Journal of Occupational and Environmental Medicine, Publish Ahead of Print

DOI : 10.1097/JOM.0000000000002307

Heart rate variability in different levels of burnout - cross-sectional study of different occupational groups Heart rate variability and burnout

Beatrice Thielmann[1], Håvard R. Karlsen[2], Sabine Darius[1], Irina Böckelmann[1]

[1]Department of Occupational Medicine, Medical Faculty, Otto-von-Guericke-University, Magdeburg, Germany

[2]Department of Psychology, Norwegian University of Science and Technology, Trondheim, Norway

Correspondence details for the *corresponding author:

Dr. med. Beatrice Thielmann

Institute of Occupational Medicine, Medical Faculty,

Otto-von-Guericke-University,

Leipziger Straße 44 (House 20)

39120 Magdeburg

Germany

beatrice.thielmann@med.ovgu.de

Phone: +49 391 67 15056

Fax: +49 391 67 15083

Orcid-ID:

Thielmann https://orcid.org/0000-0001-5192-4949

Karlsen https://orcid.org/0000-0001-6749-2319

Darius https://orcid.org/0000-0002-8404-6406

Böckelmann https://orcid.org/0000-0002-3905-3527

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Funding Sources

There are no sources of financing.

Conflict of Interest

I. B. received from the Grünenthal GmbH (Germany) a fee for an HRV presentation (medical further and advanced training 09/2019 in Dresden (Germany). All other authors declared that there are no conflicts of interests.

Acknowledgments

We would like to thank Barbara-Christina Hohmann and LydiaSiegel, who were particularly involved in the initial phase of the study (data collection). Also, we would like to thank PD Dr. med. habil. Stefan Sammito for the clinical evaluation of 24h ECG recordings.

Ethical Considerations & Disclosure

The Otto von Guericke University in Magdeburg, Germany (register no. 63/13, 67/13, 40/17 und 125/16) gave positive ethical opinions. The study complied with the guidelines of Declaration of Helsinki.

Abstract

Objectives: The aim of this study was a subjective and objective stress analysis of occupational groups.

Methods: The study examined 414 employees with patients or children contact on work. The age ranged from 22 to 63 years. Subjective stress was measured using the Maslach Burnout Inventory and objective stress with heart rate variability (HRV).

Results: 21% of subjects showed a high level of exhaustion, 12.9% a high level of cynicism and low performance. There were significant group differences between cynicism levels in meanNN ($p = .008$) and meanHR ($p = .002$). There were no significant differences in HRV for exhaustion and professional efficacy.

Conclusions: The health-impairing manifestations of the three dimensions of the burnout syndrome are not associated with the lower HRV. However, healthy subjects from a "screening" study who had not been clinically diagnosed with burnout were examined here.

Keywords: Burnout, bank employees, medical assistance, kindergarten teacher, music school teacher, autonomic nervous system, occupational medicine, prevention, health promotion

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Statement of clinical significance

The study investigates a subjective and objective stress analysis of occupational groups as a first step for health promotion and prevention. A bimodal (subjective and objective) stress assessment in the occupational medicine consultation is useful to get a detailed impression of the overall workload.

The world of work is undergoing continuous changes. As a result, we will see an increase in occupational stress, for example in terms of increased burnout.

Looking at the individual stress theories, burnout can be interpreted as a dysfunction in stress processing. While an extensive overview of the known biological stress models is out of the scope for this paper, in summary, it can be said that the functionality or dysfunctionality of mental stress and its coping is manifested in the relationship between what should be done and what can be done. If there is a balance between effort and reward, stress creates a healthy, productive challenge for work-related demands or private setting [1]. An unbalanced relationship between effort and reward or high psychological demands (e.g. work intensity and time pressure) with low control can lead to decreased performance, mental illness (e. g. depression), burnout and secondary diseases of mental illness, such as cardiovascular disease or diabetes [2–4]. In the case of excessive self-demands (self-amplification), high stress levels can lead to increased internal pressure. Self-amplifiers can be e.g. perfectionism, control pressure or excessive awareness of responsibility. Responsibilities that result from social and cultural pressures (societal imperatives) may involve a burnout risk [5]. Burnout symptoms are characteristic of occupational groups in which predominantly emotional interaction or communication between people is present [6–8]. Health care professionals and teachers, as well as the social welfare service have been thoroughly investigated [9–13]. The banking and financial services sector is in direct contact with customers and their activities are strongly focused on customer objectives. There is also a positive correlation between work–family conflicts and burnout at work [14].

On the other hand, studies have found that resilience helps reduce the effects of stress and burnout. Self-efficacy, higher mindfulness, dispositional control and support were other important predictors to have more benefits in enhancing well-being [9,15].

The symptom complex "burnout" is becoming increasingly important. In ICD-10 the World Health Organization (WHO) defined burnout as “problems related to life-management difficulty” [16]. In the ICD-11, burnout is associated in context with the workplace setting. The WHO defines burnout as follows: “Burnout is a syndrome conceptualized as resulting from chronic workplace stress that has not been successfully managed. Three dimensions characterize it: 1) feelings of energy depletion or exhaustion; 2) increased mental distance from one’s job, or feelings of negativism or cynicism related to one's job; and 3) a sense of ineffectiveness and lack of accomplishment. Burnout refers specifically to phenomena in the occupational context and should not be applied to describe experiences in other areas of life.”

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

[17]. This is the cross-sectional area of interdisciplinary work between psychiatry and psychosomatic medicine and occupational medicine. Employees with certain mental or physical dispositions may be more prone to problems with insufficient coping, which can have adverse health outcomes [18].

Heart rate variability (HRV) – defined as variations in time between consecutive heart beats – is a very sensitive indicator for dysregulation of the autonomic nervous system (ANS). The variations in heart action intervals are caused by the interplay of the two branches from the ANS. The activation of the sympathetic nerve leads to the accelerating heart rate (HR) and the stimulation of the parasympathetic nerve to the decelerating HR. The HRV analysis is a possible method for objective monitoring of mental stress and burnout [19–21]. A study showed that emotional exhaustion was negatively related to RMSSD (root mean square of successive differe), but not related with cynicism or professional efficacy [22]. The finding of another study indicates that also only emotional exhaustion being predictive for changes in HRV [23]. The autonomic nervous system has an important role in stress regulation. Chronic stress has been associated with reduced parasympathetic modulation via the vagus nerve. Its role as an independent risk factor in coronary disease is well known. The vagal dysfunction could be the missing information in explaining burnout-associated emergence of cardiovascular health.

However, there are also inconsistent data. Other results suggest that burnout is not necessarily associated with physiological disturbances in terms of reduced HRV [24,25].

The HRV parameters, for example RMSSD and high frequency spectrum (HF), are established markers of vagal function. Decreased HRV indicates mental stress and increased HRV indicates relaxation and recovery. A systematic review provides evidence that unfavorable psychosocial working conditions are associated with reduced HRV [26]. Other studies have shown reduced heart rate variability in patients with burnout [19,21] and depression [22]. A recent systematic review was unable to draw any definite conclusions concerning the link between job stress (burnout) and psychophysiological measures [27].

The aim of this study was to do a subjective and objective stress analysis of occupational groups that work with patients, clients or children, as a first step for health promotion and prevention in the context of occupational health care. We suspect that working with patients and children would mean higher emotional exhaustion and higher social engagement. We hypothesized that burnout reduced the heart rate variability.

Material and Methods

Subjects

The study population comprised 414 employees, whose work is to connect with patients, clients or children. The age ranged from 22 to 63 years (42.1 ± 10.71 years). The subjects were divided into 85% (n = 358) women and 15% (n = 59) men. Table 1 shows the distribution of the subjects in the four different occupational groups.

