OBJECTIVE MEASUREMENT OF PHYSICAL ACTIVITY OVER TIME IN OLDER ADULTS WITH HEART FAILURE

by

Catherine L. Taylor

A Senior Honors Project Presented to the

Honors College

East Carolina University

In Partial Fulfillment of the

Requirements for

Graduation with Honors

by

Catherine L. Taylor

Greenville, NC

May, 2019

Approved by:

Dr. Theresa Floegel

College of Nursing- Nursing Science Department

Objective Measurement of Physical Activity Over Time in Older Adults with Heart Failure

Older adults with heart failure are at a greater risk for mortality, hospitalizations, and poorer health when their physical function and movement is limited (Berg et al., 2014; Blecker, Paul, Taksler, Ogedegbe, Katz, 2013). In spite of modern therapies, half of older adults diagnosed with heart failure will die within five years, and quality of life deteriorates quickly in another one-third of this population (Mozaffarian et al., 2015). Additionally, almost half of older adults hospitalized for heart failure are discharged home with more functional dependence or increased mobility difficulty than their pre-hospital baseline (Rodríguez-Pascual et al., 2012). In order to sustain or improve health and quality of life in this population, it is imperative that the physical ability to perform activities of daily living is maintained in both the hospital and home setting (Berg et al., 2014). Although it is known that a decrease in physical activity and function leads to a decreased health and quality of life, there is little objective data showing changes in physical activity and function over time in the heart failure population. Therefore, it is difficult to identify key timepoints for nurses to intervene and support physical activity and function. Furthermore, self-report data on physical activity is prone to recall inaccuracies, misinterpretation, and social desirability bias (Prince et al., 2008). Objective measurement is needed to accurately capture changes in physical activity over time.

Research Questions/Aims

The primary aim of this research study was to explore the use of accelerometry over time as a measure of physical activity in older adults with New York Heart Association (NYHA) class III heart failure. We hoped to 1) explore the feasibility of the Fitbit™ step activity monitor to measure daily step activity over time and 2) explore physical activity trajectory of a preliminary sample using bi-weekly stepping as the measure.

This study measures physical activity in a small subsample of the larger study, which will be the first attempt to examine the trajectory of physical activity/function in the heart failure population through the use of objective measures. The long-term goal of this research is to develop measures to assist older adults with heart failure to maintain the highest level of physical activity and function, thus supporting their independence. In turn, this may promote health, improve quality of life, and lead to a more positive aging experience.

Literature Review

Current research shows there is a decline in physical function in older adults after hospitalization, and functional limitation can lead to a higher mortality rate and limit quality of life. There is also literature that describes the functional ability of older adults with heart failure.

The databases used to initiate the literature search were PubMed and CINAHL. Search terms used in order to narrow the search were “older adult,” “elderly,” “heart failure,” “function,” “physical function,” “accelerometry,” and “hospitalization.” Terms entered to be excluded from the search were “child” and “adolescent.” Articles and journals written in the past five years were included. After using the databases to search for these specific topics, articles were selected if they explained or studied the physical activity/function level of older adults in relation to hospitalization. Articles which studied the function and activity level of people with heart failure were also selected. Studies with no interventions were preferred.

Heart failure is one of the most common reasons for hospitalizations in the United States with an average of 4 million in the United States each year (Blecker et al., 2013). Blecker et al. (2013) revealed that the mean age for patients hospitalized with heart failure is 73.1. This statistic shows the relevance of our sample population of older adults. The results of the research study revealed that although there was a 1% decline in hospitalizations with heart failure as the primary diagnosis (between 2001 and 2009), the number of hospitalizations with heart failure as a secondary diagnosis increased by 1.6% over the same time period (Blecker et al., 2013). These results show that although there may have been an improvement in the care of patients when heart failure is first discovered, there is still a lack of interventions that help keep these patients from returning to the hospital.

