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Psychobiological responses at the beginning and the end of an academic year in teachers

Miguel A. Serrano*, Luís Moya-Albiol and Alicia Salvador

Department of Psychobiology, Faculty of Psychology, University of Valencia, Avenida Blasco Ibáñez 21, 46010, Valencia, Spain

Título: Respuestas psicobiológicas en profesores al inicio y al final de un curso académico.
Resumen: La evidencia científica indica que el estrés laboral incrementa el riesgo de enfermedad cardiovascular. Las respuestas emocionales, cardiovasculares y endocrinas se ven afectadas por la experiencia diaria. La percepción de estrés, el estado de ánimo negativo, la frecuencia cardíaca (FC) y la presión arterial (PA) incrementan en los periodos laborales. La respuesta del cortisol (C) no es tan clara, existiendo resultados contradictorios. El objetivo de este trabajo es analizar en profesores los marcadores de estrés durante dos jornadas laborales. Además se evaluó el papel del género en la respuesta de estrés en 49 profesores. Para ello, se midió la percepción de estrés, el estado de ánimo, la PA, la FC y el C al inicio y al final de un curso escolar. Los resultados muestran que las respuestas psicológicas y de FC fueron mayores al final de curso, especialmente en hombres. La PA y el C descendieron al final de curso. En conclusión, un curso académico podría afectar negativamente al estado emocional y a los niveles de FC de los profesores.
Palabras clave: Estrés Laboral; respuesta cardiovascular; cortisol; estado de ánimo, profesores.

Abstract: Evidence shows that work stress increases risk of cardiovascular disease. Emotional, cardiovascular and endocrine responses are affected by day-to-day experience. Perceived stress, negative mood, heart rate (HR) and blood pressure (BP) increase in working periods. Cortisol (C) response is not so clear, there being contradictory results. The main purpose is to study stress markers in two working days in teachers. Moreover, we evaluate the role of gender in stress markers in 49 school teachers. Perceived stress, mood, BP, HR, and C were measured at the beginning and at the end of an academic year. Results show that psychological and heart rate responses to a working day were different at the end of the year, increasing, especially in men. BP and C responses descended at the end of the year. In conclusion, an academic year could affect negatively to the emotional state and heart rate of teachers.
Key words: Work stress; cardiovascular response; cortisol; mood; teachers.

Introduction

In our society, work stress is considered to be one of the most important chronic psychosocial stressors, especially in those work populations submitted to stress such as the case of teachers (Johnson, Cooper, Cartwright, Donald, Taylor, & Millet, 2005; Yang, Ge, Hu, Chi, & Wang, 2009; Cladellas & Badia, 2010; Otero, Castro, Santiago & Villardefrancos, 2010). Chronic stress has a great variety of psychobiological consequences in human beings, which affect everyday life. It has been recommended to measure these functions under naturalistic day-to-day conditions (Steptoe & Wardle, 2005). Aditionally, longitudinal designs are preferred using biological variables in combination with subjetive ratings of stress (Dahlgren, Akerstedt & Kecklund, 2004). Furthermore, there are physiological differences between genders due to the different roles of men and women in our societies, which affect daily activity (Yang et al. 2009).

The main variables related to work stress could be divided into three basic categories: emotional, cardiovascular and endocrine responses. Emotional responses refer mainly to perceived stress (PS) and mood and are studied in relation to work stress as potential determinants of the cardiovascular system or Hypothalamo Pituitary Adrenal (HPA) axis activity. It is well established that PS is higher in working periods than in relaxing or holiday periods (Moya-Albiol, Serrano, Salvador, González-Bono & Rodríguez-Alarcón, 2005). Moreover, it has been observed that negative mood autorregulation has positive effects on the way of coping with stressful events in a working day (Mearns & Cain, 2003). In this sense, negative mood and PS has been positively related to burnout during a working day (Moya-Albiol, Serrano & Salvador, 2010a) and in stress situations (Flynn & James, 2009). Furthermore, positive affect is related to favorable profiles of functioning in several biological systems (Steptoe & Wardle, 2005). Day-to-day experiences are important as they can be considered the onset of all the changes that lead to disease. In fact, changes in blood pressure (BP) and heart rate (HR) have been associated with PS (Pollard, Pearce, Rousham & Schwartz, 2007) and mood variations (Moya-Albiol et al. 2010a) during a working day. Kamarck et al. (1998) hypothesized that emotional changes are the mechanism by means of which life events elicit cardiovascular reactions, probably due to the cumulative experience (Alonzo, 1999).

It is known that work stress causes cardiovascular problems by means of elevating BP (Kulkarni, O'Farrel, Erasi & Kochar, 1998; Lucini, Riva, Pizzinelli, & Pagani, 2007) or by affecting the autonomic nervous system (Lucini et al. 2007), which shows a uniform activation pattern to psychosocial challenge (Schommer, Hellhammer, & Kirschbaum, 2003). Concretely, BP levels increase in periods of high stress in teachers (Ritvanen, Louhevaara, Helin, Väisänen & Hänninen, 2006), living negative emotions during the day, especially when people suffer emotional inestability (Greiner, Krause, Ragland & Fisher, 2004) or with high burnout (Moya-Albiol et al. 2010a). Moreover, a heightened cardiovascular reactivity to acute stress can contribute to longitudinal changes in BP in middle-aged people (Steptoe & Marmot, 2005). Nevertheless, the possibility that high workload could be the main factor of BP increases during the working day is controversial (Greiner et al. 2004). For instance, it has been found that one week of overtime work with moderate

*** Dirección para correspondencia [Correspondence address]:**
Miguel A. Serrano. Departamento de Psicobiología. Facultad de Psicología. Universitat de València. Avda. Blasco Ibáñez, 21. 46010 Valencia (Spain). E-mail: maserrar@uv.es

workload did not produce main effects on physiological stress markers (Dahlgren, Kecklund, & Akerstedt, 2006). Relationships between psychosocial factors as work stress and cardiovascular disease risk has been found in men, but in the case of women, studies are not conclusive (Klumb & Lampert, 2004). However, it has been well documented that teachers show a higher prevalence of anxiety, hypertension, headaches, psychosomatic disorders and cardiovascular diseases (CVD) compared with other workers (Unterbrink, Zimmermann, Pfeifer, Wirsching, Brahler & Bauer, 2008).