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Procedure

The employers of the different occupational groups were contacted in advance. The employees were informed about the study by flyers (published during Health days or sent by e-mail via the administration). A response rate cannot be given with certainty. Only those employees who made an appointment with us were considered. Participation was voluntary. Only those subjects who did not have any cardiac diseases and were not taking cardiac medication (e.g. beta-blockers) were included in the study. The data were collected as part of several studies of different occupational groups. Participants answered the Maslach Burnout Inventory and wore an ECG recording device for 24 hours that was analysed to produce HRV data.

Maslach Burnout Inventory-General Survey (MBI-GS)

The Maslach Burnout Inventory (MBI) - General Survey [23] can be used for the subjective assessment of the long-term negative consequences of stress or health impairments in terms of burnout [28]. This questionnaire include 16 items that evaluate the burnout risk of the subjects [7,29]. It generates three burnout dimensions: exhaustion, cynicism and professional efficacy. The possible answers are how often you feel each item on a seven-level scale from accomplishment 0 = "never" to 6 = "daily" in the past. The mean value is calculated for each dimension.

The degree of expression of the burnout scales are for exhaustion: low ≤ 2.00, medium 2.01 - 3.19 and high ≥ 3.20 points; for cynicism: low ≤ 1.00, medium 1.01 - 2.19 and high ≥ 2.20 points; and for professional efficacy: low ≤ 4.00, medium 4.01 - 4.99 and high ≥ 5.00 points. This is followed by the creation of a composite burnout score according to Kalimo et al [8]. First the dimension "Professional efficacy" is reversed to "reduced Personal efficacy". Then the three dimensions are weighted and combined (.40 × exhaustion + .30 × cynicism + .30 × reduced professional efficacy) into a MBI sum score with the following interpretation: 0 - 1.49 no burnout (symptoms a few times a year), 1.5 - 3.49 some burnout symptoms (symptoms a few times a month) and 3.5 - 6.00 burnout risk (symptoms several times a week or daily).

Heart Rate Variability

A 3-channel-ECG was recorded over 24 hours by using Holter system medilog AR12plus (SCHILLER Medizintechnik GmbH, Obfelden, Switzerland). In an electrocardiogram (ECG) each QRS complex is detected and the normal-to-normal (NN) intervals – the interval between consecutive QRS complexes resulting from sinus node depolarization) – is determined. Variations in NN may be evaluated by time and frequency domain methods and non-linear analysis.

Afterwards, ECG recordings were visually evaluated for clinical abnormalities (e. g. ectopic beat) and for the preparation for HRV analysis by healthcare professionals. For this, the software medilog DARWIN2 (SCHILLER Medizintechnik GmbH, Switzerland) was used. The NN interval series was exported for HRV analysis, which was performed using Kubios

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

HRV Version 2.0 and 3.2 (Biosignal Analysis and Medical Imaging Group, University Kuopio, Finland) [30]. The sampling rate was 1,000 Hz. Artifact correction was performed with the settings *custom* and 0.3 without changes in trend components, as recommended by international and national guidelines for HRV analysis [31,32]. The following linear time domain HRV parameters were used: mean NN (distance between two NN intervals, mean value), SDNN (standard deviation of the NN interval), RMSSD (square root of the mean squared differences of successive NN intervals) and PNN50 (% of successive NN interval pairs that differ more than 50 ms). For the frequency analysis the Fast Fourier Transform (FFT) with a window size of 300 s and 50% window overlap was calculated for the 5-minute intervals. The frequency bands were specified with a high frequency (HF) band ranging from 0.15 to 0.4 Hz and a low frequency (LF) band ranging from 0.04 to 0.15 Hz. They were presented in LFnu (Low frequency normalized unit, corresponds to LF/(TP-VLF[1]) x 1001) and HFnu (High frequency normalized unit, corresponds to HF/(TP-VLF) x 1001). The ratio LF/HF was also calculated. In addition, non-linear parameters were used: SD1 (Standard deviation of the Poincaré plot to cross diameter), α1 (short term fluctuations of detrended fluctuation analysis) and α2 (long term fluctuations of detrended fluctuation analysis).

Statistical analyses

R software version 3.6.3 was used to compute summary statistics and run statistical analyses. We report the mean, standard deviation, 95% confidence interval of the mean, median, minimum, and maximum values on all continuous variables, as well as the frequency and percentage of the groups in the grouping variables. We tested for differences among the three levels of burnout (low, medium and high), across the three subtypes of the MBI (exhaustion, cynicism and professional efficacy), using one-way ANOVA. Since the sample was large enough for the central limit theorem to ensure that the sampling distribution of the model estimates were normally distributed, it was not necessary to check for normality of the residuals [33]. In those cases where Levene's test indicated the presence of heteroskedasticity, we ran Welch's *F* test instead. To test the relationship between the burnout levels and, respectively, gender and work groups, we used Fisher's exact test. The level of significance was set to .05.

Results

The summary statistics and results from analyses can be seen in Tables 2-4 for exhaustion, cynicism, and professional efficacy, respectively. Twenty-one percent of subjects showed a high level of exhaustion, 12.9% a high level of cynicism and low performance. No age differences were found.

There was a significant difference among male and female workers in level of exhaustion. Male workers were more frequent in the low- and medium-scoring groups in terms of exhaustion, while female workers were more frequent in the high-scoring group.

[1] TP = Total Power, VLF = Very Low Frequency

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

The ANOVAs showed significant group differences among the cynicism levels on both mean NN (F [2, 414] = 4.94, p = .008) and mean HR (F [2, 414] = 6.52, p = .002). Tukey HSD post hoc tests showed that the low cynicism group had significantly lower mean NN than the high cynicism group (p = .006), with no difference for either compared with the medium group. The low cynicism group had significantly lower mean HR than both the medium (p = .021) and the high cynicism group (p = .007).

[

There was also a significant difference in the distribution of the work groups among the three levels of cynicism ($p < .001$). From the distributions, it seemed that the bank employees (low n=19, medium n=51 and high n=9) and the medical assistance (low n=8, medium n=25 and high n=6) were more commonly in the medium cynicism group, while the kindergarten (low n=183, medium n=53 and high n=36) and music school teachers (low n=21, medium n=3 and high n=3) were more common in the low cynicism group ($p < .001$). The figures 1 and 2 shows the mean NN and HR bpm at different levels of cynicism.

There were no significant differences among the three professional efficacy groups. In total, most variables showed no significant difference among the various levels of burnout.

Discussion

This publication presents a subjective and objective stress analysis of four occupational groups that face mental stress. Only 13-21% of the subjects show high levels of exhaustion and cynicism and a low professional efficacy. There was a difference among male and female workers in level of exhaustion, but not in the other two dimensions of MBI. The bank employees and the MFA seemed to be overrepresented in the medium cynicism group, while the kindergarten and music school teachers were overrepresented in the low cynicism group. The stress analysis, using HRV, showed differences only in cynicism, but not in exhaustion and professional efficacy. This is in accordance with another study, which shown work-related cynicism on physical health were negatively linked with heart rate variability indicators [34].

Work stress is a prevalent problem. It can lead to mental illness and burnout if not effectively treated [35]. More than 1/5 of the subjects in this study showed noticeable, high levels of exhaustion and cynicism, but 45% of them presented some symptoms of the three burnout dimensions. This is important because the subjects were from occupations with customer or patient contact (e.g. bank employee, medical assistant, teacher/educator) [6–8]. It is also possible that each occupational group should be examined separately, as the prevalence of burnout is different. A study found a burnout prevalence of 2.3% in medical assistants, 7.5% in nurses, 2.2% in bank employees and 4.8% in school teacher [4]. In our sample we only found differences between the occupational groups on the cynicism dimension.

