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Development of a Fall Risk Assessment Smartphone Application

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Abstract

Background & Objective: Falls are major cause of injury among older adults. This study was aimed to develop a smartphone application that can be used to assess the fall risk among the elderly population.
Methodology: An Android application was developed with three main built-in sensors (accelerometer, gyroscope, force of gravity) that measure motion, orientation and body position.
Results: Four tests namely Timed Up and Go test (TUG), 30 second Chair Stand Test (30s CST), 4 Stage Balance Test (4SBT), and gait speed were added along with body sway to test the fall risk in the smartphone application. The fall risk score in the application will be calculated from the body sway and need to be added according to TUG and number of standing scores.
Conclusion: A smartphone application to detect the fall risk was developed. The next stage of the project involves pilot testing the newly developed smartphone application.

Introduction

Falls are major cause of injury among older adults. The WHO Global Report on falls prevention in older age describes fall as "inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects" (World Health Organization, 2008). According to WHO report around 28 to 35% of old adults fall every year ("WHO | Falls Prevention in Older Age," n.d.). 19.1% of the older adults reported falls in Malaysia in a cross sectional study involving 328 randomly selected Government Primary Care Clinics (Sahril et al., 2015). Hence early detection of falls risk is important to prevent falls.

Fall screening has been proven to reduce fall incidence among elderly individuals (Currie, 2008; Hamm, Money, Atwal, & Paraskevopoulos, 2016). In the screening for falls, functional tests can be used to detect the fall risk ("STEADI Materials for Healthcare Providers | STEADI - Older Adult Fall Prevention | CDC Injury Center," 2018). It was reported that availability of in-built sensors, continuous internet connectivity, open source operating systems, and wide usage of the smartphone makes it as an alternative against conventional fall detection and prevention tools (Habib et al., 2014). Currently the existing smartphone application is not user friendly for the common people, does not use evidence-based functional tests in addition to being expensive ("Fall Prevention," n.d., "iGeriatrics on the App Store," n.d.). Hence developing a new fall detection smartphone application based on evidence based fall risk assessment is important especially for common people and healthcare professional's use. Hence this study was planned with the objective of developing a smartphone application for fall risk assessment of older adults.

Methodology

An Android smartphone application was developed with three main built-in sensors that measure motion, orientation and position with help of an Information Technology expert. The Accelerometer, gravity and gyroscope sensors were used in the application. The sensors were made capable enough to provide raw data with high precision and accuracy.
The smartphone application developed was named "GO 360" with the intention of enabling elder adults to achieve the 360 aspect of life. GO 360 contains three evidence based functional tests which are as follow("STEADI Materials for Healthcare Providers | STEADI - Older Adult Fall Prevention | CDC Injury Center," 2018):

1. Timed Up and Go Test
2. 30- Second Chair Stand Test
3. Four Stage Balance Test

Along with this, Body sway and gait speed measurement were also added in the application

1. Timed Up and Go Test
The time taken will be noted by the app. As per the protocol, if an older adult takes more than 12 seconds to complete the TUG test, he or she is considered to be at high risk for falling. In this Go 360 app, upon tapping on the start option, the subject will have to place the phone in his pocket while sitting. The subject will then have to get up and start walking, upon hearing the "beep" sound for a 3m completion, the subject will have to turn and come back to the original position. The results are displaced in steps taken, distance walked, gait speed, time taken to complete the test and the fall risk.

2. 30- Second Chair Stand Test
The 30-s CST is administered using a chair without arm support, the participant is required to rise to a full stand on the sign of "go" and then return back to the initial seated position. The participant is encouraged to complete as many full stands as possible within 30 seconds. The score is the total number of stands within 30 seconds. Incorrectly executed stands are not counted.

In this Go 360 app, the subject will have to tap on the start option, place the phone in the pocket and immediately start the sitting to standing action for 30 seconds. The results are shown in number of standings, number of seating and falls risk.

3. Four Stage Balance Test
The main aim of this test is to assess static balance among older adults. There are four advancing positions with the beginning position of placing the feet side by side, to a more challenging position of placing the heel of one foot next to the big toe of the other, placing one foot in front of the other and to standing on one foot. The determining factor of a good balance is the ability to withstand all the 4 positions for 10 seconds each without requiring support.

In this Go 360 app, the subject will have to stand in four positions which have been instructed in the beginning. The subject will first read the instructions, place the phone in the pocket while starting the timer. Upon completing one stage, the subject will take out the phone and start the timer for the next test. The result can be seen when tapping on the body sway option.

4. Body Sway and Gait Speed

The result of the body sway and gait speed are constantly being measured throughout all of the 3 main tests. The application calibrates each person's gait and body sway the moment any of the tests are started.

