Chapter 1

Postural balance measures in elderly fallers
In 2005, approximately 15% of the population in the more developed countries were 65 years of age or older. According to the United Nations Medium Variant population projection, this number will increase to over 26% by 2050\textsuperscript{1}. Therefore, identification of potential fallers and, thus, possible prevention of falls is a very relevant aim\textsuperscript{2}. Over one-third of the community-dwelling elderly older than 65 years of age suffer from a fall each year\textsuperscript{2,3}. Falls cause up to 11% of serious injuries and up to 9% of fractures\textsuperscript{4-6}. Therefore, identification of potential fallers and, thus, possible prevention of falls is a very relevant aim\textsuperscript{7}. However, even minor injuries may trigger the vicious circle of fear and limited mobility, which in turn have adverse effects on overall health and increase the risk for additional falls and disability\textsuperscript{8}. Minimizing the risk of falling would lead to a reduction in the risk of a fracture and therefore reduce suffering and costs.

Many different intervention programs have been developed to reduce the burden of falls and fractures. However, reliable tools are still needed for controlling the effectiveness of fall intervention programs and for the early identification of fallers. Currently, different methods are used to fulfill these objectives such as observational performance tests to assess the risk of falling and performance measurements using all types of equipment\textsuperscript{9}. For observational performance tests, several assessment tools are available that combine measures of balance with measures of gait and mobility to determine a person’s risk of falling, e.g., the Berg Balance Scale and the Tinetti Gait and Balance Assessment\textsuperscript{10,11}. Furthermore, many devices exist for assessing performance, measuring for example, static balance, dynamic balance, walking velocity and mobility, muscle strength, and so on\textsuperscript{9}.

A device that is frequently used for the assessment of fall risk is the force platform. With a force platform, researchers and clinicians can quantify balance abilities\textsuperscript{12}. These force platforms produce a wide range of force platform variables by which the postural stability can be described in objective terms. However, until now no force platform derived variables have been identified that are able to discriminate between elderly fallers and nonfallers\textsuperscript{13}. 
Besides the ability to discriminate between elderly fallers and nonfallers, another aim of postural balance assessment is the prediction of falls in the future. Early identification of persons at risk could help to prevent possible injuries. If this would be possible intervention programs that aim to improve postural control could be tested for their effectiveness. Unfortunately, there are almost no studies that have used a prospective design with falls as their primary outcome. The status of force platform assisted techniques for the prediction of future falls is, therefore, at present only limited.

Hence, it can be argued that there is a need for studies that identify variables from force platform assessment techniques that can be used for prediction of future fall risk and can be used as an outcome measure in intervention-type studies.

When assessment protocols with force platform techniques are designed, it is important that the behavioral context is considered, that is to say, performing a balance task always takes place in some environmental and task-related context. It never takes place in vacuo. This means that the measurement environment plays an important role. Many studies used the force platform technique for the performance of a static stance task (standing still) with or without vision. However, it can be argued that such an assessment does not really mimic “real-world” conditions and, therefore, may not be challenging enough for many elderly persons. These single-task test conditions give participants the opportunity to compensate for possible deficits by shifting toward other control strategies. By employing an additional task, next to the primary task (e.g. standing), a more “real live mimicking” environment will be created. The assumption, hence, is that by following a dual task test procedure the tested subjects will exhibit more difficulty with the shifting toward other control strategies and, thus, possible deficits will be more easily discovered.
There is some evidence that measurements using a dual-task protocol could have additional value compared to single-task testing for the prediction of falls. At present, however, it is unclear what kind of additive task should be integrated in clinical protocols.

New insights into the results of quantitative posturography measures in elderly fallers and nonfallers are described in this thesis. This thesis explores variables from force platform assessment techniques that can be used for prediction of future fall risk and that can be used as outcome measures in intervention-type studies.

Outline of the thesis

The first objective of this thesis is to examine an intervention program that is assumed to influence postural control and post-intervention fall risk. Chapter 2 presents the results of a randomized clinical trial in elderly persons with decreased bone mineral density. The aim of this study was to investigate whether exercise combined with protein intake and calcium/vitamin D supplementation would have a larger (positive) effect on risk of falling and force platform derived postural balance outcomes compared with calcium/vitamin D supplementation only. Additional outcome measures that were used in this study are an observational balance performance test (Berg Balance Test).

The second objective of this thesis, delineated in Chapter 3, is to evaluate force platform measures of postural control. This chapter investigates whether a dual-task protocol is able to cause more disturbances of postural control in comparison to a single task only. Various types of secondary tasks are investigated to determine the most appropriate task for the elderly in a clinical setting. The task selection is based on theoretical considerations as well as on the practical feasibility. Furthermore, this chapter explores whether differences exist between fallers and nonfallers in terms of disturbance of postural control under the different additional tasks.

Chapter 4 describes the interrater and test–retest reliability of force platform variables from the dual-tasking test protocol that was described in Chapter 3.
In Chapter 5, a prospective study with 270 participants is described. The aim of this study was to determine whether force platform variables measured under dual-task testing conditions with a force platform were able to prospectively predict fallers and nonfallers in a community-dwelling elderly population over a 12-month period.

Finally, in Chapter 6, a study is described that investigates postural balance change caused by no-vision and/or compromised somatosensory information in single and dual tasking. This study also wanted to determine the (change in) dual-task costs caused by the reduction of combined sensory input.
References


