Concurrent Validity of Fitbit Charge HR and Microsoft Band 2 to Measure Heart Rate

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Abstract:
Purpose: Wrist-worn monitors are developed to unobtrusively measure heart rate (HR) at rest and during exercise. This study assessed the concurrent validity and reliability of the Microsoft Band 2 (Microsoft-Band2) and Fitbit Charge HR (Fitbit) to measure HR at rest and during exercise.

Methods: Healthy men (n=12) and women (n=12) (mean ± SD; age 24.3 ± 3.1 yr) were tested on two occasions separated by at least 7 d. The same protocol was used during each visit and consisted of 3-min conditions in the following order - supine, sitting, 6 km.h⁻¹ walk, 10 km.h⁻¹ run, and 12 km.h⁻¹ run. HR was continuously measured using a Holter monitor, Microsoft-Band2, and Fitbit, and averaged across each 3-min condition. A Bland Altman analysis was conducted to calculate the intervals of agreement (95%). A 2 tailed t-test at α = 0.05 was used to compare the mean differences in measurements with the Holter for both devices and an F-test (α = 0.05) was used to compare the measurement dispersion characteristics of both devices.

Results: The intervals of agreement for the Fitbit had comparable dispersion characteristics with the Microsoft-Band2 with the exception of the supine condition (p = 0.004). The difference between Fitbit and Holter are significantly further from zero than the difference between Microsoft-Band2 and Holter for sitting (p = 0.004) and 6 km.h⁻¹ walk (p = 0.001).

Conclusion: Microsoft-Band2 is more accurate than Fitbit at seated rest and during low intensity exercise, walking, and is comparable to Fitbit at 10km.h⁻¹ run.

INTRODUCTION
Advances in wearable technology has led to the emergence of new consumer-based wrist-worn HR monitors for personal health management. There is currently limited information available on the validity of wrist-worn HR monitors. The purpose of this study was to assess the validity of two commonly used wrist-worn HR monitors - the Fitbit Charge HR and the Microsoft Band 2.

METHODOLOGY
A total of 12 male and 12 females (mean ± SD; age 24.3 ± 3.1 yr, height 172.9 ± 10.1 cm; weight 69.4 ± 13.3 kg, BMI 23.1 ± 3.1. kg/m²) made 2 separate visits to the vascular health research laboratory at DCU. Participants were fitted with a Holter monitor and wore both a Fitbit and a Microsoft-band2 (figure 1a-c) during each laboratory visit.

RESULTS
The intervals of agreement for the Fitbit had comparable dispersion characteristics with the Microsoft-Band2 with the exception of the supine condition ( F 24,24 = 3.05, p-value = 0.004). The MB displayed significantly higher accuracy for both sitting (t 24 =2.93, p-value=0.004) and the 6 km.h⁻¹ walk (t 24 =3.24, p-value=0.001). During the 10 km.h⁻¹ run, there was an equivalent difference between the Holter and both the Microsoft-band2 and the Fitbit, but in opposite directions.

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Figure 1a
Figure 1b
Figure 1c

During each visit which was separated by 7 d, HR was measured while supine, sitting, walking and (figure 2). The dispersion between the Holter monitor and the Fitbit and Microsoft-Band2 were compared for each experimental condition using a F-test at α=0.05. The mean difference for each watch with the Holter monitor were then compared using a 2 tailed paired t-test at α=0.05.

Figure 2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SD Holter-MB</th>
<th>SD Holter-Fitbit</th>
<th>F 24,24</th>
<th>P-value</th>
<th>Mean Holter-MB</th>
<th>Mean Holter-Fitbit</th>
<th>t 24</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supine</td>
<td>8.97</td>
<td>2.93</td>
<td>3.05</td>
<td>0.004</td>
<td>-3.977</td>
<td>-0.058</td>
<td>2.03</td>
<td>0.026</td>
</tr>
<tr>
<td>Sitting</td>
<td>4.746</td>
<td>3.295</td>
<td>1.44</td>
<td>0.188</td>
<td>-0.768</td>
<td>2.689</td>
<td>2.93</td>
<td>0.004*</td>
</tr>
<tr>
<td>6 km.h⁻¹</td>
<td>5.405</td>
<td>7.825</td>
<td>1.91</td>
<td>0.141</td>
<td>-2.916</td>
<td>3.222</td>
<td>3.24</td>
<td>0.001**</td>
</tr>
<tr>
<td>10 km.h⁻¹</td>
<td>6.832</td>
<td>6.245</td>
<td>1.09</td>
<td>0.414</td>
<td>-2.902</td>
<td>2.147</td>
<td>2.67</td>
<td>0.007**</td>
</tr>
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<td>12 km.h⁻¹</td>
<td>6.887</td>
<td>7.346</td>
<td>0.937</td>
<td>0.561</td>
<td>4.166</td>
<td>6.141</td>
<td>0.961</td>
<td>0.373</td>
</tr>
</tbody>
</table>

Figure 4: Bland Altman plots