Stimulation of different foot structures and functions : effects on physical performance in older adults

STIMULATION OF DIFFERENT FOOT STRUCTURES AND FUNCTIONS

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Effects on physical performance in older adults

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Summary

The primary public health goal is to increase the number of years of good health, and therefore to maintain independence and quality of life as long as possible. However, a fall can endanger mobility, physical performance and health of the elderly and is one of the major problems of older adults and care services for the aged. Since the risk of falling increases dramatically as the number of risk factors increases, the goal of fall prevention is to modify some of the strongest risk factors through, for example, physical exercises. Physical exercise is one of the most important intervention strategies that can significantly improve physical performance and contribute to maintenance of independence and quality of life. It has the strongest evidence to minimize or eliminate some of the strongest fall risk factors, such as impairments in balance, gait, strength and range of motion. Age-related changes in musculoskeletal and sensory characteristics of the feet are important risk factors too, but have not been the focus of exercise studies to date.

As described in *Chapter 1*, the main objectives of this thesis were to evaluate the effects of stimulation of different foot structures and functions combined with conventional training on physical performance and fear of falling, and whether training reduces the rates of falls and fall-related injuries during a 12-month follow-up period in independent living, older adults. For such intervention studies, valid and reliable assessment procedures for muscle power and gait performance are needed. Hence, the three objectives of this thesis are:

1. to determine the validity and reliability of newly developed testing procedures for muscle power and gait in independent living, older adults (*Chapters 2 to 4*);
2. to evaluate the effects of stimulation of different foot structures and functions combined with conventional training on physical performance and fear of falling in independent living, older adults (*Chapters 5 and 6*);
3. to determine the effectiveness of the conventional training program to reduce falls and fall-related injuries during a 12 month follow-up period in independent living, older adults (*Chapter 7*).

The prerequisites for an objective measurement device are validity and reliability. In *Chapter 2* we investigated the reliability of an isokinetic strength-testing protocol of the knee and ankle in older adults. The results showed that the Biodex System 3 is a reliable device for muscle power measurements when used for independent living, older adults. The relative reliabilities for muscle power for knee extension and flexion and ankle dorsiflexion and plantarflexion were ‘very good’. The results of absolute reliabilities were partly satisfactory. The coefficients of variation and ratio of limits of agreement for knee extension and flexion

and ankle dorsiflexion represented acceptable agreement. No acceptable agreement was found for ankle plantarflexion.

In the last few years, accelerometer-based gait analysis systems fixed at different body locations have been proposed for ambulatory gait assessment and have been found valid and reliable for the analysis of gait parameters. However, most body-fixed accelerometer based systems are still in need of further development in older adult populations. In *Chapters 3 and 4* the validity and the reliability of the gait analysis using the DynaPort®MiniMod, a trunk tri-axial accelerometer system, were determined. The results demonstrated that the DynaPort®MiniMod system is a highly valid tool for assessment of the most important spatio-temporal gait parameters for averaged step data across a walking length of approximately 20 m and that walking speed, cadence, step duration and step length under different walking conditions can be reliably measured in independent living, older adults. However, gait variability needs to be viewed with caution because of the moderate to low validity and reliability.

There is evidence that a conventional training program that includes strength and power training, balance, mobility and stretching exercises contributes to the maintenance of independence and quality of life and has the strongest evidence base for preventing falls. Further, aged-related losses of afferent feedback of the feet, ankle dorsiflexion range of motion and toe plantarflexor strength play an important role in balance control and gait performance and are associated with the risk of falling. It was, however, unclear whether stimulation of different foot structures and functions by wearing insoles with raised projections during everyday life and during training sessions, or by foot gymnastics including exercises intended to strengthen the muscles of the feet and increase the ankle joint range of motion, has an additional effect of physical performance in older adults. The primary findings of *Chapters 5 and 6* were that the conventional training program in itself resulted in significant improvements in gait performance, muscle power and Expanded Timed Get-up-and-Go test compared to the control group in independent living, older adults. The training program had, however, no effect on self-perceived fear of falling possibly because of the low pre-training Falls Efficacy Scale of the subjects, which caused floor effects for this assessment. Neither wearing insoles during everyday life and during training sessions, nor foot gymnastic exercises integrated in conventional training, had additional effects on physical performance. Possible explanations for these findings might be that the subjects did not comply with wearing the insoles continuously or with the foot gymnastic home-program. Some subjects only wore the insoles in their indoor shoes or slippers and not in their outdoor shoes. It can be assumed that indoor activities are performed mostly while sitting and not

while standing or walking, and therefore the insoles had no stimulation effect. Further, the relatively short duration of the study periods may not be sufficient to show an adaption of gait.

The primary goal of fall prevention is to decrease the number of falls and to prevent fall-related injuries. In *Chapter 7* the effectiveness of the training program to reduce falls and fall-related injuries during a 12-month follow-up period in older adults was determined. The training program was not effective in reducing falls and fall-related injuries, although the training program resulted in significant improvements in physical performance compared to subjects without training. Possible explanations for these findings may be potential bias because of the non-randomization of the subjects, the small sample size resulting in low testing power (Type II error), the significantly younger age of the control group at baseline or the significantly improved physical performance after the training period of the subjects with training, which may result in a longer time spent exposed to a higher risk of falling during everyday life that consequently leads to a higher rate of falls.

In *Chapter 8* the main findings and limitations of these studies, as well as implications for practice and future research, are provided. In addition some personal opinions and conclusions have been included to complete this thesis. On the whole, the conventional training program in itself resulted in significant improvements in physical performance, however, it had no effects on fear of falling and rates of falls and fall-related injuries during the 12-month follow-up period compared to the control group in independent living, older adults. In spite of these partly inconsistent results, in my opinion the research area covering the optimal training program for the prevention of falls in healthy, older adults is utilized, except that the training strategy is completely new. In the future, the big challenge for public health will be to persuade the vast majority of adults, not only robust adults, to become more active. Therefore, the public health message for older adults should be to incorporate moderate-intensity physical exercises into their everyday life, and that physical exercises should provide enjoyment and not be a physical torture.