Burnout, Perceived Stress, and Cortisol Responses to Awakening

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Objective: The effects of burnout and perceived stress on early morning free cortisol levels after awakening were investigated in a group of teachers. Previous studies revealed that cortisol levels show a significant increase after awakening, with high intraindividual stability. **Methods:** Sixty-six teachers from local public schools (42 women and 24 men, mean age 42 ± 5 years) were asked to sample saliva for cortisol analysis on 3 consecutive days. On each day, cortisol levels were measured at the time of awakening and 15, 30, and 60 minutes thereafter. On the night before the third day, subjects took 0.5 mg dexamethasone orally for testing glucocorticoid feedback inhibition. Burnout and perceived stress were measured by three different questionnaires. **Results:** Perceived stress correlated with increases of cortisol levels during the first hour after awakening after dexamethasone pretreatment. In addition, teachers scoring high on burnout showed lower overall cortisol secretion on all sampling days, and a higher suppression of cortisol secretion after dexamethasone administration. In the subgroup of teachers with both high levels of perceived stress and high levels of burnout, a lower overall cortisol secretion was observed on the first 2 days, with stronger increases during the first hour after awakening after dexamethasone suppression. This subgroup also showed the lowest self-esteem, the highest external locus of control, and the highest number of somatic complaints. **Conclusions:** These results demonstrate differential effects of burnout and perceived stress on hypothalamic-pituitary-adrenal axis regulation. **Key words:** HPA axis, saliva, cortisol, stress, burnout, dexamethasone suppression test.

17-OHCS = 17-hydroxycorticosteroids; ACTH = adrenocorticotropin hormone; ANOVA = analysis of variance; CFS = chronic fatigue syndrome; CRF = corticotropin-releasing factor; DEX = dexamethasone; DST = dexamethasone suppression test; HPA = hypothalamus-pituitary-adrenal axis; MBI = Maslach Burnout Inventory; OC = oral contraceptives; PSS = Perceived Stress Scale; TBS = Teacher Burnout Scale.

INTRODUCTION

Burnout is a syndrome often observed in caregivers, eg, social service employees, nurses, or hospital staff, with physical symptoms including exhaustion, fatigue, headaches, and disturbed sleep patterns (1). In addition, nonspecific pain, reduced attention span, feelings of meaninglessness, apathy, or detachment from work can also be presented by burned out subjects (2, 3). Burnout is frequently observed in teachers. Teachers with inappropriate attitudes and responses toward students, loss of idealism, and a desire to change or quit the teaching profession often suffer from burnout. The continuing emotional burdens linked to caregiving professions and social services are thought to play a pivotal role in the etiology of this syndrome (4–6).

Besides the special environmental conditions linked to this condition, burnout shows a number of similarities with other psychosomatic disorders, eg, chronic fatigue syndrome. In CFS, symptoms also include physical exhaustion, fatigue, loss of energy, increased irritability, reduced accomplishment, and sleep and concentration difficulties (7). In contrast to burnout, the occurrence of CFS is not restricted to social service professionals. The cause of CFS is unknown, but it has been linked to a mild adrenocortical insufficiency, possibly resulting from a viral infection (8).

In addition, burnout shows associations with certain stress states. Although it is not regarded as a "classical" stress disorder, burnout often is preceded or accompanied by periods of acute or prolonged stress (9, 10). It is thought that excessive environmental demands that might be considered as stressful cause the development of inadequate emotional responses that can lead to the development of burnout (11, 12).

For some of the above-described behavioral conditions, an involvement of dysregulations of the hypothalamic-pituitary-adrenal axis has been reported (13–15). CFS has been associated with decreased basal activity of the HPA with reduced 24-hour urinary cortisol levels and lower basal afternoon cortisol levels. Moreover, after stimulation of the HPA by injection of corticotrophin-releasing factor (1 μg/kg), decreased ACTH concentrations were reported in the presence of normal cortisol levels when compared with a control group (16). The normal cortisol responses to lower levels of ACTH in subjects with CFS was compatible with the results from stimulation tests with synthetic $ACTH_{1-39}$, where patients showed increased sensitivity to small doses of $ACTH_{1-39}$, but a reduction in maximal responsiveness at higher doses. These char-

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acteristics are discussed as a mild form of adrenal insufficiency, perhaps resulting from a reduced CRF signal (13).

