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Differences in the autonomic nervous system stress status of urban and rural school teachers

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ABSTRACT

The aim of the present study was to analyze differences in the autonomic stress status between rural and urban school teachers. We analyzed the autonomic modulation in 25 pre-school and primary school teachers (40 ± 7.8 years) from a city school (n:11) and rural school (n:14) by the heart rate variability analysis. Rural school teachers presented significative higher values in RMSSD, pNN50 and SD1 heart rate variability variables than city teachers, related with better autonomic control. Working place location is a variable that affects the psychophysiological stress response in education professionals, since city school teachers presented a higher sympathetic modulation, showing a lower heart rate variability, than rural school teachers.

1. Introduction

The analysis of stress response has been extensively studied in professions with large demand to manage information, responsibility to achieve positive results or lead with huge demanding and harmful context, especially in security, military, biomedicine or education areas [1–4]. Specifically, in educational context, daily interaction in the occupational context with colleagues, families and pupils and the demands to achieve an expected result may increase the stress and anxiety levels of professionals [5–7].

Previous researches in education have found different connections between stress levels and workload, occupational climate, work environment, organizational structure or interpersonal conflicts [8–10]. Similarly, a lack of emotional intelligence could be decisive in this profession with a huge personal relationship load [11,12]. In addition, the individual ability to rest efficiently, disconnect from teaching and other related tasks or be able to obtain an acceptable level of relaxation during leisure time are other important aspects to modify the level of stress and increase well-being at work [13]. Using an effective technique such as emotional control could improve these aspects [14].

Stress is a psychophysiological response modulated by different aspects. Psychological factors associated with the professional and personal activity, nutritional habits including nutrients typology and caloric expenditure balance, physical activity, lifestyle and even dental care [15,16]. The autonomous nervous system modulates this stress responses, being able to be evaluated by the measurement of the heart rate variability (HRV) by portable devices. The evaluation of autonomic modulation is basic to understand the relationships of the subject with is working environment, its coping abilities, and the physiological correlate caused by its stress response, dependent on the controllability degree that he can have on its close context [17,18].

Among other associated causes that repeatedly appear throughout the world [19–21], environment and vital context from the educational centre situation (rural or city schools) might have some influence over the stress response of teachers, but to the best of our knowledge, no previous studies take in account this variable related with HRV measures in school teachers. The performance of teaching activity within the urban environment will entail living with some stressful conditions inherent in the city: ecological impoverishment, type of transport, the standard of living required and other common environmental stressors like noise, pollution or population concentration [22–24]. Adapting to these kinds of changing circumstances along with the internal ones within the school itself, seems to imply that the urban environment is shown as more stressful [25]. Contrasting the teacher's involvement and personal integration in both areas, it makes it possible to value the teacher's intervention in the rural community as more influential and

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close [26].

The aim of this article was to analyse differences in the autonomic stress status between rural and urban school teachers. The initial hypothesis was that urban teachers would present a higher sympathetic modulation than rural school teachers due to the higher stress level of the city.

2. Methods

2.1. Participants

We analysed 25 volunteers' pre-school and primary school teachers (Rural School Group, RSG n:14; City School Group, CSG n:11). Recognizing that it could be a small sample, it is considered a very representative sample of the staff of each center since it is close to the totality (Total staff, RSG:15; CSG:12). The sample size obtained was in accordance with a confidence level of 99% and a margin of error between 8-9%.

18 of them were women (RSG n:8; CSG n:10) and 7 men (RSG n:6; CSG n:1). The mean year of the sample was 40 years (SD = 7.84) and range from 30 to 58. It was established that the minimum teaching experience required to participate was two years, obtaining an average among teachers of 14.5 ± 7.39 years. Prior to participation, all participants were informed about the experimental procedures, being able to familiarize themselves with the measurement process and the sensors with the help of assistant teachers of physical education. The right to withdraw from the study at any time was indicated and all the participants were provided with a written informed consent following the Helsinki Declaration (as revised in Brazil, 2013). All the procedure was approved by the University Ethical Committee (project number XOTRIO1712).

2.2. Procedure

We analyzed the autonomic modulation of teacher from two different schools in Spain. The first was a rural school located in a town with less than 1,000 residents (RSG n:14), and the second was a city school located in a larger town with more than 100,000 inhabitants (CSG n:11).

All the teachers were becoming familiar with the process and the portable measuring devices training in previous preparatory meetings led by the Physical Education teachers of the centers who controlled the correct use of the heart rate monitors. In this way, anxiety and the possibility of increasing pressure or heart rate on everyone, prior to data collection were reduced. Likewise, participants were advised not to carry out activities (early training) or eat food that could stimulate them before the measurement.

The data collection was performed at the schools before beginning the teaching day (5 minutes HRV sample), with the professors sitting in a chair placed in a room with constant temperature (25.3 ± 0.1 °C) and without noise, following procedures of previous studies [27].

