

Emerging dynamics of workplace stress of employees in a large organization in Hong Kong

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Abstract

Purpose – Research on workplace stress measurements varied without much accuracy and effectiveness. The purpose of this paper is to introduce a new quantitative assessment tool emWave Pro Plus (Institute of HeartMath) and compare heart rate variability (HRV) results with the Personal and Organizational Quality Assessment (POQA) and the Perceived Stress Scale (PSS).

Design/methodology/approach – This research opted for a correlational study which involves 85 full-time employees who were working at least 40 h per week in a large corporation participated in this study. The POQA and PSS were used to correlate with HRV.

Findings – Astonishing findings emerged in this study. Significant positive correlations were found between emotional stress and HRV, and between intention to quit and HRV. In other words, the researchers have to make sense the following surprising findings: the higher the emotional stress an employee faces, the healthier they are. Healthier employees may have higher intentions of quitting their jobs. The surprising results may be attributed to personality, culture, emotional regulation and age among others.

Originality/value – This research fulfills an identified need to validate quantifiable stress measurements especially in a corporate environment. The research also shows promising results, and future studies should continue to tap into HRV as an objective measure of mental health and workplace stress.

Keywords Mental health, Job stress, Heart rate variability (HRV), Workplace stress, Objective stress measure, Hong Kong employees

Paper type Research paper

Introduction

The National Institute for Occupational Safety and Health (NIOSH) defined workplace stress as “the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or [the] needs of the worker” (NIOSH, 1999, p. 7). A stress study over a period of five years was conducted (American Psychological Association, 2011) and researchers reported that 70 percent of Americans pointed out that work was a contributing factor to stress. Moreover, a study conducted by NIOSH (1999) revealed that 40 percent of employees indicated that their jobs were very or extremely stressful. This shows that workplace stress happens not just in Hong Kong, but also globally.



Global problem

Besides Hong Kong and the USA, other developed countries are experiencing workplace stress as an emerging global problem. Canada and the UK report that workplace stress contributes to diseases, depression, injury and a decrease in organizational productivity



(Price, 2004; Ryan and Watson, 2004). In an environment where there is workplace stress, employees inculcate a negative attitude toward their work with a consequent drop in motivation, performance and efficiency. Moreover, workplace stress triggers three kinds of employee reactions: first, there may be physical ailments such as high blood pressure, heart disease and elevated cortisol levels; second, psychological effects such as escalated conflict and depression may be triggered; and third, unhealthy coping habits such as excessive consumption of alcoholic beverages may be displayed. Employees exhibit early signs of workplace stress such as a headache, insomnia, difficulty in concentrating, short temper and upset stomach. On the same side of the coin, organizational productivity drops as absenteeism, presenteeism, turnover and sick leave increase.

Financial impact

Workplace stress also impacts businesses financially on a global basis. It is estimated to cost organizations in the USA more than \$300bn annually in productivity loss, absenteeism, turnover, medical, legal and insurance costs (Rosch, 2001). In Canada, workplace stress costs 6bn Canadian dollars annually (Price, 2004). Interestingly, UK reported not in terms of a financial trade-off, but an estimated annual loss of 200m working days due to illnesses triggered by workplace stress (Ryan and Watson, 2004). Other financial losses include employee lawsuits with monetary compensations (Rosch, 2001), an increase in employees' compensation and disability claims (NIOSH, 1999). Hence, these reports indicate that workplace stress is an emergent global prevalence. From the 1970s, NIOSH started epidemiological research works on the outcomes of work-related factors in organizations. Research works from NIOSH revealed workplace stress as a workplace safety and health risk. They further reported that all workplace employees will experience workplace stress at some point in time, both in and beyond the workplace. Interestingly, employees react to workplace stress differently. Most employees go to work but do not work at their best, while others resign when overstressed (Willingham, 2008). Similarly, the American Psychological Association (2007) states that "fifty-two percent of employees report that they have considered or made a decision about their career such as looking for a new job, declining a promotion or leaving a job based on workplace stress" (p. 11). Moreover, stressed employees eradicate themselves from working for someone else by starting their own businesses (Hewlett and Buck Luce, 2006).

Stress assessments

The validity of obsolete tools being used to evaluate workplace stress is questionable as some questionnaires and survey questions contain outdated questions and unrepresented data that cannot accurately reflect today's population of workplace employees. The irony is that in assessing workplace stress, many researchers, business executives and organizational development consultants have been consistently using questionnaires, surveys and clinical instruments that were created and validated more than 25 years ago (Centre for Studies on Human Stress, 2012). Moreover, there are also some questionnaires still in use that were developed over 30 years ago via funding given by the National Institutes of Health and NIOSH.

Purpose of the research

Stress is associated with negative outcomes and we all make effort to avoid it. Workplace stress is associated with poor performance and organizations desire optimal performance from employees (McVicar *et al.*, 2013). In an effort to gain more insight into workplace stress, this research studied workplace stress as experienced by full-time employees in an actual large corporation in Hong Kong. The original purpose of this research was to introduce a new quantitative measurement tool such as emWave Pro Plus in the workplace and

compare HRV results with two other sets of quantitative self-reported measurements of stress. Mauss *et al.* (2016) report that heart rate variability (HRV) is an important biomarker (primary mediator of neurophysiologic pathway), one of the variables in the Allostatic Load Index that is easily assessable and accessible to measure workplace stress. Hence, the following four research questions were examined:

RQ1. In what way can HRV be used to accurately measure long-term effects of workplace stress in Hong Kong?

RQ2. What are the effects of workplace stress in Hong Kong on HRV?

RQ3. In what way does HRV compare with self-reports of stress in Hong Kong?

RQ4. What is the overall level of comfort a typical Hong Kong employee experiences?

