42 Aero Camino, Goleta, CA 93117
Tel (805) 685-0066 | Fax (805) 685-0067
info@biopac.com | **www.biopac.com**

White Paper: **Comparison of BioHarness™ to a Spirometer for measuring respiratory rate**

Introduction

In the field of exercise physiology, respiratory rate is a parameter that can be used to provide information on a person's physiological state and fitness. Respiratory rate has been used to, for example, determine the second ventilatory threshold1 (VT). This threshold has been associated with anaerobic or lactate threshold, which are accepted as a valid marker of the maximum steady state intensity for an endurance athlete2. Lab-based tools exist to measure respiratory function. Simple spirometers are devices that measure air flow and respiratory rate. More complex systems include gas analysis systems such as the MetaMax® 3B. It is acknowledged widely that both simple and complex lab-based systems require hardware that limits their practical use outside of the lab environment.

The BioHarness™ available from BIOPAC Systems, Inc. is a wireless, portable biomonitoring system used to measure physiological conditions including heart rate, respiration rate, temperature, activity and posture. The system comprises an electronics module and a patented Smart Fabric garment that is worn on the torso like a standard heart rate monitor. Data may be transmitted to a PC and viewed in real-time or logged on the device and later uploaded for review and analysis.

The BioHarness™ calculates breathing rate by measuring chest expansion and contraction as a subject breathes. It is the aim of the paper to compare the performance of a BioHarness™ to a spirometer during static, walking and running activities

Methods

4 male subjects ranging from ages 28 to 39 and of reasonable fitness level were tested in a lab using a LabPro spirometer and BioHarness™ system. Each subject completed a protocol as follows; 5 minutes static standing, 5 minutes treadmill walking at 5km/h and 5 minute treadmill running at a comfortable pace (≥ 7kph).

Table 1 – Test Participant Data

Subject	Sex	Age	Hgt (cm)	Wgt (kg)
1	M	28	185	70
2	M	34	173	73
3	M	39	169	100
4	M	28	170	70

Each subject wore a LabPro spirometer connected to a face mask, and a BioHarness™ for the duration of the test. Spirometer flow rate was recorded and low pass filtered to remove high frequency noise. Breathing rate was then calculated from the flow rate data by counting zero crossings on the flow rate graph. Breathing rate data from each system was compared to assess validity3.

Results

The results show there is a good correlation (r>0.94) between spirometer and BioHarness™ breathing rate. Results are summarized in *table 2*.

Table 2 – Summary of Breathing Rate Comparison Data

Parameter		Value
r		0.94
Bias		-0.3
SE		0.2
95% Limits of Agreement	*Lower*	-2.5
	Upper	2.1

Figures 3.1 and 3.2 present errors, bias and correlations between the spirometer and the BioHarness™.