The main focus of this work is the assessment of HRV at different levels of burnout. The heart rate variability is seen as a physiological stress indicator [28,36], but we found almost no relevant differences in HRV between the levels of burnout. HRV measures short-term stress

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

and it is possible that subjects had a stress-free day during the 24 hours they were measured, although they may still be aware that they had stressful lives (MBI measure more long-term stress and stress consequences). This contrasts with studies and reviews that have shown an association between stress, burnout and reduced HRV [19,21,23,26,36,37]. Researchers have identified a cut-off value of RMSSD that provides a marker for elevated cardiovascular risk [38]. Autonomic dysregulation is also related to reduced variation in blood pressure and heart rate in acute ischemic stroke [39]. It is possible that the employees in the current study are only in the beginning phases of burnout, and that the physical symptoms have not yet been completely established. A closer look at the HRV parameters in Tables 2–4 reveal that they are sometimes less favorable for the subjects with high exhaustion, high cynicism and low professional efficacy, though this difference was not great enough to reach statistical significance. The values of the HRV parameters of our study are lower than the reference values of the 50th percentile of female subjects aged ≥40 and ≤50 years [40] for exhaustion, cynicism and professional efficacy. Increased occupational stress is associated with decreased HRV, especially with decreased parasympathetic activation, according to a review [20]. Decreased parasympathetic activation was consistent with a decrease in RMSSD and HF power and an increase in the LF/HF ratio. We saw similar trends in our data.

There is an interdisciplinary cross-over between occupational medicine and psychiatry or psychosomatic medicine. The occupational medicine physician has access to people who are not covered by the classic general practitioner model because these employees do not go to a doctor. Thus, abnormalities, e.g. in MBI or ECG/HRV, can be detected at an early stage. In this way, abnormalities in the 24-hour ECG can also be detected quickly and presented to a cardiologist

In addition, targeted measures for health promotion and prevention in the sense of behavioral and relational prevention can be initiated. The positive effect of organizational interventions is supported by the finding that burnout symptoms are strongly influenced by structural factors (e. g. job demands, support, oppurtunity to exert control) [41]. The kind of interaction and feedback between supervisors and employees promotes self-efficacy of employees [9]. Stress management or mindfulness training can also have a positive effect on HRV [42].

This study has some limitations: Because of the cross-sectional design, with a snapshot of HRV over 24 hours, causal effects cannot be determined. No workloads or possible acute life events were recorded that could have influenced the responses to the MBI items and HRV. Women were overrepresented in this study, so the data are only partially transferable. Also, this could explain the gender differences in exhaustion of MBI. Due to the differential prevalence of burnout in different workgroups, it would have been of interest to examine any interaction effects between workgroup and MBI group on HRV. Unfortunately, the low number of participants in certain groups did not permit this in the current study.

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Conclusions

Although we found no clear objective results for the different stress levels, we suggest the use of bimodal stress assessment (subjective and objective) in occupational health consulting to achieve a detailed impression of the total workload. We studied healthy workers who had not been diagnosed with burnout. This study is about preventive use, whether HRV could be considered as an early sign of burnout syndrome, i.e. before a medical diagnosis is made. This idea would be a good basis for the work of a company physician in the early detection of burnout. Especially in the case of noticeable subjective strain, a method for objective stress should be supplemented (for example high levels of burnout dimensions). HRV is a useful method for measuring ANS activity in occupational medicine as an application in early diagnostics. The technical progress is remarkable. An imbalance of the ANS is an independent risk factor for cardiovascular diseases of the employee, and it is therefore of interest to detect it early. Occupational medicine is an interdisciplinary interface with general medicine and cardiology. Workers at risk for health problems may be identified early, who fall through the traditional general practitioner model, because they do not see a doctor.

List of abbreviations

ANS	Autonomic nervous system
ECG	Electrocardiogram
FFT	Fast Fourier Transform
HF	High frequency band
HFnu	High frequency normalized unit
HRV	Heart Rate Variability
LF	Low frequency band
LFnu	Low frequency normalized unit
MBI-GS	Maslach Burnout Inventory-General Survey
meanNN	Distance between two NN intervals, mean value
PNN50	% of successive NN interval pairs that differ more than 50 ms
SDNN	Standard deviation of the NN interval
RMSSD	Square root of the mean squared differences of successive NN intervals

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

TP	Total Power
VLF	Very Low Frequency
WHO	World Health Organization

References

1. Crawford ER, Lepine JA, Rich BL. Linking job demands and resources to employee engagement and burnout: a theoretical extension and meta-analytic test. *The Journal of applied psychology*. 2010;95:834–848.

2. Zylka-Menhorn V. Mental illnesses: A worldwide epidemic. *Dtsch Arztebl International*. 2011;10:[510].

3. Looseley A, Wainwright E, Cook TM, et al. Stress, burnout, depression and work satisfaction among UK anaesthetic trainees; a quantitative analysis of the Satisfaction and Wellbeing in Anaesthetic Training study. *Anaesthesia*. 2019;74:1231–1239.

4. Diekmann K, Böckelmann I, Karlsen HR, Lux A, Thielmann B. Effort-Reward Imbalance, Mental Health and Burnout in Occupational Groups That Face Mental Stress. *Journal of Occupational and Environmental Medicine*. 2020;62.

5. Brühlmann T. Burnout. In: Göbel H, Sabatowski R, eds. *Weiterbildung Schmerzmedizin: CME-Beiträge aus: Der Schmerz 2013–2014*. Berlin, Heidelberg: Springer Berlin Heidelberg; 2015:11–22.

6. Freudenberger HJ. Staff Burn-Out. *Journal of Social Issues*. 1974;30:159–165.

7. Maslach C, Jackson S. *Maslach Burnout Inventory Manual*. Palo Alto. CA: Consulting Psychologists Press; 1986.

8. Kalimo R, Pahkin K, Mutanen P, Topipinen-Tanner S. Staying well or burning out at work: Work characteristics and personal resources as long-term predictors. *Work & Stress*. 2003;17:109–122.

9. Gibbons C. Stress, coping and burn-out in nursing students. *International journal of nursing studies*. 2010;47:1299–1309.

10. Siegrist J. Burn-out und Arbeitswelt. *Psychotherapeut*. 2013;58:110–116.

11. Scheuch K, Haufe E, Seibt R. Teachers' Health. *Deutsches Arzteblatt international*. 2015;112:347–356.

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

12. Rothenberger DA. Physician Burnout and Well-Being: A Systematic Review and Framework for Action. *Diseases of the colon and rectum*. 2017;60:567–576.

13. Yu F, Raphael D, Mackay L, Smith M, King A. Personal and work-related factors associated with nurse resilience: A systematic review. *International journal of nursing studies*. 2019;93:129–140.

14. Wu G, Wu Y, Li H, Dan C. Job Burnout, Work-Family Conflict and Project Performance for Construction Professionals: The Moderating Role of Organizational Support. *International journal of environmental research and public health*. 2018;15.

15. Eddy P, Wertheim EH, Hale MW, Wright BJ. Trait Mindfulness Helps Explain the Relationships Between Job Stress, Physiological Reactivity, and Self-Perceived Health. *Journal of Occupational and Environmental Medicine*. 2019;61:e12-e18.

16. World Health Organization. International Statistical Classification of Diseases and Related Health Problems 10th Revision; 2019. Available at: https://icd.who.int/browse10/2019/en#/Z73.0.

17. World Health Organization. ICD-11 for Mortality and Morbidity Statistics (ICD-11 MMS); 2020. Available at: https://icd.who.int/browse11/l-m/en#/http://id.who.int/icd/entity/129180281.

18. Riedel-Heller S, Stengler K, Seidler A. Mental health and work. *Psychiatrische Praxis*. 2012;39:103–105.

19. Lennartsson A-K, Jonsdottir I, Sjörs A. Low heart rate variability in patients with clinical burnout. *International journal of psychophysiology : official journal of the International Organization of Psychophysiology*. 2016;110:171–178.

20. Järvelin-Pasanen S, Sinikallio S, Tarvainen MP. Heart rate variability and occupational stress-systematic review. *Industrial Health*. 2018;56:500–511.