Research method

The correlational research study explored the effects of workplace stress on HRV (HRV), which utilized the power spectral components and key time domain measures of HRV to analyze heart rate data after the employee had self-reported his or her level of stress over two scales: one was the Personal and Organizational Quality Assessment from the Institute of Heartmath and the other was the perceived stress scale (PSS) (Cohen *et al.*, 1983). After these assessments were completed, HRV, quantified by the four variables (SDNN, RMSSD, MHRR and normalized coherence) was correlated with the perceived stress quantified by the POQA-R4 rating scale as well as the PSS.

Participants

The chosen study population was made up of full-time employees in a large corporation of over 500 employees (hereinafter referred to as “Company X”). All employees of the company were welcomed to participate. The full-time participants were working at least 40 per week. Company X operates out of different locations in Hong Kong. The research was conducted in an air-conditioned room on the 19th floor within the temperature between 22 and 26°C in one of the locations in which Company X operates in Hong Kong. The building is unobstructed by the external traffic within a large urban area that has a population density of 639,900.

Study sample

Inclusion/exclusion criteria

Eligible employees were: full-time employees working at least 40 h per week for Company X; male or female; at least 18 years of age; and able to read, write and understand English. However, employees who had taken any kind of medication that might influence the results or caffeinated/alcohol beverages within 2 h prior to the session were excluded from the study.

Sampling procedures

After the participating employees of Company X signed the informed consent forms, they accessed the online POQA questionnaire as well as filling up the PSS questionnaire. Once the questionnaires were filled up, the researcher performed biometric tests on the employee using the emWave Pro Plus.

Instruments

Two scales were used to collect data on the dependent variables PSS as well as POQA. These scales represented operationalization of the dependent variables in the conceptual framework, and both of them had sound psychometric properties.

POQA-Revised 4 Model

The POQA-R4 is an instrument developed by researchers at the Institute of HeartMath. It contains 49 questions on four major scales of workplace quality directly related to health and workplace performance. The instrument gathers self-reported information on socio-demographic and key psychological and workplace elements associated with the overall quality and effectiveness of the individual and the organization. The instrument uses eight items of socio-demographic information about the respondents' characteristics which include gender, age, marital status, employment status, level of education, the number of hours worked per week, the number of years in the company and the number of years in the current role (Barrios-Choplin and Atkinson, 2000). The 49 items are divided into four factors which measure emotional vitality, emotional stress, organizational stress and physical symptoms of stress. They have been empirically validated and found to be reliable based on a measurement study conducted on the existing POQA-R database of 2,540 employed adult respondents (Barrios-Choplin and Atkinson, 2000).

Perceived stress scale

The instrument used in this research to measure perceived stress was the PSS by Cohen and Williamson (1988); therefore, the operation definition of perceived stress is the score on the PSS. The PSS is a ten-item questionnaire that measures situations in the employee's life that are deemed stressful. This Likert-type instrument has each item scored 0 (never), 1 (almost never), 2 (sometimes), 3 (fairly often), and 4 (very often). An example question on the PSS is: in the past month, how often have you felt nervous and "stressed"? The total score possibility of the PSS is 56, with the higher the number, the greater the perceived stress. Scores near 13 are considered average, with scores greater than 20 indicating high stress. The Cronbach's α internal reliability of the PSS ranges from 0.84 to 0.86 (Cohen and Williamson, 1988).

emWave Pro Plus®

The emWave Pro Plus, designed by the Institute of HeartMath (2016), is a computer software program that collects pulse data through a pulse sensor that can be plugged to a computer (See Figure 1).

The pulse sensor can be placed on the participant's earlobe or fingertip. The software then translates the information from the participant's heart rhythms into user-friendly graphics displayed on the computer monitor, which allows the researcher to watch in real-time how thoughts and emotions are affecting the participant's heart rhythms. The emWave Pro Plus uses photoplethysmography technology which is a reliable and valid method of capturing and quantifying real-time HRV data, both resting HRV and deep breathing tests based on the ability of hemoglobin to absorb light. As the amount of hemoglobin passes through the blood vessels changes due to the pulsatile nature of blood transportation, the amount of absorbed light also changes (Russoniello *et al.*, 2013). For this research, HRV was measured by various parameters: SDNN, RMSSD, MHRR and normalized coherence. SDNN is the standard deviation of all mean normal-to-normal intervals measured in milliseconds. The measure reflects the ebb and the flow of all the factors that contribute to HRV and the heart's ability to respond to hormonal changes (McCraty and Watkins, 1996; Task force of the European Society of Cardiology and the North American Association of Pacing and Electrophysiology, 1996). The RMSSD is the root mean square of successive differences between the normal heartbeats reflecting the short-term variance in heart rate. This value provides an estimate of the parasympathetic regulation of the heart (McCraty and Watkins, 1996; Task force of the European Society of Cardiology and the North American Association of Pacing and Electrophysiology, 1996). MHRR is the mean heart rate range (MHRR), which is the difference between the maximum and the minimum heart rate during each breathing cycle. The result is then expressed in beats per minute, as the mean of these