It is crucial to introduce interventions and care plans that focus on keeping patients with heart failure out of the hospital. A study completed by Helvik, Selbæk, and Engedal (2013) sampled an older adult population and aimed to discover the change in ability to perform activities of daily living (P-ADL) one year after hospitalization. The results showed that the mean P-ADL significantly decreased from the time of discharge to one-year post-hospitalization $p<0.001$ (Helvik et al., 2013). Hospitalization in older adults has been shown to negatively affect their quality of life once they are discharged, which is why we must assist them in staying out of the hospital. However, a limitation of the study was that it was self-repot and results did not elucidate where changes occurred within that year. On a more long-term scale, Berg et al. (2014) specifically investigated the long-term health related quality of life (HRQoL) in patients hospitalized with heart failure. All of the patients sampled were over the age of 60 with NYHA class II-IV heart failure. The study followed the participants for 12 years, and at the 12-year follow-up period 71% of patients died and 90% of patients were hospitalized during the 12-year span (Berg et al., 2014). The results of this study show a clear relationship between hospitalization of heart failure and mortality. The results also showed that out of the many factors assessed, physical mobility/activity was one of the greatest predictors of hospitalization or death (Berg et al., 2014).

Kaminsky and Tuttle (2015) address that the standard for assessing muscular function in patients with heart failure is lacking; but for now, the best tool to measure muscular function in this population is through the Short Physical Performance Battery test (SPPB). Pavasini et al. (2016) revealed the SPPB score is a strong marker for risk stratification and predicts an increased risk of mortality in older adults. A study completed by Arnau et al. (2016) used the Lawton-Brody Index as well as the SPPB to determine risk factors for functional decline in older adults (2016). The Lawton-Brody Index assesses five activities of daily living through a short survey. The authors explain that a decline in SPPB score and Lawton-Brody score over the one-year period showed a strong association with new disability (2016).

Studies have found that there is a decline in physical activity and function when hospitalized as an older adult and also when diagnosed with heart failure. More recently, researchers are turning to objective stepping data as a measure for physical function. One study showed a correlation between average daily stepping and SPPB scores (Floegel et al., 2019). Tudor-Locke et al. (2011) identified an average range of stepping in people with chronic disease (such as heart failure) of 1200-8800 steps a day. However, the literature does not explain the physical activity trajectory of this population, especially in the months after hospitalization. Our evaluation of intermittent average stepping over four months may provide critical information on physical activity/function trajectory in the heart failure population, and support development of interventions to support physical activity in this population.

Methods

This descriptive study was part of a larger study investigating functional trajectory after hospitalization in older adults with heart failure. We used a longitudinal design to measure physical activity over a four-month period. Institutional Review Board approval was obtained prior to study start.

Participants

The inclusion criteria included: 60 years of age and older, ambulatory without assistance from another person (assistive devices were allowed), diagnosis of heart failure NYHA class III, no medical contraindication to wearing an activity monitor, no cognitive deficits noted on medical record, a record of hospitalization due to a heart failure related condition in the previous four months, able to understand English, home-dwelling, living within 60 miles of the recruiting cardiac clinic in Eastern North Carolina, and able to have bi-weekly home visits for four consecutive months. These patients were recruited from an independent cardiology clinic in Greenville, North Carolina. We obtained a referral from the clinic which deemed the patient medically cleared to participate in the study. The exclusion criteria included residing in a skilled nursing facility and substantial cognitive decline.

Recruitment

Recruitment of participants took place at a cardiology clinic in eastern NC. The Nurse Practitioner and Registered Nurses were aware of the inclusion criteria and referred potential participants. The staff briefly explained the study to patients, and if interested, they were referred to investigators for further explanation. If interested in participation, the investigators thoroughly reviewed the study and obtained informed consent.

Measurement Tools

As part of the larger study, several measurements of physical function and physical activity were obtained. Function was assessed by SPPB and hand grip strength. As an objective measure of physical activity, we used the Fitbit Alta™ activity monitor to record step activity.

The FitBit Alta™ was placed and worn around the participants ankle using a flexible nylon band. We collected weekly step counts. The accelerometer was worn on the ankle to obtain a more accurate step count; devices worn on the hip or wrist are less accurate in older adults with slow or altered gait (Floegel, Florez-Pregonero, Hekler, & Buman, 2016). Additional measures obtained were the KATZ ADL Questionnaire, Lawton-Brody Instrumental Activities of Daily Living Scale (IADL), 20-Item Short Form Survey Instrument (SF-20), Mini Nutritional Assessment (MNA), selected questions from the Pittsburgh Sleep Quality Index (PSQI), and the Geriatric Depression Scale (GDS-15).

