SIX MINUTE WALK TEST

MOBILE PHONE WALK TEST SOFTWARE FOR ASSESSMENT OF CARDIO-PULMONARY HEALTH

SARAH SANDOCK, KENNETH XU, JACK RENFREW, JOSH KOLZ, JESSICA KOU

CLIENT: DAVID VAN SICKLE, PH.D   **ADVISOR:** THOMAS YEN, PH.D

ABSTRACT

The Six-Minute Walk Test (6MWT) application utilizes the iPhone's accelerometer, audio, internet access, and data storage capabilities to create a useful test for determining functional exercise capacity at home. This test compliments regular exercise and routine rehabilitation for those suffering from poor cardiopulmonary health by allowing the user to track their condition. This application provides the user with an easily-navigatable program that displays clear results. The test is simple and includes both visual and verbal instructions. A personal pedometer is programmed into the application as well as a data logger and emailing system that allows the user to freely track their progress. It also comes with a pretest that calculates the step distance for the user in case they do not know it. We preformed testing on the accuracy measurements of the pedometer and decided that no single setting will work for every user and therefore we added in a sensitivity adjuster so that the user can tailor it to their settings.

INTRODUCTION

The Six-Minute Walk Test is a walk test performed in a period of six minutes by patients with cardio-pulmonary diseases. The primary measurement is the distance that the patient can walk at a normal pace on a flat, hard surface of a straight 100 foot course. Currently the test is preformed in a clinical setting and monitored by a technician (ATS, 2002). The distance traveled in each performance can be compared and analyzed with the previous data in order to indicate the health condition of the patient both before and after medical intervention.

The 6MWT is an extremely powerful and research-proven test, but there are downfalls in its accessibility. First, the test requires a technician or doctor to be present making the test expensive, upward of two-hundred dollars (Van Sickle, 2010). Second, the test is time consuming for both the hospital and the patient. Widespread use of the test can be achieved by taking advantage of the recent advance in personal technology. Combining the 6MWT with the iPhone allows for high accessibility and provides the patient with the flexibility to perform it at their own convenience. Most importantly, the 6MWT application will be available for download via the iTunes Store.

FINAL DESIGN

APPLICATION DESIGN CRITERIA

- iPhone application
- Easily navigated interface
- Follow ATS standards
- Ability to store and organize data
- Integrate audio encouragement
- Self-interpretable results
- Safe for home use
- Accessible to population
- Under 150 megabytes

INTERFACE & USABILITY TESTING

Design I : Wizard – predetermined linear path of screens
Design II : Branched – main menu and high connectivity of sections & screens
Design III : Hybrid – main menu and low connectivity of sections & screens

Table 1: Simplification of design matrix ; Green – Great / Yellow – OK / Red - Bad

Speed of navigation and user rating data was collected from test subjects. Ease of use, using Hick's and Fitt's equations, were calculated by evaluation of the interface simulations.

The hybrid design was chosen for its over all high performance in testing and for its excellence in user rating. Small modifications were made to the interface simulation to create final flow design based on practicality of programming.

FLOW DESIGN & FUNCTIONALITY

Figure 1: Above is final flow design chosen based of results on usability testing. Program is entered from the left-top corner and the yellow highlighted page is the main menu. The blue, green, and purple arrows represent offshoots from the main menu and represent the information storage, testing, and history pages of the application respectively.

Table 2: (right): iPhone functionality with corresponding use within programming

iPhone Functionality	6MWT Application
Accelerometer	Pedometer & Distance
Audio Playback	Verbal Instructions & Audio Encouragement
Data Storage	Track History
Call Capability	Emergency Phone Call
Internet Access	Export Data