The autonomic modulation was studied by the analysis of HRV using a Polar V800 heart rate monitor (Polar, Kempele, Finland) with chest band sensor, a validated instrument for HRV analysis [28]. The R-R series were analyzed using the Kubios HRV software (version 2.0, Biosignal Analysis and Medical Imaging Group, University of Kuopio, Finland), developed in accordance with the recommendations of the existing scientific literature [29]. The correction factor on the artifact measurement used in the analysis of the present sample was established between very low and medium. The following HRV variables were assessed: mean heart rate (HRmean, bpm); percentage of differences between normal adjacent R-R intervals greater than 50ms (PNN50, No); the square root of the average of the sum of the differences squared between normal adjacent R-R intervals (RMSSD, ms); the low-frequency band in normalized units (low-frequency, LF-nu); the high-frequency band in normalized units (high frequency, HF-nu); LF/HF frequencies ratio (LF/HF); sensitivity of the short-term variability (SD1, ms) and the long-term variability (SD2, ms) of the non-linear spectre of the HRV.

The analysis of these variables provides information on the balance of the autonomic nervous system, the load of the sympathetic and parasympathetic systems, as well as the adaptation capacity of each professional at the time of data collection.

Table 1
Heart rate variability results of rural and urban school teachers.

	RSG n = 14	CSG n = 11	Z	p	Cohen's *D*
HRmean	82.30 ± 24.73	79.58 ± 16.55	-0.307	0.739	-0.11
RMSSD	65.85 ± 66.19	30.80 ± 19.10	-1.997	0.046	-0.53
pNN50	19.83 ± 16.01	9.06 ± 11.16	-2.911	0.004	-0.67
LF	76.95 ± 11.73	79.46 ± 8.82	-1.276	0,202	0.21
HF	22.95 ± 11.72	20.49 ± 8.77	-1.579	0.114	-0.21
LF_HF	4.97 ± 3.99	5.43 ± 4.48	-1.524	0.128	0.12
SD1	46.62 ± 46.86	21.85 ± 13.60	-1.997	0.046	-0.53
SD2	130.65 ± 61.26	77.36 ± 28.97	-0.906	0.365	-0.87

2.3. Statistical analysis

The statistical analysis was carried out using the SPSS 22.0 statistical program. Descriptive were analyzed for each variable (M and SD). To analyse differences between the two groups a Mann-Whitney U test was carried out. The Effect Size was calculated by Cohen´s D. The significance level was 0.05.

3. Results

Results are presented as Medium ± Standard Deviation. Rural school group presented significative higher values in RMSSD, pNN50 and SD1 than city teachers' group. No other significant results were found in other HRV variables (Table 1), nor between HRV values and the age or experience of the participants.

4. Discussion

The aim of the present study was to analyse differences in the autonomic stress status between rural and urban school teachers. The initial hypothesis was confirmed since city school teachers presented a higher sympathetic modulation than rural school teachers.

We found how city teachers presented a significant lower RMSSD and pNN50 than rural teacher, showing a higher sympathetic modulation as previous authors reported [30,31]. This hyperactivation of sympathetic nervous system was also confirmed by the large ES in the higher LF and LF/HF ratio, and lower HF of city teachers than rural ones. In this line, also the nonlinear domain parameters (SD1 and SD2) showed the sympathetic activation of city teacher since presented lower values, significantly in SD1, than rural ones. It is of standing out that time domain and nonlinear domain variables presented a higher sensibility to detect differences in autonomic modulation in this population, results in line with previous research conducted in education area, specifically in novel nurse student performing their first clinical stay [32]. These data evidence the higher physiological stress response of city teachers comparing with the rural teachers, showing how the environment is a crucial factor to modulate the stress response in this collective. This result was in line with previous authors that suggested that urban teachers have more stressors motivated by the remarkable deficient conditions or poorest relationships at work. These conditions could be given by saturated classrooms and unequal educational resources inside the school center. In addition, fewer colleagues' support could be perceived when a more complex institutional organization chart exists with a huge number of teachers in each institution [33]. By contrary, the higher parasympathetic modulation of rural teacher could be related with that rural schools are characterized by a reduced

number of students by class, a more assertive working climate, acting over high occupational welfare and reduced stress level [34]. In fact, the organizational climate and team spirit are pointed out as the most relevant predictors of satisfaction and stress at work [35].

Other authors add the disruptive attitudes of current schoolchildren in urban or suburban contexts as the main trigger of these problems. It is evident that the characteristics of each educational stage modifies the possible source of stress. In preschool and elementary school, constant attention, physics efforts to support students, along conflicts with families are very frequent. However, conflicts related with student's behaviour could be continuous in Secondary [36]. The origins of these circumstances could be caused by marginal minorities or families with a significant lack of management of emotional intelligence [37]. The sum of these factors can lead to confirm significative differences in occupational stress between both kind of teachers, being urban teachers who present a higher workload and conflicts in their positions [38]. If the professionals reside in addition to working in urban environments, is a factor that might increase the appearance of stress by living with some triggers such as pollution, crowds, noises, etc. This is postulated as a bio-psychosocial factor that affect directly the lifestyle and organic system of citizen, affecting too the stress response of city teachers [39].