Procedures

Participants completed demographic, health, and lifestyle surveys during the first visit. Medical and other health data were collected from the medical record. Objective measurements were repeated at each bi-weekly visit for a total of nine visits. The lifestyle surveys were completed at the first visit and the final (ninth) visit. We requested the participant wear the accelerometer for seven consecutive days after each bi-weekly visit to record daily step counts and active minutes. At the end of the week, the participant mailed the accelerometer back to the study investigator in a pre-paid, pre-addressed envelope. The participant received a reminder phone call to return the accelerometer. At the completion of each participant visit, the participant received an incentive gift card of $25.

Analysis

Stepping data was accessed via the Fitbit™ mobile application. The app revealed the daily step count of the participants from the days of use. Investigators reached a consensus to omit days in which a step count of less than 300 was recorded, however, if the participant consistently recorded less than 300 to less than 500 steps a day, we omitted days of 100 recorded steps or less. Descriptive statistics (mean, standard deviation, range, percent proportion) were used to analyze demographic and clinical characteristics and accelerometer stepping data. Additionally, graphic depiction of stepping data was created. We used Microsoft Excel and SPSS v24 to analyze the data.

Results

We show results from nine participants who completed the overall study and had at least five bi-weekly episodes of recorded stepping data. Participants were 74.9 ± 4.5 years of age, had a mean ejection fraction of 36.7% ± 7.1%, BMI range 27.1 to 38.8, and 8.1 ± 3.1 comorbidities (Table 1).

Table 1. Demographics and health history of participants (N = 9)

Characteristic	n (%)
Age, M ± SD	74.9 ± 4.5
Gender, Female	1 (11.1)
Race, African American	4 (44.4)
BMI, M ± SD	31.1 ± 4.8
Ejection Fraction, M ±SD	36.7 ± 7.1
Comorbidities, M ±SD	8.1 ± 3.1
Marital status	
Married	4 (11.1)
Widowed	2 (22.2)
Single	1 (11.1)
Divorced	2 (22.2)

Figure 1 shows the bi-weekly stepping average for the nine participants over the course of the 16-week study. Four participants were hospitalized during the study period, while five participants did not require hospitalization. Participants had 82.1% recorded step data across the study. Missing stepping data were due to hospitalizations (participant 106), device error (participant 101 and 108), investigator error (participant 106), and lost device (participant 110). Participant feedback regarding activity monitor wear included comfort of band, easy to keep in place, and low maintenance. We are unaware of the monitor being removed by any participant other than for bathing. Overall, there was high inter-participant stepping variability across the study, but low intra-participant variability.

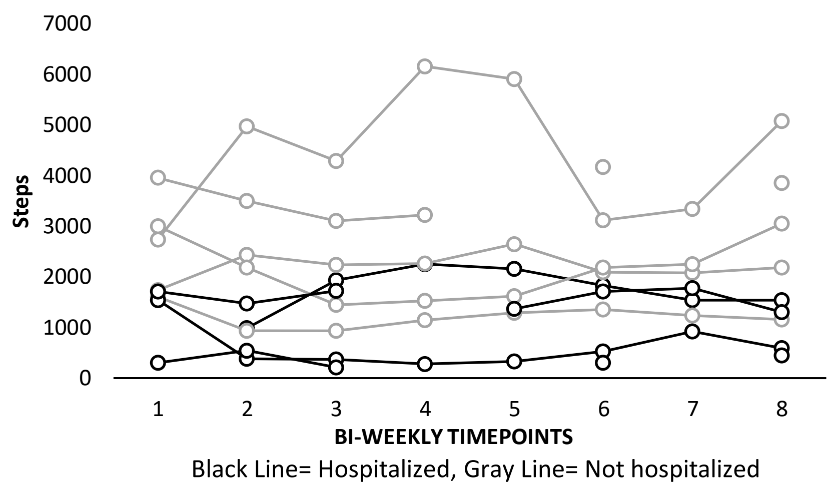

Figure 1. Step Activity of All Participants Over Study Period

Figures 2-5 show the bi-weekly stepping averages for participants who were re-hospitalized during the study period. Arrows identify hospitalization timepoints. Participant 101 was hospitalized at the end of week 10 (time-point 6) Figure 2 shows the decline in participant steps the weeks prior to and immediately after the hospitalization period. It was at two-weeks post-hospitalization that the participant's recorded step activity began to be maintained.

