Comparison of ActiGraph, Fitbit and Manual Step Count During a Two-Minute Walk Test in People with Multiple Sclerosis: A Pilot Study

V Block, PT, DPTSc (c);\textsuperscript{1} A Lizée, MSc;\textsuperscript{2} E Crabtree, MD;\textsuperscript{2} C Bevan, MD;\textsuperscript{2} J Graves, MD, PhD;\textsuperscript{2} M Tremblay, MD, PhD;\textsuperscript{2} B Nourbakhsh, MD;\textsuperscript{2} A Green, MD, MCR;\textsuperscript{2} M Pletcher, MD, MPH;\textsuperscript{2} B Cree, MD, PhD, MAS;\textsuperscript{2} DD Allen, PT, PhD;\textsuperscript{2} JM Gelfand, MD\textsuperscript{2}

\textsuperscript{1}University of California San Francisco / San Francisco State University: Graduate Program in Physical Therapy; \textsuperscript{2}University of California San Francisco: School of Medicine, Clinical Neurology; \textsuperscript{3}University of California, San Francisco: School of Medicine, Epidemiology and Biostatistics

**Background:**
- Multiple sclerosis (MS) commonly leads to impairments in gait
- Remote physical activity monitoring in the patient’s natural environment has the potential to augment measurement of MS-related disability and disease progression and might have prognostic value.
- Neurological disability may influence the fidelity of step count monitoring

**Objective:**
Compare remote physical activity monitoring using commercially available devices in people with MS with a broad range of ambulatory impairments.

**Methods:**
Subjects:
- 61 adults with MS at UCSF MS Center.

Exclusion criteria:
- Recent clinical relapse (≤30 days), physical comorbidities that could contribute to gait impairment and confound results.

Measures of step count during 2-minute walk (2MW):
- Fitbit Flex®
- Research-grade accelerometer (ActiGraph)
- Manual step counting (by a physical therapist)

**Results:**
Bland-Altman plots showed:
- No systematic difference between the number of steps measured by Fitbit vs. manual counts (across the range of step counts).
- ActiGraph measurements tended to under-record actual steps taken at slower gait speeds.
- Interclass correlation coefficients (ICC) comparing total step counts across methods during the 2MW revealed moderate correlations.

**Discussion:**
- Wrist-worn commercial accelerometers (Fitbit® Flex) appear to provide a valid alternative to more expensive, research grade accelerometers for determining step count in people with MS, particularly at slower gait speeds.
- Further study is ongoing in the community setting to evaluate associations with longer-term patterns of neurological impairment and gait abnormalities.

**Appendix:**

Table 1: Participant Demographic Data

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Progressive</th>
<th>Relapsing</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>61</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td>Age (y)*</td>
<td>50 (14.4)</td>
<td>58.5 (8.4)</td>
<td>46.3 (15.0)</td>
</tr>
<tr>
<td>EDSS †</td>
<td>4.0 (0-6.5)</td>
<td>6.0 (3.0-6.5)</td>
<td>2.8 (0-6.0)</td>
</tr>
<tr>
<td>DD (y) ‡</td>
<td>10 (4-21)</td>
<td>15 (8-20)</td>
<td>9 (4-22)</td>
</tr>
</tbody>
</table>

* Mean (standard deviation); † median (range)
EDSS = Kurtzke Expanded Disability Status Scale; DD = disease duration

**Table 2: Interclass Correlation Coefficients**

<table>
<thead>
<tr>
<th>Step Count Measures</th>
<th>Fitbit vs. manual</th>
<th>Fitbit vs. ActiGraph</th>
<th>ActiGraph vs. manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC (95% CI)</td>
<td>0.69 (0.53 - 0.80)</td>
<td>0.59 (0.40 – 0.73)</td>
<td>0.76 (0.63 - 0.85)</td>
</tr>
</tbody>
</table>

References: www.fitbit.com, ActiGraph LLC, Pensacola, FL.

Acknowledgement: The FITriMS study is a sub-study of the UCSF Health e-Heart study. Research reported in this publication was supported by the National Center for Advancing Translational Sciences of the NIH under Award Number KL2TR000143 (JMG).