ORIGINAL ARTICLE

Effect of transcutaneous electrical acupoint stimulation in heart rate variability in post-on-call trainees

Low Hsueh Jing, MMed (Anaesth)[1], Cheah Onn Kee, MMed (Anaesth)[1], Ng Boon Hau, MMed[2], Siti Nidzwani Mohamad Mahdi, MMed (Anaesth)[1], Wan Rahiza Wan Mat, MMed (Anaesth)[1], Liu Chian Yong, MMed (Anaesth)[1]

[1]Department of Anaesthesia and Critical Care, Faculty of Medicine, Universiti Kebangsaan Malaysia, Hospital Canselor Tuanku Muhriz, Kuala Lumpur, Malaysia, [2]Respiratory Unit, Department of Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, Hospital Canselor Tuanku Muhriz, Kuala Lumpur, Malaysia

ABSTRACT

Introduction: Anaesthesiology is a high-demand speciality with 24-hour on-call shifts, which can lead to significant stress and impaired sleep quality among anaesthetists. Non-pharmacological interventions like acupuncture have been widely explored for stress relief. This study aims to evaluate the impact of transcutaneous electrical acupoint stimulation (TEAS) on physiological parameters, specifically heart rate variability (HRV) and sleep quality, in anaesthesiology trainees following 24-hour on-call duty.

Materials and Methods: A total of 38 anaesthesiology trainees, following 24-hour ICU on-call shifts, were recruited for this single-centre cross-sectional clinical trial. The participants were required to complete two 24-hour on-call duties. Demographic data and baseline sleep quality assessments were collected following the first on-call duty. Upon completion of the second on-call shift, participants underwent 20 minutes of TEAS at bilateral PC6 (Neiguan), LI4 (Hegu), LR3 (Taichong), and ST41 (Jiexi) points. Heart rate variability (HRV) parameters, blood pressure, and heart rate were recorded before and after TEAS. Post-TEAS sleep quality was assessed following an overnight rest.

Results: The results demonstrated a significant reduction in systolic blood pressure compared to baseline (109.5±8.9 vs 111.9±10.1 mmHg, $p = 0.006$), as well as a significant decrease in diastolic blood pressure (69.3±8.0 vs 70.9±9.0 mmHg, $p = 0.037$) and heart rate (65.8±9.2 vs 67.4±9.8 bpm, $p = 0.034$). There was significant improvement in all aspects of sleep quality ($p < 0.001$). However, no statistically significant changes were observed in heart rate variability (HRV) parameters, including high-frequency (HF) power, low-frequency (LF) power, and the LF/HF ratio.

Conclusion: TEAS may offer potential benefits in managing cardiovascular stress and improving sleep quality in high-stress environments, such as post-call recovery. Nevertheless, its impact on autonomic nervous system regulation, as reflected by HRV, appears limited.

KEYWORDS:
Transcutaneous electrical acupoint stimulation, acupuncture, heart rate variability, sleep quality

INTRODUCTION

Anaesthesiology is a rapidly evolving medical speciality that plays a critical role in peri-operative care, emergency management, intensive care, and pain management. However, it is a high-stress field characterised by long, unpredictable working hours and demanding academic expectations.[1-3] Anaesthetists frequently face extended shifts and on-call duties, leading to substantial on-call stress. Contributing factors include sleep deprivation, patient care uncertainties, time pressure for decision-making, and heavy workloads.[4,5] If not properly managed, these stressors can result in chronic fatigue, burnout, and an increased risk of cardiovascular and metabolic diseases.[6]

Prolonged on-call duties also disrupt sleep patterns, leading to circadian rhythm disturbances and chronic sleep disorders.[7] Insufficient sleep can impair cognitive function, decrease alertness, and negatively affect work performance, heightening the risk of medical errors.[8] Early detection of sleep issues and timely interventions to improve sleep quality are essential to safeguard the health of anaesthetists and ensure the safe delivery of patient care.