TESTING

(Stride Distance) * (Number of Steps) = Distance Walked

The major measurement calculated by the Six Minute Walk Test is the absolute distance traveled by the user. The most accurate method that the application can use is to calculate this distance by multiplying the products of two individual calculations: the stride distance of the user and the number of steps walked by the user in a specific test.
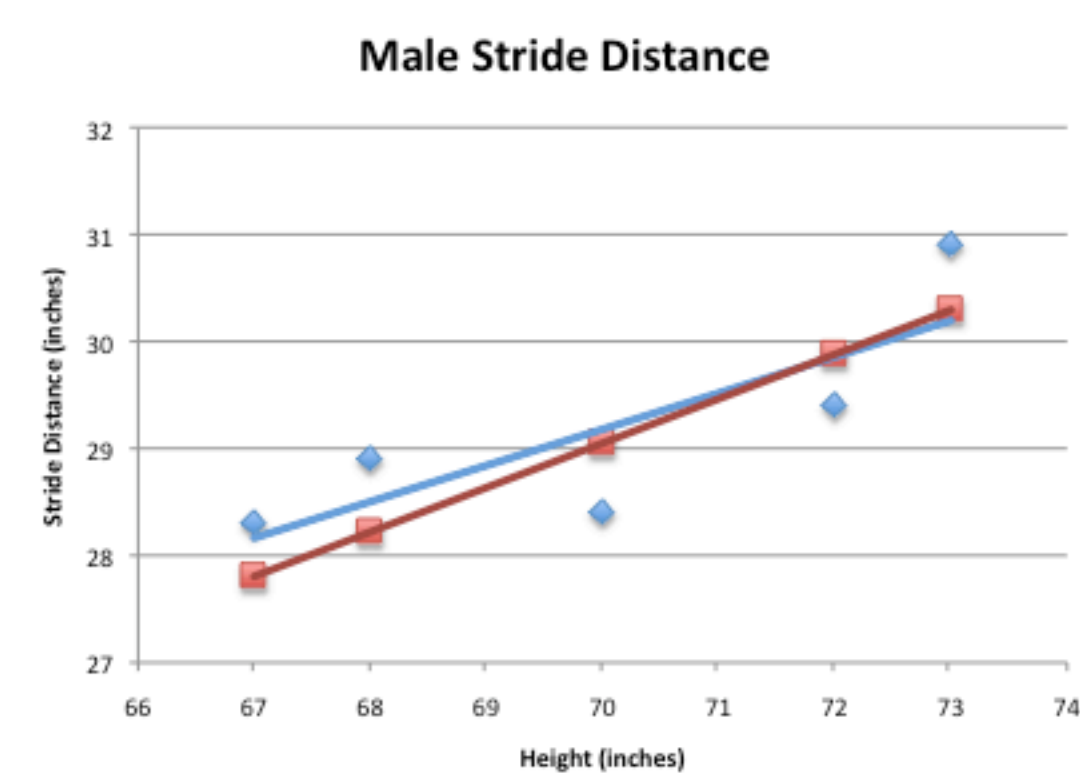
STRIDE DISTANCE

