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A growing problem of falls in the aging population: A case study on Poland – 2015–2050 forecast

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ABSTRACT

Poland entered the period of intensive aging of population. In the coming 25 years, the percentage of persons aged 65 and over in Poland will increase from 13% of the total population in 2010 to 23% in 2035 (ca. 10 million). The problem of falls resulting from aging of the body was presented using the example of Poland. The article describes main issues related to etiology, epidemiology, diagnosis, prevention and social consequences of falls caused by the impairment of musculoskeletal system in the group of persons aged 65 and over. The authors present the prospective estimation of falls in Poland until 2050. The article underlines key role of diagnosis and prevention of falls of older persons.

1. Introduction

World Health Organization (WHO) defines a fall as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level. According to this definition WHO statistics exclude falls due to self-harm; falls from animals, burning buildings, transport vehicles and machinery, and falls into water [1]. The main reason of falls is frailty which is the key word for understanding the special functional disability in elderly people.

Falls among older people are one of the major issues of everyday life. They constitute a burden both, for the individuals who suffer from the fall and their caregivers [2]. In the group of persons aged 65 and over the falls are the cause of disability more often than in other age groups, which results in more responsibilities for caregivers and often in providing 24-hour care for the injured [3]. In Western Europe countries 10–20% of patients with hip fractures resulting from the fall are institutionalized [4]. For people independent in self-care pre-fracture, as many as 20–60% of older patients required assistance for everyday tasks up to 2 years after fracture [4]. Progressing disability leads to dependency from other persons, which significantly deteriorates the quality of life of both, seniors and their caregivers [3]. Every fourth caregiver of an older person reported that they had altered their usual routine after the first fall of their care recipient [5]. However the elderly fear the fall more than their caregivers: the mean Falls Efficacy Scale International (FES-I) value of the family caregivers was significantly lower than that of the patients (85.39 versus 99.02, $P < 0.001$) [6]. The most frequent complications of falls are fractures of the femur (2% of cases), fractures of the humerus, wrist and pelvis (5%), head trauma, intracranial hematomas and injury of internal organs (10%) [7].

The objective of the article is to analyze the falls caused by the impairment of musculoskeletal system leading to frailty in the group of persons aged 65 and over in respect of etiology, epidemiology, diagnosis, prevention as well as the prospective estimation of falls until 2050.

2. Risk of fall

The process of aging affects the whole organism, including musculoskeletal system. With age, all elements that constitute musculoskeletal system undergo the process of aging: joints, bones

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and muscles. Arthritis can develop within the joints. Metabolism and vascularization disorders of cartilage hamper its regeneration, leading to the loss of bone mass and enhanced susceptibility to microtrauma. Fasciae, ligaments and joint capsule lose their elasticity and strength, mainly due to the changes in collagen structure. Osteoporosis may develop within the bones; their mechanical strength is reduced, the loss of bone mass and disorders of bone structure may occur [8,9].

Sarcopenia is one of the key processes related to the aging of the body which impacts imbalance. Sarcopenia is the loss of skeletal muscle mass as well as the impairment and reduction of muscle strength (the process affects in the first place mostly lower limbs). The loss of muscle mass affects 25% of the population aged between 50 and 70. As many as 40% of persons aged 80 and over suffer from the loss of muscle mass [10,11]. Reduced muscle mass and strength, as well as related reduced mobility, make it difficult to react to obstacles quickly. Additionally, due to progressive degenerative changes in musculoskeletal system gait pattern is also altered. The steps are shortened, the associated movements of upper limbs are reduced, the stance phase is longer, kyphotic posture moves the center of gravity forward, the gait is slowed [2,12]. Moreover, involution of the musculoskeletal system, due to the location of proprioceptors in tendons and muscle spindles, negatively impacts proprioception. With aging, nerve conduction is also slowed; response time is longer and disorders of the integration of sensory and motor response can be observed. This leads to reduced physical activity, whereas the lack of physical activity additionally increases the risk of falls (besides the risk resulting from the sarcopenia) [2,13].

Sarcopenia has several contributing factors, lifestyle among others: lack of physical activity, weight gain as a result of fat mass increase, the use of stimulants (e.g. smoking) [14–18]. The multinomial regression model returned a significant association for obesity and frailty (OR = 3.52, 95% confidence interval (CI) = 1.34–9.13), as well as obesity and pre-frailty (OR = 2.23, 95% CI = 1.29–3.84) [19]. The increase in proinflammatory cytokines (1A, and MYOD1), tumor necrosis factor alpha and oxidative stress play the key role among humoral factors [20–22]. As to the genetic factors, they include the decrease in the number of motor units [20,23].

