THE IMPACT OF SEX ON HEART RATE VARIABILITY
DURING BEREAVEMENT

By

KRYS TAL SHANNON JOVEL

A Thesis Submitted to The Honor College
In Partial Fulfilment of the Bachelors degree
With Honors in
Psychology
THE UNIVERSITY OF ARIZONA
MAY 2015

Approved by:

Dr. Mary-Frances O’Connor
Department of Psychology
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Abstract

Women have been identified as possessing higher heart rate variability (HRV) which in turn creates a cardio-protective barrier from Cardiovascular Disease (CVD) related deaths (Abhishekh et al 2013, Furholz et al 2013). It is then menopausal status and not biological age that causes high HRV in women and would explain why CVD is the number one killer for women world-wide (WHO 2013). As women age and experience menopause the cardio-protective ability of estrogen is decreased. Furthermore, by studying estrogen levels of bereaved persons the relationship between HRV and bereavement can be seen as moderated by certain sex hormones. Menopausal status did show to have a strong effect on HRV (p=0.023), but there was no significant difference between men’s HRV and those of either pre- or post-menopausal women. However the results for post-menopausal women do trend towards the expected and with more participants may become significant.

*Keywords:* Bereavement, Menopause, Heart Rate Variability
Introduction

Heart rate variability (HRV) and its relation to the parasympathetic nervous system has been long studied by Stephen Porges. It has been found that the right side of the vagus nerve is directly related to emotional regulation. A persons’ ability to regulate emotion correlates with a higher HRV, a stronger parasympathetic nervous system. Therefore vagal function and HRV is relevant when trying to understand the psychological and physiological connections within the human body (Porges 1994). A way to measure HRV is to record an individual’s heart rate over a period of time (Gianaros 2003). Arguably the best way to determine heart rate variability and cardiac vagal control is through the use of an electrocardiograph (EKG), by determining the respiratory sinus arrhythmia (RSA) through examining the length between heart rate peaks in regards to breathing. High resting RSA and consequently high HRV mirrors the body’s ability to sufficiently regulate emotion (Calkins 2007). RSA, otherwise known as high-frequency HRV, is best to determine cardiac vagal control and parasympathetic activity (Gianaros 2003).

Heart rate variability has been found to be a significant predictor of Cardiovascular Disease (Tsuji et al 1996) and is used in many psychophysiology experiments. Those who are bereaved, are experiencing the loss of a loved one, are more susceptible to Cardiovascular Disease (CVD) with the greatest rates in acute bereavement (Buckley et al 2009, 2012; O’Connor et al 2002). Buckley and colleagues found that acute bereavement is associated with lower HRV, which increases the risk of CVD deaths in the bereaved population. The female population has been found to hold a cardio-protective ability that unfolds as high HRV. The cardio-protective ability of females is theorized to be caused by estrogen, the reproductive hormone that has been identified as having receptors in the central autonomic system (Abhishekh et al 2013, Furholz et al 2013). Women are shown as having higher vagal tone, high HRV,
overall (Huang et al 2013). According to the World Health Organization, CVD is the number one killer of women world-wide, more specifically the top cause of death for older women (60+) is CVD (2013). As women age estrogen levels decrease, and as they enter menopause, HRV decreases causing an increase in CVD mortalities. Overall as the general population ages so too does their HRV decrease (Abhishekh et al 2013).

What has not been studied, as of yet, is menopausal status interaction with HRV during bereavement. More specifically, if a post-menopausal woman who is estrogen-deficient were to experience the death of a loved one and enter into a period of bereavement would their HRV differ from a pre-menopausal woman? Would it differ significantly from a man? We predict that low HRV, as a characteristic and not a changing variable, will be lower in post-menopausal women not simply due to age but the shift in hormones. For women that would mean it is not age nor being female that is a predictor of heart rate variability but instead the levels of estrogen and menopausal status that predict the cardio-protective abilities of the sex. Furthermore we discuss that this will association between HRV and menopausal status will be affected negatively by bereavement resulting in the lowest HRV to be found in a post-menopausal bereaved person.