For acute versus chronic stress states, involvement of dysregulations of the HPA are less clear. Although it is generally accepted that situations of acute stress lead to an activation of the HPA axis in animals as well as in people (17–20), chronic stress has been associated with increased as well as decreased HPA activation. For example, some studies investigating the associations between chronic stress and HPA activity reported an increased basal activity of the HPA with higher urinary, plasma, or salivary cortisol levels, whereas others found evidence for lowered HPA activity in chronically stressed individuals (21–23). Early findings of decreased HPA activity suggested lower 17-OHCS levels (24), or lower basal plasma cortisol levels (25, 26) in chronic stress conditions, such as bereavement or awaiting an enemy attack in warfare. More recently, evidence for reduced HPA activity has also been reported in posttraumatic stress disorder, with hyposecretion of ACTH and cortisol under baseline conditions (27, 28). Lower cortisol stress responses to a laboratory stress task were observed in individuals suffering from chronic work stress (29). One explanation for the opposite regulations of the HPA seen in chronic stress could be that adaptational and coping processes are involved, and that the personality of the subjects might determine how HPA regulation is affected by the stressor (30).

With regard to burnout, however, no studies are available that investigate possible HPA dysregulations associated with this condition. Some authors proposed that burnout might result in lower basal HPA activity (31), inasmuch as the emotional exhaustion seen in burnout is similar to the fatigue seen in CFS. However, the often stressful work conditions of persons afflicted by burnout could also be regarded as a state of chronic stress, although no empirical proof for these hypotheses has been presented.

The present study was designed to investigate possible HPA dysregulations in burnout by using the morning cortisol response to awakening as an index of HPA activity. Awakening seems to represent an endogenous stimulation for the HPA (32–35). Results from this laboratory suggest that measurement of the cortisol response to awakening shows good intraindividual stability over time and that it can serve as a marker for HPA activity (36). Most recently, the morning cortisol increase was shown to be associated with prolonged psychological stress due to chronic work overload (37). Besides the assessment of the cortisol response to awakening, a low-dose dexamethasone test was included in this study (38). This test is more sensitive for diagnosis of decreased HPA activity than the standard procedure using 1 to 2 mg of DEX (39).

METHODS

Subjects and General Experimental Outline

A total of 66 teachers were investigated. The group consisted of 42 female and 24 male teachers with a mean age of 43.6 ± 9.5 years. All teachers were medication-free except for 17 women using oral contraceptives. The teachers were recruited through their principals to participate in a study investigating the association between stress and endocrine parameters. After recruitment, all study materials were sent to the teachers. Teachers gave written informed consent for participation in the study. After completion of the study, teachers either returned all materials to the laboratory or materials were picked up by employees of our institute. There was no monetary incentive for participation.

Teachers were asked to sample saliva for cortisol assessment on 3 working days. On the third day of saliva sampling, a low-dose dexamethasone suppression test was performed (see below). On each sampling day, teachers were asked to complete a state questionnaire providing information about health status, acute stress, and daily activities. Besides these state questionnaires, all teachers also completed personality and health inventories (see below).

Saliva Collection

On 3 work days, teachers were asked to sample saliva at the time of awakening and 15, 30, and 60 minutes thereafter. Because classes started for all teachers at 8:00 AM, the sampling period ranged from 5:30 to 7:30 AM. Sampling was performed with the Salivette (Sarstedt; Rommelsdorf, Germany). Teachers were informed about the necessity of strictly following the time schedule for saliva sampling to obtain valuable data. Furthermore, they were instructed that saliva sampling should be completed within a 1-week period after reception of all study materials. Subjects were instructed to start saliva sampling immediately at the time of awakening and to stay in bed until the second saliva sample was obtained, ie, 15 minutes after awakening. Also, subjects were asked to complete sampling before breakfast to avoid contamination of saliva with food or drinks. If the normal daily routine did not allow following this sampling procedure, teachers were instructed to wait at least half an hour before breakfast. Also, subjects were asked not to brush their teeth before completion of saliva sampling, in order to avoid contamination of saliva with blood through microinjuries in the oral cavity. Teachers were additionally instructed to store all samples in the freezer until the return of the samples to the laboratory. When returning the samples to the laboratory, the sampling in accordance with the guideline was again confirmed.

Dexamethasone Suppression Test

On the night before sampling day 3, all teachers took 0.5 mg of dexamethasone orally (Jenapharm; Jena, Germany). Teachers were instructed to ingest the DEX tablet between 10:00 and 11:00 PM. Saliva assessment during the next morning was identical to the first 2 experimental days.