21. Lo E-WV, Wei Y-H, Hwang B-F. Association between occupational burnout and heart rate variability: A pilot study in a high-tech company in Taiwan. *Medicine*. 2020;99:e18630.

22. Kanthak MK, Stalder T, Hill LK, Thayer JF, Penz M, Kirschbaum C. Autonomic dysregulation in burnout and depression: evidence for the central role of exhaustion. *Scandinavian journal of work, environment & health*. 2017;43:475–484.

23. Wekenborg MK, Hill LK, Thayer JF, Penz M, Wittling RA, Kirschbaum C. The Longitudinal Association of Reduced Vagal Tone With Burnout. *Psychosomatic medicine*. 2019;81:791–798.

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

24. Traunmüller C, Stefitz R, Gaisbachgrabner K, Hofmann P, Roessler A, Schwerdtfeger AR. Psychophysiological concomitants of burnout: Evidence for different subtypes. *Journal of psychosomatic research*. 2019;118:41–48.

25. Henning MA, Sollers J, Strom JM, et al. Junior doctors in their first year: mental health, quality of life, burnout and heart rate variability. *Perspectives on medical education*. 2014;3:136–143.

26. Jarczok MN, Jarczok M, Mauss D, et al. Autonomic nervous system activity and workplace stressors--a systematic review. *Neuroscience and biobehavioral reviews*. 2013;37:1810–1823.

27. Looff PC de, Cornet LJM, Embregts, P J C M, Nijman HLI, Didden HCM. Associations of sympathetic and parasympathetic activity in job stress and burnout: A systematic review. *PloS one*. 2018;13:e0205741.

28. Böckelmann I, Seibt R. Methoden zur Indikation vorwiegend psychischer Berufsbelastung und Beanspruchung — Möglichkeiten für die betriebliche Praxis. *Zeitschrift für Arbeitswissenschaft*. 2011;65:205–222.

29. Schaufeli W, Leiter M, Maslach C, Jackson S. Maslach Burnout Inventory -- General Survey (GS). *Maslach Burnout Inventory Manual*. 1996;31.

30. Tarvainen MP, Lipponen JA, Niskanen JP, Ranta-Aho PO. *Kubios HRV (ver. 3.3) User's Guide:* Kubios Oy.; 2019.

31. ESC/NASPE. 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. *European heart journal*. 1996;17:354–381.

32. Sammito S, Thielmann B, Seibt R, Klussmann A, Weippert M, Böckelmann I. Guideline for the application of heart rate and heart rate variability in occupational medicine and occupational science. *ASU International*. 2015.

33. Pek J, Wong O, Wong ACM. How to Address Non-normality: A Taxonomy of Approaches, Reviewed, and Illustrated. *Frontiers in psychology*. 2018;9:2104.

34. Viljoen M, Claassen N. Cynicism as subscale of burnout. *Work (Reading, Mass.)*. 2017;56:499–503.

35. Beer LT de, Pienaar J, Rothmann S, JR. Work overload, burnout, and psychological ill-health symptoms: a three-wave mediation model of the employee health impairment process. *Anxiety, stress, and coping*. 2016;29:387–399.

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

36. The A-F, Reijmerink I, van der Laan M, Cnossen F. Heart rate variability as a measure of mental stress in surgery: a systematic review. *International archives of occupational and environmental health*. 2020.

37. Togo F, Takahashi M. Heart rate variability in occupational health --a systematic review. *Industrial Health*. 2009;47:589–602.

38. Jarczok MN, Koenig J, Wittling A, Fischer JE, Thayer JF. First Evaluation of an Index of Low Vagally-Mediated Heart Rate Variability as a Marker of Health Risks in Human Adults: Proof of Concept. *Journal of clinical medicine*. 2019;8.

39. Tian G, Li Xiong, Leung H, Soo Y, Leung T, Wong LK-S. Beat-to-beat blood pressure variability and heart rate variability in relation to autonomic dysregulation in patients with acute mild-moderate ischemic stroke. *Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia*. 2019;64:187–193.

40. Sammito S, Böckelmann I. New reference values of heart rate variability during ordinary daily activity. *Heart rhythm*. 2017;14:304–307.

41. Aronsson G, Theorell T, Grape T, et al. A systematic review including meta-analysis of work environment and burnout symptoms. *BMC public health*. 2017;17:264.

42. van der Zwan, Judith Esi, Vente W de, Huizink AC, Bögels SM, Bruin EI de. Physical activity, mindfulness meditation, or heart rate variability biofeedback for stress reduction: a randomized controlled trial. *Applied psychophysiology and biofeedback*. 2015;40:257–268.

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Figure 1. Mean NN at different levels of cynicism

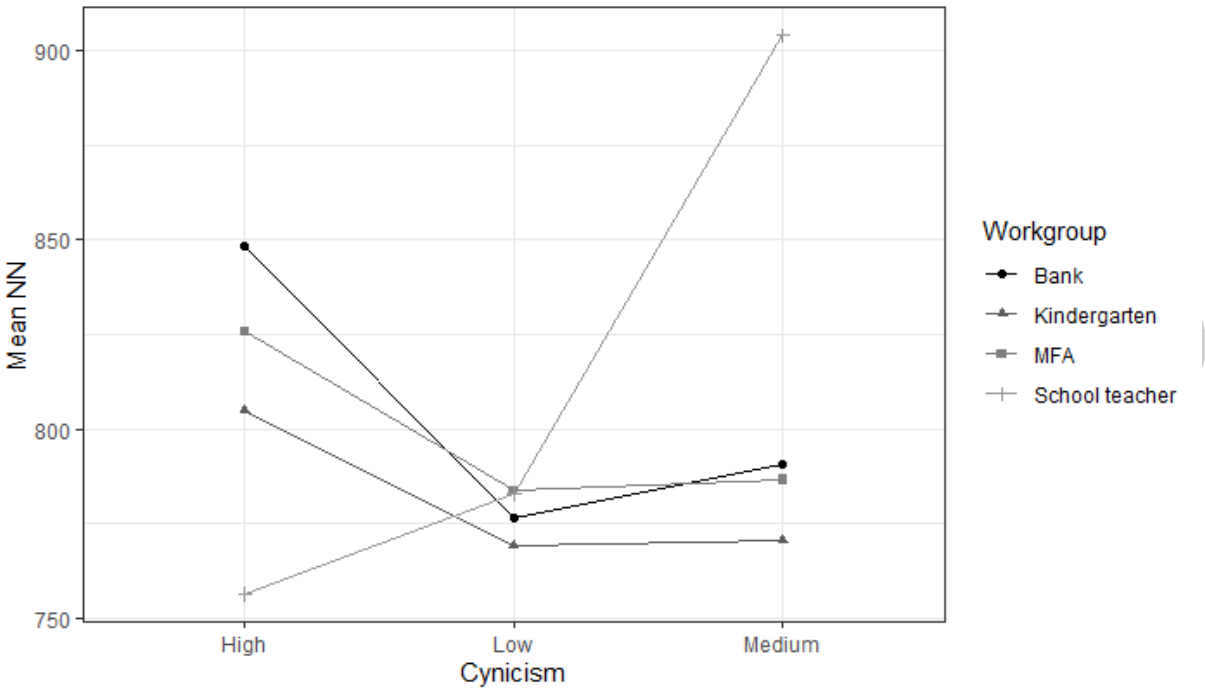
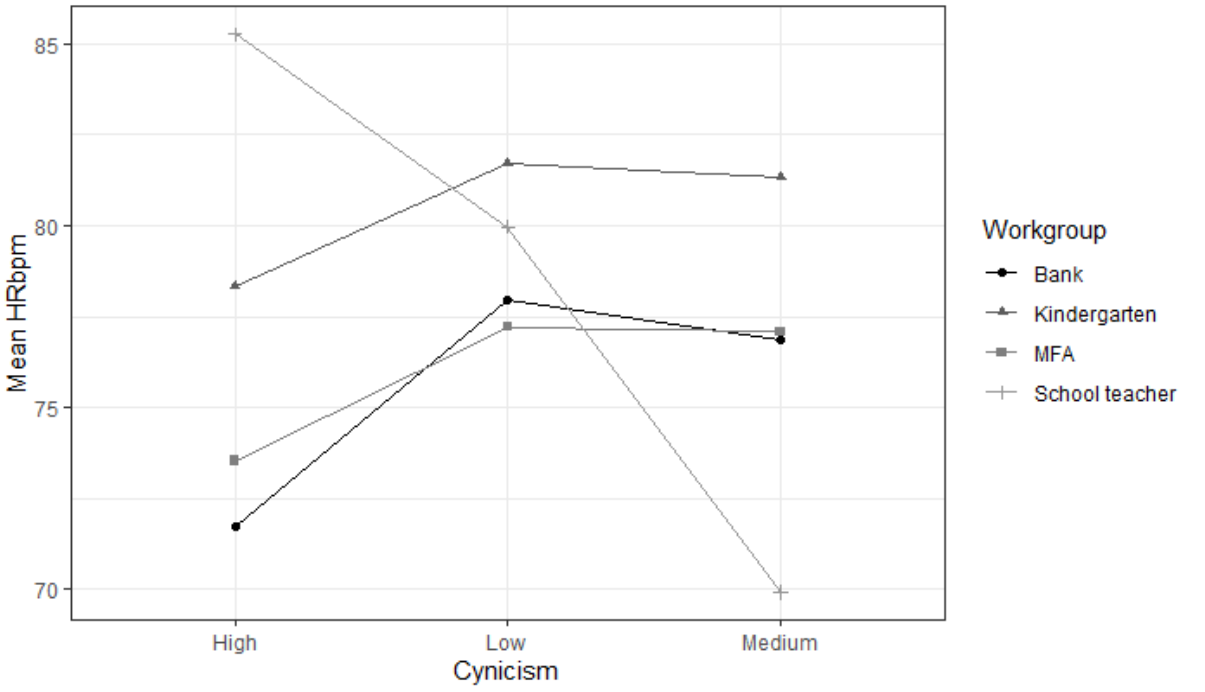