Non-pharmacological interventions like acupuncture have been widely explored for stress relief. Acupuncture, rooted in Traditional Chinese Medicine, involves stimulating specific acupoints to restore the balance of Qi, a form of bioenergy.[9,10] Among commonly used acupoints, PC6 (Neiguan) is known for its cardiac protection, while LI4 (Hegu), LR3 (Taichong), and ST41 (Jiexi) are associated with general health and immune function.[11-16] Modern adaptations, such as transcutaneous electrical acupoint stimulation (TEAS), offer needleless alternatives that are easier to standardise, less invasive, and more accessible.[17]

Stress is closely linked to dysregulation of the autonomic nervous system (ANS), which can be assessed through heart rate variability (HRV).[18] HRV analysis, particularly frequency-domain parameters such as low-frequency power (LF), high-frequency power (HF), and the LF/HF ratio, provides insights into sympathovagal balance and ANS function.[19-24] This study aimed to assess the impact of TEAS on HRV and sleep quality in anaesthesiology trainees after 24-hour on-call shifts.

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Corresponding Author: Ng Boon Hau
Email: ngboonhau@hotmail.com

MATERIALS AND METHODS

This cross-sectional study, with project code JEP-2021-912, was conducted with approval from the Medical Research and Ethics Committee of Hospital Canselor Tuanku Muhriz, Universiti Kebangsaan Malaysia.

Anaesthesiology post-graduate trainees who had completed a 24-hour on-call duty in the intensive care unit (ICU) were recruited. Written informed consent was obtained prior to participation. Exclusion criteria included known psychiatric or sleep disorders, cardiac diseases, use of cardiac implantable electronic devices, cigarette or alcohol consumption within 24 hours prior to the on-call duty, and skin infections at acupoint sites.

Participants completed two separate 24-hour ICU on-call duties. After the first duty, they were instructed to rest overnight and completed demographic data and sleep quality assessments the following day (pre-TEAS data). Following the second 24-hour on-call duty, participants attended a TEAS intervention session. Caffeinated beverages were prohibited on the morning of the intervention. The session took place in a quiet, air-conditioned room, where participants wore a Polar H10 heart rate monitor with a chest strap positioned at the xiphoid process. Baseline blood pressure (BP), heart rate (HR), and heart rate variability (HRV) parameters were recorded after a 10-minute rest.

The acupoints PC6 (Neiguan) and LI4 (Hegu) on the upper limbs and LR3 (Taichong) and ST41 (Jiexi) on the lower limbs were identified bilaterally. These areas were cleaned with alcohol swabs, and electrode pads were applied to the acupoints. Ipsilateral electrodes were connected in series—PC6 to LI4 and LR3 to ST41—and a continuous wave stimulation at 5 Hz was delivered using an electroacupuncture machine (Hwato SDZ III) for 20 minutes. TEAS stimulation intensity was gradually increased to each participant's maximum tolerance of tingling or numbness in the hands and legs. After the session, participants rested for 10 minutes, after which post-intervention BP, HR, and HRV parameters were recorded. The following morning, after overnight rest, participants completed post-TEAS sleep quality assessments.

Study Research Tool

Heart Rate Variability Assessment

Autonomic nervous system (ANS) function was assessed using HRV analysis. The following frequency-domain indices were defined and measured: high-frequency power (HF; 0.15–0.4 Hz), low-frequency power (LF; 0.04–0.15 Hz), and the LF/HF ratio, representing the ratio of low-frequency to high-frequency HRV.

Likert Scale for Sleep Quality Feedback

This study employed a self-reported sleep quality feedback tool, utilizing a 10-point Likert scale with endpoints ranging from 'worst quality' (score of 1) to 'best quality' (score of 10). The scale evaluated five aspects of sleep quality: sleep duration (total sleep over 24 hours), sleep efficiency (ease of falling and returning to sleep), overall sleep quality (ability to maintain sleep and the presence of disturbances), satisfaction (subjective perception of sleep), and daytime alertness (ability to remain attentive).

A pilot study was conducted to assess the face validity and reliability of the sleep quality feedback. Five participants not involved in the main study were tested to ensure clarity and comprehension of the feedback items, with all expressing good understanding. A reliability analysis was performed on 155 subjects not involved in the interventional study using Cronbach's alpha. The analysis demonstrated a Cronbach's alpha coefficient of 0.882, indicating excellent internal consistency ($\alpha > 0.70$) across the four main items related to sleep quality.