Methods

Participants

Participants include 12 non-bereaved/control and 10 recently bereaved persons. Those who are bereaved completed the initial assessment of a much larger study within a month of losing their spouse. Participants were recruited through advertisements in various communities and through a search of recent obituaries in Arizona. Those with depression or other mental disorders and physical ailments that would affect HRV were excluded. Also those who were currently on an aspirin regiment were excluded as their effect on HRV and CVD is currently under analysis within the larger study of which this is one small piece. Bereaved individuals
were primarily female, all identified as white and were on average older than the non-bereaved sample. Table 1 provides more descriptive data for both groups.

Table 1 – Participant Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Bereaved (n=10)</th>
<th>Non-Bereaved (n=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>66.6% ± 12.40</td>
<td>51.92% ± 11.76</td>
</tr>
<tr>
<td>Sex (female)</td>
<td>70.00%</td>
<td>47.70%</td>
</tr>
<tr>
<td>Race (white)</td>
<td>100.00%</td>
<td>83.30%</td>
</tr>
<tr>
<td>Ethnicity (non-caucasian)</td>
<td>10.00%</td>
<td>33.30%</td>
</tr>
<tr>
<td>Menopausal Status (post-menopausal)</td>
<td>50.00%</td>
<td>33.33%</td>
</tr>
</tbody>
</table>

Procedure

This is a cross-sectional and quantitative study looking at bereaved and non-bereaved participants with menopausal status and HRV as predictors of CVD. Participants were invited to the Grief, Loss and Social Stress (GLASS) Lab and after obtaining informed consent were attached to sensors and a baseline recording of heart rate variability taken through EKG. Specifically, this data was recorded with a Zephyr BioHarness 3, sampled at 1024 Hz. Interbeat interval series were derived from the raw EKG using an r-spike detection algorithm. Heart period variability in the high frequency band (0.12–0.4 Hz) was extracted using CMetX Software (Allen, 2002). Following this EKG recording psychometric evaluations were given to the participant. Here, participants were asked standard demographic questions and for female-identified persons their menopausal status (i.e. “When was your last period?”).
Results

An analysis of variance (ANOVA) was used to find differences between HRV (logRSA) among the two sexes and bereavement statuses (Figures 1 and 2). Further ANOVA’s were run to find HRV differences among menopausal statuses (pre- and post-) and bereavement (bereaved and control). There was not a significant difference between HRV by sex [Male = 5.14, Female = 4.41; F(1,20)=1.047, p=0.318] (Figure 1). There also was not a significant difference between the bereaved and non-bereaved in regards to HRV [bereaved=4.4, non-bereaved/control=5.03; F(1,20)=0.779, p=0.388] (Figure 2). In Figure 3 females are divided first by bereavement status then menopausal status, finding a strong relationship between menopausal status and HRV [F(1,8)=7.836, p=0.023] but not bereavement and HRV [F(1,8)=3.028, p=0.120]. No relationship was found between bereavement and menopausal status [F(1,8)=0.744, p=0.413]. Figure 4 further describes the relationship between HRV and menopausal status among the bereaved and non-bereaved, giving values and standard deviations. A one-way t-test was performed to identify the difference between men and pre-menopausal women and men to post-menopausal women. On average men had lower HRV compared to pre-menopausal females (M=5.137, SE=0.601 and M=5.863, SE=0.836; respectively); however this was not significant t(11) = -0.604, p=0.558. Lastly the average HRV for men was compared to that of post-menopausal women. Here men on average had a higher HRV (M=5.137, SE=0.6011) compared to the post-menopausal females (M=3.92, SE=0.3814). Though not significantly different t(17) = 1.665, p=0.114 the results do trend towards the expected. All statistical analyses were completed using IBM SPSS Software.
Figure 1 – HRV (logRSA) differences by Sex

Figure 2 – HRV (logRSA) differences by Bereavement
Figure 3 – Differences in HRV (logRSA) by Bereavement and Menopausal Status

![Box plot showing differences in HRV (logRSA) by bereavement and menopausal status.]

