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Original Research Article Outline:

CORRELATION BETWEEN LIFE SATISFACTION AND HEART RATE VARIABILITY COHERENCE AMONG BLUE-COLLAR WORKERS – CASE STUDY IN A MALAYSIAN ELECTRONIC MANUFACTURING COMPANY

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ABSTRACT

Introduction. In addition to having a higher risk of more physical and psychological health problems, blue-collar workers form the largest proportion of the workforce in industries. Thus, it is important to ensure their well-being which can have broader benefits for economic growth and society. This study aims at investigating the relationship between subjective well-being, namely life satisfaction and heart rate variability (HRV) coherence as an objective indicator. The second aim is to evaluate whether any differences in HRV coherence across three levels of life satisfaction groups (dissatisfied, neutral, and satisfied) after a brief session of resonant breathing training. **Methods**. A total of 313 female blue-collar workers from an electronic manufacturing company participated in this study. All participants completed a satisfaction with life scale (SWLS). Their HRV coherences were then recorded at baseline or rest and after attending a brief session of resonant breathing. **Results and Analysis**. We found a significant correlation between life satisfaction and HRV coherence after the intervention but not at rest, implying a current state of cardiac activity did not reflect workers' attitudes toward their life. Moreover, less satisfied workers showed greater cardiac coherence improvement than those who perceived more satisfaction in life. **Discussion**. This finding suggests that brief resonant breathing training can help workers achieve greater HRV coherence which offers its potential as a strategy to combat workplace stressors.

Keywords: Heart rate variability, Coherence, Life Satisfaction, Blue-collar Workers, Well-being.

INTRODUCTION

Since blue-collar workers make up a significant portion of the workforce in industries, it is crucial to ensure their well-being which leads to broader benefits including productivity and efficiency, economic stability, social equity, and quality of life (Dėdelė et al., 2019; WHO, 2019). Blue-collar work involves more physically demanding duties and includes manual labor, typically in industries such as manufacturing, construction, maintenance, and transportation (Hessels et al., 2018). They often face harsh working conditions, potential exposure to hazardous materials, and higher psychosocial stressors such as job insecurity, limited access to resources, or limited opportunities for career advancement. Accordingly, they reported lower perceived well-being, compared to white-collar workers (Dėdelė et al., 2019; Hessels et al., 2018). However, this population has been understudied in well-being research.

Furthermore, one of the important components of well-being is life satisfaction, a subjective measure of an individual's overall evaluation of their life quality and happiness (Edward Diener et al., 2002). As life satisfaction depends on individual values, perception, and cultural factors, two people with similar levels of well-being may perceive different levels of life satisfaction based on their unique values, expectations, and experiences. While life satisfaction studies have been conducted on general workers and white-collar workers (Adegbite et al., 2020; Krygier et al., 2013; Lomas et al., 2019), less attention has been paid to blue-collar workers.

Considering the subjective nature of life satisfaction evaluation, it is important to investigate whether life satisfaction can be reflected by an objective indicator such as derived from an individual’s cardiovascular activity, namely heart rate variability (HRV). HRV describes the variation in time between consecutive heartbeats (R-R intervals) (Shaffer & Ginsberg, 2017). HRV is a measure of the autonomic nervous system (ANS) function which affects how every organ in the body functions (Shaffer & Ginsberg, 2017). The ANS consists of two branches: the parasympathetic and sympathetic nervous systems which work in balance to promote homeostasis. HRV analysis can be divided into time and frequency domains (Shaffer & Ginsberg, 2017). The most commonly reported time domain measures in well-being studies are the standard deviation of all normal normal-to-normal intervals (SDNN) and the square root of the mean of the squares of differences between consecutive RR intervals (RMSSD). SDNN reflects a measure of overall cardiovascular adaptability and RMSSD reflects mainly parasympathetic activation of ANS. Frequency domains HRV parameters are computed from the power spectrum of RR interval data and explain the frequency component distribution or band of HRV. The bands are typically high frequency (HF: 0.15-0.4 Hz), low frequency (LF: 0.04-0.15 Hz), and very low frequency (VLF: 0-0.04 Hz).

