Self-directed assessment of standing balance and falls risk

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***Abstract*— Assessment of health and physical function using smartphones has enormous potential to provide low cost, scalable access to care outside of clinical environments. Validation of the algorithms and outcome measures used by smartphone apps is important to avoid harm to patients.**

Falls are a complex, common and costly problem in the older adult population. We report results for the real-world deployment of a smartphone app for self-directed, unsupervised assessment of balance and falls risk. Results for a sample of 594 smartphone assessments from 147 unique phones show a strong association between self-reported falls history and the falls risk and balance impairment scores produced by the app, suggesting they may be provides clinically useful outcome measures.

I. Introduction

Falls in older adults pose a major public health and societal challenge. Population based, self-directed falls risk screening solutions have enormous potential to address the falls challenge, yet it is unclear whether or not the data that they produce is of sufficient quality to yield clinically meaningful insights. In this study we address this issue through analysis of data from the initial deployment of a smartphone application that uses a self-directed measurement of standing balance alongside a self-reported questionnaire to assess balance, falls risk and help prevent falls.

II. Data

This study reports an analysis of anonymized data obtained from users of the Kinesis Balance™ fall prevention app (Kinesis Health Technologies, Dublin, Ireland), a Class I medical device, between September 2020 and May 2021. The app is freely available on the Google Play store and uses a questionnaire on clinical falls risk factors, combined with a standing balance test and machine learning algorithms to assess balance and falls risk. Participants were provided with advice and exercises to stay healthy and help prevent falls, based on their level of risk (as determined by the machine learning algorithm).

BRG is a director of Kinesis Health Technologies Ltd, a company with a license to commercialise this technology.

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III. Methods

Upon installing the app, participants are asked to enter some profile information and complete a fall risk assessment. Each assessment consisted of a questionnaire with 12 questions on clinical falls risk factors and medical history as well as a standing balance test, in which participants held the phone firmly against their torso and stood with their eyes open, in a semi-tandem stance, for 30 seconds. The app contains audio and visual instructions on how to prepare for and complete the test, as well as data quality checks to ensure tests are performed correctly. 19 quantitative balance features were calculated from the smartphone IMU sensor data for each balance assessment including a statistical fall risk estimate and a percentile balance score.

A one-way ANOVA was used to test the association between self-reported falls history and both the Balance score and falls risk estimate, with $\alpha=0.05$.

IV. Results

A sample of 594 smartphone assessments from 147 unique phones were included in the analysis with an average of 4.0±7.1 assessments per phone. The sample contained 76 males and 71 females, with a mean age of 56.5±17.0 years.

A strong association was observed between the calculated falls risk estimate and self-reported falls history ($F=60.26$, $p<0.0001$). A strong association was also observed between the calculated balance score and self-reported falls history ($F=7.45$, $p<0.001$). Balance and falls risk scores were both also strongly associated with self-reported mobility problems ($F=30.81$, $p<0.0001$; $F=56.91$, $p<0.0001$).

V. Discussion

This study reports results for the real-world deployment of a smartphone application that enables users to capture their balance performance, enter simple clinical data, and access machine learning algorithms that predict their risk of falling.

Results show a strong association between predicted falls risk and balance score with falls history. Results suggest algorithms using smartphone inertial sensor data from a self-directed standing balance test as well as self-reported questionnaire data may produce clinically useful measures of falls risk and balance impairment, suitable for use by an older adult, unsupervised in the home environment.

Smartphone apps for assessment of balance and falls risk could be used as part of a comprehensive digital platform to prevent falls, and be used by older adults and their carers to evaluate risk of falling, prescribe interventions and monitor progress against personalized exercise goals.