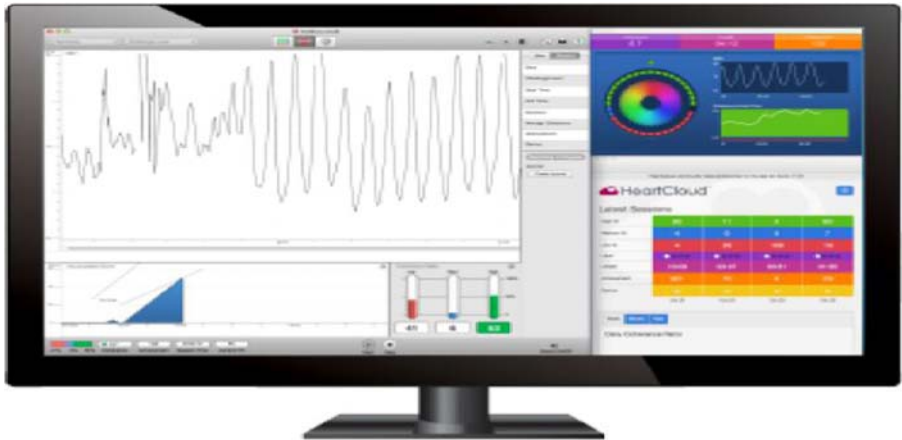


Figure 1.
EmWave Pro Plus
Computer Hardware
and HRV Monitor
Reading

Source: Institute of HeartMath (2016)

heart rate differences for each measured cycle (McCarty and Watkins, 1996; Task force of the European Society of Cardiology and the North American Association of Pacing and Electrophysiology, 1996). Finally, normalized coherence is a frequency domain measure of coherence where power in the coherence peak of the power spectrum density is divided by total power. This measure represents the ratio of coherence relative to total power and ranges from 0 to 100 (McCarty and Watkins, 1996). Moreover, a coherent heart rhythm is visualized as a harmonic sine-wave-like signal with a narrow, high-amplitude peak in the low frequency (0.04–0.26 Hz) region of the HRV spectrum. Coherence is evaluated by detecting the maximum (coherence) peak in the 0.04–0.26 Hz range, calculating the integral in a window 0.030 Hz wide, centered on the highest peak in that region, and then calculating the total power of the entire spectrum (Shaffer *et al.*, 2014). The emWave Pro Plus is based on decades of research, incorporating the patented HRV measurement and has been used by tens of thousands of people in over 85 countries (Institute of HeartMath, 2016).

Data collection

The data collection schedule was from July 7, 2017 to September 30, 2017.

Recruitment processes

Employees of Company X were invited to participate in this study. A recruitment e-mail was sent to employees of Company X a week before the start of the research study. The recruitment e-mail briefly described the study, the inclusion/exclusion criteria, as well as the compensation (incentive) for the participants if they chose to participate and complete the research study requirements. The exclusion criteria was listed to inform the potential participants the reasons why they would not qualify for this research study so that they did not need to attend the researcher's visit, thus further protecting their privacy.

Informed consent

At the visit by the researcher at one of the meeting rooms in the official premises of Company X, the participants who chose to participate completed the informed consent process before the data collection began. To fully complete this process, each participant read the informed consent form and was allowed to ask any additional questions regarding the study before signing and dating the informed consent form. Finally, the participant received a personal copy of his or her informed consent form. The researcher determined if the participant was eligible for the research study by asking the participant whether he or she had consumed any caffeinated/alcohol beverages within 2 h prior to the session.

During data collection

After the participant had signed the informed consent form, the research study data were collected in three sets: online survey – POQA, filled by the participants; pen-filling survey – PSS, filled by the participants; and objective measurements (HRV) collected by the researcher.

For HRV measurements, each participant was recorded individually in a quiet room, in a seated position. The participants received instructions for the test and the emWave Pro Plus pulse sensor was placed on their earlobes. Participants were instructed to remain seated, to stay relaxed and to refrain from making any significant or rapid body movements. Each session started with the five-minute resting state HRV assessment where the participant was told to breathe normally. Once the five minutes were up, participants were instructed to breathe according to the six-breath protocol. This breathing method provided a physiological challenge to assess the maximum HRV range (amplitude) during a one-minute period through deep breathing at the specific rate of five seconds of inhalation and five seconds of exhalation. Once achieved, there were six complete breath cycles over the course of one minute. The emWave Pro Plus software uses a breath-pacer to facilitate the regularity of the breathing. The entire minute has to be artifact-free so that the six cycles of the minimum and the maximum can be determined. Participants' compliance has to be closely monitored as insufficient deep breathing or poor synchronization with the breath pacer may result in lower test results. The average duration for each HRV testing session is 7 min. The researcher who administered the HRV test was a HeartMath certified practitioner.

Data analysis

Descriptive characteristics and Pearson correlation analysis between HRV measures (IBI, SDNN, RMSSD, MHRR, normalized coherence, total power, very low frequency, low frequency and high frequency power along with the low frequency/high frequency ratio), POQA and PSS scales were performed using the SPSS Version 22.0 (IBM Corp, 2013). The significance level for correlations was set at α of 0.05. To correct for skewness, HRV frequency domain measures and RMSSD were natural log transformed prior to performing the correlation analysis.

Demographic characteristics

A total of 87 people signed the consent forms to participate, of which two were excluded due to technical artifacts in the data set related to the one-minute of six deep-breath cycles protocol. This resulted in 85 participants who completed the HRV measurements, POQA and PSS questionnaires. The majority of the subjects were female (61.1 percent) and 38.8 percent were male. Most of the subjects were within the age 31–40 (47 percent). In total, 43.5 percent were within the age 21–30, and 8.2 percent were within the age 41–50. Only one subject was more than 50 years old and no subjects were under age 21 (See Figure 2).

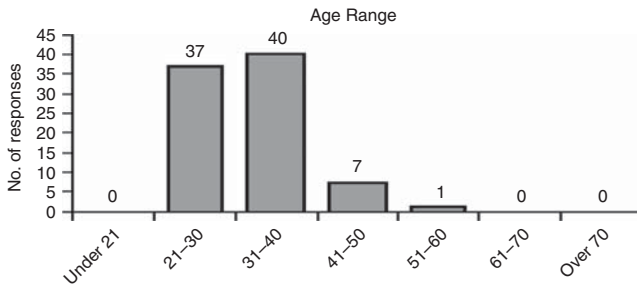
The majority of participants reported working between 41 and 50 hours per week (47 percent); 21 percent of participants reported working between 36 and 40 hours per week; 17.6 percent working 51–59 hours per week and 14 percent reported working more than 60 hours (See Figure 3).