The study did not incorporate validated sleep quality questionnaires, as their methodology did not align with the specific criteria of these instruments.[25]

Devices

Sensor

The Polar H10 HR sensor chest strap is a commercially available HRV monitor designed to detect cardiac electrical activity. Its reliability has been validated against the gold standard for measuring R-R intervals using an ECG Holter monitor.[26]

Output Display

The heart rate monitor was connected via Bluetooth to a smartphone running the EliteHRV© application. The app analysed the heart's electrical signals, providing frequency-domain data on HRV, including HR, LF power, HF power, and the LF/HF ratio. Cross-validation studies have demonstrated that HRV measurements obtained through this smartphone application are reliable when compared to conventional ECG-derived parameters.[27]

Intervention Device

The electroacupuncture device employed for transcutaneous electrical acupoint stimulation (TEAS) therapy was the Hwato Electronic Acupuncture Treatment Instrument, model SDZ-III. This device delivered continuous wave stimulation at a frequency of 5 Hz for 20 minutes, with an optimal intensity ranging from 6 to 15 mA, adjusted according to the trainees' maximum tolerance to maintain minor muscle twitches.

Acupoints

TEAS electrode pads were applied to the following acupoints:

1. PC6 (Neiguan) is located 4cm proximal to the wrist crease, between the tendons of the extensor carpi radialis and palmaris longus (Figure 1A).
2. LI4 (Hegu) is located on the dorsum of the hand, between the first and second metacarpal bones, at the midpoint of the second metacarpal bone and close to its radial border (Figure 1B).
3. LR3 (Taichong) is located on the dorsum of the foot in the distal hollow at the junction of the first and second metatarsal bones (Figure 1C).
4. ST41 (Jiexi) is located at the midpoint of the transverse crease of the ankle joint, between the tendons of the extensor digitorum longus and hallucis longus (Figure 1D).

Statistical Analysis

The sample size was determined with an alpha value set at 0.05 and a power of 80%. The calculation was based on a previous study by Wu et al., which reported a mean

Table I: Demographic data of participants. Data were presented as mean (standard deviation) or frequency (percentage), as appropriate

Variables	Trainees (n=38)
Age (years)	34.5+1.8
BMI (kg/m^2)	24.1+3.4
Gender	
Male	22(57.9)
Female	16(42.1)
Race	
Chinese	18(47.4)
Malay	11(28.9)
Indian	6(15.8)
Other	3(7.9)

Table II: Heart Rate Variability Parameters of Participants before and after TEAS. Data were presented as median [25th–75th percentile], as appropriate

Parameters	Pre TEAS	Post TEAS	p-value
Low Frequency (LF) (ms^2)	885.6 [545.7-1445.9]	870.2[497.8-2063.0]	0.46
High Frequency (HF) (ms^2)	845.4 [397.1-1469.9]	637.8[427.6-1664.4]	0.83
LF: HF Ratio	1.1[0.6-2.2]	1.0[0.6-2.0]	0.65

*p value < 0.05 (overall comparison) with Wilcoxon Signed Ranks Test

Table III: Blood Pressure and Heart Rate before and after TEAS. Data were expressed in mean ± standard deviation as appropriate

Variables	Pre TEAS	Post TEAS	p-value
SBP (mmHg)	111.9±10.1	109.5±8.9	0.006*
DBP (mmHg)	70.9±9.0	69.3±8.0	0.037*
HR (bpm)	67.4±9.8	65.8±9.2	0.034*

*p value < 0.05 (overall comparison) with paired t-test.

Table IV: Sleep Quality Items Feedback. Data were expressed in median [25th-75th percentile] as appropriate

Parameter	Pre TEAS	Post TEAS	p-value
Sleeping Duration (hours)	7.00[6.00-7.00]	7.00[6.00-8.00]	<0.001
Efficiency	7.00[4.75-8.00]	9.00[8.00-9.25]	<0.001
Quality	7.00[5.00-8.00]	9.00[8.00-9.25]	<0.001
Satisfaction	6.00[4.75-7.25]	9.00[8.00-9.25]	<0.001
Alertness	6.00[4.75-7.00]	9.00[8.00-9.25]	<0.001

*p value < 0.05 (overall comparison) with Wilcoxon Signed Ranks Test.