HPA axis activation is one of the most characteristic responses to stress (DeVries, Glasper & Detillion, 2003; Scholtz, Hammerfald, Ehlert & Gaab, 2011) with a quick habituation to psychosocial stress (Schommer et al. 2003). Cortisol (C) response level during the day has been considered a good marker of psychosocial stress response (Patacchioli, Angelucci, Dellerba, Monmazzi & Leri, 2001). In a job context, young teachers exhibited significantly greater C excretion during high stress period (Ritvanen et al. 2006), and also hypercortisolemia in high stress situations in emergency doctors has been described (Weibel, Gabrion, Aussedat & Kreutz, 2003). Nevertheless, the relationship between work stress and increases in C levels remains unclear (Kunz-Ebrecht, Kirschbaum, Marmot, & Steptoe, 2004). For instance, a lack of differences between working and non-working days has been found in different studies (Goldstein, Shapiro, Chicz-DeMet, & Guthrie, 1999) and no relationships between working conditions and C levels have been found (Holleman, Vreeburg, Dekker, y Penninx, 2012). Thus, it cannot be assumed that higher levels of C have been found in working days compared with non working days. Nevertheless, HPA dysregulation is associated with CVD (Matthews, Schwartz, Cohen, & Tersa, 2006) and with illness in general (Hausser, Mojzisch & Schulz-Hardt, 2011). In fact, C has been considered as a transducer of psychosocial and emotional experience into physiological activation and an influence on feelings of well-being (Adam, Hawkley, Kudielka, & Cacioppo, 2006).

Taking all of this into account, the main objective of this work is to check whether there is an increase in the teachers' stress marker levels (PS, mood, HR, BP, and C) at the end of an academic year. To this end, we explored the changes in markers along two different moments of an academic year: at the beginning and at the end. We hypothesized, based on scientific literature, an increase in PS, negative mood, HR and, BP at the end of this period, but not necessarily in C levels. Another objective is to study gender effects in stress markers in order to test whether men are more vulnerable to CVD.

Methods

Participants

A total of 5 different schools took part in the investigation. The schools were selected by taking into account different criteria such as the educational level of the students and the area in which they were located. Both of these variables could influence the level of stress perceived by the teachers. Thus, all the schools were public schools with similar location characteristics, and there were no differences in the educational level of the students. Participants who voluntary participate in the study were asked to give a written informed consent for participation in the study following the declaration of Helsinki. There was no monetary incentive for partaking. Finally, 80 teachers wanted to participate voluntarily. Voluntary teachers had similar sociodemographic characteristics.

Teachers were initially screened using a general questionnaire to evaluate habits, health aspects, and drug intake; those who smoked, were not free of medication, used oral contraceptives or had any illness were eliminated. Moreover, two women's data were not considered because they were pregnant when the experiment was carried out. The final sample was composed of 49 full-time school teachers, 11 men and 38 women, with a mean age of 42.83 years (SD = 9.21) and a mean body mass index of 23.15 Kg/m^2 (SD = 2.77). The different proportion of men to women is representative of the percentage of each gender in the public schools of the Valencian Community.

Procedure

In order to reclutate participants, an informative meeting was programmed for teachers of each school where brief and general information was given. Afterwards, the appointments were established with teachers who voluntarily decided to participate in the study. The experimental protocol was composed of two sessions (at the beginning and at the end of an academic year) in which all subjects were questioned and evaluated about the same psychological, cardiovascular and endocrine aspects three times. Subjects were told to come half an hour before starting their working day, between 7:30 and 8:30 hours approximately, depending on their timetable. They did not eat or smoke from awakening to the test and did not train or practice exercise 36 hours before arriving at the school. Firstly, subjects provided the first salivary sample and indicated the degree of stress experienced from the moment they woke up as well as their mood state with the PANAS questionnaire. At this moment, BP and HR were also registered. Afterwards, subjects were informed about the next appointment which coincided with the middle of the working day. From this moment onwards teachers carried out their habitual activities of a working day. Between 12:30 and 13:30 hours approximately, each subject carried out the second session test in which the second sample of saliva was collected as well as measures of HR and BP together with evaluation of mood and perceived stress during this morning. Teachers were informed about the next appointment. At 17:00 hours, coinciding with the end of the working day, the last session was carried out following the same procedure as described in the first one. After finalizing, a battery of trait questionnaires, which included the Job Content Questionnaire, was given to each subject.

Psychological Profiles

Psychological profiles were evaluated by means of a diary, which evaluated mood and perceived stress.

Mood was evaluated by the PANAS questionnaire (Watson, Clark & Tellegen, 1988), which is composed of 20 items. Half of them permit one to obtain a global score of the positive mood, and the other half of the negative mood. Positive mood refers to feelings of enthusiasm, activity, state of alertness, energy and gratificant participation. Negative mood refers to a general dimension of subjective distress and a reluctant participation which includes a variety of aversive emotional states such as discomfort, anger, culpability, fear and nervousness. The bidimensionality of the questionnaire has been confirmed in Spanish samples (Sandín, Chorot, Lostao, Joiner, Santed & Valiente, 1999), with a validity of 0.89 and 0.91 for positive and negative mood, respectively.