We found how the heart rate variability of present study in teachers presented lower values, particularly in RMSSD and pNN50 than elite military [40], soldiers [41,42] and elite football players [43], but higher than amateur aerobic athletes and biomedicine students in clinical simulation context [44,45]. A possible explanation to understand these results may be that elite athletes and elite soldiers exhibit values of greater adaptability and modulation related to stress control, because they achieve greater psychophysiological adaptations with more prevalent nature by daily training based in high stress and physical demand, as we can see in their significative higher HRV values [46,47]. In this way, a constant training is considered as an essential part of their formation to face a demanding daily work. By contrary, students are younger and inexperienced yet, so when they are involved in simulated real practice, it makes their anticipatory response to stress higher in the most of their related values than older and more experienced subjects. Teachers' group may have greater control over the situations by their experience and because their routine, although important in the emotional aspects, is not as aggressive as in the populations related to high sports performance or safety, but it seems some internal load variables are affected by their daily work with sympathetic activation values similar or higher than students or other above populations mentioned. We did not find in this sample significant differences between age and years of teaching practice in relation to stress, but in several studies is shown how in some cases younger and inexperienced teachers do not face situations with the same capacity as more experienced teachers. However, teachers who have been teaching for years might experience exhaustion and decreased effectiveness [48–50].

If we compare this data with other studies that have tried to present average values in healthy population without job differentiation, it has been observed that teachers have lower values in general, more pronounced in CSG, especially in HF and SD1 variables [51,52]. This fact show us how school teachers could be a professional collective that present a higher organic stress response than normal population, fact that could explain the work leave of this collective, higher than other professions, but it is important to emphasize that the authors expose the great individual variability found in all variables, with certain tendency to decrease values when subjects' age increases. It has also been observed that exist some gender differentiation (minor differences in HRV values in men than women), but future studies should confirm this fact. Regarding, no significant gender differences have been identified in relation to the internal stress values in this study, but as it has been exposed in the literature presented earlier in this article, there is a tendency for women to perceive in a more stressful way their work at the school.

The hyperactivation of the sympathetic nervous system is an effectively organic response to deal with an acute stimulus, but when this response in maintained chronicling, hyperactivation of the sympathetic nervous system may be one of the factors at physiological level related to different psychopathologies such as anxiety or stress even with post-traumatic stress or depression as it has been commented previously. All of these elements affects directly in all the professional performance [53]. In fact, it is one of the main causes of work leave in the healthcare and education sector [54]. Different international reports clearly warn of this trend, work-related stress represents in Europe between 50% and 60% of the lost days of work, being more frequent and perceived in educational and healthcare sectors [55], even deriving from situations with direct violence in the workplace [56]. These stressful stimuli can lead to a depressive mood where obvious symptoms will be shown such as loss of interest in the activity, decreased energy, feelings of low self-esteem, poor concentration and different alterations in sleep or food. Undoubtedly, the impact of these patterns is relevant, as well as it is leading to increase distractions, errors in judge, intransigence and failures in normal activities and responsibilities [57,58]. Teachers are a collective with high work leave, in United Kingdom 73% confirm and recognize that they have experimented stress in the last twelve months, being worried about carrying this anxiety out of the school in 83%. These professionals have also expressed that their work has had a negative impact on their well-being in the last twelve months, thinking that that work pression affects their mental health in 70% of all the cases, even considering leaving their position over 67% [59]. Specifically, a national Spanish union report showed that 74% presented anxiety states, reaching 13% with depression that leads to work leave [60].

5. Practical application

Educational sector, along with safety and health, remains one of the most affected by workplace stress and anxiety disorders, which can lead to a state of depression or other pathologies if it is not reduced. The use of HRV would provide teachers an effective tool to control autonomous response in an educational context, allowing to know psychophysiological stress status and enabling intervention that could modulate the sympathetic tone of city school teacher with interventions based on a good recovery, physical training [61], yoga [62], meditation [63] or mindfulness [64].

6. Limitations and future lines of research

The low number of participants analysed was the first limitation of the present study; at this date no more centers and teachers could be recruited to be part of this study, but the sample is representative of total staff of both schools. In addition, the no measures of amylase or cortisol stress hormones limited the hormonal stress response analysis in the present research. This limitation was subject to a lack of enough technological and financial resources for further study. As future lines of research, we propose to analyze the differences in the autonomous modulation of teachers in other population areas with greater difference in population, as well as to compare them between educational stages: schools, secondary schools and universities.

7. Conclusion

Working place location is a variable that affects the psychophysiological stress response in education professionals, since city school teachers presented a higher sympathetic modulation, showing a lower heart rate variability than rural school teachers.

RSG, rural school group; CSG, city school group; HRmean, heart rate mean; RMSSD, root-mean square differences of successive heartbeat intervals; pNN50, percentage of successive RR-interval pairs differing in more than 50 milliseconds in the entire recording divided by the total

number of RR intervals; LF: low-frequency band; HF: high-frequency band; LF/HF Ratio: LF /HF; SD1, transverse axis; SD2, longitudinal axis.

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