difference in heart rate variability (HRV) of 5.67 beats per minute and a standard deviation of 11.3 beats per minute. Using the Snedecor and Cochran formula, the required sample size, accounting for a 10% dropout rate, was calculated to be 37.[28]

Data analysis was conducted using SPSS for Windows version 23.0 (IBM Corp, Armonk, NY, USA). Results are presented as mean (standard deviation), median (interquartile range), or frequency (percentage) as appropriate. An independent-sample paired t-test was utilised for comparisons of blood pressure and heart rate. The Wilcoxon signed-rank test was applied for the comparative analysis of HRV parameters (LF, HF, LF/HF ratio) and sleep quality items. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Thirty-eight participants were recruited for the study. Demographic data for these participants are presented in Table I.

As shown in Table II, the frequency domain analysis of HRV, including LF power, HF power, and the LF/HF ratio, did not demonstrate significant differences before and after TEAS treatment.

As seen in Table II, SBP, DBP, and HR showed significant reductions following TEAS compared to measurements taken before TEAS.

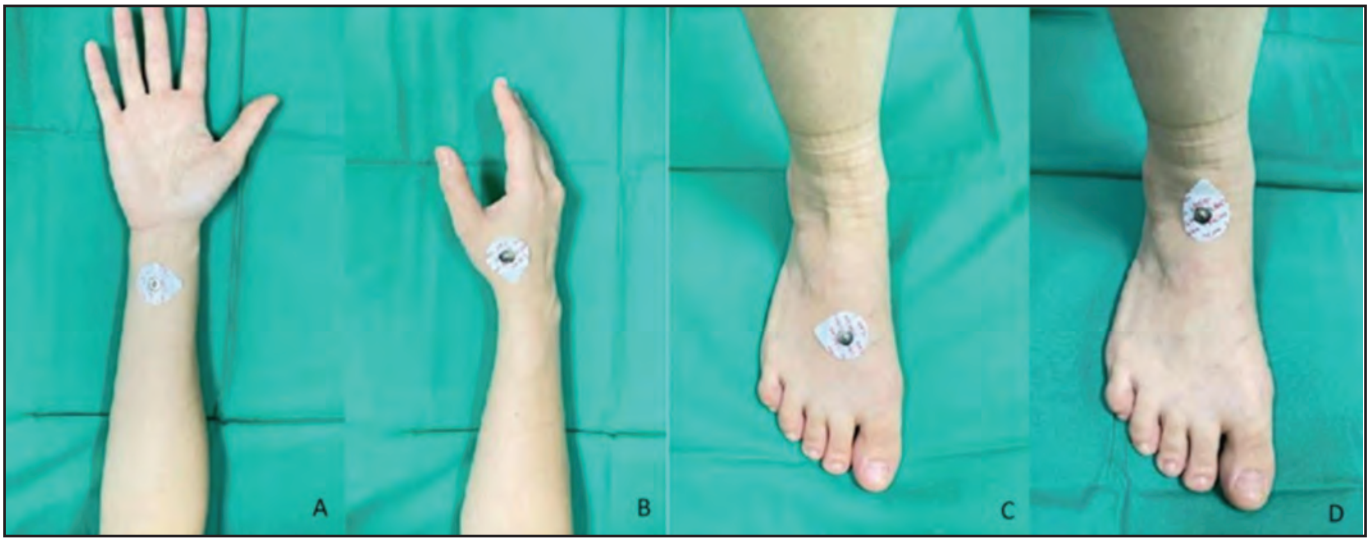

Fig. 1: (A) PC6 Neiguan. (B) LI4 Hegu. (C) LR3 Taichong. (D) ST41 Jiexi

Significant improvement was seen in all five sleep items, including the duration of sleep, sleep efficiency, sleep quality, sleep satisfaction, and alertness. However, a notable disparity was seen in the sleep items after TEAS, with a p-value less than 0.05, as shown in Table IV.