Figure 2. Mean HRbpm at different levels of cynicism



Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Table 1. *Descriptive statistics for the different work groups*

	Total sample	Bank	MFA	Kindergarten	Music school	Group differences
	(*N* = 417)	(*N* = 79)	(*N* = 39)	(*N* = 272)	(*N* = 27)	
LF (n.u.)						
Mean ± SD	64.09 ± 20.47	69.04 ± 12.34	69.90 ± 10.55	68.08 ± 12.63	72.86 ± 11.28	*F* = 1.40, *p* = .243
CI	64.09 (62.12, 66.05)	69.04 (66.32, 71.76)	69.90 (66.59, 73.21)	68.08 (66.58, 69.58)	72.86 (68.60, 77.12)	
Median	69.57	71.65	72.32	69.90	75.3	
Minimum	1.00	31.36	36.28	22.10	45.7	
Maximum	90.90	88.32	84.02	90.90	89.4	
HF (n.u.)						
Mean ± SD	29.53 ± 14.11	30.83 ± 12.27	29.99 ± 10.52	31.92 ± 12.63	27.14 ± 11.28	*F* = 1.44, *p* = .231
CI	29.53 (28.18, 30.89)	30.83 (28.13, 33.54)	29.99 (26.69, 33.29)	31.92 (30.42, 33.42)	27.14 (22.88, 31.40)	
Median	28.50	28.16	27.58	30.10	24.7	
Minimum	1.00	11.64	15.93	9.10	10.6	
Maximum	77.90	68.19	63.61	77.90	54.3	
LF/HF ratio						
Mean	2.59 ± 1.55	2.79 ± 1.53	2.69 ± 1.15	2.68 ± 1.59	3.35 ± 1.84	*F* = 1.52, *p* = .209

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

± SD						
CI	2.59 (2.45, 2.74)	2.79 (2.45, 3.12)	2.69 (2.33, 3.05)	2.68 (2.49, 2.87)	3.35 (2.65, 4.04)	
Median	2.29	2.54	2.62	2.33	3.047	
Minimum	0.28	0.46	0.57	0.28	0.84	
Maximum	10.00	7.59	5.27	10.00	8.409	
Mean NN						
Mean ± SD	780.85 ± 86.84	794.07 ± 91.35	792.10 ± 86.67	774.14 ± 85.47	793.46 ± 84.59	$F = 1.56$, $p = .197$
CI	780.85 (772.51, 789.18)	794.07 (773.92, 814.21)	792.10 (764.90, 819.30)	774.14 (763.99, 784.30)	793.46 (761.55, 825.37)	
Median	773.21	780.60	775.69	765.20	799.20	
Minimum	591.70	618.59	657.87	591.70	621.60	
Maximum	1101.49	1101.49	1038.07	1101.37	1015.60	
Mean HR bpm						
Mean ± SD	79.76 ± 8.80	76.53 ± 8.68	76.57 ± 7.77	81.18 ± 8.65	79.44 ± 8.80	$F = 8.01$, $p = .000$
CI	79.76 (78.91, 80.60)	76.53 (74.62, 78.45)	76.57 (74.13, 79.01)	81.18 (80.15, 82.21)	79.44 (76.12, 82.76)	
Median	79.53	76.86	77.35	80.68	77.73	

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Minimum	54.47	54.47	57.80	57.69	64.47	
Maximum	103.75	97.00	91.20	103.75	101.19	
RMSSD (ms)						
Mean ± SD	35.56 ± 16.09	35.08 ± 15.31	35.47 ± 16.32	35.83 ± 15.83	34.42 ± 20.82	$F = 0.093$, $p = .964$
CI	35.56 (34.02, 37.11)	35.08 (31.71, 38.46)	35.47 (30.35, 40.60)	35.83 (33.95, 37.71)	34.42 (26.56, 42.27)	
Median	31.80	31.92	31.97	31.99	29.00	
Minimum	10.97	10.97	13.61	12.65	12.50	
Maximum	111.50	78.27	82.75	111.50	106.80	
PNN50 (%)						
Mean ± SD	10.67 ± 8.71	10.74 ± 9.12	11.41 ± 9.75	10.70 ± 8.49	9.16 ± 8.46	$F = 0.36$, $p = .779$
CI	10.67 (9.84, 11.51)	10.74 (8.73, 12.75)	11.41 (8.35, 14.47)	10.70 (9.69, 11.71)	9.16 (5.97, 12.35)	
Median	8.89	9.37	9.66	8.99	7.50	
Minimum	0.19	0.19	0.28	0.30	0.90	
Maximum	44.00	40.52	41.47	44.00	33.90	
SD1 (ms)						

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Mean ± SD	25.60 ± 14.44	24.81 ± 10.82	25.08 ± 11.54	26.03 ± 15.70	24.41 ± 14.71	$F = 0.23$, $p = .873$
CI	25.60 (24.22, 26.99)	24.81 (22.42, 27.19)	25.08 (21.46, 28.71)	26.03 (24.16, 27.89)	24.41 (18.87, 29.96)	
Median	22.50	22.57	22.61	22.77	20.50	
Minimum	7.76	7.76	9.62	8.94	8.80	
Maximum	207.00	55.34	58.52	207.00	75.50	
α_1						
Mean ± SD	1.26 ± 0.16	1.19 ± 0.18	1.21 ± 0.12	1.28 ± 0.15	1.33 ± 0.16	$F_W = 0.99$, p = .321
CI	1.26 (1.25, 1.28)	1.19 (1.15, 1.23)	1.21 (1.18, 1.25)	1.28 (1.27, 1.30)	1.33 (1.27, 1.39)	
Median	1.29	1.22	1.23	1.31	1.38	
Minimum	0.66	0.66	0.92	0.72	1.03	
Maximum	1.60	1.53	1.40	1.60	1.53	
α_2						
Mean ± SD	0.87 ± 0.25	0.48 ± 0.07	0.50 ± 0.06	1.02 ± 0.09	1.02 ± 0.09	$F =$ 1108.38 p =.000
CI	0.87 (0.84, 0.89)	0.48 (0.47, 0.50)	0.50 (0.48, 0.52)	1.02 (1.01, 1.03)	1.02 (0.99, 1.06)	
Medi	0.98	0.48	0.50	1.02	1.04	