Previous research has established that HRV represents a wide range of well-being aspects including physical and psychological health (e.g., (Dang et al., 2021; Sloan et al., 2017; Sutarto, Khairi, et al., 2020; Thielmann et al., 2021; Young & Benton, 2018)). Higher HRV is associated with better regulation of emotions, higher mental well-being, and lower anxiety. Low HRV corresponds to dysregulation of the ANS and becomes a significant predictor of poor physical and mental health disorders, and other life problems (Jarczok et al., 2022; Shahrestani et al., 2015). Whilst some research has been conducted on HRV and life satisfaction (Krygier et al., 2013; Sloan et al., 2017), no study has been carried out among blue-collar workers.

Furthermore, the Institute of HeartMath proposed a *cardiac* or *HRV coherence* term, referring to the pattern of the rhythm over time, instead of the heart rate (at any point in time), that represents the more subtle ANS and emotional dynamics as well as physiological harmonization (McCraty et al., 2014). A coherent heart rhythm is characterized by its generally harmonic, sine-wave-like signal, and synchronization between the respiratory, blood pressure, and heart rhythms. It produces a very narrow, high-amplitude peak in the low-frequency area (usually about 0.1 Hz) of the HRV power spectrum, with no significant peaks in the VLF or HF bands. An individual who experiences different emotions will present different oscillatory activities in the HRV as shown in Figure 1 (McCraty, 2015). Therefore, an individual HRV coherence provides a more complete picture of her or his subjective experiences and states. However, much less is known about the correlation between life satisfaction and HRV coherence, particularly in blue-collar workers.

Meanwhile, previous research has shown that resonant breathing technique or heart-focused breathing at about 5-7 breath cycles per minute helps an individual to achieve cardiac coherence (P. M. Lehrer & Gevirtz, 2014; Sutarto, Khairai, et al., 2020). It facilitates the identification and cultivation of a particular positive emotion (McCraty et al., 2014). The last two decades have seen a growing trend toward the use of resonant breathing (RB) as a strategy to improve emotional and physical health (P. Lehrer et al., 2020). Nevertheless, there is still needed to investigate whether a single brief intervention of resonant breathing, could increase acute HRV coherence which may mitigate negative emotional symptoms at the workplace. If such an intervention works, workers can apply it daily, particularly when encountering stressors which in turn may improve their well-being.

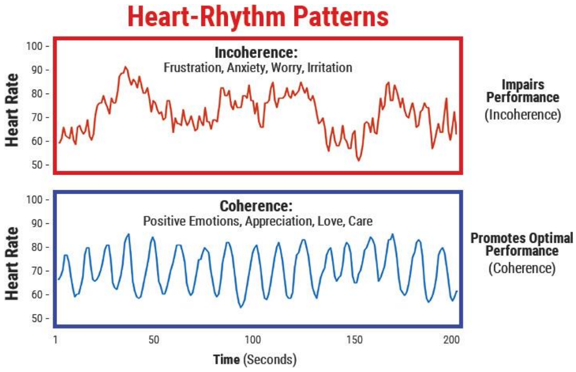

Figure 1. Heart rhythm patterns (Institute of Heart Math (McCraty, 2015)

Based on the aforementioned review, this study aims to evaluate the correlation between well-being, represented by perceived life satisfaction, and heart rate variability, indicated by cardiac coherence. Further, two hypotheses are formulated. Firstly, there is a significant positive correlation between perceived life satisfaction and cardiac coherence (H1). Secondly, workers who are less satisfied with their life will show greater improvement in cardiac coherence than those who have greater satisfaction after attending a brief intervention of resonant breathing (H2). Understanding the relationship between life satisfaction and HRV will help to identify strategies to promote overall health and well-being among blue-collar workers.

METHOD AND ANALYSIS

Participants

A total of 314 blue-collar female workers in an electronic manufacturing industry located in Kuantan, Pahang, Malaysia participated in this study. We recruited only female participants to reduce design bias since the gender difference may influence HRV measures (Shahrestani et al., 2015). The participation was voluntary and each participant provides written consent. All procedures in this study were in accordance with the Declaration of Helsinki.