DISCUSSION

Numerous studies have explored various acupuncture techniques for stress reduction. In our study, we found improvements in SBP, DBP, HR, and sleep quality following TEAS. However, we observed no significant changes in HRV parameters. This finding contrasts with Wu et al., who reported that laser acupuncture stimulation at the PC6 (Neiguan) acupoint modulated the ANS by inhibiting sympathetic activity and enhancing vagal tone, leading to improvements in LF, HF, and LF/HF ratio, which in turn reduced stress.[29] In our study, the lack of significant HRV improvement may be attributed to the healthy status of our participants, who exhibited intact ANS functioning capable of effective physiological autoregulation of blood pressure and heart rate.[30] Moreover, our study involved only a single session of TEAS therapy. Sparrow et al. indicated that longer durations of acupuncture treatment over weeks to months may be necessary to observe significant reductions in the LF/HF ratio, reflecting decreased physiological stress.[31]

Our findings indicate a reduction in physiological parameters such as SBP, DBP, and HR post-TEAS intervention among trainees, aligning with studies by Haker et al. and Wei et al., which demonstrated significant reductions in mean HR following LI4 (Hegu) acupoint stimulation in healthy subjects. However, those studies did not observe significant changes in SBP and DBP after therapy.[32] In contrast, Nishijo et al. reported a reduction in heart rate following PC6 (Neiguan) stimulation, while Kimura et al. noted significant decreases in SBP and HR in patients with mild hypertension after acupuncture at multiple acupoints, including PC6, LI4, LR3, ST41, and GV20.[33] Although our results were statistically significant, the observed reductions in physiological parameters were minimal and may lack clinical significance.

Our study showed a significant improvement in sleep satisfaction from baseline after the TEAS session compared to sleep satisfaction without TEAS therapy. Lee et al. reported that acupuncture at HT7 (Shenmen) and PC6 (Neiguan) served as an effective therapeutic approach for insomnia post-stroke by reducing sympathetic hyperactivity.34 Similarly, Chiou et al. found that TEAS effectively enhanced pain, mood, and sleep quality in patients with spinal cord injuries and myofascial pain when applied for seven consecutive days at LI4 and PC7 acupoints.[35] Furthermore, Song et al. demonstrated improved postoperative sleep efficiency in their subjects after TEAS.[36] The mechanism behind these effects may involve neuroendocrine modulation through the regulation of neurotransmitters and endogenous substances, thereby influencing sleep quality.[37] TEAS has been associated with increased levels of serotonin, oxytocin, acetylcholine, and gamma-aminobutyric acid (GABA), alongside decreased levels of glutamate, norepinephrine, and dopamine, all of which contribute to improved sleep quality. Additionally, elevated melatonin levels facilitate sleep-wake regulation, while endogenous substances such as enkephalins, endomorphins, and beta-endorphins possess anxiolytic and mood-modulating properties that enhance sleep health.[37] Another plausible explanation is that TEAS may stabilize cerebral electrical activity by activating hippocampal δ waves and inhibiting β waves, thus reducing neuronal stress and exerting sedative and hypnotic effects that promote better sleep quality.[38]

LIMITATIONS

This study exclusively evaluates the effects of a single-session TEAS intervention on HRV. We lack data on the effects of longer durations or multiple sessions of TEAS treatment. The acupoint selection was based on a generalized formula and may not have been individualized for all participants. Traditional Chinese Medicine emphasises personalised treatment through syndrome differentiation, suggesting that a standardised acupoint approach may not yield optimal effects. Lastly, while the on-call hours were standardized, variations in workload among different shifts could still influence outcomes.

CONCLUSION

A single session of TEAS was found to significantly reduce systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) while also markedly improving sleep quality in anaesthesiology trainees following 24-hour ICU on-call duty. Despite these positive outcomes, TEAS did not produce any significant changes in heart rate variability (HRV) parameters. These findings suggest that TEAS may offer potential benefits in managing cardiovascular stress and improving sleep quality in high-stress environments, such as post-call recovery. Still, its impact on autonomic nervous system regulation, as reflected by HRV, appears limited.