Perceived stress was evaluated by means of several Likert items ranked by a four-point scale which reflects the degree of stress experienced in different tasks or possible situations in each period of measurement (at the beginning, middle, and the end of the working day). The questionnaire was elaborated by us and included the following items: a) from awakening to the first appointment: driving; go to work in public transport; go to work by car without driving; argue with someone; laugh; talk to someone satisfactorily; relax; walk; do home tasks; and take the children to school or to the school bus stop; b) in the other periods: argue with someone; laugh; talk to someone satisfactorily; relax; give a student a "ticking-off"; teach without problems; work meetings; be on duty or replace a colleague; the breaks; maintain discipline in the classroom; have too much work to do; prepare the lectures; have little work to do; manage or supervise other people; cope with questions of policy; do boring bureaucratic tasks; assume risks; share work or responsibilities with other colleagues; and make important decisions.

Cardiovascular measures

The BP (mmHg) was recorded by means of an autoinflation digital BP monitor (DS-143D) while subjects were sitting. The accuracy of cuff pressure was of $\pm$3 mmHg. A presentable exhaust system for deflation (3 mmHg/scs) was used. The cuff was of a standard adult size with a coverage arm circumference of 12 to 14 cm. The monitor employed the oscillometric method to determine BP, inferred from changes in the intensity of pulse oscillations in the occluding cuff. The monitor also offered a value of HR in the moment in which BP was being measured. The validity of this method has been previously established (Fowler, Jameson, Lyons, Jeffers, Webster & Petrie, 1991).

Hormonal Determination

Subjects were informed about the necessity of following the instructions regarding the time schedule for saliva sampling, in order to obtain valuable data. Three measures of cortisol in saliva (Csal) over the working day (at the beginning, middle and the end) were taken.

Saliva was directly collected from mouth to tube (Unitek R). Samples were centrifuged (5000 rpm, 15$\pm$2ºC) and frozen at -20ºC until determination by radioimmunoassay (RIA) at our laboratory (Central Research Unit, Faculty of Medicine, University of Valencia, Spain). Samples from each subject were run in duplicate in the same assay.

Csal was determined by a commercial kit adapted as was recommended in the protocol (Orion Diagnostica, Espoo, Finland). 125I-cortisol tracer and a high specific antibody were used. Csal levels were expressed in nmol/l, the sensitivity was 1 nmol/l, and internal and external controls were included in the assays. Good precision was obtained with intra and interassay variation coefficients below 5%. More details about hormonal determination have been previously described elsewhere.

Statistical analysis

Repeated measures ANOVAs were performed for psychological state profiles (positive and negative mood and perceived stress), cardiovascular variables (HR and BP) and Csal levels over the working day, with 'working day' (WD) (at the beginning (1) and at the end (2) of the course) and 'moment' (at the beginning (1), middle (2), and end (3) of the working day) as within-subjects factor, and 'gender' as between-subjects factor. Greenhouse-Geisser adjustments for degree of freedom were employed where appropriate. Change scores (in the case of psychological variables) or reactivity (in the case of physiological variables) were assessed via simple change scores (subtracting initial levels from those of the middle and the end of the working day). To study differences between groups, ANOVAs were carried out. Bonferroni post-hoc tests were performed when significant differences were found. Pearson or Spearman correlations tests (depending on the cases) were carried out to examine relationships between physiological and psychological responses to the working day. All the analyses were performed by the SPSS 17.0 for Windows. Mean values in the text are expressed as mean $\pm$ SD. The alpha level was fixed at .05.

Results

Psychological measures

In *PS*, an interaction between "working day", "moment" and "gender" has been found (F (2, 44) = 3.165, p = .05). It is observed that men in the WD2 have lower levels when they arrived at the school, but during the morning they perceived more stress than women and they themselves in WD1. At the end of the WD perceived stress levels are similar among groups (Figure 1).

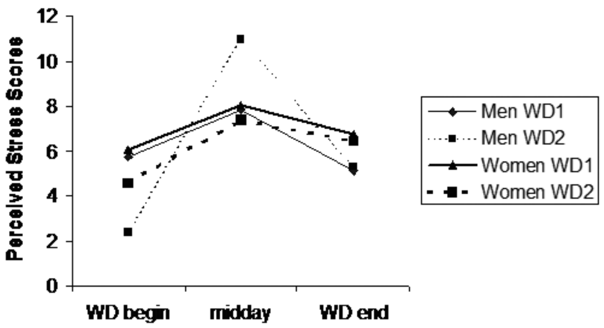


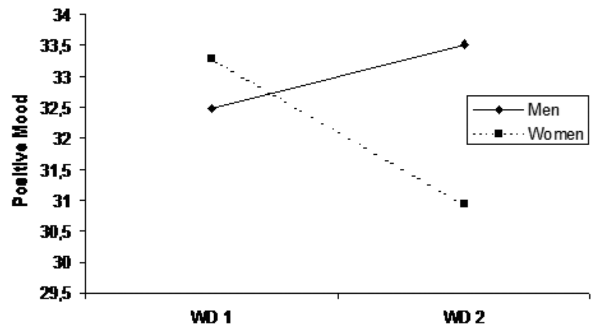
Figure 1. PS evolution along the two WDs in men and women.