Life Satisfaction

Life satisfaction was measured using the Satisfaction with Life Scale (SWLS) (Ed Diener et al., 1985) which consists of 5 items to measure individuals' global cognitive of their satisfaction with their life. The scale is a reliable and valid measure of life satisfaction which has a significant correlation with other factors such as income, social relationships, health, and other aspects of well-being (Janzarik et al., 2022; Krygier et al., 2013; Lomas et al., 2019). Participants were asked to rate on a 7-point Likert scale (1: strongly disagree to 7 strongly agree). Higher scores reflect more satisfaction with life. The sum scores of SWSL were categorized as extremely satisfied (31 – 35), satisfied (26 – 30), slightly satisfied (21 – 25), neutral (20), slightly dissatisfied (15 – 19), dissatisfied (10 – 14), and extremely dissatisfied (5 – 9).

HRV Coherence

HRV was measured using the emWave Pro system, designed and developed by the Institute of Heart Math. The device utilizes photoplethysmography (PPG) sensor technology, which is a reliable and valid way of obtaining and quantifying real-time HRV using infrared light to detect blood flow (Low & McCraty, 2018). In this study, the coherence achievement or score is used as an index of HRV which is defined as the highest peak in the 0.04 to 0.26-hertz range of the HRV power spectrum, calculating the integral in a window 0.03 Hz wide centered on the highest peak in that region, and then calculating the total power of the entire spectrum. (McCraty, 2015). The more stable the HRV amplitude, frequency, and waveform, the higher the level of coherence. The coherence meter offers values of low (red), medium (blue), and high (red) percentages of coherence (Figure 2). Several studies have found the effectiveness of the emWave Pro for HRV assessment in various settings, including stress and anxiety reduction, academic and work performance enhancement (Burch et al., 2019; Low & McCraty, 2018; McCraty, 2017; Sutarto, Khairai, et al., 2020).

Figure 2. Short-term HRV activity using emWave Pro (Institute of Heart Math)

Procedure

On the day of the assessment, workers came into a dedicated quiet room. They obtained a briefing about the research objectives and then provided their signed informed consent. The emWave sensor was then placed on the right earlobe. The participants were instructed to remain seated and relaxed for a five-minute resting state and to breathe normally to obtain a standard baseline measurement of HRV (Laborde et al., 2017). Each participant then was taught how to perform resonant breathing, following the previous established protocol (P. M. Lehrer & Gevirtz, 2014). Participants were encouraged to sit comfortably and focus on their breathing. They were allowed to close their eyes which can help them breathe without distractions. Resonant breathing involves deep and slow inhalation through the nose for a count of approximately 4-5 seconds. During exhalation, participants were instructed to gently exhale through their mouth (pursed lip breathing) for a count of approximately 4-5 seconds, allowing their diaphragms to contract and release the air from their lungs. They should maintain a steady and consistent pace, taking approximately 5-6 full breaths per minute. During the intervention session, the emWave Pro system provides visual feedback through the computer display which helps participants to keep track of their breathing rate. After learning and familiarizing with this breathing exercise, each participant practiced breathing at their resonance and data were recorded during five minutes. The software calculated the coherence scores and then displayed them in real time on the screen.

Data Analysis

Descriptive statistics were used to summarize the data with numeric variables, represented by the mean and standard deviation (SD) and categorical variables (department, marital status, SWLS groups) were represented by absolute (*n*) and relative frequency. To anticipate an SWLS category that has less than five cases, the original seven SWLS categories were collapsed into broader three groups: dissatisfied, neutral, and satisfied. Since all data violate normality assumptions, non-parametric tests Spearman analysis was conducted to examine the correlation between all variables while Kruskal-Wallis tests were performed to assess the differences in all cardiac coherences between SWLS groups. SPSS version 23.0 (IBM) was used to analyze all statistics with the significance levels α were set at 0.05

RESULT

Table 1 summarizes the descriptive data of demographic characteristics and HRV coherence of all participants. The average age of all participants is 31.96 years with working experience of 9.68 years. Most workers were assigned to the department of production (65.2%) with marital status as unmarried (64.2%). This implied that millennial workers account for the greatest proportion of the workforce in this factory.