The rest of the frequency tables for the demographic characteristics are presented in Figures 4–8.

Quantitative data results

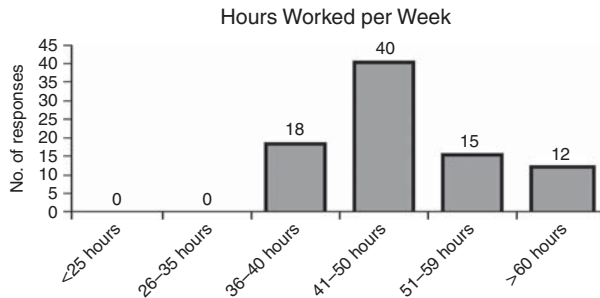
HRV and subjective stress

Three significant negative correlations were found between subjective stress and HRV measures: perceived stress and five-minute mean inter-beat-interval (IBI), $r = -0.217$, $p < 0.05$; perceived stress and five-minute SDNN, $r = -0.255$, $p < 0.05$, and perceived stress and Ln five-minute RMSSD, $r = -0.282$, $p < 0.01$.



Source: By authors

Figure 2.
Age range
of participants
as reported from
POQA-R4

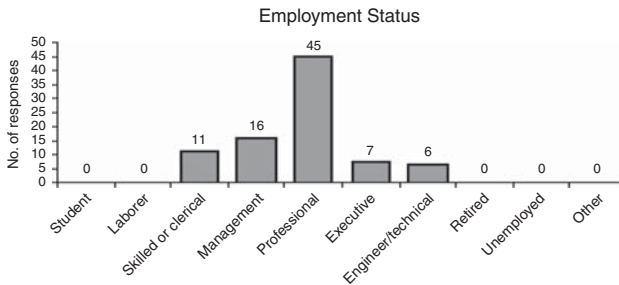


Source: By authors

Figure 3.
Hours worked per
week of participants
as reported from
POQA-R4

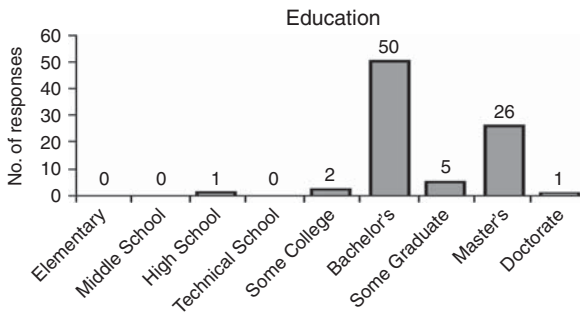
HRV and age

Significant negative correlations were found between age and the HRV measures; one-minute SDNN ($r = -0.235, p < 0.01$), five-minute SDNN ($r = -0.290, p < 0.01$), five-minute RMSSD ($r = -0.395, p < 0.01$), total power ($r = -0.272, p < 0.05$), very low frequency ($r = -0.215, p < 0.05$) and high frequency ($r = -0.402, p < 0.01$). There are more significant relationships between the HRV measurements during the five-minute resting period than with the one-minute deep breathing assessment.



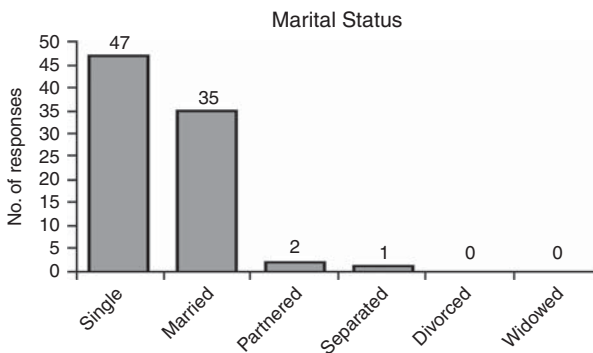
Source: By authors

Figure 4.
Employment status
of participants
as reported from
POQA-R4



Source: By authors

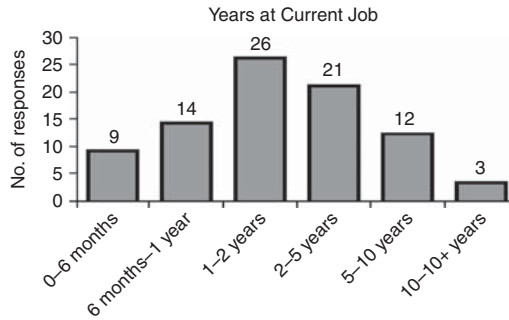
Figure 5.
Education levels
of participants
as reported from
POQA-R4



Source: By authors

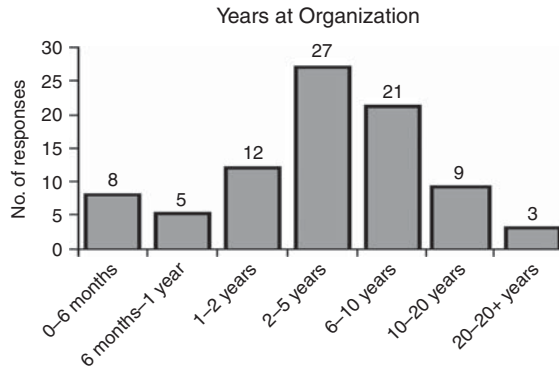
Figure 6.
Marital status
of participants
as reported from
POQA-R4

Figure 7.
Years at current
job of participants
as reported from
POQA-R4



Source: By authors

Figure 8.
Years at organization
of participants
as reported from
POQA-R4



Source: By authors

HRV and emotional stress

First of all, a significant positive correlation was found between emotional stress and the MHRR, $r = 0.216$, $p < 0.05$.