In the case of positive mood, a significant effect for "moment" (*F* (1.566, 42.048) = 3.477; $p < .05$), the interactions "working day*gender" (*F* (1, 46) = 6.518; $p < .05$), and "moment*gender" (*F* (1.566, 111.310) = 4.44; $p < .05$) were found. Post-hoc analysis for the interaction "Working day*gender" showed that women significantly reduced their scores in positive mood (*F* (1, 36) = 12.123, $p < .001$). Men increased their scores but not significantly. However, there are no significant differences between men and women (Figure 2A). The interaction "Moment*gender" reflects a different evolution between genders along the WD (*F* (2, 9) = 6.666, $p < .05$, and *F* (1.506, 54.201) = 3.892, $p < .05$, for men and women, respectively). In men, particularly, there is a significant increase in positive mood during the morning (*F* (1, 10) = 14.671, $p < .01$). In women, scores in positive mood are significantly lower at the end of the day than in the morning or at midday (*F* (1, 37) = 4.416, $p < .05$; *F* (1, 36) = 10.02, $p < .01$, respectively) (Figure 2B).

Cardiovascular measures

For Systolic Blood Pressure (SBP), only an effect for the factor "working day" has been found (*F* (1, 45) = 10.845; $p < .01$). SBP levels are higher in WD1 than WD2. Post hoc analyses point out significant differences in the three moments (*F* (1, 48) = 11.772, $p < .001$; *F* (1, 46) = 18.742, $p < .001$ and *F* (1, 48) = 18.757, $p < .001$, respectively) (Figure 3A). No significant effects for Diastolic Blood Pressure (DBP) have been observed, although levels are higher in WD1 than WD2 (Figure 3B). The factor "Gender" was not significant.

A)



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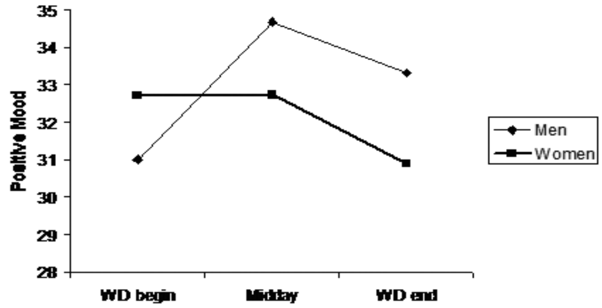
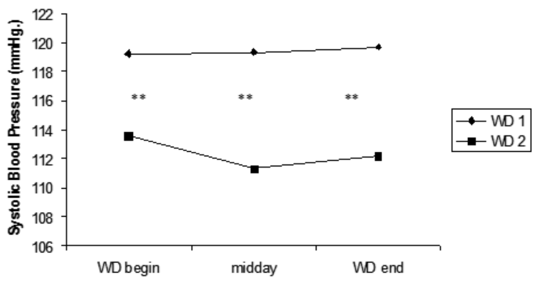


Figure 2. "Working day*gender" interaction (A) and "moment*gender" interaction (B) for positive mood.

For *negative mood*, no significant effects have been found.

A)



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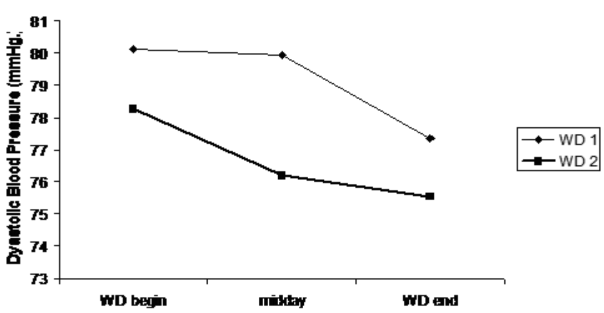


Figure 3. SBP (A) and DBP (B) on both working days.

For *HR*, a significant effect for the factor "moment" (F (2, 42) = 12.437, p < .001), and for the interactions "working day*moment", "moment*gender" and "working day*moment*gender" have been found (F (2, 42) = 4.299; p < .05, F (2, 42) = 7.262, p < .01, and F (2, 42) = 5.265; p < .01, respectively). The third-order interaction points out that the evolution of HR in men in WD2 is different from women or men in WD1; that is, there is an increase during the day, there being a great elevation from morning to midday (around 15 bpm on average). Concretely, in men the evolution of HR in both WD is different: in WD2 there are significant increases between the morning HR and the other two (middle and at the end of WD) (F (1, 9) = 6.692, p < .05; F (1, 10) = 20.051, p < .001, respectively). In women, only an effect of the factor "moment" has been found (F (2, 33) = 10.596, p < .0001), showing a HR increase between midday and the end of the WD (F (1, 37) = 17.499, p < .001) (Figure 4A).

A)

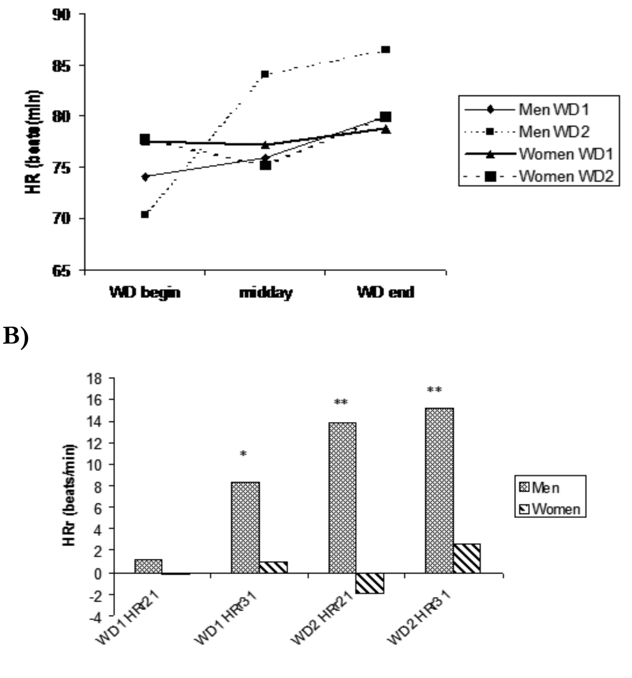


Figure 4. HR (A) and HR reactivity (B) of men and women on both working days.