Demographic and Psychological Assessment

On each sampling day, teachers were asked to provide specific information about alcohol consumption, total hours of sleep, time of

awakening, and self report of health status and acute stress. For this purpose, a state questionnaire was provided for each day. Information on sex, age, height, and body weight was obtained once with a demographic questionnaire.

In addition, teachers completed several trait questionnaires. Assessment of burnout was performed with two different questionnaires. First, a German version (40) of the Maslach Burnout Inventory was used (41). As in the English version, this questionnaire has three scales with a total of 22 items (emotional exhaustion, 9 items, eg, "I feel burned out from my work," "reduced efficiency"; 8 positively formulated items, eg, "I feel animated when working closely together with my students"; depersonalization, 5 items, eg, "I do not really care what happens to my students"). Each item is ranked on a 7-point scale, ranging from "never" to "daily."

A second questionnaire was used that was originally designed exclusively for the assessment of burnout in teachers. The Teacher Burnout Scale consists of 21 items that are ranked on a 6-point scale ranging from "totally disagree" to "totally agree" (42). The 21 items constitute four scales (job satisfaction, 5 items, eg, "I look forward to teaching in the future"; perceived administrative support, 6 items, eg, "I receive adequate praise from my supervisors for a job done well"; coping with job-related stress, 6 items, eg, "I feel depressed because of my teaching experiences"; attitudes toward students, 4 items, "The students act like a bunch of animals").

Furthermore, an additional questionnaire was used for the assessment of locus of control. The Questionnaire of Competence and Control consists of 32 items that rank on a 6-point scale ranging from "totally wrong" to "completely right" (43). The statements are divided into four subscales with eight statements each (self-concept of own competence, eg, "Sometimes I feel inactive and devoid of ideas"; internality, eg, "Whether I will have an accident or not, solely depends on my own behavior"; powerful others control, eg, "Other people often prevent realization of my own personal plan"; chance, eg, "Many events in my life happen by chance").

Assessment of stress was performed with the Perceived Stress Scale (44). This questionnaire consists of 14 items of which 7 are positively formulated (eg, "In the last month, how often have you felt that things are going your way?") and 7 are negatively formulated (eg, "In the last month, how often have you felt that you were unable to control the important things in your life?"). The PSS can be used for the assessment of nonspecific, appraised stress during the last month.

Finally, a questionnaire for the subjective assessment of bodily complaints was used in this study. The Freiburger Checklist of Bodily Complaints is available in several versions (45). Here, a shorter version of 36 items that are each rated with six categories ranging from "never" to "very often" was used. The 36 items form four subgroups of complaints: cardiovascular complaints, gastrointestinal complaints, somatoform complaints, and pain. The four subscales are also aggregated in one scale called general bodily complaints.

Cortisol Analysis

Salivary cortisol was analyzed with a time-resolved fluorescence immunoassay described in detail elsewhere (46). Here, a stable cortisol-biotin conjugate is used in combination with rabbit cortisol antibodies for assessment of cortisol concentrations in saliva. Intra- and interassay variability were less than 10% and 12%, respectively.

Statistical Analysis

To test specific effects on cortisol levels, several groups were built to enter as independent variables in subsequent ANOVAs. For the variable "burnout," the seven subscales of the two burnout questionnaires were z transformed and then aggregated into a single variable, providing a mean of 0 and a SD of 1.0. This variable was used to build a group consisting of teachers scoring high on the burnout scales (individual $z > 0$) and a low burnout group (individual $z < 0$). For gender and use of oral contraceptives, dummy variables were introduced. The perceived stress score of the PSS was median split, providing two groups of teachers with high or low stress, respectively. The median split was preferred before the mean split to allow differential analysis of both the effects of burnout and perceived stress on the cortisol levels.

Two-way (day by time) within-subject ANOVAs with repeated measurements on both factors were computed to test the cortisol increase after awakening, differences between the days, and the effect of dexamethasone on the early morning free cortisol levels. Three-way (group by day by time) within-subject ANOVAs with repeated measurements on two factors (day by time) were computed to test effects of several factors on the early morning cortisol levels, ie, burnout, stress, gender, and use of oral contraceptives within the group of women. When significant, these factors were controlled for as covariates in subsequent ANOVAs.