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

an						
Minimum	0.10	0.36	0.36	0.10	0.85	
Maximum	1.20	0.65	0.66	1.20	1.17	
Age						
Mean ± SD	42.11 ± 10.71	43.52 ± 9.27	42.79 ± 10.37	40.80 ± 10.95	50.22 ± 8.70	$F_W = 0.01$, p = .910
CI	42.11 (41.09, 43.14)	43.52 (41.48, 45.56)	42.79 (39.54, 46.04)	40.80 (39.50, 42.10)	50.22 (46.94, 53.50)	
Median	42	43	42.2	40.85	52	
Minimum	22	23	22.11	22	27	
Maximum	63	61	61.5	63	62	
Gender						
Male	59	18 (30.5%)	0 (0.0%)	30 (50.8%)	11 (18.6%)	$p < .001$
Female	358	61 (17.0%)	39 (10.9%)	242 (67.6%)	16 (4.5%)	

Notes. For continuous variables, mean, standard deviation, 95% confidence interval, median, minimum and maximum values are reported, along with results from ANOVA (α1 and age were tested using Welch's F test because the groups were heteroskedastic). For categorical variables, *n* and % are reported, along with results from Fisher's exact test. LF = low-frequency, HF = high-frequency, n.u. = normalised units, RMSSD = Square root of the mean squared differences between successive NN intervals. PNN50 = % of successive NN interval pairs that differ more than 50 ms. α_1 = short term fluctuations of detrended fluctuation analysis, α_2 = long term fluctuations of detrended fluctuation analysis.

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Table 2. *Descriptive statistics of independent variables and test of group differences among the burnout groups, exhaustion*

	Total sample	Low exhaustion	Medium exhaustion	High exhaustion	Group differences
	(*N* = 417)	(*N* = 240)	(*N* = 87)	(*N* = 90)	
LF (n.u.)					
Mean ± SD	68.74 ± 12.33	67.91 ± 13.39	69.17 ± 11.56	70.56 ± 9.74	$F_W = 0.88$, $p = .421$
CI	68.74 (67.56, 69.93)	67.91 (66.21, 69.60)	69.17 (66.74, 71.60)	70.56 (68.55, 72.57)	
Median	70.7	70.6	71.1	70.8	
Minimum	22.1	22.1	31	43.5	
Maximum	90.9	89.4	90.9	90.7	
HF (n.u.)					
Mean ± SD	31.22 ± 12.32	32.06 ± 13.38	30.79 ± 11.55	29.41 ± 9.73	$F_W = 0.88$, $p = .421$
CI	31.22 (30.04, 32.41)	32.06 (30.37, 33.75)	30.79 (28.37, 33.22)	29.41 (27.40, 31.42)	
Median	29.3	29.4	28.9	29.2	
Minimum	9.1	10.6	9.1	9.3	
Maximum	77.9	77.9	69	56.5	
LF/HF ratio					
Mean ± SD	2.75 ± 1.57	2.70 ± 1.58	2.77 ± 1.64	2.84 ± 1.48	$F = 0.25$, $p = .780$
CI	2.75 (2.60, 2.90)	2.70 (2.50, 2.90)	2.77 (2.43, 3.11)	2.84 (2.53, 3.14)	
Median	2.413	2.404	2.459	2.4255	
Minimum	0.284	0.284	0.449	0.77	
Maximum	9.998	8.409	9.998	9.746	
Mean NN					
Mean ± SD	780.85 ± 86.84	780.38 ± 86.11	791.99 ± 96.23	771.32 ± 78.59	$F = 1.26$, $p = .284$
CI	780.85	780.38	791.99	771.32	

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

	(772.51, 789.18)	(769.49, 791.28)	(771.77, 812.21)	(755.09, 787.56)	
Median	773.21	765.20	782.40	774.57	
Minimum	591.70	595.70	626.21	591.70	
Maximum	1101.49	1101.49	1037.90	992.41	
Mean HR bpm					
Mean ± SD	79.76 ± 8.80	79.81 ± 8.65	78.69 ± 9.34	80.63 ± 8.66	$F = 1.08$, $p = .341$
CI	79.76 (78.91, 80.60)	79.81 (78.72, 80.91)	78.69 (76.73, 80.66)	80.63 (78.84, 82.42)	
Median	79.53	79.72	79.02	79.15	
Minimum	54.47	54.47	57.81	64.12	
Maximum	103.75	102.22	98.63	103.75	
RMSSD (ms)					
Mean ± SD	35.56 ± 16.09	37.10 ± 17.17	34.09 ± 13.52	32.88 ± 15.03	$F = 2.73$, $p = .066$
CI	35.56 (34.02, 37.11)	37.10 (34.93, 39.27)	34.09 (31.25, 36.93)	32.88 (29.78, 35.99)	
Median	31.80	32.36	31.90	30.27	
Minimum	10.97	10.97	14.20	12.40	
Maximum	111.50	111.50	104.72	79.32	
PNN50 (%)					
Mean ± SD	10.67 ± 8.71	11.28 ± 9.09	10.03 ± 6.91	9.68 ± 9.20	$F = 1.41$, $p = .246$
CI	10.67 (9.84, 11.51)	11.28 (10.13, 12.43)	10.03 (8.58, 11.48)	9.68 (7.78, 11.58)	
Median	8.89	9.30	9.12	6.85	
Minimum	0.19	0.19	0.40	0.35	
Maximum	44.00	44.00	26.41	40.52	
SD1 (ms)					
Mean ± SD	25.60 ± 14.44	27.02 ± 16.83	24.11 ± 9.55	23.26 ± 10.62	$F = 2.84$, $p = .060$

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

CI	25.60 (24.22, 26.99)	27.02 (24.89, 29.15)	24.11 (22.10, 26.11)	23.26 (21.07, 25.45)	
Median	22.50	22.95	22.50	21.43	
Minimum	7.76	7.76	10.10	8.77	
Maximum	207.00	207.00	74.05	56.10	
α_1					
Mean ± SD	1.26 ± 0.16	1.26 ± 0.17	1.26 ± 0.15	1.27 ± 0.16	$F = 0.30$, $p = .741$
CI	1.26 (1.25, 1.28)	1.26 (1.24, 1.28)	1.26 (1.23, 1.29)	1.27 (1.24, 1.31)	
Median	1.29	1.30	1.27	1.27	
Minimum	0.66	0.66	0.80	0.94	
Maximum	1.60	1.57	1.60	1.55	
α_2					
Mean ± SD	0.87 ± 0.25	0.87 ± 0.25	0.87 ± 0.26	0.86 ± 0.26	$F = 0.13$, $p = .878$
CI	0.87 (0.84, 0.89)	0.87 (0.84, 0.90)	0.87 (0.82, 0.93)	0.86 (0.80, 0.91)	
Median	0.98	0.98	0.99	0.99	
Minimum	0.10	0.36	0.40	0.10	
Maximum	1.20	1.20	1.17	1.15	
Age					
Mean ± SD	42.11 ± 10.71	41.19 ± 10.76	41.72 ± 11.78	44.95 ± 8.95	$F_W = 2.30$, $p = .110$
CI	42.11 (41.09, 43.14)	41.19 (39.83, 42.55)	41.72 (39.25, 44.20)	44.95 (43.10, 46.80)	
Median	42.00	41.00	41.60	46.00	
Minimum	22.00	22.11	22.00	23.00	
Maximum	63.00	63.00	62.00	62.00	
Gender					
Male	59	37 (62.7%)	16 (27.1%)	6 (10.2%)	$p = .044$
Female	358	203 (56.7%)	71 (19.8%)	84 (23.5%)	
Work group					

