A REVIEW OF THE LITERATURE:

AS TO HOW EMOTIONAL DYSREGULATION CAUSED BY POST TRAUMATIC STRESS DISORDER IMPACTS HEART RATE VARIABILITY

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Introduction

- Post traumatic stress disorder (PTSD) is a debilitating mental health condition that has a prevalence of around 3% in general population of the UK [⁵]
- It is characterised by re-experiencing a traumatic event.
- It impacts both physical and psychological characteristics.
- PTSD not only affects quality of life but also increases the risk of suicide. [1]

Current treatment issues:

- Trauma-focused therapies are currently the recommended first line treatments for PTSD, but up to **two thirds** maintain a PTSD diagnosis after therapy. [²]
- It is often not diagnosed and treated in a timely matter due to the overlapping symptoms and the tendency of clinicians to inadequately investigate it. [1]

Through a better understanding of PTSD, we can develop more **effective novel therapies** and **improve screening** for PTSD to identify those that need it, which is where heart rate variability comes into play.

PTSD is a serious public health problem that places heavy burdens on individuals and society.

Define key concepts

• Emotional regulation

This is a key concept underlying many mental health conditions including PTSD. Many of the symptoms of PTSD are due to **emotional dysregulation** e.g., hyperarousal to threat, poor regulation of negative emotional states such as sadness or anger. [²]

• The autonomic nervous system

Parasympathetic nervous system

Autonomic nervous system

Sympathetic nervous system 🖌

• Heart rate variability

HRV is a measure of the variation in time between each heartbeat. [7]



Figure 1 [⁹] Electrocardiogram demonstrating Heart Rate Variability

It is regulated by the parasympathetic nervous system through the vagus nerve. So, it is a useful indicator of **parasympathetic activity**. When HRV is high there is high parasympathetic activity and vice versa.

Low HRV is an indicator of **poor physical health**, in particular cardiovascular disease, as well as **poor mental health**, such as depression and anxiety.



Figure 2 ^{[6}] Diagram showing the vagus nerve

PTSD Chronic and recurrent stress leading to emotional dysregulation Sympathetic hyper activity Supressed parasympathetic activity Low vagel tone Low HRV

SPH

| Heart rate variability parameters ['] | | | | | | | | |
|---|--|--|--|--|--|--|--|--|
| Time-domain: | Frequency-domain: | | | | | | | |
| quantify the amount of variability in measurements of the time between successive heartbeats | measurements estimate the distribution of power or energy in the heart beats | | | | | | | |
| Root mean square of successive differences (RMSSD) Standard deviation of NN intervals (SDNN) | High frequency (HF-HRV; 0.15-0.40 Hz) Low frequency (LF-HRV; 0.04-0.15 Hz) LF/HF ratio | | | | | | | |

HRV is the most used measure of autonomic nervous system activity because it is non-invasive as well as easy and inexpensive to monitor.

Findings

Almost all of the studies we looked at showed that PTSD was associated with low HRV.