Where ANOVA procedures revealed significant interactions, Newman-Keuls post hoc tests were used to specify statistical effects. Also, in case of significant results, effect sizes were computed. In case of insignificant results, the power of the respective test was computed according to Cohen (47). Adjustment of degrees of freedom was used according to Greenhouse-Geisser, where appropriate.

RESULTS

The assessment of cortisol levels during the first hour after awakening showed significant increases on all 3 days, with attenuated levels after dexamethasone treatment. Figure 1 shows the early morning free cortisol levels on the 3 days for all time points.

On days 1 and 2, early morning free cortisol levels showed a highly significant 50% to 70% increase within the first half hour after awakening ($F(3,180) = 30.8$; $p < .001$). Free cortisol levels increased from about 15 nmol/liter at the time of awakening to 25 nmol/liter 30 minutes thereafter on both days. After

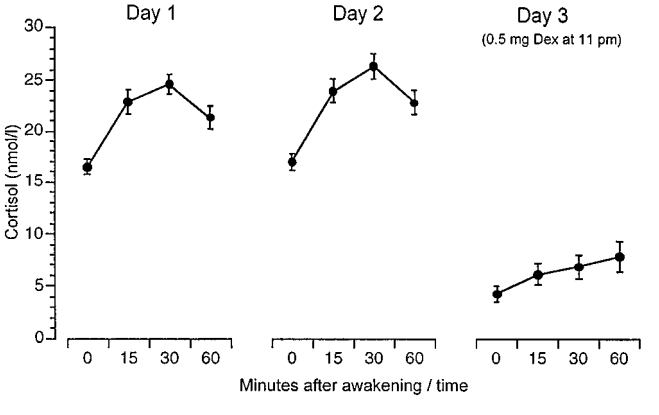

Fig. 1. Mean salivary cortisol levels (± SE) on 3 days at 0, 15, 30, and 60 minutes after awakening. On day 3, an overnight low-dose dexamethasone suppression test (DST, 0.5 mg) was performed.

administration of dexamethasone on day 3, free cortisol levels were significantly lower at the time of awakening and showed a smaller but still significant increase from 4 nmol/liter at the time of awakening to 7 nmol/liter 60 minutes thereafter ($F(3,180 = 7.2$; $p < .001$). The effect size for the cortisol increase after awakening on days 1 and 2 was $f^2 = .42$, explaining 30% of the variability in the early morning free cortisol levels ($\omega^2 = .30$). On day 3, the effect size for the cortisol increase was $f^2 = .10$, explaining 9% of variability in the free cortisol levels of day 3 ($\omega^2 = .09$).

Testing effects of gender and use of oral contraceptives revealed significant differences in the early morning free cortisol levels after awakening. Women showed higher increases in cortisol levels than men in the first hour after awakening, and within the group of women the use of oral contraceptives resulted in overall lower cortisol levels. Inasmuch as these effects have been reported previously in other samples, they are not presented here in detail (36). Because of their significance, gender and use of oral contraceptives were entered as covariates in subsequent ANOVAs. Testing effects of state variables, ie, total amount of hours slept, time of going to bed, and alcohol consumption on level or increase of early morning free cortisol levels did not reveal any significant differences (all F values < 1, $p > .20$).

Next, the effect of burnout on the early morning free cortisol levels was investigated. Spearman rank intercorrelations between the seven burnout scales ranged between $r = .34$ and $r = -.64$, suggesting that the seven scales assessed different aspects of burnout. Transformation of the seven burnout scales into one z variable and splitting it at 0 revealed 36 teachers (mean $z = -2.04$; SD 1.22) who formed a low burnout group. Thirty teachers (mean $z = 2.59$; SD 1.62) were assigned to the high burnout group. U tests showed that the teachers assigned to high and low burnout differed significantly on all seven scales ($p < .001$) of the two burnout questionnaires, indicating that the two burnout groups discriminated between the several aspects of burnout assessed in the two questionnaires. Figure 2 shows the z scores of the seven burnout scales of the two questionnaires for the two burnout groups.

Teachers in the high burnout group showed lower cortisol levels on all 3 days ($F(1,64) = 15.3$; $p < .001$). The effect size for burnout was $f^2 = .27$, explaining 21% of variability of the early morning cortisol levels ($\omega^2 = .21$). There was no significant interaction (burnout by days), or (burnout by time), respectively. Figure 3 shows the early morning free cortisol levels on all 3 days for teachers with low and high burnout.