HRV and relational tension

A significant negative correlation was found between normalized coherence and relational tension ($r = -0.222$, $p < 0.05$).

Very low frequency (VLF) and intention to quit

A significant positive correlation was found between intention to quit and five-minute Ln VLF, $r = 0.234$, $p < 0.05$.

PSS and POQA-R4

The PSS and POQA-R4 were strongly correlated, except for relational tension.

A summary of results

This chapter presented descriptive statistics and quantitative correlational results between HRV (objective stress), PSS and POQA-R4 (subjective self-reported stress) that attempted to answer the following research questions:

RQ1. In what way can HRV be used to accurately measure the effects of workplace stress in Hong Kong?

H_0 . There is no (statistically significant) relationship between HRV and workplace subjective stress ($H_0: r = 0$).

H_1 . There is a (statistically significant) relationship between HRV and workplace subjective stress ($H_1: r < > 0$).

Since there were three significant negative relationships between PSS (short term stress) and HRV; perceived stress and five-minute IBI, $r = -0.217, p < 0.05$, perceived stress and five-minute SDNN, $r = -0.255, p < 0.05$ and perceived stress Ln five-minute RMSSD, $r = -0.282, p < 0.01$, H_0 would be rejected. This indicates that overall HRV is significantly correlated with short-term perceived workplace stress:

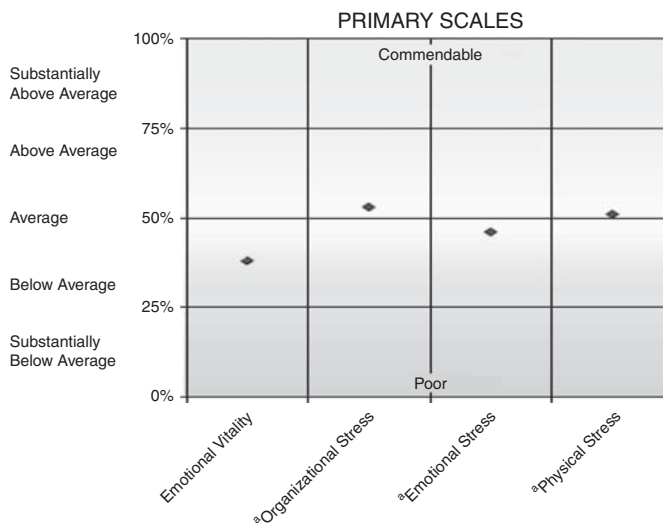
RQ2. What are the effects of workplace stress in Hong Kong on HRV?

A negative relationship between short-term perceived stress and HRV means that the lower the short term perceived stress, the higher the overall HRV the person is capable of producing. Moreover, a significant positive correlation was found between emotional stress and the MHRR, $r = 0.216, p < 0.05$, which indicates that the higher the emotional stress an employee faces, the higher his or her HRV:

RQ3. In what way does HRV compare with self-reports of stress in Hong Kong?

The participants self-report results on the POQA revealed the stressors and after effects of employee stress. Comparing the four primary scales of the organizational scores to norms from a large convenience sample of 5,971 working adults, Figure 9 shows that out of the four primary scales: emotional vitality, organizational stress, emotional stress and physical stress, with emotional vitality and emotional stress within the Below Average range.

From the correlational analysis, it was reported that a significant positive correlation was found between emotional stress and the MHRR, $r = 0.216, p < 0.05$, which indicates that the higher the emotional stress an employee faces, the higher his or her HRV. Moreover, from the associated subscales in Figure 10, out of the nine subscales, emotional



Note: ^aReverse coded to show the degree of improvement over time

Source: By authors

Figure 9. Organizational scores as compared to norms from a large sample of 5,971 employees as reported from the POQA-R4

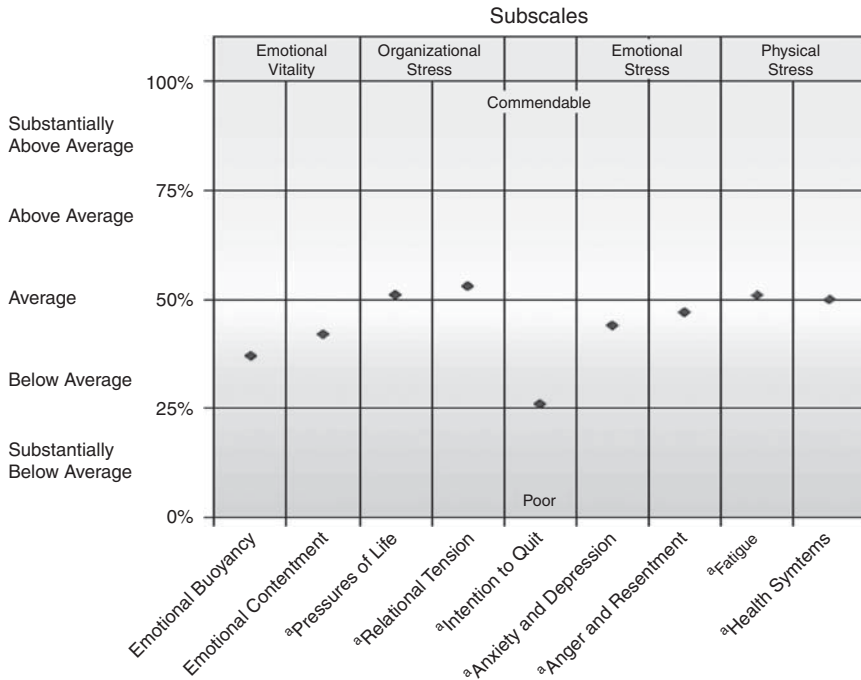


Figure 10. Associated subscales as reported from the POQA-R4

Note: ^aReverse coded to show the degree of improvement over time
Source: By authors

buoyancy, emotional contentment, intention to quit, anxiety & depression, and anger and resentment were within the below average range.

