Falls are not an inevitable consequence of aging. Effective fall prevention strategies can be applied, offering an opportunity to help reduce falls among older persons. Nowadays, several risk factors for falling can be identified and by reducing these risks also falls can be reduced. Therefore, a smartphone is being adapted to be used as a fall risk prediction and prevention tool, based on its sensing capabilities.

**The Problem**

Fall risk assessment and prevention is rarely a part of an older person’s routine. Typically, fall prevention is performed by clinical experts in clinical environments and the technology used is typically too costly, not portable and time consuming, which limits their use as routine. In spite of the recognized efficiency of these techniques, prevention is not yet widely applied. Therefore, falls represent a serious and common problem for older persons, who can suffer from injury, loss of independence and reduced quality of life. With the increasing proportion of older persons in society, these problems are becoming further serious. Clinic-centric models are therefore increasingly unsatisfactory and fall prevention became a challenge, particularly for older persons living in community.

**Fig. 1** Smartphone-based fall risk prediction system.
Gait Analysis
Acceleration data is acquired at the lower back of the trunk and used to extract several gait measures, including step length and speed.

30-Sec. Chair Stand
The smartphone is placed on the chest, secured by the crossed arms, and measures of lower limb strength and movement quality are obtained.

One Leg Standing
This test assesses static balance based on acceleration-based measures acquired at the level of the trunk.

Voluntary Stepping
Stepping response is a common postural reaction to avoid falls. The smartphone evaluates the number of steps a person can perform in 15sec.

Ankle Flexion
The range of motion is calculated based on angle variations. An adequate range of motion is required for several functional daily living activities.

Icon-FES
An iconographical version of FES has been produced to assess fear of falling.

The Concept
Risks are diverse and many of them are modifiable. Wearable systems based on inertial sensors are able to detect functional ability and mobility problems and have the advantage of being portable and low cost, so they can be used outside clinical environments, i.e. in the community. If risk factors are assessed more frequently, problems can be earlier recognized, so that the design, application and/or modification of fall prevention programs are performed at an earlier stage. The popularity of mobile phones is likely to continuously increase in the near future, due to decreasing prices thus projecting an overall acceptance regarding it as a fall prevention platform. Therefore, the smartphone is being adapted to be used as a fall prediction and prevention system.

Fall Prevention
The smartphone is equipped with inertial sensors, which can be used to analyze movements and detect problems. The purposed solution aims to monitor risks over extended periods of time, so that historical data can be built and analyzed to provide an overall and time dependent risk score. The developed solution will be able to assist health care practitioners on tests execution, both at seniors home and clinical environments. Also, it will be adapted to be used by seniors meant for a daily-basis, unsupervised assessment of risks. In this first approach, several tests were adapted to the smartphone, targeting several dimensions of risks, i.e. fear of falling, mobility and balance problems, lower limb strength, ankle flexibility and voluntary stepping response. Experimental results of the system, which are still work in progress, are making us optimistic regarding the feasibility of a reliable phone-based fall predictor, which can be of great value for older persons and society. Additionally, fall prevention exercises, targeting specific risks such as strength, flexibility and balance, will be adapted to serious games or dances. The smartphone will guide the person throughout the exercises, as well as evaluate the performed movements, while keeping the users motivated to improve their physical performance and activity, and ultimately, to avoid falls.

Future Work
Further studies need to be performed, not only to improve the automatic extraction of movement features, but also to expand the relation of risk factors with risk, which is still not very clear. Studies with target users are also a key point to improve interaction techniques, including interfaces design. Prediction, prevention and detection will be combined into one system, which can be of great value for older persons and society, in the context of fall prevention and security.