CONFLICT OF INTEREST

None

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None

REFERENCES

1. Bakshi SG, Divatia JV, Kannan S, Myatra SN. Work-related stress: A survey of Indian anesthesiologists. J Anaesthesiol Clin Pharmacol 2017; 33(1): 86-91.
2. Nyssen, A.-S. and I. Hansez. Stress and burnout in anaesthesia. Curr Opin Anesthesiol 2008;21(3): 406-11.
3. van der Wal, R.A.B., J. Wallage, and M.J.L. Bucx. Occupational stress, burnout and personality in anesthesiologists. Curr Opin Anaesthesiol 2018; 31(3): 351-6.
4. Lindfors PM, Nurmi KE, Meretoja OA, Luukkonen RA, Viljanen AM, Leino TJ, et al. On-call stress among Finnish anaesthetists. Anaesthesia 2006;61(9): 856-66.
5. Sanfilippo F, Noto A, Foresta G, Santonocito C, Palumbo GJ, Arcadipane A, et al. Incidence and Factors Associated with Burnout in Anesthesiology: A Systematic Review. BioMed Research International 2017:8648925.
6. Moreno CRC, Marqueze EC, Sargent C, Wright Jr KP, Ferguson SA, Tucker P, et al. Working Time Society consensus statements: Evidence-based effects of shift work on physical and mental health. Industrial Health 2019; 57(2): 139-57.
7. Walker WH 2nd, Walton JC, DeVries AC, Nelson RJ. Circadian rhythm disruption and mental health. Transl Psychiatry 2020; 10(1): 28.
8. Wali SO, Qutah K, Abushanab L, Basamh R, Abushanab J, Krayem A. Effect of on-call-related sleep deprivation on physicians' mood and alertness. Ann Thorac Med 2013; 8(1): 22-7.
9. Vickers A, C Zollman. ABC of complementary medicine. Acupuncture. BMJ 1999; 319(7215): 973-6.
10. White A, E Ernst. A brief history of acupuncture. Rheumatology (Oxford), 2004. 43(5): 662-3.
11. WH Liu, C Chen, F Wang, SN Guo, Y Hao, SD Li. Development trend and current situation of acupuncture-moxibustion indications. World Journal of Acupuncture - Moxibustion, 2020; 30(4): 245-50.
12. Li H, Wu C, Yan C, Zhao S, Yang S, Liu P, et al. Cardioprotective effect of transcutaneous electrical acupuncture point stimulation on perioperative elderly patients with coronary heart disease: a prospective, randomized, controlled clinical trial. Clinical Interventions in Aging 2019; 14: 1607-14.
13. Lu SF, Huang Y, Wang N, Shen WX, Fu SP, Li Q, et al. Cardioprotective Effect of Electroacupuncture Pretreatment on Myocardial Ischemia/Reperfusion Injury via Antiapoptotic Signaling. eCAM 2016: 1-9.
14. Shan Y, Wang ZQ, Zhao ZL, Zhang M, Hao SL, Xu JY, et al. An fMRI Study of Neuronal Specificity in Acupuncture: The Multiacupoint Siguan and Its Sham Point. eCAM 2014: 1-6.
15. Shin KM, Park JE, Lee S, Choi SM, Ahn YC, Lee JW, et al. Effect of Siguan Acupuncture on Gastrointestinal Motility: A Randomized, Sham-Controlled, Crossover Trial. EeCAM 2013: 1-7.
16. K Maheshkumar, B Deenadayalan, A Akila, V Venugopal, S Poonguzhali. Effectiveness of taichong (LR3) acupuncture point on blood pressure in patients with hypertension: A randomized sham control trial. AIMED 2021; 8(1): 58-62.
17. Jun MH, Kim YM, Kim JU. Modern acupuncture-like stimulation methods: a literature review. Integr Med Res 2015; 4(4): 195-219.
18. Larson JD, Gutowski KA, Marcus BC, Rao VK, Avery PG, Stacey DH, et al. The Effect of Electroacustimulation on Postoperative Nausea, Vomiting, and Pain in Outpatient Plastic Surgery Patients: A Prospective, Randomized, Blinded, Clinical Trial. Plastic and Reconst Surg 2010; 125(3): 989-94.
19. Kim HG, Cheon EJ, Bai DS, Lee YH, Koo BH. Stress and Heart Rate Variability: A Meta-Analysis and Review of the Literature. Psychiatry Investig 2018; 15(3): 235-45.
20. Taelman J, Vandeput S, Spaepen A, Van Huffel S, et al. Influence of Mental Stress on Heart Rate and Heart Rate Variability. Springer Berlin Heidelberg 2009;1366-9.
21. Fang SC, Wu YL, Tsai PS. Heart rate variability and risk of all-cause death and cardiovascular events in patients with cardiovascular disease: a meta-analysis of cohort studies. Biol Res For Nursing 2020; 22(1): 45-56.
22. Akselrod S, Gordon D, Ubel FA, Shannon DC, Berger AC, Cohen RJ. Power spectrum analysis of heart rate fluctuation: a quantitative probe of beat-to-beat cardiovascular control. Science, 1981; 213(4504): 220-2.
23. Heart rate variability: standards of measurement, physiological interpretation and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Circulation 1996;93(5):1043-65.
24. Thielmann B, R Pohl, I Böckelmann. Heart rate variability as a strain indicator for psychological stress for emergency physicians during work and alert intervention: a systematic review. J Occup Med Toxico 2021; 16(1): 24.
25. Ibáñez V, Silva J, Cauli O. A survey on sleep assessment methods. PeerJ 2018; 6(25): e4849.
26. Gilgen-Ammann R, Schweizer T, Wyss T. RR interval signal quality of a heart rate monitor and an ECG Holter at rest and during exercise. Eur J Applied Physiol 2019; 119(7): 1525-32.
27. Schaffarczyk M, Rogers B, Reer R, Gronwald T. Validity of the Polar H10 Sensor for Heart Rate Variability Analysis during Resting State and Incremental Exercise in Recreational Men and Women. Sensors, 2022; 22(17): 6536.
28. Snedecor, G.W. and Cochran, W.G. Statistical Methods, eight edition. Iowa state University press, Ames, Iowa, 1989: 1191.
29. Wu JH, Chen HY, Chang YJ, Wu HC, Chang WD, Chu YJ, et al. Study of autonomic nervous activity of night shift workers treated with laser acupuncture. Photomed Laser Surg 2009; 27(2): 273-9.
30. Jesus FG, Duque AP, Sant C, Massolar A, Lopes GPF, Carvalho ACA, et al. Transcutaneous Electrical Nerve Stimulation of PC5 and PC6 Acupoints Increases Sympathovagal Balance but Not Oxidative Stress in Healthy Subjects: A Randomized Clinical Trial. JAMS 2021; 14(5): 183-92.