Table 1. Summary of descriptive data

		mean or *N*	SD or %
Age		31.96	12.43
Work experience		9.68	11.63
Department	Production	204	65.2%
	Precision	35	11.2%
	Hawk	5	1.6%
	Molded	17	5.4%
	ASL	17	5.4%
	Gull	10	3.2%

	Keysight	25	8.0%
Status	Single	201	64.2%
	Married	92	29.4%
	Widowed / divorced	20	6.4%
Pre-Coherence	Low (red)	42.68	26.64
	Medium (blue)	24.53	16.42
	High (Green)	32.90	26.37
	Coherence	0.85	0.53
Post-Coherence	Low (red)	13.38	19.29
	Medium (blue)	13.64	15.92
	High (Green)	73.27	31.43
	Coherence	2.14	1.25
Delta coherence		1.29	1.25

The distribution of cardiac coherence measures for all participants before and after the intervention is also displayed in table 1. Figures 3 and 4 illustrate the distribution of cardiac coherence according to SWLS categories. Participants in all categories show cardiac improvement after a brief session of resonant breathing as indicated by decreased low coherence ratio (red), reduced medium coherence (blue), and increased high coherence (green), as well as greater coherence achievement at post-session compared to pre-session. It seems that the most notable improvement was observed in the dissatisfied group compared to the neutral and satisfied groups.

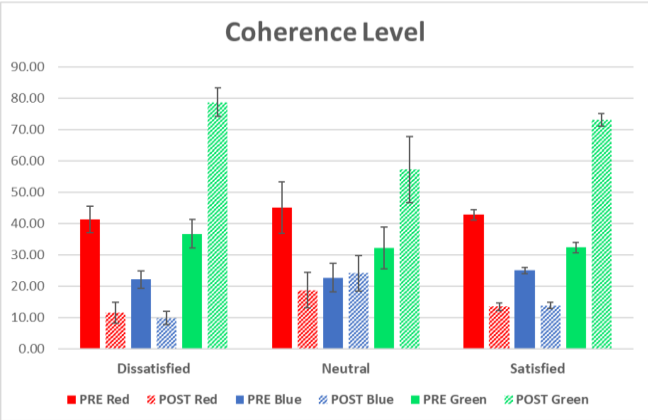

Figure 3. Distribution of cardiac or HRV coherence level across SWLS groups at pre-and post-intervention. Error bars indicate the standard errors of the means.

The Spearman tests in table 2 show that perceived life satisfaction, measured by SWLS, significantly correlates with cardiac coherence (ρ = -0.21, p<0.01) and delta coherence (ρ = -0.20, p<0.01) after resonant breathing intervention. However, the association between SWLS and coherence during baseline was not found (ρ = -0.03, p = 0.62).

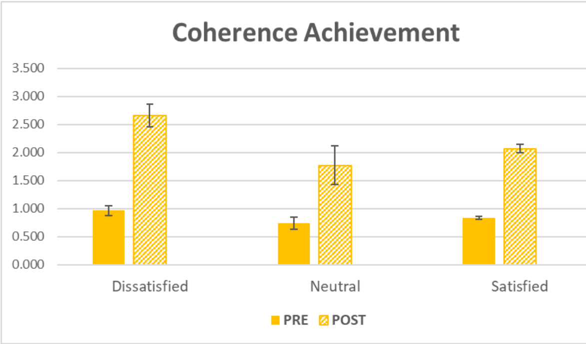

Figure 4. Coherence achievement or scores at pre-and post-intervention. Error bars indicate the standard errors of the means

Table 2. Spearman coefficient correlation between all measured variables

	SWLS total	Coherence_Pre	Coherence_Post
SWLS total	1	-0.03	
Coherence_Pre	-0.03	1	
Coherence_Post	-0.21^{***}	0.15^{**}	1
Delta Coherence	-0.20^{***}	0.21^{***}	-0.92^{***}

As shown in table 3, the Kruskal-Wallis tests reveal that there are significant differences in coherence scores and delta coherence across three SWLS groups after a short session of resonant breathing technique. No significant difference was observed on cardiac coherence before the session across the SWLS groups. Post-hoc methods with adjusted Bonferroni correction were then performed following the significant findings which found that less satisfied workers experienced greater improvement in coherence than more satisfied workers (all $p < 0.05$). There was no significant difference in HRV cardiac coherence between the neutral group and less as well as more satisfied workers.