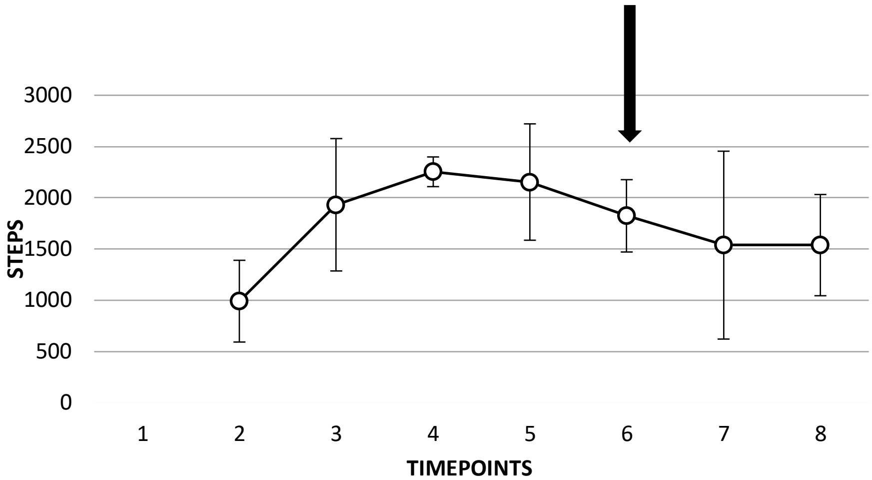

Figure 2. Step Activity of Participant 101. Missing recorded step data from timepoint 1 due to device error. Arrow indicates hospitalization timepoint.

One participant was a habitually low stepper, however, they began the study with 1542 recorded average daily steps before declining to an average of 617 recorded daily steps over the remaining study period. This participant was hospitalized at week 2 (between timepoints 1 and 2) and again at week 9 (timepoint 5) (See Figure 3).

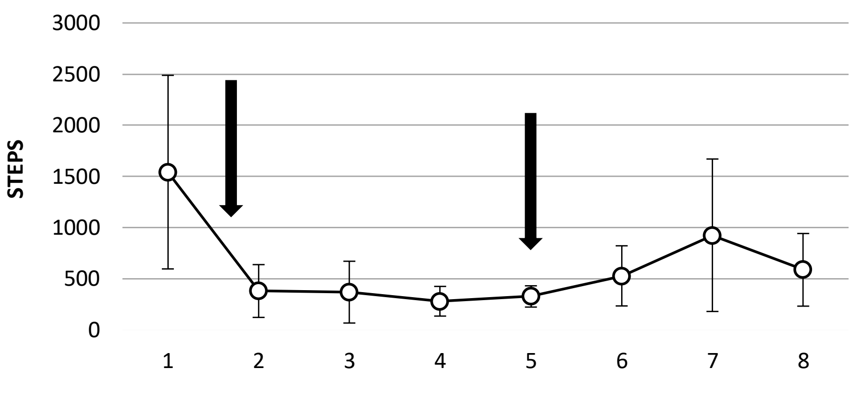

Figure 3. Step Activity of Participant 104, who experienced 2 hospitalizations.

Another hospitalized participant had several weeks of missing data. Weekly stepping data from timepoints 4 and 5 were missing due to a prolonged hospital stay. Another week of stepping data was missed related to investigator error. Although a weekly stepping trend cannot be identified, this participant had a very low recorded step average across the entire study period (see Figure 4).

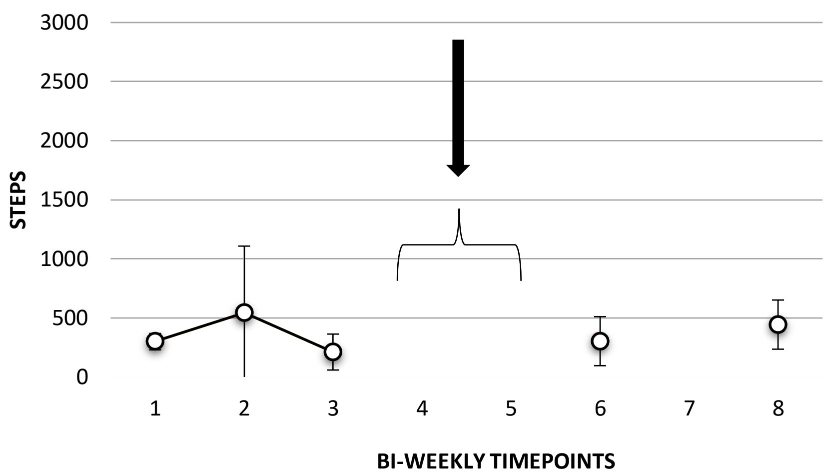

Figure 4. Step Activity of Participant 106. Missing recorded step data from timepoints 4 and 5 due to hospitalization, timepoint 7 due to investigator error.