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Bank	79	48 (60.8%)	16 (20.3%)	15 (19.0%)	$p = .542$
MFA	39	18 (46.2%)	9 (23.1%)	12 (30.8%)	
Kindergarten	272	155 (57.0%)	57 (21.0%)	60 (22.1%)	
Music school	27	19 (70.4%)	5 (18.5%)	3 (11.1%)	

Notes. For continuous variables, mean, standard deviation, 95% confidence interval, median, minimum and maximum values are reported, along with results from ANOVA (high and low frequency power and age were tested using Welch's *F* test because the groups were heteroskedastic). For categorical variables, *n* and % are reported, along with results from Fisher's exact test. LF = low-frequency, HF = high-frequency, n.u. = normalised units, RMSSD = Square root of the mean squared differences between successive RR intervals. PNN50 = % of successive RR interval pairs that differ more than 50 ms. α_1 = short term fluctuations of detrended fluctuation analysis, α_2 = long term fluctuations of detrended fluctuation analysis.

ACCEPTED

Table 3. *Descriptive statistics of independent variables and test of group differences among the burnout groups, cynicism*

	Total sample	Low cynicism	Medium cynicism	High cynicism	Group differences
	($N = 417$)	($N = 231$)	($N = 132$)	($N = 54$)	
LF (n.u.)					
Mean ± SD	68.74 ± 12.33	67.94 ± 13.01	68.97 ± 12.42	71.63 ± 8.16	$F_W = 0.84$, $p = .438$
CI	68.74 (67.56, 69.93)	67.94 (66.26, 69.61)	68.97 (66.86, 71.09)	71.63 (69.45, 73.81)	
Median	70.7	70.591851	70.75	71.911918	
Minimum	22.1	22.1	31.360742	45.8	
Maximum	90.9	90.9	90.7	86.5	
HF (n.u.)					
Mean ± SD	31.22 ±	32.05 ±	30.96 ±	28.34 ± 8.16	$F_W = 0.84$, $p = .438$

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

	12.32	13.01	12.39		
CI	31.22 (30.04, 32.41)	32.05 (30.37, 33.73)	30.96 (28.85, 33.07)	28.34 (26.17, 30.52)	
Median	29.3	29.4	29.25	28.0410825	
Minimum	9.1	9.1	9.3	13.5	
Maximum	77.9	77.9	68.187499	54.2	
LF/HF ratio					
Mean ± SD	2.75 ± 1.57	2.70 ± 1.63	2.80 ± 1.61	2.83 ± 1.16	$F = 0.27$, $p = .764$
CI	2.75 (2.60, 2.90)	2.70 (2.49, 2.91)	2.80 (2.52, 3.07)	2.83 (2.52, 3.14)	
Median	2.413	2.406	2.42	2.5665615	
Minimum	0.284	0.284	0.459919	0.846	
Maximum	9.998	9.998	9.746	6.404	
Mean NN					
Mean ± SD	780.85 ± 86.84	771.57 ± 84.02	784.45 ± 84.58	811.74 ± 97.44	$F = 4.94$, $p = .008$
CI	780.85 (772.51, 789.18)	771.57 (760.73, 782.40)	784.45 (770.02, 798.88)	811.74 (785.75, 837.73)	
Median	773.21	761.50	775.12	794.80	
Minimum	591.70	591.70	618.59	655.30	
Maximum	1101.49	1101.37	1101.49	1037.90	
Mean HR bpm					
Mean ± SD	79.76 ± 8.80	81.07 ± 8.65	78.54 ± 8.41	77.08 ± 9.46	$F = 6.52$, $p = .002$
CI	79.76 (78.91, 80.60)	81.07 (79.96, 82.19)	78.54 (77.11, 79.97)	77.08 (74.56, 79.60)	
Median	79.53	80.53	78.73	77.36	
Minimum	54.47	57.69	54.47	57.81	
Maximum	103.75	103.75	98.63	101.19	
RMSSD (ms)					
Mean ± SD	35.56 ± 16.09	36.25 ± 17.33	34.86 ± 15.18	34.36 ± 12.38	$F = 0.48$, $p = .617$
CI	35.56 (34.02,	36.25 (34.01,	34.86 (32.27,	34.36 (31.06,	

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

	37.11)	38.48)	37.45)	37.66)	
Median	31.80	31.80	31.71	31.52	
Minimum	10.97	12.50	10.97	15.00	
Maximum	111.50	111.50	82.75	75.00	
PNN50 (%)					
Mean ± SD	10.67 ± 8.71	10.75 ± 8.85	10.63 ± 9.00	10.46 ± 7.48	$F = 0.028$, $p = .972$
CI	10.67 (9.84, 11.51)	10.75 (9.61, 11.89)	10.63 (9.09, 12.16)	10.46 (8.46, 12.45)	
Median	8.89	8.60	9.13	9.45	
Minimum	0.19	0.30	0.19	0.90	
Maximum	44.00	44.00	41.47	29.60	
SD1 (ms)					
Mean ± SD	25.60 ± 14.44	26.44 ± 17.10	24.66 ± 10.73	24.31 ± 8.74	$F = 0.89$, $p = .412$
CI	25.60 (24.22, 26.99)	26.44 (24.24, 28.65)	24.66 (22.83, 26.49)	24.31 (21.98, 26.64)	
Median	22.50	22.50	22.44	22.31	
Minimum	7.76	8.80	7.76	11.10	
Maximum	207.00	207.00	58.52	53.10	
α_1					
Mean ± SD	1.26 ± 0.16	1.27 ± 0.16	1.24 ± 0.17	1.29 ± 0.13	$F = 1.93$, $p = .147$
CI	1.26 (1.25, 1.28)	1.27 (1.25, 1.29)	1.24 (1.21, 1.27)	1.29 (1.25, 1.33)	
Median	1.29	1.30	1.27	1.30	
Minimum	0.66	0.72	0.66	0.92	
Maximum	1.60	1.60	1.55	1.52	
α_2					
Mean ± SD	0.87 ± 0.25	0.95 ± 0.19	0.72 ± 0.28	0.87 ± 0.25	$F_W = 0.26$, $p = .774$
CI	0.87 (0.84, 0.89)	0.95 (0.93, 0.98)	0.72 (0.67, 0.77)	0.87 (0.80, 0.94)	
Median	0.98	1.01	0.57	0.99	
Minimum	0.10	0.10	0.36	0.40	

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Maximum	1.20	1.20	1.17	1.15	
Age					
Mean ± SD	42.11 ± 10.71	41.23 ± 10.93	42.75 ± 10.32	44.32 ± 10.44	$F = 2.18$, $p = .114$
CI	42.11 (41.09, 43.14)	41.23 (39.82, 42.64)	42.75 (40.99, 44.51)	44.32 (41.54, 47.11)	
Median	42.00	41.00	43.00	45.50	
Minimum	22.00	22.11	22.00	23.00	
Maximum	63.00	63.00	62.00	61.00	
Gender					
Male	59	31 (52.5%)	21 (35.6%)	7 (11.9%)	$p = .801$
Female	358	200 (55.9%)	111 (31.0%)	47 (13.1%)	
Work group					
Bank	79	19 (24.1%)	51 (64.6%)	9 (11.4%)	$p < .001$
MFA	39	8 (20.5%)	25 (64.1%)	6 (15.4%)	
Kindergarten	272	183 (67.3%)	53 (19.5%)	36 (13.2%)	
Music school	27	21 (77.8%)	3 (11.1%)	3 (11.1%)	

