258 According to the Global Physical Activity Survey (GPAQ), 43.2% of the 60-69 age group (female: 55.6%; male:
259 29.7%) in TBSA 2017 data; 64.5% (female: 77.3%; male: 47.1%) of the age group 70 and over met
260 recommended conditions [150 minutes of moderate or 75 minutes of vigorous-intensity work per week or at least
261 600 metabolic equivalent work (METs) per minute) level of high and moderate physical activity] [27].

262 Malnutrition in the elderly leads to deterioration of general health status and an increased risk of non-
263 communicable diseases, especially cardiovascular diseases and sarcopenia. Nutrition is a key factor in the aging
264 process; it helps to maintain and protect health and reduce the risk of non-communicable diseases [27,30].

265

266 CONCLUSION

267 With aging, some changes occur in the cardiovascular system, and as a result of these changes, the risk of
268 cardiovascular disease increases. Cardiovascular diseases are one of the leading causes of death in the elderly.
269 Therefore, necessary precautions should be taken to reduce the risk of developing these diseases. Excess weight, a
270 life without physical activity, unhealthy diet, etc. conditions that increase the risk of cardiovascular disease.
271 Providing weight control, encouraging physical activity, gaining adequate fluid intake and healthy eating habits,
272 preventing smoking and alcohol use, avoiding stress, ensuring the correct use of drugs, etc. These are important
273 practices in preventing the risk of cardiovascular disease and the progression of the existing disease.
274 Unhealthy nutrition and resulting obesity cause the formation of nutrition-related non-communicable diseases
275 (cancer, cardiovascular diseases, osteoporosis, diabetes, etc.) [29]. Studies have shown that physical exercise; It
276 has been shown that it reduces the risk of developing type 2 diabetes and having a heart attack by 50 percent, and
277 that this significant reduction may also be valid for some cancer diseases and high blood pressure [29,31].

278 DECLARATIONS**279 Acknowledgments**

280 We would like to thank the staff of the journal *Aging Pathobiology and Therapeutics*, who helped with the English
281 language editing of our article.

282 Authors' contributions

283 Single author:

284 The author contributed solely to the article.

285 Two or more authors: Topuz İ, Şişko E

286 Made substantial contributions to conception and design of the study and performed data analysis and
287 interpretation: Topuz İ, Şişko E;

288 Performed data acquisition, as well as provided administrative, technical, and material support: Topuz İ, Şişko E

289 Availability of data and materials

290 Not applicable.

291 Financial support and sponsorship

292 There are no sources of funding for the study reported, any relevant grant numbers and the link of funder's. None.

293 Conflicts of interest

294 All authors declared that there are no conflicts of interest.

295

296 Ethical approval and consent to participate

297 Not applicable.

298 Consent for publication

299 Not applicable.

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Supplementary Materials

None.