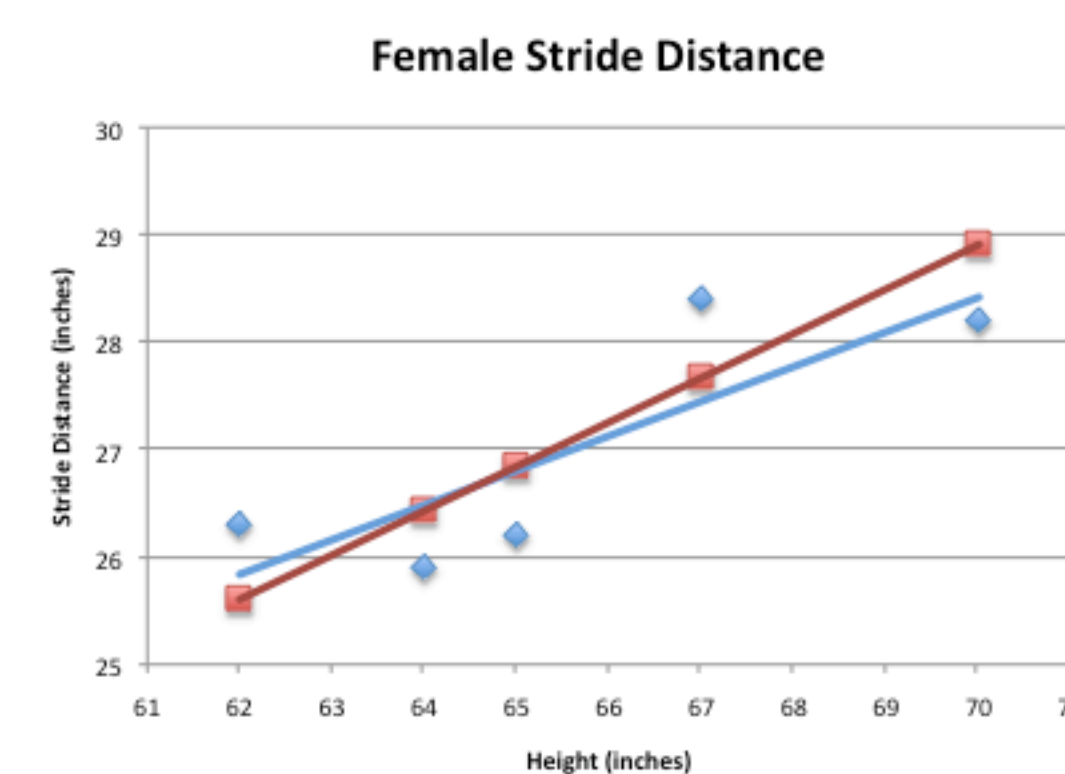Figure 2: Male calculation of stride: Height * 0.415

Figure 3: Female calculation of stride: Height * 0.413

◆ Measured   ◆ Calculated

To calculate the stride distance of the user the program uses a multiplier based on gender along with the user's height that was stored in their personal information section. The multipliers are 0.415 and 0.413 for men and women respectively (Hellie, 2010).

The user will be able to generate a more customized stride distance by taking a quick test available in the personal information section of the application.
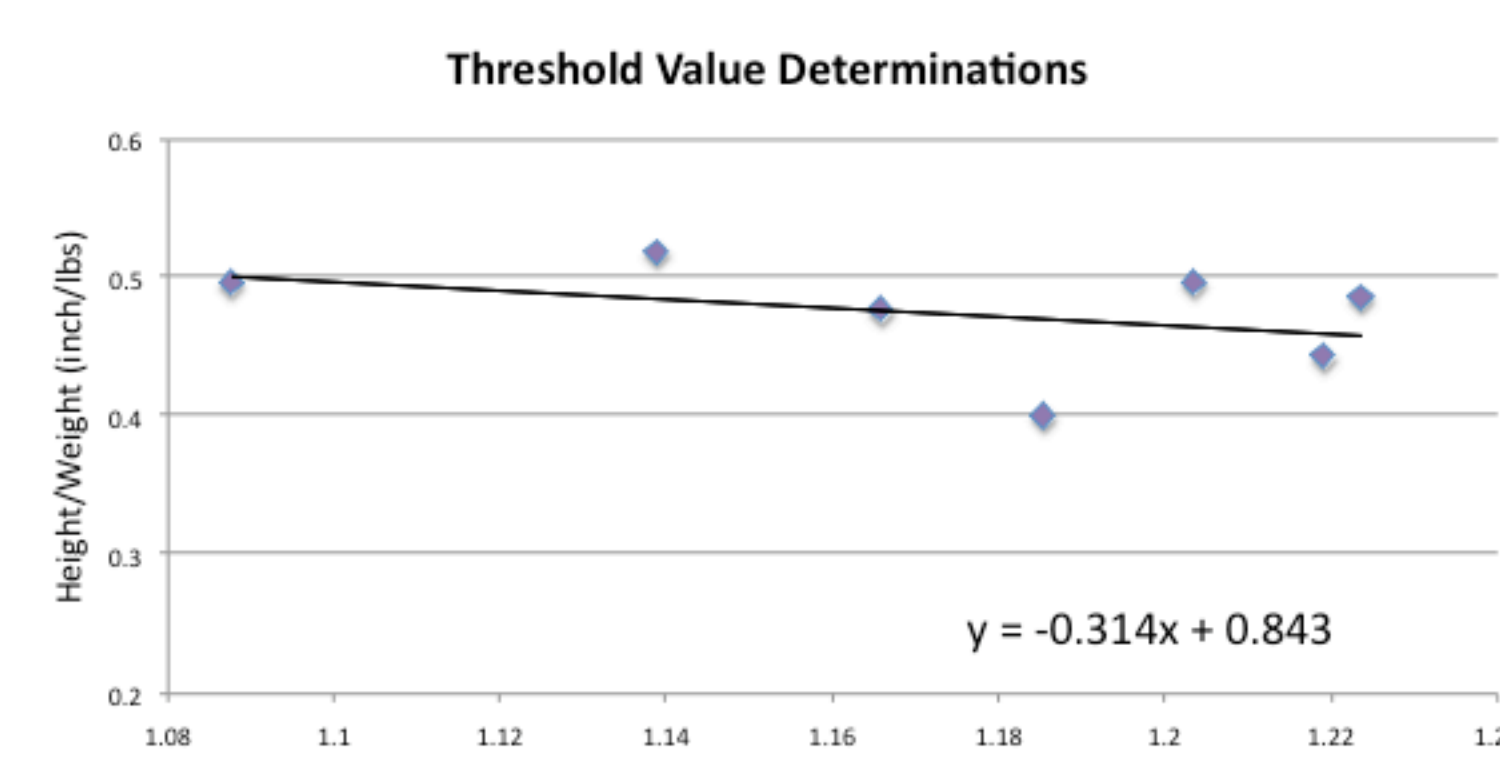
PEDOMETER