For *HR reactivity*, a significant effect of the factors "working day" and "moment" factors and the interaction "working day*gender" has been found (F (1, 43) = 8.156, p < .01; F (1, 43) = 13.345, p < .01, and F (1, 43) = 9.869, p < .01, respectively). One-way ANOVAs comparing men and women, moment to moment in each WD, showed that men have significantly higher HR reactivity than women along WD1 (F (1, 46) = 4.57, p < .05) and during the morning and all the day in WD2 (F (1, 47) = 19.257, p < .001; F (1, 48) = 16.526, p<.001, respectively) (Figure 4B). Furthermore, in general, HR reactivity in WD2 is higher than in WD1 (F (1, 43) = 8.156, p < .01).

Cortisol

For *C levels*, "working day", "moment" and their interaction are significant (F (1, 131.673) = 8.094, p < .05; F (1.590, 800.351) = 29.555, p < .001 and F (1.744, 39.661) = 2.208, p = .05 respectively). The interaction points out that, beginning with non statistically significant C levels in both WDs, the evolution is different during the morning (F (1, 46) = 23.199, p < .001), increasing in WD1 and decreasing significantly in WD2. In the afternoon, C levels decrease in both WDs, although in WD1, C levels are greater than in WD2 (F (1, 47) = 12.726, p < .01).

In general, C levels are always higher in WD1 than WD2. Post-hoc analyses show that there are significant reductions in C levels in WD2 (F (1, 46) = 21.686, p < .001). Furthermore, differences between morning C level and that at both midday and the end, have been found when post-hoc analyses for the factor "moment" were performed (F (1, 47) = 65.168, p < .001; F (1, 46) = 93.066, p < .001, respectively) (Figure 5A).

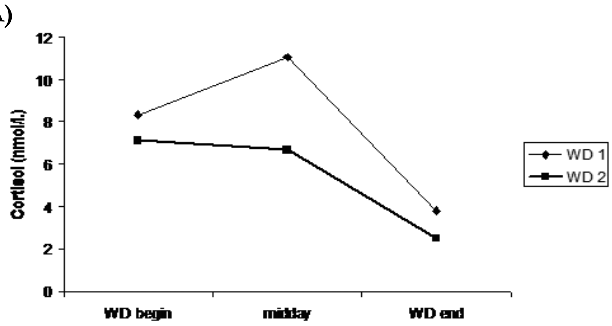
For C response, "moment" and the interaction "working day*moment" are significant (F (1, 45) = 22.938, p < .001; F (1, 45) = 4.695, p < .05, respectively). Post-hoc analyses point out that in WD1 there are increases in the morning and reductions at the end (F (1, 47) = 25.116, p < .001). These differences are maintained in WD2, although instead of increases in the morning there is a slight descent (F (1, 46) = 11.959, p < .001). When both WDs are compared, a less marked response is found in WD2, in the morning and in the evening (F (1, 46) = 8.840, p < .01, F (1, 46) = 9.835, p < .01, respectively) (Figure 5B). No gender differences have been found.

Relationships between variables

In *WD1*, perceived stress is associated with cardiovascular variables. Concretely, the PS at the beginning is statistical and significantly related to the HR at the beginning and HR at the end (r = -.300; p < .05 and r = -.310; p < .05, respectively). Furthermore, PS at the end is negatively related to SBP at the beginning and at the end and to DBP at the beginning (r = -.302; p < .05; r = -.312, p < .05; r = -.283, p < .05, respectively).

In *WD2*, the PS at the beginning is related to midday C (r = -.338; p < .05) and midday PS to midday and end HR (r = .332, p < .05: r = .286, p < .05, respectively). Moreover, PS at the end has a significant relationship to all moments of SBP (r = -.341, p < .05, r = -.295, p < .05 and r = -.395; p < .01), to DBP at the beginning and at the end (r = -.296; p < .05, r = -.357; p < .05, respectively) and C at the end (r = -.392; p < .01).

A)



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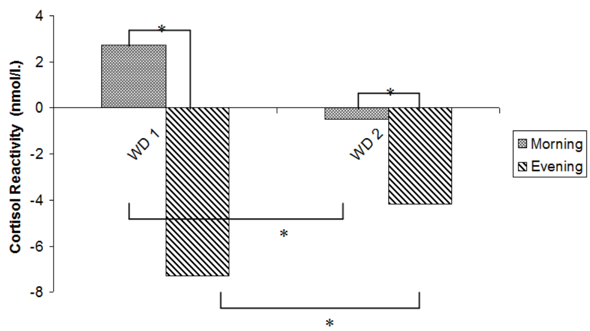

Figure 5. C levels (A) and C response (B) along both working days.

Discussion

Passing through an academic year does not leave teachers unharmed. On the contrary, there are changes in psychophysiological variables between the working day at the end of a course and at the beginning. When the psychological state along the two working days were compared, PS was no different, which leads to the conclusion that the period of the academic year does not influence this variable. Taking into account this result, we consider that there is not higher PS depending on the period of the academic year. This is in accordance with Serrano, Moya-Albiol & Salvador (2008), who did not find differences in psychosomatic symptoms between two working days. In fact, scientific literature has only found differences in PS between working and holiday periods (Moya-Albiol et al. 2005).

It should also be noted that a generalized descent in positive affectivity and a lack of changes in negative affectivity have been found in our results. This is, in part, in agreement with recent findings which indicate that deterioration in health at the end of the academic year could be due to accumulated experiences (Alonzo, 1999). To this regard, it should be noted that a lack of positive affectivity may lead to the development of physical illness (Steptoe & Wardle, 2005). In addition, the descent in negative affectivity is mediated by gender, in the sense that men have a better mood than women along the working days, and women live the end of the course more negatively than men.