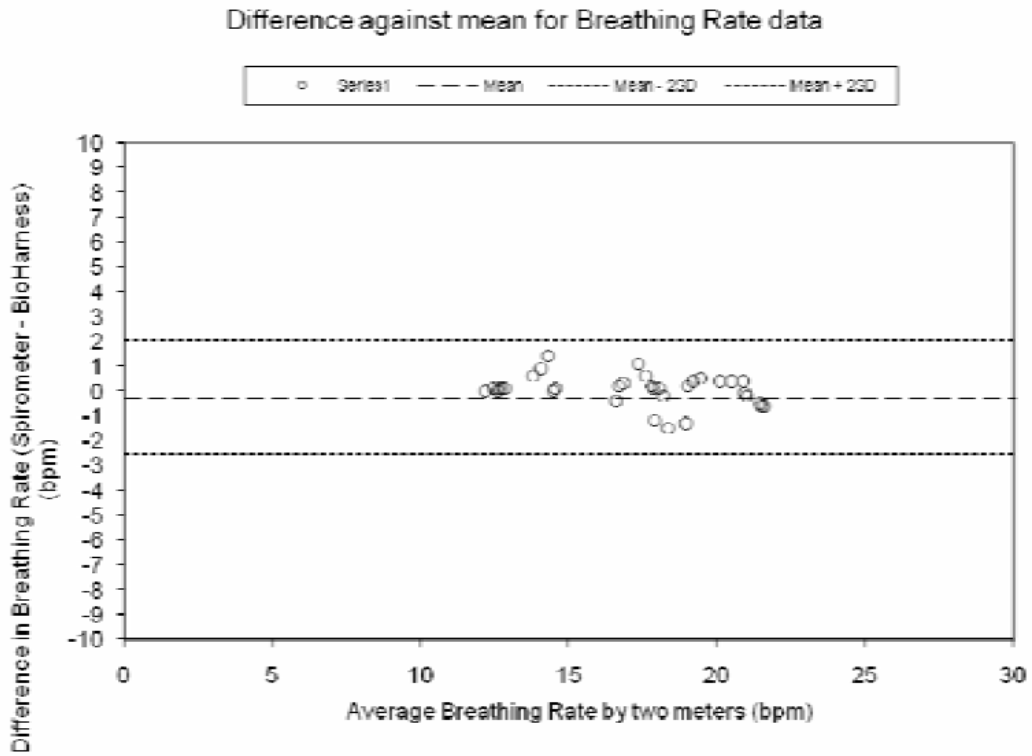

Fig 3.1 Difference against mean breathing rate (Spirometer – BioHarness™)