The combination of the two burnout questionnaires for identification of the teachers suffering from high

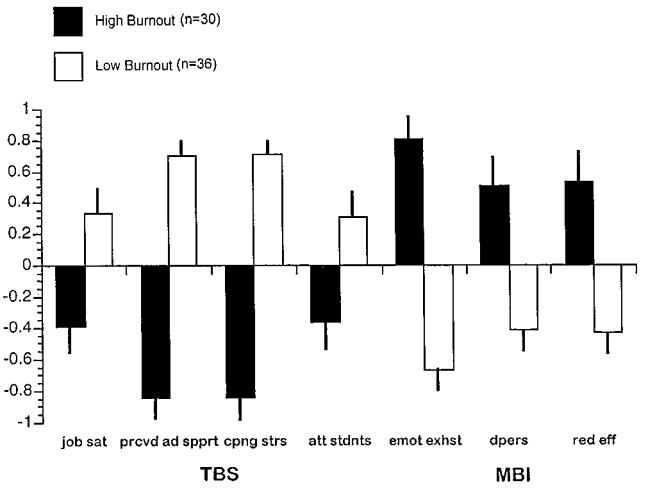

Fig. 2. Scores of the two burnout groups for seven subscales of two burnout questionnaires. TBS = Teacher Burnout Scale; job sat = job satisfaction; prcvd ad spprt = perceived administrative support; cpng strs = coping with job-related stress; att stdnts = attitudes toward students; MBI = Maslach Burnout Inventory; emot exhst = emotional exhaustion; dpers = depersonalization; red eff = reduced efficiency. All group differences are significant with $p < .05$ (U test).

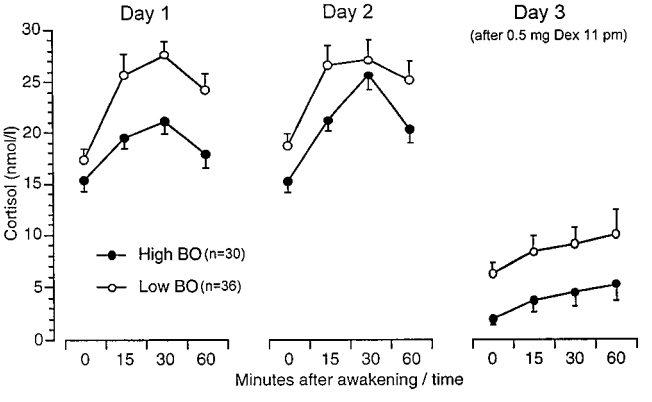

Fig. 3. Mean salivary cortisol levels (± SE) for two groups of teachers with low and high burnout (BO) on 3 days at 0, 15, 30, and 60 minutes after awakening. On day 3, an overnight dexamethasone suppression test (0.5 mg) was performed.

levels of burnout resulted in the most apparent endocrinological differences. Differentiating high and low burnout with the MBI alone resulted in groups of 34 teachers with low and 32 with high burnout, with significantly lower cortisol levels in the teachers with high burnout, but a reduced effect size ($F(1,64) = 7.3$, $p < .01$). Similar findings can be reported for use of the TBS alone. Here, differentiation of two groups with high ($N = 28$) and low ($N = 38$) burnout resulted in lower cortisol levels for the high burnout group ($F(1,64) = 5.9$, $p < .01$).

Because the comparability of cortisol samples after dexamethasone administration on day 3 with the cor-

tisol levels on the first 2 days is limited, ANOVAs were also performed separately for the first 2 days, and for the third day. The respective (burnout by day by time) within-subject ANOVA for the first 2 days revealed an effect for the factor (burnout) of $F(1,64) = 10.67$; $p = .002$, with an effect size of $f^2 = .16$, ($\omega^2 = .14$). The respective two-way (burnout by time) within-subject ANOVA for the four cortisol samples of the third day revealed an effect of $F(1,64) = 7.31$; $p < .01$, with an effect size of $f^2 = .11$ ($\omega^2 = .10$).

Next, the association between perceived stress and cortisol secretion was investigated. The mean score of the PSS for this sample was 26.3, with a median of 25 and a SD 6.95 and scores ranging from 8 to 52. Dividing the group at the median resulted in 33 teachers with low (15.4 ±3 .5) and 33 teachers with high (35.8 ± 6.4) perceived stress. An ANOVA analysis suggested that perceived stress scores did not have a significant effect on cortisol responses to awakening on the first 2 days ($F < 1$; $p > .20$). On the third day, however, the interaction (stress by time) was significant ($F = 3.4$; $p = .02$; after Greenhouse Geisser correction). Figure 4 shows the cortisol samples during the first hour after awakening for the two stress groups on day 3.