Figure 4 – HRV (logRSA) by Menopausal and Bereavement Status

<table>
<thead>
<tr>
<th>bereavement status of the participant (bereaved vs. control)</th>
<th>menopausal status</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>pre-menopausal</td>
<td>7.2600</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>post-menopausal</td>
<td>4.3125</td>
<td>1.56400</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.9020</td>
<td>1.89001</td>
<td>5</td>
</tr>
<tr>
<td>bereaved</td>
<td>pre-menopausal</td>
<td>5.1650</td>
<td>1.12430</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>post-menopausal</td>
<td>3.6060</td>
<td>.71171</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.0514</td>
<td>1.06162</td>
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</tr>
<tr>
<td>Total</td>
<td>pre-menopausal</td>
<td>5.8633</td>
<td>1.44742</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>post-menopausal</td>
<td>3.9200</td>
<td>1.14420</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.4058</td>
<td>1.45105</td>
<td>12</td>
</tr>
</tbody>
</table>
Discussion

Between sexes, males were found to have higher HRV, as opposed to lower HRV as previous literature suggests (Abhishekh et al 2013, Huang et al 2013). It is possible that the large amount of women who are post-menopausal in the sample (75%, combined groups) had such a strong effect on HRV (p=.023) that this overcame the previous sex dichotomy. Also, those who are bereaved had lower HRV confirming what has been shown in previous literature (Buckley et al 2009, 2012). Bereavement status did not have a significant effect on HRV (p=.120) compared to that of menopausal status (p=0.023), and there was no interaction between bereavement status and menopausal status on HRV (p=0.413). Therefore we suspect that as women age they lose their cardio-protective high HRV and bereavement status may not have as strong of an effect on HRV as previously thought when taking menopausal status into account.

Potential Implications

This challenges the idea that neither age nor sex but menopausal status, with the natural changes in endogenous sex hormones, contributes to high heart rate variability in females. It is thought that estrogen is the cardio-protective factor that postmenopausal women are lacking (Brito-Zurita et al 2003, Leicht et al 2003). Therefore when identifying those who are bereaved or any who are at risk for CVD it is important to also monitor hormone levels as for women, and men (Ullah et al 2011), we see these HRV “traits” change through time but are not specifically matched with age.

Limitations

Recruiting for this study was a delicate procedure as bereavement is a vulnerable time for many people and death a reverent subject. To remedy this a relationship between the researcher and participants is needed to not have feelings of intrusion mar the study results, and hopefully achieved. Physical illness such as respiratory distress or any cardiac related anomalies will
hinder HRV results and so participants with these conditions have been excluded resulting in a smaller sample size. Current medications that a bereaved person is taking may play a role in the bereavement process and will overshadow the regulating process of the parasympathetic system of the body. Therefore participants were excluded if on certain medications including aspirin, but other medications that are not currently known to affect HRV may have impaired EKG readings.

**Future Directions**

Other studies have looked at the effect of menstrual status, which phase a woman is in her menstrual cycle, and its effect on HRV and/or CVD (Bai et al 2009, Childs et al 2010, McKinley et al 2009 & Tenan et al 2014). Here the results are mixed on if there is a difference between menstrual phases and their impact on HRV, though differences may be intensified when stress measures are introduced or when the population only includes pre-menopausal women (Childs et al 2010, McKinley et al 2009, respectively). Future researchers may include different medical treatment options to lessen the risk of CVD caused deaths in bereaved persons. Potential treatment options could include endogenous hormone therapies for post-menopausal women and beta-blockers and lifestyle changes for all persons to impact heart rate variability and decrease the likelihood of Cardiovascular Disease. Hoyt & Falconi’s 2015 review suggests that timing of hormonal life events such as menopause and menarche have a large impact on CVD mortality with early menarche associated with a 15% increase (as found in Prentice & Viner 2012). Also reported in their 2015 review is evidence suggesting that the increase in CVD risk during menopausal transition may be due to the weight gain and insulin changes (Schianca et al 2006). However this may only being one portion of a large immune-hormone cycle as Mondul et al (2005) suggests that estrogen also plays a role in immune function that can affect insulin homeostasis. Other populations may also be looked at to confirm the theory of estrogen’s role in HRV. Pregnant women have different levels of “normal” hormone values, by investigating the
role estrogen and other sex hormones have on the cardiovascular system of a gravid individual medical interventions can become more specialized in accordance with the change of hormone levels. Jacobs et al investigated the relationship between reproductive histories, the amount of births, to cardiovascular disease (2012). It was found that those with a high frequency of births were less likely to pass from Cardiovascular Diseases compared to women who had not been pregnant. Jacobs and colleagues suggest that these multiply pregnancies, and possibly the major changes in hormones, brings about these lower rates of CVD mortality. By studying the mind-body connection, interventions can be refined more to fit a specific type of population and guess work for psychological and physiological specialists can be reduced.
References


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