Results and Discussion

Evaluation of a fall risk application is a crucial tool for the elderly so that their fall risks can be analyzed as quickly as possible and necessary precautions can be taken. However, very few studies have been published which focus on the use of smartphone applications in detecting fall. Fall risk itself can be determined through various tests and very few studies have been able to narrow down the definitive lists of the tests. Hence, for GO 360, the four main tests were used which were Timed Up and Go (TUG), 30 second Chair Stand Test (30s CST), 4 Stage Balance Test (4SBT) and gait speed. However, gait speed was not taken as a separate test, it was in fact added as a background sensor which starts to run once the patient starts the TUG test. The Go 360 application was developed with the features mentioned above.

Testing the smartphone application by the investigator himself has shown that it can measure the data as mentioned in the methodology section. In order to confirm the validity and reliability of application, further pilot testing is required.

The app can detect the time taken to cover the 6-meter distance in the Timed up and Go test. However, the inability to reset the values of the steps and distance is one of the limitation. The phone is required to restart in order for the two said values to be set at zero. However, the time taken does start at zero and if a researcher subtracts the initial distance from the final distance, then the actual distance covered can be obtained.

The second test which is automatically recorded by the app is the gait speed. A well-functioning older adult having a gait speed of less than 0.7 m/s is considered to be having a risk of fall (Hong et al., 2016). Hence assessing gait speed with this app provides data for fall risk assessment. The fall risk is currently being determined based on body sway, the application detects any abnormal body sway and gives the result as "high risk" after each test since the phone is kept in a slanted position. The actual body sway can be determined by placing the phone on the chest, in a straight position and performing the 4-stage balance test. The application has yet to be set based on the time taken during TUG.

30-second chair sit to stand also requires setting the results based on number on standings. Currently, the body sway and gait speed of the person is constantly being calculated in the background, hence, the researcher has yet to set the results based on each test rather than on the body sway and gait speed.

The phone may be in an insecure position while being kept in the pocket when conducting the tests. To improve the accuracy and to secure the phone, a fitness belt can be used to attach the phone at the hip level.

The timer currently starts when the user presses the start button. By the time the user adds the phone to the pocket, the timer may have already added additional seconds which further add to the limitation of the app. The app needs to be voice automated or have a beeping sound that will allow the user to place the phone in the pocket or fitness belt and then start walking or standing upon signal.

Conclusion

The study has developed a smartphone application for detecting falls, which can be used by the older population or by Health care professionals. The next stage of the study involves pilot testing this app. The app has yet to be set using the time taken scores for TUG to determine the fall risk. Further refinement of the app is required to make it more effective and user friendly.

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References

1. Currie, L. (2008). Fall and Injury Prevention. In R. G. Hughes (Ed.), *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville (MD): Agency for Healthcare Research and Quality (US). Retrieved from http://www.ncbi.nlm.nih.gov/books/NBK2653/
2. Fall Prevention: An app to help clinicians manage fall risk in patients. (n.d.). Retrieved August 2, 2018, from https://www.evidenceinmotion.com/products/fall-prevention-app/
3. Habib, M., Mohktar, M., Kamaruzzaman, S., Lim, K., Pin, T., & Ibrahim, F. (2014). Smartphone-Based Solutions for Fall Detection and Prevention: Challenges and Open Issues. *Sensors*, *14*(4), 7181–7208. https://doi.org/10.3390/s140407181
4. Hamm, J., Money, A. G., Atwal, A., & Paraskevopoulos, I. (2016). Fall prevention intervention technologies: A conceptual framework and survey of the state of the art. *Journal of Biomedical Informatics*, *59*, 319–345. https://doi.org/10.1016/j.jbi.2015.12.013
5. Hong, C., Won, C. W., Kim, B.-S., Choi, H., Kim, S., Choi, S.-E., & Hong, S. (2016). Gait Speed Cut-Off Point as a Predictor of Fall in Community-Dwelling Older Adults: Three-Year Prospective Finding from Living Profiles of Elderly People Surveys in Korea. *Korean Journal of Family Practice*, *6*(2), 105–110. https://doi.org/10.21215/kjfp.2016.6.2.105
6. iGeriatrics on the App Store. (n.d.). Retrieved August 2, 2018, from https://itunes.apple.com/us/app/igeriatrics/id365560773?mt=8
7. Sahril, N., Ahmad, N. A., Razak, M. A. A., Ying, C. Y., Sooryanarayana, R., Awaluddin, S. M., … Wong, N. I. (2015). Falls among older adults: Findings from screening at the Ministry

of Health Malaysia Primary Care Clinics. *Medical Journal of Malaysia*, *70*(Supplement 1). Retrieved from http://www.e-mjm.org/2015/v70s1/mjm-sept-suppl-2203.html
8. STEADI Materials for Healthcare Providers | STEADI - Older Adult Fall Prevention | CDC Injury Center. (2018, February 15). Retrieved August 1, 2018, from https://www.cdc.gov/steadi/materials.html
9. WHO | Falls Prevention in Older Age. (n.d.). Retrieved August 1, 2018, from http://www.who.int/ageing/projects/falls_prevention_older_age/en/
10. World Health Organization (Ed.). (2008). *WHO global report on falls prevention in older age*. Geneva, Switzerland: World Health Organization.