Teachers reporting high levels of perceived stress showed an identical initial suppression of cortisol levels after dexamethasone pretreatment, followed by stronger increases during the first hour after awakening. Although cortisol levels were comparable between the two groups at the time of awakening, they were 2-fold increased 60 minutes after awakening. Newman-Keuls post hoc tests indicated that the two groups were significantly different starting 15 minutes after awakening.

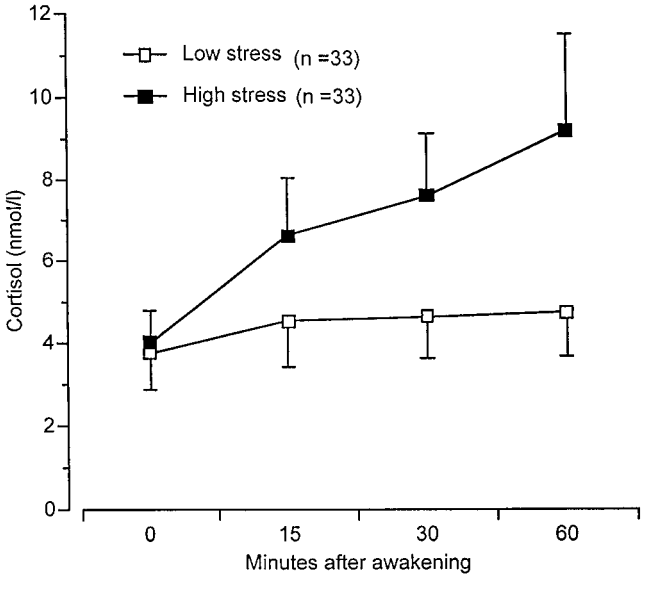

Fig. 4. Mean salivary cortisol levels after an overnight 0.5 mg DST for two groups of teachers with high and low perceived stress.

Next, the differential effects of burnout and perceived stress on the endocrine variables were investigated. χ^2 tests were performed to investigate the distribution of chronic stress and burnout in the total group. From the 33 teachers reporting high levels of stress, 20 also reported high levels of burnout. From the 33 teachers with low levels of stress, only 10 reported high levels of burnout ($\chi^2 = 6.12$; $p < .01$). A within-ANOVA score was computed to compare burnout and stress scores with the cortisol levels after dexamethasone suppression. Results from ANOVA suggested that the effects of burnout and perceived stress on the cortisol secretion were independent from each other (all p values $> .20$), with burnout determining the level of cortisol suppression after dexamethasone, and stress scores determining the increase.

Finally, associations between burnout, perceived stress, and psychological and health variables were investigated by performing multiple t tests. For most of the personality and health variables, significant differences occurred. In the group with high scores in both burnout and stress, the number of pain-related complaints was twice as high compared with the other groups. For the personality variables, high scores in burnout and stress resulted in the lowest levels of self-confidence, internality, and highest levels of social and fatalistic externality. Table 1 shows the mean scores of the psychological and physical complaints variables in the four groups and indicates the significant differences between them.

DISCUSSION

The results of the present study suggest a dysregulation of HPA axis functioning in burnout. Teachers with high levels of burnout showed blunted cortisol levels during the first hour after awakening on 2 consecutive days and an increased suppression of cortisol levels after DEX on a third day. This effect was independent of the amount of perceived stress. High levels of perceived stress were associated with stronger increases of cortisol levels after awakening after a low-dose dexamethasone pretreatment the night before. The nonsignificant interaction of perceived stress and burnout suggests that the HPA activity might be independently affected by conditions of chronic stress and burnout, respectively.

