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## Review

# Balance training in the intervention of fall risk in elderly with diabetic peripheral neuropathy: A review



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## ABSTRACT

Diabetic peripheral neuropathy (DPN) was the most common complications of elderly diabetic, which could contribute to an increased risk of falling. Despite the increased prevalence of elderly diabetic, high risk of falls and serious consequences of falls in elderly with DPN, It is necessary to adopt means of reducing the risk of falls in elderly with DPN. Impaired balance in the elderly with DPN was the most important risk factor of increasing falls. This review will introduce the epidemiology of falls in elderly with DPN, analysis the reasons for high risk of falls in elderly with DPN, provide a review of the development of balance training in the intervention of fall risk in elderly with DPN and offer recommendations to medical personnels on how to provide an efficient balance training for elderly with DPN.

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## 1. Introduction

With the intensification of the degree of aging, the proportion of older people aged over 60 increased year by year [1], leading to an increased prevalence of diabetes in elderly [2]. Diabetic peripheral neuropathy (DPN) was the most common complications of elderly diabetic, occurring in up to 60% of elderly diabetic [3–5], leading to the decreased sensitivity of proprioceptive and vestibular function, slower reaction times, greater postural instability and altered walking patterns, which could contribute to an increased risk of falling [6]. It had

been shown that elderly who suffer a fall would have high incidence of fall-related fractures [7], delayed falls injury rehabilitation [8], and increased recurrent falls [9], thus resulting in reduced quality of life, and even increased mortality [10]. It had been noted that that impaired balance in the elderly with DPN was the most important risk factor of increasing falls [11]. Appropriate balance training could improve balance in elderly patients with DPN, and reducing its risk of falling. Currently, Balance training had been increasingly used in the risk of falls in elderly with DPN. This article reviews the research progress of application of balance training to fall risk in elderly with DPN.

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## 2. Epidemiology of falls in elderly with DPN

In recent years, Epidemiological studies showed a higher incidence of falls in the elderly with DPN. DeMott et al. [12] followed up 20 cases of elderly patients with DPN for 1 year and found that the incidence of falls of up to 65%. Similarly, In China, Xie Jinmei et al. [13] investigated 62 cases of elderly patients with DPN incidence of falls and found that 79% had occurred fall. Among people age 65 years and older, Falls were the most common cause of death [14]. Particularly, DPN would further increase their risk of falling, recent studies had shown that DPN was an independent risk factor for falls and injuries. Elderly with DPN were 23 times more likely to fall and are 15 times more likely to report an injury compared with matched non-neuropathic subjects [11]. So taking active intervention to reduce the risk of falls in elderly with DPN, to prevent falls in elderly with DPN, and to improve their quality of life is very important.

## 3. Application of balance training to fall risk in elderly with DPN

A report by the Quality Standards Subcommittee of the American Academy of Neurology indicated that people with DPN have probable (level B evidence) risk of falling and that those with disorders of balance and gait have established (level A evidence) risk of falling [15]. Ghanavati et al. [16] found that balance and physical coordination in elderly with DPN were lower significantly than without DPN. Body balance was affected by many factors, including the vestibular, visual, proprioceptive, lower extremity muscle strength and range of motion and so on. Among them, the decline of proprioceptive, vestibular and lower extremity muscle strength were the main reasons for impaired balance in elderly with DPN [17]. At present, studies that were mainly to promote the recovery of balance and to reduce its risk of falling in elderly with DPN were through the following balance training methods.

### 3.1. Proprioceptive training

#### 3.1.1. Nerve conduction training

Research showed that the walking ability [18] and fall risk of DPN [19] and its degree of neuropathy were positively correlated. DPN could cause demyelination and axonal degeneration of nerve fibers, slowed nerve conduction velocity, delayed reflex reaction time, causing balance function decline. On the one hand, lower extremity aerobic exercise training could control glycemic in elderly with DPN [20] and disrupt the normal progression of DPN. On the other hand, it can improve lower limb muscle oxygen uptake and the sensitivity of nerve conduction and proprioceptors during walking, shorten the reaction time of reflection, enhanced body balance function, thereby reducing the risk of falling. Dixit et al. [21] had treated 87 elderly with DPN aerobic exercise training for 8 weeks, the frequency of each exercise session was 3–6 days of the week of moderate intensity treadmill exercises, the results showed the degree of neuropathy was significantly reduced, a

significant increase in the patients' epidermal nerve fiber branch and nerve conduction velocity.

#### 3.1.2. Nerve perception training

Because of a lesion or dysfunction of the nervous system, elderly with DPN suffer foot pain and plantar baroreceptor loss, causing their lower limb proprioception information errors, and foot posture changed significantly, thereby resulting in walking posture instability and risk of falls increased. Mickle et al. [22] showed that the incidence of foot pain in the elderly with a history of falls was significantly higher than that without pain. Infrared light therapy and tactile stimulation technology training by improving nerve perception function of elderly with DPN, enhanced the attitude control capability, thereby improving balance and reducing the risk of falling. Infrared light therapy using of infrared thermal effects of human tissue depth, could expand blood vessels, increase blood flow, block the vicious cycle of pain, relieve pain, improve the perception of foot nerve function and orientation control. Powell et al. [23] found that infrared light therapy could significantly reduce foot pain in elderly with DPN, enhance balance, and reduce the risk of falling. Plantar stimulation technique was the use of noise stimulation, electrical stimulation and mechanical stimulation and so on, to enhance the elderly with DPN foot and lower limb proprioception perception thresholds, and enhance its balance. Khaodhiar et al. [24] used mechanical stimulation to the specific areas of the foot, specifically the heel, ball, and big toe regions in 20 diabetic patients with moderate to severe neuropathy, the results showed that a significant increased in plantar vibration sense, tactile and proprioceptive threshold. Najafi et al. [25] used electrical stimulation to the planter in 56 mild to moderate DPN, treatments were administered 5 times per week for 6 weeks, the results showed that a significant increased in proprioceptive threshold and postural stability. Menz et al. [26] applicated the passive tactile cues to ankle, calf and knee in 10 elderly with DPN, The stimulus produced a shear force on the skin of less than 0.02 N, insufficient to provide a stabilizing reaction, the results showed that a significant increase in postural stability in elderly with DPN.

### 3.2. Vestibular training

Elderly with DPN due to aging and neuropathy factors, vestibular nerve damaged, leading to vestibular dysfunction. Kim et al. [27] found that the incidence of vestibular dysfunction in elderly patients with DPN was nearly 60%, which could cause declined information integration capabilities of brain, reduced ability to control body balance, leading to increased risk of falls. Fall risk in the diabetes with vestibular dysfunction was 2.3 times than that without vestibular dysfunction [28]. Vestibular function training in elderly with DPN, could make a correct understanding of sensory signals into the brain quickly and make the right judgment motion response by sensory reorganization, and enhance balance function, thus reducing the risk of falling. Akbari et al. [29] had treated 20 patients with DPN whose average age was 56 years with vestibular training exercise, such as rotational movement, posture reactive movement, after 20 weeks, the overall ability to stabilize, ability to stabilize before and around of the

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