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

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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; Cladelles & 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). Additionally, longitudinal designs are preferred using biological variables in combination with subjective 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 Hypothalamic 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 autoregulation 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 could 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 (Rivnan, Louhevaara, Helin, Väisänen & Hänninen, 2006), living negative emotions during the day, especially when people suffer emotional instability (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 & Mar Parl, 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...
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, Ehler & 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 (Patacchioni, Angelucci, Dellerba, Monnazzi & 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, & 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 (Hauser, 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 voluntarily 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/m² (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 gratifying 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 ±3 mmHg. A presentable exhaust system for deflation (3 mmHg/sec) 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±2°C) and frozen at -20°C 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 ± SD. The alpha level was fixed at .05.

Results

Psychological measures

In PS5, 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 per-
ceived 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.](image)

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.

![Figure 3. SBP (A) and DBP (B) on both working days.](image)
Para HR, un efecto significativo para el factor “momento” ($F(2, 42) = 12.437, p < .001$), y para las interacciones “trabajo día*momento”, “momento*género” y “trabajo día*momento*género” se han encontrado ($F(2, 42) = 4.299; p < .05$, $F(2, 42) = 7.262, p < .01$, y $F(2, 42) = 5.265; p < .01$, respectivamente). El tercer orden de interacción señala que la evolución de HR en hombres en WD2 es diferente de mujeres o hombres en WD1; es decir, existe un aumento durante el día en WD2 ($F(1, 48) = 8.156, p < .01$).

**Cortisol**

Para $C$ levels, “trabajo día”, “momento” y su interacción son significativos ($F(1, 131.673) = 8.094, p < .05; F(1.590, 800.351) = 29.555, p < .001$ y $F(1.744, 39.661) = 2.208, p = .05$ respectivamente). La interacción señala que, con nulas diferencias estadísticamente significativas de $C$ niveles en ambos WDs, la evolución es diferente durante el día ($F(1, 46) = 23.199, p < .001$), con incremento en WD1 y disminución significativamente en WD2. En general, los $C$ niveles son mayores en WD2 que en WD1. Análisis post-hoc muestran que existen reducciones significativas en $C$ niveles en WD2 ($F(1, 46) = 21.686, p < .001$). Además, diferencias existen entre los días de trabajo y aquellos de medio día y final, debido a la reducción de post-hoc análises para el factor “momento” fueron realizados ($F(1, 47) = 65.168, p < .001; F(1, 46) = 93.066, p < .001$, respectivamente) (Figura 5A).

Para $C$ response, “momento” y la interacción “trabajo día*momento” son significativos ($F(1, 45) = 22.938, p < .001; F(1, 45) = 4.695, p < .05$, respectivamente). Análisis post-hoc muestran que en WD1 las diferencias tienen lugar en el momento y disminuciones hasta el final ($F(1, 47) = 25.116, p < .001$). Estas diferencias son mantenidas en WD2, aunque incremento en WD1, hay una disminución en WD2. Post-hoc analyses muestran que en WD1 hay un incremento en WD1 y disminución significativa en WD2. Cuando los WDs son comparados, hay una respuesta menos marcada en WD2, en el momento y en la noche ($F(1, 46) = 8.840, p < .01; F(1, 46) = 9.835, p < .01$, respectivamente) (Figura 5B). No se encontraron diferencias de género.

**Relaciones entre variables**

En WD1, la presión arterial es asociada con variables cardiovasculares. Concretamente, el PS en el trabajo es estadísticamente significativo y se relaciona con el $HR$ en el trabajo y el $HR$ al final ($r = -.300; p < .05$ y $r = -.310; p < .05$, respectivamente). Por lo tanto, el PS en el trabajo es negativamente relacionado con la SBP en el trabajo y al final y con la DBP en el trabajo ($r = -.302; p < .05; r = -.312, p < .05; r = -.283, p < .05$, respectivamente).

En WD2, el PS en el trabajo está asociado con una reducción de $C$ niveles ($r = -.338; p < .05$) y el PS de medio día y final HR ($r = .332, p < .05; r = .286, p < .05$, respectivamente). Además, el PS en el trabajo tiene una relación estadísticamente significativa a todos los puntos de $SBP$ ($r = -.341, p < .05; r = -.295, p < .05$ y $r = -.395; p < .01$), a $DBP$ en el trabajo y al final ($r = -.296; p < .05$; $r = -.357; p < .05$, respectivamente) y $C$ en el final ($r = -.392; p < .01$).
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 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-Sanchis & 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 Hauser 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 exclusively 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, con-

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