$y = -0.314x + 0.843$

Figure 4: Threshold value dependent on height-weight ratio of user

The iPhone's accelerometer measures the acceleration in three directions (x,y,z) and displays these readings as a constant. The iPhone will be secured on the individual through a belt such that only one direction will experience significant changes in its acceleration readings. This direction, x, is measured at a fourteen Hz frequency. A step is registered when the accelerometer reading in the x direction surpasses a certain threshold.

Each individual was tested in a range of threshold values. The program was then calibrated until the steps read by the program matched the actual number of steps taken by the user. This threshold value was then correlated to the height-weight ratio of the individual.

We could not find a strong enough correlation between height, weight and threshold value to calculate accurate results. We decided that no single setting will work for every user and therefore we added in a sensitivity adjuster so that the user can tailor it to their settings.

CONCLUSION

- ✓ Functional 6MWT iPhone application
- ✗ Emergency phone call capability
- ✓ interface that maximizes Hick's and Fitt's #
- ✓ Safe for home use
- ✓ Consistent results
- ✓ Easy to track progress

An accessible home version of the six minute walk test has been created on the iPhone that allows users to gauge progress made in improving their cardio-pulmonary health.

FUTURE

Immediate Future
- Modify sensitivity controls
- Exit program to call 911 (iPhone OS 4)
- Test on subjects with C-P Disease

Future Semester(s)
- Chart view for data points
- Measure fatigue via speech analysis
- Integrate with online logging program
- Modify for healthy individuals
- Modify for total fitness tracking
- Compatible with series of iPhone add-ons
  - Blood sugar reader
  - Heart rate monitor

Figure 5: Current version of Johnson & Johnson (LifeScan) device that will be modified to sync with Apple products

REFERENCES:
ATS Board of Directors (2002). ATS Statement: Guidelines for the Six-Minute Walk Test. Am J RespirCrit Care Med, 166, 111-114.
Beggs, W. D. A., Graham, J. C., Monk, T. H., Shaw, M. R. W., &Howarth, C. I. (1972). Can hicks law and fitts law be combined. Act Psychologica, 36(5), 348-357.
Longstreth, L. E. (1988). Hicks law - its limit is 3 bits. Bulletin on the Psychonomic Society, 26(1), 8-10.
Hellie, L. (2010). "How to measure your step or stride." BellaOnline. http://www.bellaonline.net/articles/art39548.asp

6MWT
Six Minute Walk Test