These psychological changes have physiological implications. Our results show that HR increases along the working days, it being higher at the end of the morning classes or at the end of the working day. This fact is in accordance with previous studies that have associated different psychosocial factors with changes in the cardiovascular system (Belkic, Landsbergis, Schnall & Baker, 2004; Pollard et al. 2007). In spite of the lack of differences between working days, subjects in WD2 are more reactive than in WD1. Considering that an academic year could be seen as a chronic stressor, this higher reactivity at the end of the course would show an accumulation of stressors, in line with the study of Moya-Albiol, Salvador, González-Bono, Martínez-Sanchís & Costa (2001), where higher reactivity is associated with chronic stress. Moreover, it has been recently reported that cardiovascular reactivity is useful in long-term BP predictions (Mosely & Linden, 2006). Nevertheless, we do not find higher BP levels at the end of the course, but the contrary. This may be due to the possibility that punctual BP measures are not precise enough to study cardiovascular responses in a naturalistic setting. In fact, ambulatory BP is considered a good method of evaluating chronic stress in situational studies (Kamarck et al. 2002), and especially when relationships between BP and psychosocial risk factors are studied (Diene, Fouquet & Esquirol, 2012). However, recent studies have indicated that “increases in blood pressure and heart rate are primarily mediated by the activity of the sympathetic adreno-medullary (SAM) system which is generally linked to pleasant and unpleasant stimulation, rather than specifically reacting to (job) strain” (Bradley et al. 2008). Furthermore, cardiovascular activity is related to motivational intensity and effort (Gendolla et al. 2008). Thus, our results could be reflecting a lower implication (effort) at work, as recently has been noted by Hausser et al. (2011) when indicate that measures of heart rate and blood pressure in job strain research might reflect task difficulty or motivational intensity.

As happens in psychological variables, HR response is mediated by gender. Men change their response pattern in WD2, they showing higher HR at midday or at the end of the working day. Furthermore, men have higher HR and higher HR reactivity than women at all the measure points, except at the beginning of the working day. This is clearer at the end of the course. These results support, in our sample, the tendency of men to suffer from CVD in comparison to premenopausal women (Belkic et al. 2004). Nevertheless, the literature indicates that, in general, men are more reactive in BP and women in HR (Serrano et al. 2008), but in this sample, men are more HR reactive to a working day than women. On the other hand, we do not find gender differences in BP, which is in accordance with the statement that relationships between work stress and BP apply to everybody, and not exclusiveley to men (Kulkarni et al. 1998).

At endocrine level, our results show that there is a general decrease in C levels at the end of the year, which could be explained as an endocrine adaptation to work stress, considering that in chronic stress periods higher C levels are described (Moya-Albiol, Serrano & Salvador, 2010b), and taking into account that HPA system is related to aversive strain (including hypertension and impairments in immune function) (Hausser et al. 2011). This interpretation is in agreement with the fact that an acute stressor increases C response, as occurs during the morning in WD1. Nevertheless, in WD2 there is no increase during the morning, but on the contrary there is a decrease. Another approach may be to interpret teachers' C response at the beginning of the course as adequate, and that at the end this response would disappear due to habituation to the stressors. In fact, in WD2 C is less pronounced during the morning and the evening compared to WD1. In addition, reduction in diurnal C amplitude was seen in a large study of groups reporting increased levels of stress (Rosmond, Dallman, & Björntorp, 1998), in subjects with burnout (Pruessner, Hellhammer & Kirschbaum, 1999, Moya-Albiol et al. 2010a) and in female teachers with allostatic load (Bellingrath, Weigl & Kudielka, 2009). Dahlgren et al. (2006) concluded that fatigue and exhaustion may be related to individual differences in the C response to stress. Furthermore, C measures should be used in combination with subjective ratings of stress and fatigue, preferably in a within subject design (Dahlgren et al. 2006).

Finally, correlations show interesting relationships between variables depending on the time when teachers are measured. Thus, while in WD1 data do not reflect the classical result which indicates that PS affects cardiovascular variables, in WD2 the expected results occur only with HR, not with BP and C. This may be interpreted along the same line as the explanation for BP and C responses.

This study has some limitations due, basically, to the limited number of subjects and the inequal gender participation. However, the proportion of men and women is representative of the Spanish teacher population. Moreover, the lack of control of measured variables during the academic year difficult the interpretation of the obtained results. Thus, future studies should consider these aspects; concretely, having a greater sample could contribute to have more robust results. Furthermore, in order to test the validity of our results we consider necessary to have a continuous evaluation of the variables, at least control the evolution of the studied variables every month.

In conclusion, psychological and cardiovascular response to a working day in teachers is different at the end of the year, especially in men. Taking into account that some authors have indicated that the physiological mechanism mediating work stress and CVD is not yet clarified (Hanson, Godaert, Maas & Meijman, 2001; Serrano, Moya-Albiol & Salvador, 2009; Diene et al. 2012) our results provide more information about the evolution of variables that could be related to CVD and to emotional states during an academic year. However, the lack of response in BP and in C in our study and the lack of the expected relationships between PS with BP and C are difficult to explain. It is possible that our sample is not critically stressed; in fact, they were working when the study was made and no one was diagnosed from stress or burnout. Thus, our results can be considered as normal daily work stress responses and should be taken as response tendencies that could be the origin of future pathological stress syndromes in a non-ill active population. In this sense, it should be necessary, from a prevention risk point of view, to check the levels of mood and heart rate in male and female teachers during the academic year in order to prevent illness, considering that both variables are easy to measure.