A significant positive correlation was found between intention to quit and five-minute Ln VLF, $r = 0.234$, $p < 0.05$, which indicates that healthier employees may have higher intentions of quitting their jobs:

RQ4. What is the overall level of comfort a typical Hong Kong employee experiences?

A significant negative correlation was found between age and the HRV measures; one-minute SDNN ($r = -0.235$, $p < 0.01$), five-minute SDNN ($r = -0.290$, $p < 0.01$), five-minute RMSSD ($r = -0.395$, $p < 0.01$), total power ($r = -0.272$, $p < 0.05$), VLF ($r = -0.215$, $p < 0.05$) and high frequency ($r = -0.402$, $p < 0.01$). This indicates that the older the employee, the lesser his or her overall HRV. A significant negative correlation was also found between relational tension and normalized coherence ($r = -0.222$, $p < 0.05$), which may indicate that the healthier an employee, the lesser the relational tension. The mean PSS score is 17.69 where 13 is considered average while 20 or above is considered high stress. On the other hand, the mean overall stress score in the POQA is 8.4 where 0 is the lowest (most calm) and 14 is the highest (most stressed).

A discussion on the findings

RQ1

In this study, it was hypothesized that POQA and PSS would have a negative correlation with HRV. In line with the findings of previous studies, there were more significant

relationships between the HRV measures and PSS than with the POQA. Most historical workplace stress research that correlates HRV with workplace stress shows a negative correlation between the variables. For instance, the results are consistent with those of Da Silva *et al.* (2015) when they assessed the correlation between PSS and HRV parameters and reported that the increase in perceived stress is correlated to a lower HRV in healthy young subjects. Moreover, Da Silva *et al.* analyzed data from 35 healthy young volunteers and found a significant correlation between perceived stress and low frequency (ms²) by frequency domain HRV analysis. Probably due to the smaller number of subjects, other global variables such as total power and SSNN had also negative coefficients, but did not have any significant correlation with PSS-14, yet this study contributed to the literature three additional significant negative correlations between PSS and HRV, with perceived stress and five-minute mean IBI; perceived stress and five-minute SSNN, and perceived stress and Ln five-minute RMSSD.

Similarly, Föhr *et al.* (2015) found that subjective self-reported stress has been associated with the objective physiological stress which is consistent with the result of this research. Hence, Föhr *et al.* suggested that the objective stress assessment such as HRV provides an additional aspect to the evaluation of stress.

RQ2

It was surprising to see a significant positive correlation between emotional stress and the MHRR, which indicates that the higher the emotional stress an employee faces, the higher his or her HRV. At first glance, it seems counterintuitive; however, the researcher offers four perspectives to explain this surprising finding.

Personality. According to Turiano *et al.* (2013), it appears that an employee can be a “healthy neurotic.” Turiano and his team concluded that the health anxiety that employees who are high in neuroticism or emotional stress may feel adaptive when it is accompanied by high conscientiousness. In other words, neuroticism or emotional stress may lead the person to worry but conscientiousness leads the person to be self-disciplined and to take action when one’s behavior veers into the unhealthy range. The unhealthy neurotics are the ones whose low conscientiousness means that they have fewer healthy coping mechanisms. Turiano *et al.* further pointed out that when employees were stressed and unhappy, they might turn to overeating, drinking, and smoking. Nevertheless, they said that it was possible that other known health culprits could play a role such as lack of sleep or even a relationship conflict.

Asian culture. Numerous research studies have established that using emotion suppression, whether routinely or experimentally induced, is associated with the unhealthy well-being (Tsai, 2016). Moreover, emotion suppression eliminates the experience of positive emotions while enhancing the experience of negative emotions. Contrary to western cultures, the Asian culture tends to mask negative emotions which are deemed as signs of maturity and awareness. In addition, their reluctance to express negative emotions has potential negative relational concerns which threaten group harmony. This may provide insights to the current research which holds the view that unhealthy Asian employees tend to suppress their emotions and that the suppressed emotions are not regulated successfully.

Emotion regulation. Emotion regulation involves the process by which people manage both negative and positive emotions. Furthermore, successful emotion regulation, by either reappraisal or suppression, has been shown to lead to increased vagally mediated HRV (Fujimura and Okanoya, 2012). Fujimura and Okanoya therefore suggest that healthier employees (in this research study) are able to better regulate their emotional stress as compared to the unhealthier ones because participants with a high baseline of vagally mediated HRV may be spontaneously using emotion regulation strategies more often during an emotional conversation than participants with a low baseline of vagally mediated HRV.

Age factor. As the majority of the participants in this research were between the age of 21 and 40 (considered as a young population group), according to R. McCraty, these participants are possibly still physiologically resilient and as the amount of HRV reflects long-term processes, emotional stress traits would not show up until later in life, reflecting a depletion of the wear and tear on the ANS (personal communication, October 10, 2017).

RQ3

From the POQA, the low score of emotional vitality indicates low scores on both emotional buoyancy and emotional contentment subscales. A low score on the emotional buoyancy subscale indicates that it is likely that the employees feel that they have low levels of emotional energy available for investment in their work and personal lives. A low score on the emotional contentment subscale suggests that the employees may be feeling only low levels of contentment and inner peace with their lives, both at work and off the job.