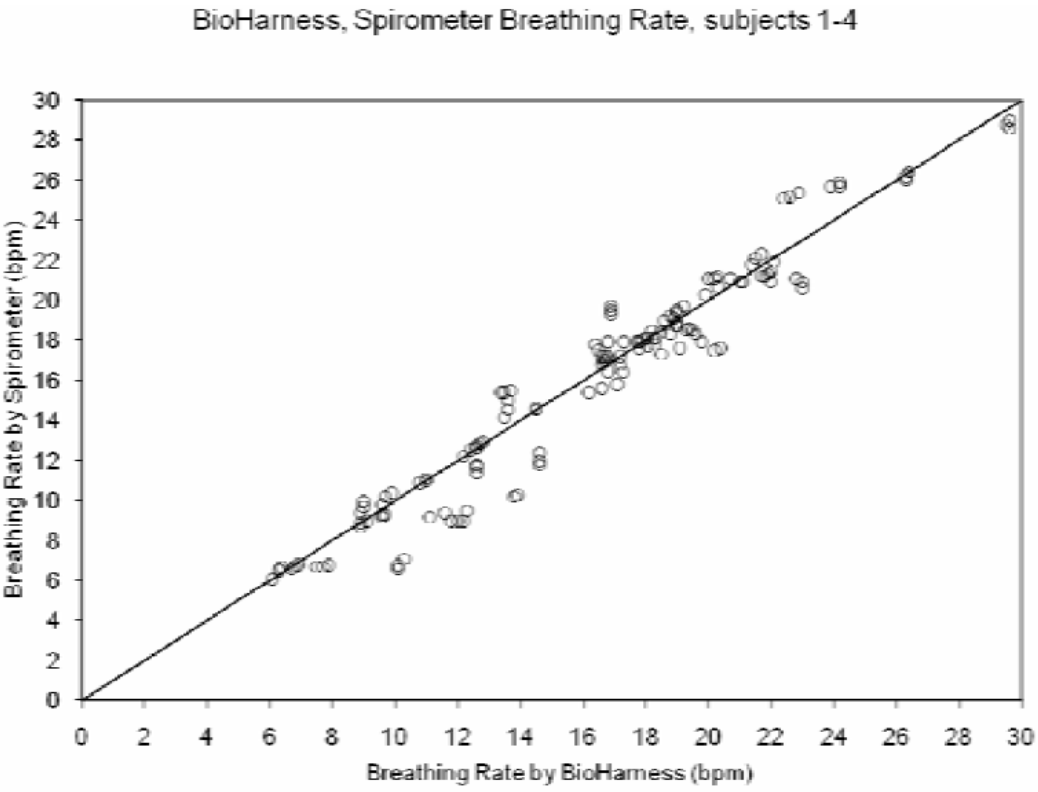

Figure 3.2 Correlation Spirometer vs. BioHarness™

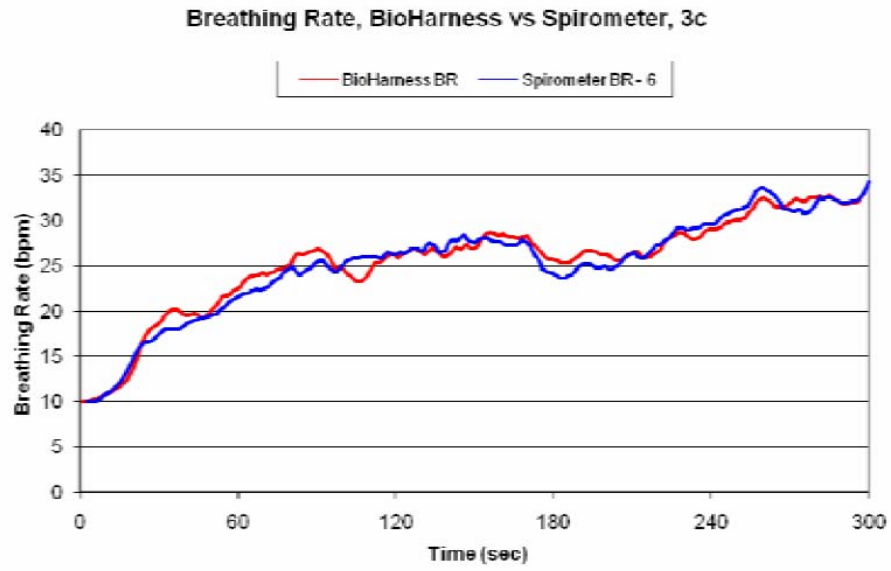

Figure 3.3 Example graph Spirometer vs. BioHarness™ breathing rate subject 3, test c – running

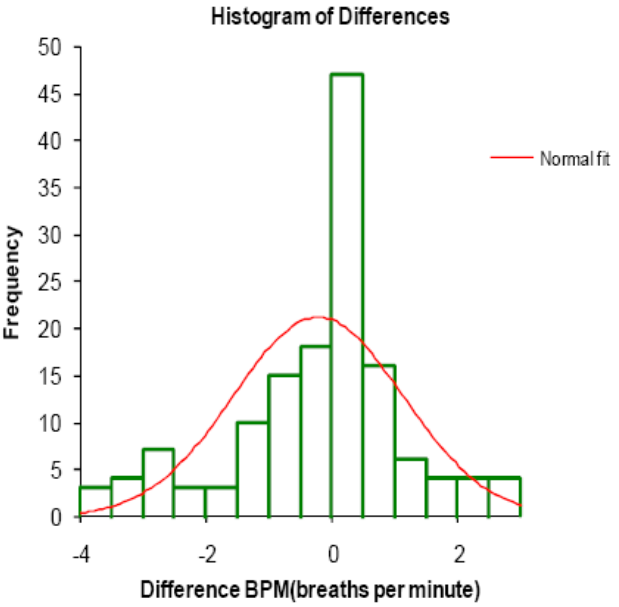

Figure 3.4 Histogram of Differences

Conclusions

From the initial result from this data set it appears that a BioHarness™ can be used to reliably measure respiratory rate during static activity, walking, and running. A wider study is ongoing using a larger group of test subjects to increase the confidence in these initial findings. Based on this initial study, and experience in the field to date, it appears that the lightweight, wireless and portable BioHarness™ can be used for physiological measurement both in the lab and in the field. With particular reference to breathing rate, a potential use for the BioHarness™ may be the detection of the break point in respiratory rate, which has been associated with ventilatory threshold4.

References

1. Respiratory rate is a valid and reliable marker for the anaerobic threshold: implications for measuring change in fitness. Daniel G. Carey , Leslie A. Schwarz , German J. Pliego and Robert L. Raymond, *Journal of Sports Science and Medicine* (2005) 4, 482-488.
2. Exercise Physiology by Stanley P. Brown, Wayne C. Miller, Jane M. Eason.
3. Altman DG, Bland JM. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*, 1986; i: 307-310.
4. Perceptual and motor skills, NABETANI Teru; UEDA Takeshi; TERAMOTO Keisuke; 2002, vol. 94 (1), no3, pp. 851-859.