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References

Adam, E. K., Hawkley, L. C., Kudielka, B. M. & Cacioppo, J. T. (2006). Day-to-day dynamics of experience-cortisol associations in a population-based sample of older adults. *Psychosomatic Medicine, 68, 657-661.*

Alonzo, A. (1999). Acute myocardial infarction and posttraumatic stress disorder: The consequences of cumulative adversity. *Journal of Cardiovascular Nursing, 13*(3), 33-45.

Belkic, K. L., Landsbergis, P. A., Schnall, P. L. & Baker, D. (2004). Is job strain a major source of cardiovascular disease risk? *Scandinavian Journal of Work Environment and Health, 30*(2), 85-128.

Bellingrath, S., Weigl, T. & Kudielka, B. M. (2009). Chronic work stress and exhaustion is associated with higher allostatic load in female school teachers. *Stress, 12*(1), 37-48.

Bradley, M. M., Miccoli, L., Escrig, M. A. & Lang, P. J., (2008). The pupil as a measure of emotional arousal and autonomic activation. *Psychophysiology, 45*, 602-607.

Cladellas, R. & Badia, M. (2010). La gestión del tiempo de los profesores universitarios en función de la modalidad educativa: sus efectos psicosociales. *Revista Española de Pedagogía, 68* (246), 297-310.

Dahlgren, A., Akerstedt, T. & Kecklund, G. (2004). Individual differences in the diurnal cortisol response to stress. *Chronobiology International, 21*, 913-922.

Dahlgren, A., Kecklund, G. & Akerstedt, T. (2006). Overtime work and its effects on sleep, sleepness, cortisol and blood pressure in an experimental field study. *Scandinavian Journal of Work, Environment and Health, 32*(4), 318-327.

DeVries, A., Glasper, E. R. & Detillion, C. E. (2003). Social modulation of stress responses. *Physiology & Behavior, 79*, 399-407

Diane, E., Fouquet, A. & Esquirol, Y. (2012). Cardiovascular diseases and psychosocial factors at work. *Archives of Cardiovascular Disease, 105*, 33-39.

Flynn, N. & James, J. (2009). Relative effects of demand and control on task-related cardiovascular reactivity, task perceptions, performance accuracy and mood. *International Journal of Psychophysiology, 72*(2), 217-227.

Fowler, G., Jameson, M. J., Lyons, D., Jeffers, T. A., Webster, J. & Petrie, J. C. (1991). Sphygmomanometers in clinical practice and research. In E. O'Brien, K. O'Malley (Ed.), *Handbook of hypertension, vol 14: blood pressure measurements*. Amsterdam: Elsevier, pp. 72-94.

Gendolla, G. H. E., Richter, M. & Silvia, P. J. (2008). Self-focus and task difficulty effects on effort-related cardiovascular reactivity. *Psychophysiology, 45*, 653-662.

Goldstein, I. B., Shapiro, D., Chicz-DeMet, A. & Guthrie, D. (1999). Ambulatory blood pressure, heart rate, and neuroendocrine responses in women nurses during work and off work days. *Psychosomatic Medicine, 61*, 387-396.

González-Bono, E., Salvador, A., Serrano, M. A. & Ricarte, J. (1999). Testosterone, cortisol and mood in sports team competition. *Hormones & Behavior, 35*, 55-62.

Greiner, B. A., Krause, N., Ragland, D. & Fisher, J. M. (2004). Occupational stressors and hypertension: a multi-method study using observer-based job analysis and self-reports in urban transit operators. *Social Science & Medicine, 59*(5), 1081-1094.

Hanson, E. K. S., Godaert, G. L. R., Maas, C. J. M. & Meijman, T. F. (2001). Vagal cardiac control through the day: the relative imporantance of effort-reward imbalance and within-day measurements of mood, demand and satisfaction. *Biological Psychology, 56*, 23-44.

Hausser, J. A., Mojzisch, A. & Schulz-Hardt, S. (2011). Endocrinological and psychological responses to job stressors: An experimental test of the Job Demand—Control Model. Psychoneuroendocrinology, 36, *2021-1031*.

Holleman, M., Vreeburg, S. A., Dekker, J. J. & Penninx, B. W. (2012). The relationships of working conditions, recent stressors and childhood trauma with salivary cortisol levels. *Pyschoneuroendocrinology, 37*(6), 801-809.

Johnson, S., Cooper, C., Cartwright, S., Donald, I., Taylor, P. & Millet, C. (2005) The experience of work-related stress across occupations. *Journal of Management Psychology, 20*, 178–87.

Kamarck, T. W., Janicki, D. L., Shiffman, S., Polk, D. E., Muldoon, M. F., Liebenauer, L. L. & Schwartz, J. E. (2002). Psychosocial demands and ambulatory blood pressure: a field assessment approach. *Physiology & Behavior, 77*, 699-704.

Kamarck, T. W., Shiffman, S .M., Smithline, L., Goodie, J. L., Paty, J. A., Gnys, M. & Jong, J. Y. (1998). Effects of task strain, social conflict, and emotional activation on ambulatory cardiovascular activity: daily life consequences of recurring stress in a multiethnic adult sample. *Health Psychology, 17*, 17-29.

Klumb, P. L. & Lampert, T. (2004). Women, work, and well-being 1950-2000: a review and methodological critique. *Social Science & Medicine, 58*, 1007-1024.

Kulkarni, S., O'Farrel, I., Erasi, M. & Kochar, M. S. (1998). Stress and hypertension. *Wisconsin Medical Journal*, *December*, 34-38.

Kunz-Ebrecht, S. R., Kirschbaum, C., Marmot, M. & Steptoe, A. (2004). Differences in cortisol awakening response on work days and weekends in women and men from Whitehall II cohort. *Psychoneuroendocrinology, 29*(4), 516-528.