On the same side of the coin, the low score of emotional stress as shown in Figure 9 indicates low scores on both the anxiety/depression and the anger/resentment subscale in Figure 10. When looking at the normative summary scales which are reverse coded, low scores on the anxiety/depression subscale indicate that a notable proportion of employees may be experiencing high levels of anxiety, unhappiness, sadness and/or depression. Low scores on the anger/resentment subscale indicate that a notable proportion of employees may be experiencing high levels of anger and resentment and may experience difficulty in controlling their feelings and emotions. Hence, from the correlational analysis, it was reported that a significant positive correlation was found between Emotional Stress and MHRR, which indicates that the higher the emotional stress an employee faces, the higher his or her HRV. Discussions on this were noted in *RQ2*.

Intention to quit. The poor score on this subscale in the POQA indicates that there is an increased likelihood of a notable proportion of employees who are feeling sufficiently dissatisfied with their work environment and that they are thinking about leaving the organization (i.e. quitting their jobs). Yet another surprising finding from the research is that a significant positive correlation between intention to quit and five-minute Ln VLF which indicates that healthier employees may have higher intentions of quitting their jobs. From the literature review, a VLF peak, ranging between 0.0033 and 0.04 Hz, is associated with an increased risk of adverse effects, and the VLF has stronger correlations with “all-cause mortality” than HF and LF power. According to McCraty and Shaffer (2015), a lower VLF is the most predictive of future health problems, since a low VLF power is associated with arrhythmic death and posttraumatic stress disorder. Furthermore, the low power in VLF is associated with high inflammation and has been correlated with low levels of testosterone (McCraty and Shaffer, 2015).

Trying to make sense that healthier employees have an intention to quit, according to Porges (2017), from a polyvagal perspective, when an employee is in a situation that resembles a life-threatening situation, he or she may be unable to utilize mobilization strategies (quitting their jobs) or use social engagement strategies (relating to other colleagues) to get out of the situation. Additionally, the “neuroception” features of that challenge may cause that employee to experience a shutdown condition, which is characterized by the old unmyelinated vagus and coupled with reduced blood flow, especially blood flow to the brain and exhibiting dissociative features. Porges further stated that the greater issue is not the traumatic experience at the workplace, but the making sense of the physiological response that the traumatic event has triggered. In other words, it is not just about the bad event but the consequences of that event on the employees’ physiology and on their nervous systems that is profoundly changing their ability to adapt in the workplace. This may well explain why employees who are not having intentions to quit are what Porges has coined as “immobilized with (or without) fear.”

RQ4

In line with previous research findings, significant findings between age and the HRV measures indicate that the older the employee, the lesser his or her overall HRV (Russoniello *et al.*, 2013). It is surprising, however, that the MHRR in the one-minute deep breathing assessment was not as significantly related to age, especially as age was highly correlated with the SDNN and RMSSD in the five-minute resting HRV assessment. A possible explanation for this is that the one-minute deep breathing assessment is a challenge test that is getting at how much overall HRV the participants' system is capable of producing at that time. Having that in mind, the majority of the participants in this research were between the age of 21 and 40 (considered as a young population group), which possibly explains why the age correlations in the one-minute assessments were not stronger if the age range was not wide enough (R. McCraty, personal communication, September 22, 2017).

Relational tension. A significant negative correlation was also found between relational tension and normalized coherence, which may indicate that the healthier an employee, the lesser the relational tension. According to R. McCraty, relational tension is clearly a source of stress, and he suggests that it is one of the most harmful types of stress. When there is a lower coherence in the one-minute test, especially if the amount of HRV is within the normal range (MHHR and SDNN), he suspects that it indicates an issue with the coupling of the respiratory and the cardiovascular systems within the brainstem. He postulates that this will eventually be shown to be an early warning indicator and is associated with future health challenges (personal communication, September 26, 2017). Furthermore, McCraty (2017) states that relational tension due to lack of coupling and alignment with others may be reflected in lower coupling of the respiratory and cardiovascular systems. He describes how HRV synchronization between mothers and young children nourishes a biological synchronized rhythm which provides the foundation for a social rhythm for the child. Hence, the development of one's internal biological oscillators is critical to future social connection and self-regulation.

Where relational tension is concerned, Porges (2017) suggests that "toxic load" should be understood from the psychological and physiological standpoint such as bodily cues. A healthy employee needs to feel "safe" not just physically but "as an emotion, mood or affective state" as well. Porges postulates that physiologically, it is of paramount importance to feel safety such as how the employee's nervous system desires to feel safe. A decrease in relational tension can be seen as having "effective social interactions" among colleagues, superiors and subordinates which "may actively dampen defense systems and, when defense is down-regulated [...] [employee's] physiological state provides neural opportunities for [one] to learn and to form strong social bonds while simultaneously supporting health, growth and restoration," thus healthier employees (Porges, 2017, p. 115). Porges instigates the significance of social interactions in enabling employees to feel safe because an absence of compassionate face-to-face interactions among colleagues which include bodily cues and vocal cues with warm controlled voices triggers bodily state shifts which fuels the internal defenses and foster miscommunication and misunderstandings amongst colleagues such as "task instructions." Moreover, the researcher has observed how the increased use of technology in the workplace such as online chats dampens face-to-face interactions. Porges further describes how the social engagement system activates the Vagus nerve where for instance, having calm conversations will not only enhance connection with other colleagues but it triggers neural circuits in our bodies that calm the heart, relax the gut and turns off the fear response. The Vagus nerve is further described as having the ability to transmit messages quickly from the brain stem to the heart, lungs and intestines. Moreover, the Vagus nerve regulates some facial muscles, including the ear, and can enhance our ability to give others appropriate facial cues and even hear others better. Hence, the Vagus nerve influences the employee's heart rate and breathing, and is involved in how an employee perceives, reacts and recovers from stress. When an employee feels confident in a

social context, his or her heart rate and breathing slows down, the blood pressure drops with stress responses switching off. The body enters a state of physical calmness. Hence, an employee feels safe to move closer to another colleague, making intimacy possible. Therefore, social engagement can enhance our sense of safety, creating a positive feedback loop which leads to further calming. On the other hand, if the body detects that he or she (an employee) is in “danger,” it switches to the fight/flight response, driven by the body’s hypothalamic–pituitary–adrenal axis, which changes into symptoms of anxiety in the workplace context.