Figure 5 shows the recorded step activity of another participant who experienced a re-hospitalization. His hospitalization occurred between timepoints 1 and 2. This participant had a consistently low but stable weekly stepping average.

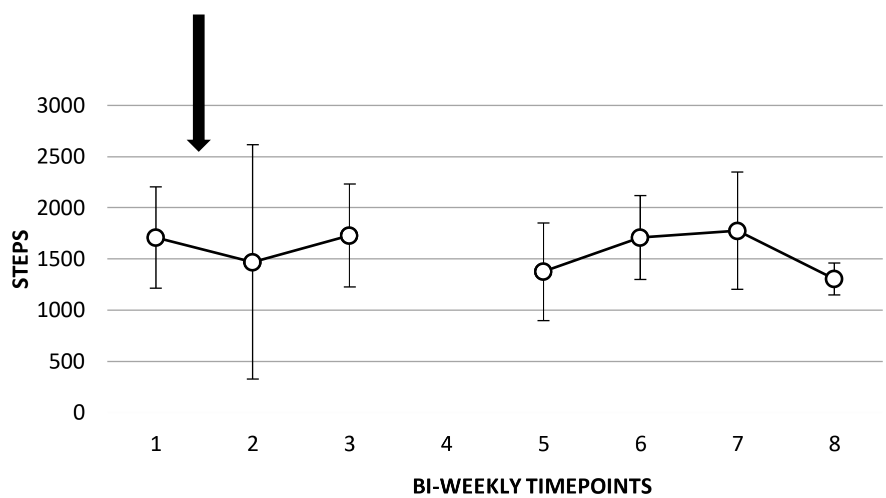

Figure 5. Step Activity of Participant 110. Missing recorded step data from timepoint 4 due to lost device.

Discussion

This study used accelerometry to assess physical activity over time by using bi-weekly stepping data as a measure of physical activity. Overall, there was high wear time of the accelerometer throughout the study (82.1%). The nine participants averaged 1995 daily steps over the entire study period. Our sample averaged on the lower end of the Tudor-Locke (2011) findings of 1200-8800 steps a day in the chronically ill population. Although this was a small sample size, there may be a trend in stepping associated with hospitalization in the heart failure population. Four of the nine participants were re-hospitalized during the study period. These four participants just averaged 1075 daily steps over the study period, while the five participants who remained at home averaged 2732 daily steps. A trend in lower stepping activity may be a marker for re-hospitalization. Furthermore, a low stepping count may be indicative of poor recovery from hospitalization. Thus, nursing may use this objective measure to inform interventions targeting those patients who might benefit most from physical activity support. This in turn may support health and quality of life in this population.

Limitations

The sample size was not large enough to confirm test feasibility of the accelerometer use for physical activity measurement or activity trajectory in this population. A longer study may be needed to confirm these findings.

Halfway through the study, the monitor vendor changed the process of data access and exportation. Because of this change, we had to access all of the data manually. Manual, tedious collection of the data may increase the chance of human error. This may be a consideration for future studies requiring larger sample sizes and quicker data recovery.

Each participant was given thorough instruction on how to wear the accelerometer, when to wear the accelerometer, and exactly when and how to return the accelerometer to the research staff. However, it is unknown if the participants strictly followed the instructions and wore the accelerometer for the correct and same amount of time each day and week. The participants were all instructed to wear the accelerometer around their ankle 24 hours a day except when bathing. We are unable to confirm if each participant followed this pattern of use.