Symptoms of sarcopenia include reduced physical performance, a decrease in muscle strength, fatigue, balance disorders, movement and gait coordination disorders (unsteady, wide-based gait with short step length). Mental ill health, anxiety, apathy and depression can also be observed. There is an increased risk of injuries and falls, which, because many patients also suffer from osteoporosis, are the cause of bone fractures [3].

Other changes that increase the risk of fall with aging include [24–26]:

- structural changes in the sense of balance – the decrease in sensory epithelium population and vestibulocochlear nerve axons,
- visual impairment – trough reduced visual acuity, adaptation to darkness and color sensitivity. The field of view is more narrow, the sensitivity to glare is increased and visual-spacial functions are disturbed. The level of anabolic hormones such as testosterone, estrogen and growth hormone decreases,
- protein absorption disorder and vitamin D deficiency resulting from dietary factors,
- orthostatic hypotension which occurs in as many as 16% of older persons.

Prospective observational study comprised of 788 consecutive patients aged 79.5 ± 7.6 years based in Poland, identified primary risk factors for geriatric falls. Study shown that increased fall probability was associated with age ≥76 years ($P < 0.001$), body mass index (BMI) <23.5 ($P = 0.007$), Mini-Mental State Examination <20 ($P = 0.004$), Barthel Index <65 ($P = 0.002$), hemoglobin <7.69 mmol/L ($P = 0.017$), serum protein <70 g/L ($P = 0.008$), albumin <32 g/L ($P = 0.001$), and calcium level <2.27 mmol/L. The multivariate logistic regression model revealed four independent factors associated with the risk of fall: delirium (OR = 7.33; 95% CI = 2.76–19.49), history of falls (OR = 2.55; 95% CI = 1.05–6.19;), age (OR = 1.14; 95% CI = 1.05–1.23), and BMI (OR = 0.91; 95% CI = 0.83–0.99) [27].

Table 1
Aging-associated diseases that increase the risk of fall.

Musculoskeletal system disorders	e.g. sarcopenia, rheumatoid arthritis, ankylosing spondylitis, osteoporosis, osteoarthritis
Neurological	e.g. strokes, transient ischemic attack, delirium, myelopathy[a], vertebrobasilar artery syndrome, peripheral neuropathies), cardiovascular disorders (myocardial infarction, cardiac arrhythmia)
Metabolic	Hypothyroidism, hypoglycemia, anemia, dehydration, hypokalaemia, hyponatremia
Gastrointestinal	Diarrhea, syncope after eating or defecating
Genitourinary system	Urinary incontinence, micturition syncope, nocturia[b]
Mental	Depression, anxiety
Neurodegenerative	Parkinson's disease, Alzheimer's disease, dementia
Acute diseases	e.g. pneumonia, infections, dehydration, etc.

Source: own work based on [2,28].

[a] The symptom of several conditions with common feature of compressing the spinal cord or large vessels that supply the spinal cord.

[b] Nocturnal enuresis.

Besides musculoskeletal system disorders, other aging-associated diseases, e.g. neurological diseases or metabolic disorders also constitute the factor that increases the risk of fall (Table 1) [2].

The significant factors increasing the risk of fall are: presence of depression, presence of chronic disease and a reduced functional independence. The significant factors increasing the risk of fractures are: a history of fall, age, *T*-score value for trochanter bone mineral density [29]. Prior fracture, rheumatoid arthritis, and femoral neck *T*-score are identified as significant risk factors for major fractures (for any fractures, the influence of falls are also significant) [30]. Institutionalized older people after total hip arthroplasty for femoral neck fracture continue to be exposed to high risk of recurrent, possibly injurious falls, which is closely correlated with significantly diminished individual functional capabilities [31]. The risk of falls and fractures is associated with the occurrence of respiratory tract infections. A low waist-to-hip ratio is a risk factor for falls with fractures. Older subjects with a history of fracture are characterized by a worse functional status [32].

The side effects of medicines are also one of the leading causes of falls in older persons. The following drugs used by the elderly can contribute to the risk of falls: antihypertensives, diuretics, antiarrhythmic agents, antidiabetics as well as drugs acting on the nervous system, such as benzodiazepines, phenothiazines, antidepressants [2].

3. Epidemiology

3.1. World

According to WHO statistics falls are the second leading cause of unintentional injury death (after road traffic injuries). It is estimated that each year 424,000 persons die due to falls or complications following the fall, out of which 80% take place in low- and middle-income countries. Each year 37.3 million falls are severe enough to require medical attention. The largest morbidity occurs in people aged 65 years or over [33]. The mortality related to falls is age-dependent, increasing from 50/100,000 to 65 and reaching 150 and 5252/100,000 respectively to 75 and 85 years