31. Sparrow K, Golianu B. Does Acupuncture Reduce Stress Over Time? A Clinical Heart Rate Variability Study in Hypertensive Patients. Med Acupunct 2014; 26(5): 286-94.
32. Haker E, Egekvist H, Bjerring P. Effect of sensory stimulation (acupuncture) on sympathetic and parasympathetic activities in healthy subjects. Journal of the Autonomic Nervous System 2000; 79(1): 52-9.
33. Nishijo K, Mori H, Yosikawa K, Yazawa K. Decreased heart rate by acupuncture stimulation in humans via facilitation of cardiac vagal activity and suppression of cardiac sympathetic nerve. Neurosci Lett 1997;227(3):165-8.
34. Lee SY, Baek YH, Park SU, Moon SK, Park JM, Kim YS, et al. Intradermal acupuncture on shen-men and nei-kuan acupoints improves insomnia in stroke patients by reducing the sympathetic nervous activity: a randomized clinical trial. Am J Chin Med 2009; 37(6): 1013-21.
35. Chiou YF, Yeh ML, Wang YJ. Transcutaneous Electrical Nerve Stimulation on Acupuncture Points Improves Myofascial Pain, Moods, and Sleep Quality. Rehabil Nurs 2020; 45(4): 225-33.
36. Song B, Chang Y, Li Y, Zhu J. Effects of Transcutaneous Electrical Acupoint Stimulation on the Postoperative Sleep Quality and Pain of Patients After Video-Assisted Thoracoscopic Surgery: A Prospective, Randomized Controlled Trial. Nature and Science of Sleep 2020; 12: 809-19.
37. Spence DW, Kayumov L, Chen A, Lowe A, Jain U, Katzman MA, et al. Acupuncture Increases Nocturnal Melatonin Secretion and Reduces Insomnia and Anxiety: A Preliminary Report. JNCN 2004; 16(1): 19-28.
38. Li C, Wang Y, Li B, Su S. Comparative study on effect of acupuncture at neiguan (pc6) and shenmen (ht7) acupoints on brain wave of sleep deprivation model rats. Hubei J TCM 2017; 39(6): 13–6.