All accelerometers were returned to the researchers using a pre-packaged and pre-stamped envelope. Due to the type of stamp pre-purchased for each envelope, the accelerometer did not return to the researcher for 5-7 days after the participant mailed it back. This left a small window of time to charge the device and retrieve the step data before returning the device to the participant at their next scheduled home visit. Several times the accelerometer did not make it back to the researchers in time, so a second monitor needed to be initialized and brought to the participant to avoid missing a week of step data. Assigning two and sometimes three monitors to each participant required strict attention to logins, correct labeling of each monitor, and separating the monitors on the charging station. Future studies with a greater number of participants should consider additional strategies to receive monitors in a timely manner.

Conclusion

Our findings provide support for long term use of accelerometry to measure physical activity in older adults with heart failure. Findings from the larger trial will explore the association of stepping activity and physical function. The use of accelerometry has the potential to quantify daily physical activity/function without the need of burdensome physical assessment or use of invasive measures. These findings will support development of nursing interventions to improve or maintain physical function after hospital discharge.

References

Arnau, A., Espaulella, J., Serrarols, M., Canudas, J., Formiga, F., & Ferrer, M. (2016). Risk factors for functional decline in a population aged 75 years and older without total dependence: A one-year follow-up. *Archives of Gerontology and Geriatrics,65*, 239-247. doi:10.1016/j.archger.2016.04.002

Berg, J., Lindgren, P., Kahan, T., Schill, O., Persson, H., Edner, M., & Mejhert, M. (2014). Health-related quality of life and long-term morbidity and mortality in patients hospitalised with systolic heart failure. *Journal of the Royal Society of Medicine Cardiovascular Disease,*1-9. doi:10.1093/eurheartj/eht308.p1490

Blecker, S., Paul, M.P, Taksler, G., Ogedegbe, G., & Katz, S. (2013). Heart failure–associated hospitalizations in the United States. *Journal of the American College of Cardiology,61*(12), 1259-1267. doi:10.1016/j.jacc.2012.12.038

Floegel, T. A., Allen, K. D. & Buman, M. P. (2019). A pilot study examining activity monitor use in older adults with heart failure during and after hospitalization. *Geriatric Nursing, 40*(19), 185-189. doi:10.1016/j.gerinurse.2018.10.001

Floegel, T. A., Florez-Pregonero, A., Hekler, E. B., & Buman, M. P. (2016). Validation of consumer-based hip and wrist activity monitors in older adults with varied ambulatory abilities. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences,72*(2), 229-236. doi:10.1093/gerona/glw098

Helvik, A., Selbæk, G., & Engedal, K. (2013). Functional Decline in Older Adults One Year After Hospitalization. *Archives of Gerontology and Geriatrics,57*(3), 305-310. doi:10.1016/j.archger.2013.05.008

Kaminsky, L. A., & Tuttle, M. S. (2015). Functional assessment of heart failure patients. *Heart Failure Clinics,11*(1), 29-36. doi:10.1016/j.hfc.2014.08.002

Mozaffarian, D., Benjamin, E. J., Go, A. S., Arnett, D. K., Blaha, M. J., Cushman, M., . . . Turner, M. B. (2015). Heart disease and stroke statistics—2016 update: A report from the American Heart Association. *Circulation,133*(4). doi:10.1161/cir.0000000000000350

Pavasini, R., Guralnik, J., Brown, J. C., di Bari, M., Cesari, M., Landi, F., … Campo, G. (2016). Short Physical Performance Battery and all-cause mortality: systematic review and meta-analysis. *BMC Medicine*, *14*, 215. doi: 10.1186/s12916-016-0763-7

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Connor-Gorber, S., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *The International Journal of Behavioral Nutrition and Physical Activity*, 5, 56-5868-5-56. doi:10.1186/1479-5868-5-56

Rodríguez-Pascual, C., Vilches-Moraga, A., Paredes-Galán, E., Ferrero-Marinez, A. I., Torrente-Carballido, M., & Rodríguez-Artalejo, F. (2012). Comprehensive geriatric assessment and hospital mortality among older adults with decompensated heart failure. *American Heart Journal,164*(5), 756-762. doi:10.1016/j.ahj.2012.08.009

Tudor-Locke, C., Craig, C. L., Aoyagi, Y., Bell, R. C., Croteau, K. A., De Bourdeaudhuij, I., . . . Blair, S. N. (2011). How many steps/day are enough? For older adults and special populations. *International Journal of Behavioral Nutrition and Physical Activity,8*(80), 1-19. doi:doi:10.1186/1479-5868-8-80