The Usefulness of Activity Trackers in Elderly with Reduced Mobility: A Case Study

Jonas Lauritzen
University of Seville, Spain
JonasLauritzen@atc.us.es
Background

- Balance
- Strength
- Flexibility
  - Indoor exercises

- Endurance/Stamina
  - Outdoor exercise
  - Walking

GameUp
Background

• Encourage elderly to walk more and keep walking
  – Provide motivational feedback
  – Provide overview of progress
  – Make recommendations
  ➔ To evaluate their current effort

• A method of accurately quantifying activity
  – Activity trackers/Pedometers
  – GPS (*not possible in GameUp*)
Goal

• Examine the accuracy of two present activity trackers:
  – Fitbit Ultra (*activity tracker*)
  – Samsung Galaxy S3 (*pedometer application*)

• Compare Elderly with normal and reduced mobility and healthy adults
Healthy Adults (HA)

Age: 25 – 45
No gait disabilities
• Global exclusion criteria
  – Cognitive impairment
  – Conditions that hinder gait or correct device placement
Procedure

- Participants instructed to
  - Walk a distance of 20m on a straight outlined path
  - Walk at their own pace
  - Use their own walking aid, if any \(\text{(not HA)}\)

- Participants always had someone by their side \(\text{(not for HA)}\)

- Setup
  - Path, Start & finish position marked out clearly
  - Test area closed for other activities/traffic
  - Participants were offered practice “runs”
Instruments

- Wrist
  - Fitbit Ultra
- Hip
  - Fitbit Ultra
  - Samsung Galaxy S3 (*Noom*)
- Feet
  - Video camera
- Time to complete
  - Stopwatch
Results

HA
n = 6
Age: 35.33 ± 6.53

NME
n = 7
Age: 84.14 ± 3.67

RME
n = 5
Age: 87.6 ± 3.91
Results

- POMA gait score
  12 indicates max
  HA = 11.83 ± 0.41
  NME = 9.14 ± 0.9
  RME = 5 ± 1.58
  \( p < 0.05 \)

- Time to complete 20m/
  avg. walking speed
  \( p = 0.001 \)
Results

- Wrist placed Fitbit
  - RME performs worse than NME ($p=0.003$)
  - RME performs worse than HA ($p=0.004$)

- Hip placed Fitbit
  - RME performs worse than HA ($p=0.009$)

- Hip placed Smartphone
  - RME performs worse than NME ($p=0.005$)
  - RME performs worse than HA ($p=0.017$)

- No significant difference between NME and HA

Independent Kruskal-Wallis & Mann-Whitney U tests
Results

• POMA, highly negatively correlated with
  – Age
  – Time to Complete \((\text{avg. speed positively correlated})\)
  – Number of Steps Taken
  – Error Percentage in all devices/wear locations

• Time to Complete and Number of Steps Taken correlated with Error Percentage in all devices/wear locations

• Age was not correlated with Error Percentage

• Age highly negatively correlated with avg. speed
Results

• RME data characterized by large undercounting

• RME wrist worn Fitbit failed to detect any steps in 4/5 participants
  – Detected only 1.79% of steps taken when detecting

• RME displayed overall low accuracy (Error percentage > 60%) and poor precision

• Best results obtained in hip worn Fitbit in HA (2.86% ± 2.34%)
Discussion

• Poor device performance in RME
  – Small steps
  – Little/no vertical foot displacement
  – Slow/a abrupt walking pace
  – Static wrist position (Holding on to rollator handles)
    → Sensor not subjected to enough vertical displacement

• Activity trackers usually not targeted at RME \(\text{(and some NME)}\), but people with faster pace/stride length – HA
Conclusion

- Tested devices not advisable for use in RME, even when placed in accordance to manufacturer recommendations

- Optimum device and placement is Fitbit Ultra at Hip

- Alternative methods required for people with reduced mobility
  - Counting rollator wheel rotations
  - Impact sensor on canes
Recent changes

- Recommended wear updated – wrist no longer recommended
- Fitbit Ultra no longer available in sale
- Fitbit Ultra replaced by Fitbit the One
GameUp project is cofunded by the AAL Joint Programme (AAL-2011-4-090)

Cofounders:
- The Research Council of Norway
- Gobierno de España
- Ministerio de Industria, Energía y Turismo
- Schweizerische Eidgenossenschaft
- Confédération suisse
- Confederazione Svizzera
- Confederaziun svizra
- Swiss Confederation
- Federal Department of Economic Affairs FDEA
- Federal Office for Professional Education and Technology OPET

Partners:
- Ibernex
- O+berri
- Klinik Valens
- Cyberlab
- Norut
- Universidad de Revilla
- Tromsøysund Menighet
About EDSS

About POMA

The authors are not linked or financially supported by companies or manufacturers of the devices used in this study and does not benefit from the results of the present study. The authors would like to acknowledge the “Fundación Doña María” nursing home in Seville, Spain (www.fundomar.org) for their assistance and for letting us use their facilities and thank the inhabitants who participated in this study and to also thank physiotherapists Mr. Israel Fernandez and Mr. Manuel Lima for their help and assistance. The authors would also like to acknowledge the members of the GameUp consortium.

This work was supported by the European Ambient Assisted Living (AAL) Project; GameUp, project code AAL-2011-4-090.