Table 3. Summary of Kruskal-Wallis tests

	Coherence Pre	Coherence Post	Delta
Chi-Square ($df = 2$)	1.01	8.97	6.13
p-value	0.60	0.01	0.05

DISCUSSION

Considering the significant contribution of blue-collar workers in the economic and societal impacts, it is important to investigate their life satisfaction, as an indicator of well-being, with respect to HRV or cardiac activity which has been less studied previously. This study aims to evaluate whether any correlation between perceived life satisfaction and HRV coherence. We found that participants' perceived life satisfaction correlates with cardiac coherence after attending a brief session of resonant breathing training but not during the baseline. This finding did not support H1 that lower perceived life satisfaction is reflected through lower cardiac coherence at rest which also contradicts prior studies (Jandackova & Jackowska, 2015; Krygier et al., 2013). This inconsistent finding could be attributed to the different HRV parameter measures. Jandackova & Jackowska, (2015) used total power from the time-domains indices, and Krygier et al., (2013) utilized high frequency of the frequency domains. While the analysis in this study used coherence ratios, automatically provided by the emWave Pro system. Another possible explanation is that perceived life satisfaction might be less representative of a current well-being status. Life satisfaction measures how an individual's attitude towards her or his life, rather than an assessment of their current feelings while HRV coherence at rest indicates the current physiological state of the participant. A prior study in the same factory using similar instruments found that there was an association between cardiac coherence and other dimensions of well-being, indicated by negative emotional symptoms including depression, anxiety, and stress (Sutarto, Khairi, et al., 2020). This implied that different dimensions or aspects of well-being may not be reflected similarly through HRV coherence.

Furthermore, as expected, our findings support H2 that less satisfied workers achieved greater cardiac coherence than workers with higher perceived life satisfaction after the intervention. This suggests that dissatisfied groups gained more benefits from the intervention than the satisfied group although both groups show increased HRV coherence. It seems that dissatisfied participants were much more relaxed even in a relatively short breathing training which in turn was more efficient to increase their coherence. This finding supports prior studies (Li et al., 2022; Sutarto, Khairai, et al., 2020) which also found the effectiveness of resonant breathing in increasing HRV coherence among those who had lower well-being conditions.

This study poses some limitations that should be considered when interpreting the findings. We did not employ a control group which prevents us from inferring causality or whether resonant breathing intervention truly affects the cardiac coherence improvement. The current study also only included female participants, so the findings may not be generalizable to other populations. Future research needs to address these limitations by including a control group and recruiting participants of both genders and other types of industries to enhance the validity and generalizability of the findings.

Notwithstanding the limitations, this study offers an understanding of the relationship between life satisfaction and HRV coherence which may help policymakers develop targeted interventions and support systems to address these challenges effectively. Besides, the effectiveness of a brief intervention of resonant breathing to improve HRV coherence offers an opportunity to be applied in the workplace. Practicing resonant breathing will not interfere with the workers' tasks as one single session only takes five minutes. However, workers should regularly practice to form a habitual behavior and ultimately gain more physical and psychological health (Li et al., 2022)

CONCLUSION

The present study examined the correlation between life satisfaction and cardiac or HRV coherence and whether any differences in coherence improvement across different levels of life satisfaction after a brief resonant breathing training intervention. Results demonstrate that life satisfaction was reflected by HRV coherence at rest while less satisfied workers performed much better at increasing their coherence after the intervention than their counterparts.

Despite the study's limitations, these findings suggest that brief resonant breathing training can help workers achieve greater HRV coherence which offers its potential as a strategy to combat workplace stressors.

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