Notes. For continuous variables, mean, standard deviation, 95% confidence interval, median, minimum and maximum values are reported, along with results from ANOVA (high and low frequency power and α_2 were tested using Welch's F test because the groups were heteroskedastic). For categorical variables, n and % are reported, along with results from Fisher's exact test. LF = low-frequency, HF = high-frequency, n.u. = normalised units, RMSSD = Square root of the mean squared differences between successive RR intervals. PNN50 = % of successive RR interval pairs that differ more than 50 ms. α_1 = short term fluctuations of detrended fluctuation analysis, α_2 = long term fluctuations of detrended fluctuation analysis

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Table 4. *Descriptive statistics of independent variables and test of group differences among the burnout groups, professional efficacy*

	Total sample	Low professional efficacy	Medium professional efficacy	High professional efficacy	Group differences
	(*N* = 417)	(*N* = 54)	(*N* = 62)	(*N* = 301)	
LF (n.u.)					
Mean ± SD	68.74 ± 12.33	68.95 ± 10.22	68.13 ± 12.88	68.83 ± 12.60	*F* = 0.09, *p* = .912
CI	68.74 (67.56, 69.93)	68.95 (66.22, 71.67)	68.13 (64.92, 71.33)	68.83 (67.41, 70.26)	
Median	70.7	69.7756005	69.9	71.4	
Minimum	22.1	43.5	38.5	22.1	
Maximum	90.9	89.4	90.7	90.9	
HF (n.u.)					
Mean ± SD	31.22 ± 12.32	31.01 ± 10.20	31.86 ± 12.88	31.13 ± 12.58	*F* = 0.09 , *p* = .907
CI	31.22 (30.04, 32.41)	31.01 (28.29, 33.73)	31.86 (28.65, 35.06)	31.13 (29.71, 32.55)	
Median	29.3	30.146331	30.1	28.6	
Minimum	9.1	10.6	9.3	9.1	
Maximum	77.9	56.5	61.5	77.9	
LF/HF ratio					
Mean ± SD	2.75 ± 1.57	2.63 ± 1.40	2.75 ± 1.77	2.76 ± 1.55	*F* = 0.16, *p* = .849
CI	2.75 (2.60, 2.90)	2.63 (2.26, 3.01)	2.75 (2.31, 3.19)	2.76 (2.59, 2.94)	
Median	2.413	2.315946	2.323	2.493	
Minimum	0.284	0.77	0.626	0.284	
Maximum	9.998	8.409	9.746	9.998	
Mean NN					
Mean ± SD	780.85 ±	772.26 ±	793.81 ±	779.72 ±	*F* = 0.98, *p* = .376

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

	86.84	80.18	95.60	86.10	
CI	780.85 (772.51, 789.18)	772.26 (750.87, 793.64)	793.81 (770.01, 817.61)	779.72 (769.99, 789.45)	
Median	773.21	762.14	778.96	773.45	
Minimum	591.70	626.23	595.70	591.70	
Maximum	1101.49	1032.45	1032.39	1101.49	
Mean HR bpm					
Mean ± SD	79.76 ± 8.80	80.50 ± 8.33	78.78 ± 9.20	79.82 ± 8.81	$F = 0.58$, $p = .559$
CI	79.76 (78.91, 80.60)	80.50 (78.27, 82.72)	78.78 (76.49, 81.07)	79.82 (78.83, 80.82)	
Median	79.53	80.75	79.01	79.51	
Minimum	54.47	60.27	58.12	54.47	
Maximum	103.75	98.63	102.22	103.75	
RMSSD (ms)					
Mean ± SD	35.56 ± 16.09	36.62 ± 14.11	37.12 ± 18.41	35.05 ± 15.93	$F = 0.56$, $p = .573$
CI	35.56 (34.02, 37.11)	36.62 (32.86, 40.39)	37.12 (32.54, 41.70)	35.05 (33.25, 36.85)	
Median	31.80	32.03	32.31	31.34	
Minimum	10.97	16.30	10.97	12.40	
Maximum	111.50	79.32	111.50	106.80	
PNN50 (%)					
Mean ± SD	10.67 ± 8.71	11.39 ± 8.80	11.82 ± 10.26	10.31 ± 8.35	$F = 0.98$, $p = .378$
CI	10.67 (9.84, 11.51)	11.39 (9.04, 13.73)	11.82 (9.26, 14.37)	10.31 (9.37, 11.25)	
Median	8.89	9.31	9.27	8.26	
Minimum	0.19	0.90	0.19	0.28	
Maximum	44.00	39.72	44.00	41.47	

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

SD1 (ms)					
Mean ± SD	25.60 ± 14.44	25.90 ± 9.97	26.25 ± 13.01	25.41 ± 15.40	$F = 0.10$, $p = .905$
CI	25.60 (24.22, 26.99)	25.90 (23.24, 28.56)	26.25 (23.01, 29.49)	25.41 (23.68, 27.15)	
Median	22.50	22.65	22.82	22.20	
Minimum	7.76	11.50	7.76	8.77	
Maximum	207.00	56.10	78.90	207.00	
α_1					
Mean ± SD	1.26 ± 0.16	1.26 ± 0.14	1.26 ± 0.17	1.26 ± 0.16	$F = 0.0078$, $p = .992$
CI	1.26 (1.25, 1.28)	1.26 (1.22, 1.30)	1.26 (1.22, 1.30)	1.26 (1.24, 1.28)	
Median	1.29	1.27	1.28	1.29	
Minimum	0.66	0.93	0.94	0.66	
Maximum	1.60	1.51	1.55	1.60	
α_2					
Mean ± SD	0.87 ± 0.25	0.82 ± 0.26	0.90 ± 0.24	0.87 ± 0.25	$F = 1.29$, $p = .275$
CI	0.87 (0.84, 0.89)	0.82 (0.75, 0.89)	0.90 (0.84, 0.96)	0.87 (0.84, 0.90)	
Median	0.98	0.96	0.99	0.99	
Minimum	0.10	0.36	0.10	0.36	
Maximum	1.20	1.15	1.20	1.17	
Age					
Mean ± SD	42.11 ± 10.71	40.17 ± 11.14	42.34 ± 11.27	42.41 ± 10.51	$F = 1.02$, $p = .362$
CI	42.11 (41.09, 43.14)	40.17 (37.20, 43.15)	42.34 (39.54, 45.15)	42.41 (41.23, 43.60)	
Median	42.00	39.50	44.55	42.00	
Minimum	22.00	23.00	23.00	22.00	
Maximum	63.00	61.00	63.00	62.00	

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited

Gender					
Male	59	6 (10.2%)	6 (10.2%)	47 (79.7%)	$p = .427$
Female	358	48 (13.4%)	56 (15.6%)	254 (70.9%)	
Work group					
Bank	79	13 (16.5%)	9 (11.4%)	57 (72.2%)	$p = .350$
MFA	39	6 (15.4%)	2 (5.1%)	31 (79.5%)	
Kindergarten	272	32 (11.8%)	48 (17.6%)	192 (70.6%)	
Music school	27	3 (11.1%)	3 (11.1%)	21 (77.8%)	

Notes. For continuous variables, mean, standard deviation, 95% confidence interval, median, minimum and maximum values are reported, along with results from ANOVA. For categorical variables, *n* and % are reported, along with results from Fisher's exact test. LF = low-frequency, HF = high-frequency, n.u. = normalised units, RMSSD = Square root of the mean squared differences between successive RR intervals. PNN50 = % of successive RR interval pairs that differ more than 50 ms. α_1 = short term fluctuations of detrended fluctuation analysis, α_2 = long term fluctuations of detrended fluctuation analysis.

ACCEPTED

Copyright © 2021 American College of Occupational and Environmental Medicine. Unauthorized reproduction of this article is prohibited