| Study subgroup | F | PTSD | | | Health-controls | | | SMD | SMD |
|--|---------------------|----------|-------|-----------|-----------------|-------|--------|---------------------------------------|-----------------------|
| | Mean | SD | Total | Mean | SD | Total | Weight | IV, random, 95% CI | IV, random, 95% CI |
| Blechert et al.66 | 5.36 | 0.88 | 23 | 6.16 | 1.17 | 32 | 6.9% | -0.74 (-1.30, -0.19) | |
| Chang et al.36 | 5.07 | 1.13 | 32 | 5.75 | 1.1 | 192 | 7.1% | -0.61 (-0.99, -0.24) | |
| Cohen et al.33 | 4.57 | 3.97 | 14 | 6.01 | 5.66 | 25 | 6.8% | -0.27 (-0.93, 0.38) | |
| Cohen et al.64 | 0.12 | 0.024 | 9 | 0.18 | 0.04 | 9 | 6.2% | -1.73 (-2.86, 0.61) | |
| Ray et al.46 | 315.89 | 509.96 | 41 | 657 | 777 | 41 | 7.0% | -0.51 (-0.95, -0.07) | |
| Keary et al.67 | 3.8 | 0.4 | 20 | 3.6 | 0.5 | 20 | 6.8% | 0.43 (-0.19, 1.06) | T |
| Lakusic et al.30 | 4.56 | 4.62 | 34 | 4.82 | 4.73 | 34 | 7.0% | -0.05 (-0.53, 0.42) | |
| Meyer et al.73 | 896 | 796 | 18 | 2,509 | 2,903 | 23 | 6.8% | -0.71 (-1.34, -0.07) | |
| Moon et al.37 | 157.56 | 31.99 | 34 | 332.83 | 36.07 | 27 | 6.3% | -5.11 (-6.18, -4.05) | |
| Park et al.71 | 3.5 | 0.2 | 45 | 4.2 | 0.2 | 43 | 6.8% | -3.47 (-4.14, -2.80) | - |
| Shah et al.72 | 4.96 | 0.83 | 31 | 5.33 | 0.91 | 385 | 7.1% | -0.41 (-0.78, -0.04) | |
| Slewa-Younan et al.69 | 324.08 | 98.95 | 12 | 875.7 | 134.9 | 23 | 5.9% | -4.34 (-5.63, -3.06) + | |
| Thome et al.70 | 6.35 | 0.19 | 57 | 41 | 6.93 | 25 | 5.6% | -9.03 (-10.53, -7.54) | |
| Tucker et al.35 | 6,736.2 15,288.4 13 | | | 1,210.2 | 2,636.7 | 32 | 6.8% | 0.65 (-0.01, 1.31) | + |
| Wahbeh and Oken32 | 237.9 | 438.6 | 52 | 236.9 | 395.9 | 29 | 7.0% | 0.00 (-0.45, 0.46) | |
| Total (95% CI) | 435 | | | | | 940 | 100.0% | -1.58 (-2.32, -0.84) | . • |
| Heterogeneity: Tau2=1.99, | chi2=334.91, df | =14 (p<0 | .0000 |)1), I2=9 | 6% | | | 1917 - 2017 - 2020 - 201 7 | -4 -2 0 2 4 |
| Test for overall effect: Z=4.18 (p<0.0001) | | | | | | | | | Lower-HRV Greater-HRV |

Figure 3. Standard mean difference in HF-HRV between individuals with PTSD and healthy controls taken from a meta-analysis [1]

SMD: standard mean difference, HF-HRV: high-frequency heart rate variability, PTSD: posttraumatic stress disorder.

• Exposure to chronic threat in PTSD may change the function of the vagus nerve causing the low HRV.

Individual with PTSD may constantly perceive threats and experience fear because of **disinhibition of the threat circuits** [¹¹]. They may also have impaired reactions to stressful events characterised by emotional dysregulation.

• Inflammation in the brain found in patients with PTSD may be mediating the association with HRV.

There is increased inflammation in patients with PTSD, which has been shown to potentially change brain structure and function. The inflammation in PTSD was found in amygdala and the dorsomedial prefrontal cortex, which are areas of the brain that have been found to be related to HRV. Therefore, a reduction of HRV may be considered as an indicator for PTSD, due to increased inflammation and changes in brain structure and function. HRV could play a role in the diagnosis and treatment of PTSD and maybe as a biomarker in research. [1]

• Behavioural health factors may account for much of the association between PTSD and HRV. Whilst most studies show an association between low HRV and PTSD, however when some accounted for the following three behavioural health factors there was no longer any correlation; cigarette consumption, history of alcohol dependence, and sleep disturbance. They accounted for 95% of the shared variation. [⁸]



Figure 4 [10] Diagram showing areas where inflammation can be found in people with PTSD

Conclusion

- These finding only emphasise the negative impact of PTSD on health.
- There is a growing research showing the **negative association** between HRV and PTSD.
- HRV could potentially be used as a useful biomarker to monitor PTSD and its treatment in the future.
- The study exploring the behaviour confounding factors highlights how interventions for individuals with PTSD aimed at smoking and alcohol cessation as well as sleep improvement could have meaningful, long-term benefits, both psychiatric and cardiovascular.

Limitations

- The key limitation is that none of the papers I looked at were able to identify the directionality of the association; if lower HRV is a risk factor for developing PTSD, or if lower HRV is a factor that develops due to PTSD. This is because of the cross sectional nature of the data; to examine the role of HRV further, longitudinal studies are needed. [3]
- Most of the articles did not report the trauma type or looked at people who had experienced different traumas.^[1]
- Since there are many HRV parameters different studies found that different paraments were associated and that others were not. Perhaps a more standardised method of calculating HRV would be better.
- I looked at 5 papers given the time and team member constraints.
- Areas for future study are a longitudinal study on HRV and PTSD as well as how vagal innervation could potentially be a treatment for PTSD.

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