Mean score. The mean PSS score is 17.69 where 13 is considered average while 20 or above is considered high stress. On the other hand, the mean overall stress score in the POQA is 8.4 where 0 is the lowest (most calm) and 14 is the highest (most stressed). In this study, the correlational analysis between PSS and POQA are significantly correlated, therefore, this suggests that the overall level of comfort an employee experiences is a level close to high stress. Moreover, from the discussions in RQ3, out of the four primary scales: emotional vitality, organizational stress, emotional stress and physical stress, both emotional vitality and emotional stress are within the below average range, while the rest of the scales are in the average range. The poor score on the intention to quit subscale of POQA is the most surprising finding and is considered a red flag to management as it indicates that a notable proportion of employees are feeling sufficiently dissatisfied with their work environment that they are thinking about quitting their jobs.

Limitations and delimitations

A limitation of measurement bias might have occurred since the survey data were self-reported, results depended on the effort and honesty of each participant. Participants in the study might have been reluctant to give socially unacceptable answers in the questionnaires, for fear of being judged or are not self-aware enough to provide accurate responses. This might skew the results and caused errors in the correlational analysis. Since the research was on workplace stress, another limitation of surrogate information error might have occurred because the stress the employees experienced might have been non-workplace related such as family bereavement and loss, relationship breakdown, financial problems, family illnesses, commuting pressures, etc. It was also observed that the age range of the participants seemed to have skewed toward the younger population group of 21–40 and this might have led to a design bias limitation. Furthermore, participants that came from four lines of services within the corporation were not equally distributed – Department A (57.6 percent), Department B (11.7 percent), Department C (22.3 percent) and Department D (8.2 percent), which might have delineated a narrow demographic range of the corporation known as a measurement bias (Shuttleworth, 2009).

According to an article search, this was the first research conducted on the relationship between HRV, POQA and PSS in Hong Kong and using HRV as a potential physiological objective measurement for workplace stress. The sample size ($n = 85$) of HRV measures was relatively large compared to other research studies and according to Clinical & Translational Science Institute (2017), the total sample size was of a significant level to achieve a power of 0.80 and an estimated effect size of 0.30.

Implications for office work

The overall research also implied that an average employee experiences a close to high level of workplace stress on a regular basis and, therefore, presenting a universal threat to organizational costs and workplace performance. The research data have concluded that emotional stress and relational tension are inherent in the workplace. Emotional stress may deplete one’s internal resources regardless of whether one is healthy or non-healthy. Consequently, employee turnover may occur when employees are dissatisfied with the workplace environment. Besides, existing

employees who do not have any intention of quitting may be exhibiting immobilization with (or without) fear, leading to a drop in workplace performance. It is, therefore, very critical to find new and effective tools such as HRV assessments to measure and monitor stress as well as having effective interventions to reduce and prevent workplace stress.

Implications for organizations

It is recommended that organizations ought to implement organizational resilient strategies such as mindfulness psychology and integrative health coaching programs as an integral part of a strategic framework of change management initiatives. The act of being mindful for employees and leaders within an organization means to be aware in the present moment, intention in thought and purposeful in action. Additionally, beneficial outcomes for the overall organization include competitive advantages, employee engagement, decreased attrition, increased productivity, better well-being, leadership development, better collaboration leading to healthier organizational culture, climate, longevity and social coherence.

Recommendations for further research

A purpose of having future research is to align the various research works with the social and global coherence notion propelled by the HeartMath Institute. Future research will continue to address topics ranging from stress to reducing violence, reducing health costs, emotional regulation, biofeedback interventions, stress management and even other non-workplace topics such as the academic performance of children of different ages, PTSD, intuition and much more. Hence, further research on the effects of employee stress and HRV needs to be conducted. The researcher has several suggestions for future research.

Repeat research

Similar research can be conducted in other Asian countries such as Singapore, Taiwan with a more diversified age group. A second way is to repeat the research with other subjective perceived stress surveys.

Heart-brain and face-heart connections

Integrating the works of McCraty (2017) and Porges (2017), comparable studies on heart-brain and face-heart connections can be further explored to add to the current body of knowledge regarding relational tension and resilience.

HRV research

Future research studies could use HRV stress measurements to evaluate the effectiveness of stress management interventions. Based on the findings, organizations can objectively identify the most effective intervention types and customize an employee assistance program to reduce workplace stress. Another study could include repeating the original research with additional primary biomarkers which can serve as confirmatory approaches.

Conclusion

This research has explored the correlation between a new quantitative stress measurement known as the emWave Pro Plus and compared it with two other sets of quantitative self-reported perceived stress data: the POQA (POQA) from HeartMath (Barrios-Choplin and Atkinson, 2000) and the PSS (Cohen *et al.*, 1983). This research has looked at the effects of Hong Kong employees' workplace stress on HRV. Two surprising findings have been found in the research in terms of emotional stress and intention to quit. First, a significant positive correlation has been found between the emotional stress and the MHRR, which indicates that the higher the emotional stress an employee faces, the higher his or her HRV. Second, a significant positive correlation has been

found between intention to quit and five-minute Ln VLF, which indicates that healthier employees may have higher intentions of quitting their jobs. Discussions have been held to explain these surprising findings in order to make sense of the data. The research shows promising results and future studies should continue to tap into HRV as an objective measure of mental health and workplace stress.

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