It is noteworthy that with the combination of two different burnout questionnaires the reported endocrinological differences were most pronounced. The MBI focuses on feelings of exhaustion, detachment from

TABLE 1. Mean ± SD of Personality and Health Variables in the Four Groups with High and Low Stress and High and Low Burnout Scores, Respectively

	High Burnout		Low Burnout	
	Low stress	High stress	Low stress	High stress
N	10	20	23	13
Self-concept	34.1 ± 3.47[a]	**27.0** ± 6.02[b]	34.0 ± 6.5	32.07 ± 4.83
Internality	34.8 ± 2.82	29.5 ± 5.66	33.26 ± 5.2	32.46 ± 2.81
Powerful others control	25.1 ± 5.32	**29.8** ± 5.3	23.95 ± 4.19	26.69 ± 4.6
Chance	22.8 ± 5.0	26.0 ± 5.47	21.86 ± 4.57	21.84 ± 5.17
Physical complaints	27.9 ± 19.63	**48.1** ± 21.2	21.52 ± 14.7	21.61 ± 13.9

[a] Mean ± SD.
[b] Bold print indicates significant group versus mean differences ($p < .01$; $N = 66$).

work, and a loss of drive as observed in all social service professions. The TBS, in contrast, was designed to address more specifically the problems a teacher is confronted with, ie, administrative support, attitudes toward students, and leadership. It seems that using both questionnaires resulted in the best key to identify unsatisfied, chronically stressed, and burned out teachers. Endocrinologically, this seems to be reflected in lower cortisol levels at and during the first hour after awakening, and a stronger suppression of cortisol after dexamethasone pretreatment. Future studies need to elucidate whether there is a direct link between the degree of exhaustion and fatigue often reported in burnout, and the lower cortisol secretion in these teachers. It is of interest in this regard that a decreased HPA responsiveness has also been reported for CFS patients (7).

Inasmuch as perceived stress was not associated with differences during the first 2 sampling days but a stronger increase after dexamethasone pretreatment, there seems to be a significant difference between stress as measured with the TBS and the perceived stress as measured with the PSS. We suggest that a key factor for differentiation between the two is the chronicity and exhaustion. The TBS measures the degree of stress that the teachers were not willing to accept for a prolonged period, resulting in the desire to quit the teaching profession. The PSS, in contrast, asks for the ability to cope with the current stress load, and does not cover feelings of exhaustion. A recent study in students suffering from chronic work overload reported higher cortisol increases after awakening (37). The inability to find these effects on the first 2 sampling days in the present study could be due to the differences of the stress scale used, different sample/effect sizes, or the different populations investigated. However, the larger increases of cortisol levels after DEX seen in teachers who reported high levels of stress extends the recent findings to suggest a decreased feedback sensitivity in these subjects. In animal models, it has been shown that chronic stress can lead to higher glucocorticoid stress responses by facilitation of the HPA response over time (48). Here, chronic stress is thought to result in increased catecholaminergic input to CRF-containing cells, which in turn leads to increased ACTH and glucocorticoid levels.

Another interesting observation of the present study is that teachers with both high levels of stress and high levels of burnout showed the highest number of bodily complaints and the lowest self-esteem. Because self-esteem has been reported previously as being associated with burnout, the question occurs whether it can be regarded as a risk factor for the development of the burnout syndrome, together with the accompanying endocrine changes. Future studies will need to investigate the role of self-esteem in that regard.

It should be mentioned that the present study used a method for the assessment of HPA functioning that was developed and evaluated by this laboratory very recently (36). Results obtained with different populations suggested that the magnitude of the cortisol increase within the first 30 minutes after awakening is very comparable to that after pharmacological stimulation. The cortisol response after awakening shows a close association with $ACTH_{1-24}$ (Synacthen)-induced cortisol secretion, suggesting that the increase might reflect adrenal capacity or sensitivity, or both, for ACTH (Kirschbaum et al., in preparation). In contrast to pharmacological tests in the laboratory, the assessment of the morning cortisol increase can be easily performed in the subject's natural environment with only minimal divergence from daily routines. Thus, this technique could be a valuable addition to the toolbox of the psychosomatic researcher.

Finally, some restrictions apply to the study that call for cautious interpretation of the findings. Due to its cross-sectional design, the study cannot deliver "cause or effect analyses" to describe the complex relationships between the different variables investigated. Although there is evidence that work stress

often precedes the development of burnout, it has been shown that it does not necessarily result in burnout (1). Also, no other endocrine parameters were available from this sample; thus no statements can be made about circadian rhythmicity and HPA reactivity to pharmacological stimulation.

In conclusion, the results of the present study suggest cumulative effects of perceived stress and burnout on psychological and health variables, with differential effects on HPA axis activity. The present data provide preliminary support for the idea that stresses and strains do not necessarily affect a hormonal stress system in only one direction. Although some methodological restrictions apply, these data could set the stage for more complex and dynamic models of HPA regulation in response to specific environmental or endogenous demands.

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