Lucini, D., Riva, S., Pizzinelli, P. & Pagani, M. (2007). Stress management at the worksite: reversal of symptoms profile and cardiovascular dysregulation. *Hypertension, 49*(2), 291-297.

Matthews, K., Schwartz, J., Cohen, S. & Seeman, T. (2006). Diurnal cortisol decline is related to coronary calcification: CARDIA Study. *Psychosomatic Medicine, 68*, 657-661.

Mearns, J. & Cain, J. E. (2003). Relationships between teachers' occupational stress and their burnout and distress: roles of coping and negative mood regulation expectancies. *Anxiety, Stress and Coping: an International Journal, 16*(1), 71-82.

Mosely, J. V. & Linden, W. (2006). Predicting blood pressure and heart rate change with cardiovascular reactivity and recovery: results from 3-year and 10-year follow up. *Psychosomatic Medicine, 68*(6), 833-843.

Moya-Albiol, L., Salvador, S., González-Bono, E., Martínez-Sanchis, S. & Costa, R. (2001). The impact of exercise on hormones is related to autonomic reactivity to mental task. *International Journal of Stress Management. 8*, 215-229.

Moya-Albiol, L., Serrano, M. A. & Salvador, A. (2010a). Burnout as an important factor in the psychophysiological responses to a work day in teachers. *Stress and Health, 26*(5), 382-393.

Moya-Albiol, L., Serrano, M. A. & Salvador, A. (2010b). Job satisfaction and cortisol awakening response in teachers scoring high and low on burnout. *The Spanish Journal of Psychology, 13*(2), 629-636.

Moya-Albiol, L., Serrano, M. A., Salvador, A., González-Bono, E. & Rodríguez-Alarcón, G. (2005). Respuesta psicofisiológica de estrés en una jornada laboral. *Psicothema, 17*(2), 205-211.

Otero, J. M., Castro, C., Santiago, M. J. & Villardefrancos, E. (2010). Exploring stress, burnout and job dissatisfaction in secondary school teachers. *International Journal of Psychology and Psychological Therapy, 10*(1), 107-123.

Patacchioli, F. R., Angelucci, L., Dellerba, G., Monmazzi, P. & Leri, O. (2001). Actual stress, psychopathology and salivary cortisol levels in irritable bowel syndrome (IBS). *Journal of Endocirnology Investigation, 24* (3), 173-177.

Pollard, T. M., Pearce, K. L., Rousham, E. K. & Schwartz, J. E. (2007). Do blood pressure and heart rate responses to perceived stress vary according to endogenous estrogen level in women? *American Journal of Physical Anthropology, 132*(1), 151-157.

Pruessner, J. C., Hellhammer, D. H. & Kirschbaum, C. (1999). Burnout, perceived stress, and cortisol responses to awakening. *Psychosomatic Medicine, 61*, 197-204.

Ritvanen, T., Louhevaara, V., Helin, P., Väisänen, S. & Hänninen, O. (2006). Responses of the autonomic nervous system during periods of perceived high and low work stress in younger and older female teachers. *Applied Ergonomics, 37*, 311-318.

Rosmond, R., Dallman, M. F. & Björntorp, P. (1998). Stress-related cortisol secretion in men: relationships with abdominal obesity, endocrine, metabolic and hemodynamic abnormalities. *Journal of Clinical Endocrinology and Metabolism, 83*(6), 1853-1859.

Sandín, B., Chorot, P., Lostao, L., Joiner, T. E., Santed, M. A. & Valiente, R. M. (1999). Escalas de afecto positivo y negativo: validación factorial y convergencia estructural. *Psicothema, 11*, 37-51.

Scholtz, W., Hammerfald, K., Ehlert, U. & Gaab, J. (2011). Individual differences in the cortisol response to stress in young healthy men: testing the roles of perceived stress reactivity and threat appraisal using multiphase latent growth curve modeling. *Biological Psychology, 87*(2), 257-264.

Schommer, N. C., Hellhammer, D. H. & Kirschbaum, C. (2003). Dissociation between reactivity of the hypothalamus-pituitary-adrenal axis and the sympathetic-adrenal-medullary system to repeated psychosocial stress. *Psychosomatic Medicine, 65*(3), 450-460.

Serrano, M. A., Moya-Albiol, L. & Salvador, A. (2008). The role of gender in teachers' perceived stress and heart rate. *Journal of Psychophysiology, 22*, 58-64.

Serrano, M. A., Moya-Albiol, L. & Salvador, A. (2009). Estrés laboral y salud: indicadores cardiovasculares y endocrinos. *Anales de Psicología, 25*, 150-159.

Steptoe, A. & Wardle, J. (2005). Positive affect and biological function in everyday life. *Neurobiology of aging, 26S*, S108-S112.

Steptoe, A. & Marmot, M. (2005). Impaired cardiovascular recovery following stress predicts 3-year increases in blood pressure. *Journal of Hypertension, 23*(3), 529-536.

Unterbrink, T., Zimmermann, L., Pfeifer, R., Wirsching, M., Brahler, E. & Bauer, J. (2008). Parameters influencing health variables in a sample of 949 German teachers. *International Archives of Occupational and Environmental Health, 82, 117–23.*

Watson, D., Clark, L. A. & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

Weibel, L., Gabrion, I., Aussedat, M. & Kreutz, G. (2003). Work-related stress in an emergency medical dispatch center. *Annals of Emergency Medicine, 41* (4), 500-506.

Yang, X., Ge, C., Hu, B., Chi, T. & Wang, L. (2009). Relationship between quality of life and occupational stress among teachers. *Public Health, 123*, 750-755.

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