Brain-Heart (Cardiovascular) Interactions in Stress and Anxiety Related Disorders

Implications for Increased Cardiovascular Disease Risk

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HEART RATE VARIABILITY AND MOBILE HEALTH

Mobile health technology has become ubiquitously integrated in smart devices (e.g. mobile phones, smart watches), using various measures of physiologic parameters such as body temperature, electrical conductance, photoplethysmography (PPG), and electrocardiography rate variability (HRV).1 Of these, HRV is important for its association with autonomic tone and mental stressors, such as depression,2-5 anxiety disorders,6 and PTSD.7-9 Understanding the context of daily stress and stress dynamics, through continuous measures, may allow for individualized stress management.10 Multiple features derived from HRV, such as the standard deviation in the beat-to-beat interval and frequency domain measures, correlate with acute stress, and can be monitored in real time.11-13 Biofeedback has become a common approach to improve cardiac coherence, which uses measurements of high frequency HRV in conjunction with controlled breathing to increase vagal tone.14,15 HRV measured through ECG through 12-lead electrocardiogram and through mobile device are not fully equivalent,16 although PPG derivations of HRV from smart phones and watches do show high correlation.17,18 Other modalities, such as accelerometry data, may improve the accuracy of HRV in evaluating acute stress, but further research is needed to identify the best measures for both acute and chronic stress, as well as mobile-health based interventions.10,19,20

REFERENCES

1. *Real-time mental stress detection based on smartwatch*: IEEE; 2017.

2. Huang M, Shah A, Su S, et al. Association of Depressive Symptoms and Heart Rate Variability in Vietnam War-Era Twins: A Longitudinal Twin Difference Study. *JAMA Psychiatry.* 2018;75(7):705-712.

3. Kidwell M, Ellenbroek BA. Heart and soul: heart rate variability and major depression. *Behav Pharmacol.* 2018;29(2 and 3 - Special Issue):152-164.

4. Autonomic dysfunction and heart rate variability in depression, Stress(2015).

5. Vaccarino V, Lampert R, Bremner JD, et al. Depressive symptoms and heart rate variability: evidence for a shared genetic substrate in a study of twins. *Psychosom Med.* 2008;70(6):628-636.

6. Clinical and non-clinical depression and anxiety in young people: A scoping review on heart rate variability, Autonomic Neuroscience: Basic and Clinical(2017).

7. Alvares GA, Quintana DS, Hickie IB, Guastella AJ. Autonomic nervous system dysfunction in psychiatric disorders and the impact of psychotropic medications: a systematic review and meta-analysis. *J Psychiatry Neurosci.* 2016;41(2):89-104.

8. Shah A, Vaccarino V. Heart rate variability in the prediction of risk for posttraumatic stress disorder. In. *JAMA Psychiatry.* Vol 722015:964-965.

9. Shah AJ, Lampert R, Goldberg J, Veledar E, Bremner JD, Vaccarino V. Posttraumatic stress disorder and impaired autonomic modulation in male twins. *Biol Psychiatry.* 2013;73(11):1103-1110.

10. Hao T, Walter KN, Ball MJ, Chang H-Y, Sun S, Zhu X. StressHacker: Towards Practical Stress Monitoring in the Wild with Smartwatches. *AMIA Annual Symposium proceedings AMIA Symposium.* 2017;2017:830-838.

11. Park D, Lee M, Park SE, Seong JK, Youn I. Determination of optimal heart rate variability features based on SVM-recursive feature elimination for cumulative stress monitoring using ECG sensor. *Sensors (Switzerland).* 2018;18.

12. Park H, Dong SY, Lee M, Youn I. The role of heart-rate variability parameters in activity recognition and energy-expenditure estimation using wearable sensors. *Sensors (Switzerland).* 2017;17:1698.

13. Salahuddin L, Cho J, Jeong MG, Kim D. Ultra short term analysis of heart rate variability for monitoring mental stress in mobile settings. *Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings.* 2007:4656-4659.

14. *A smartphone based cardiac coherence biofeedback system*: IEEE; 2014.

15. van der Zwan JE, de Vente W, Huizink AC, Bögels SM, de Bruin EI. Physical Activity, Mindfulness Meditation, or Heart Rate Variability Biofeedback for Stress Reduction: A Randomized Controlled Trial. *Applied Psychophysiology Biofeedback.* 2015;40:257-268.

16. Guzik P, Piekos C, Pierog O, et al. Classic electrocardiogram-based and mobile technology derived approaches to heart rate variability are not equivalent. *International Journal of Cardiology.* 2018;258:154-156.

17. Lu G, Yang F, Taylor JA, Stein JF. A comparison of photoplethysmography and ECG recording to analyse heart rate variability in healthy subjects. *Journal of Medical Engineering and Technology.* 2009;33:634-641.

18. Selvaraj N, Jaryal A, Santhosh J, Deepak KK, Anand S. Assessment of heart rate variability derived from finger-tip photoplethysmography as compared to electrocardiography. *Journal of Medical Engineering and Technology.* 2008;32:479-484.

19. *Smartwatch: Performance evaluation for long-term heart rate monitoring*: IEEE; 2015.

20. *cHRV uncovering daily stress dynamics using bio-signal from consumer wearables* 2017.