International Journal of Behavioral Medicine
2007, Vol. 14, No. 4, 213–221

Is Burnout Related to Allostatic Load?

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Background: *Burnout has a negative impact on physical health, but the mechanisms underlying this relation remain unclear. To elucidate these mechanisms, possible mediating physiological systems or risk factors for adverse health in burned-out employees should be investigated.* Goal: *The aim of the present study among 290 Dutch managers was to explore whether allostatic load mediates the relationship between burnout and physical health.* Method: *Burned-out managers, as identified with the Maslach Burnout Inventory General Survey (MBI-GS), were compared with a healthy control group with regard to their allostatic load. The allostatic load index included eight parameters: Body-mass index (BMI), systolic and diastolic blood pressure (SBP and DBP), C-reactive protein (CRP), high-density lipoprotein (HDL), cholesterol, glycosylated hemoglobin (HbA1C) and glucose.* Results: *Contrary to expectations, burned-out managers did not differ from healthy managers with regard to their scores on the allostatic load index. An additional analysis, using groups of managers in the extreme deciles of exhaustion (the core symptom of burnout), did also not reveal differences in allostatic load.* Conclusion: *Burnout seems not to be associated with this proxy measure of allostatic load. The mediating physiological mechanisms between burnout and objective physical health remain to be elucidated.*

Key words: Allostatic load, blood pressure, burnout, cholesterol, glucose, physical health

Burnout is defined as a work-related syndrome, primarily caused by a demanding work environment (Halbesleben & Buckley, 2004; Maslach, Schaufeli, & Leiter, 2001). Accumulated evidence suggests that burnout has a negative impact on physical health, for example, on cardiovascular disease, diabetes, or common infections (Shirom, Melamed, Toker, Berliner, & Shapira, 2005). However, the mechanisms linking burnout with negative physical health outcomes are unclear (Leiter & Maslach, 2001; Maslach et al., 2001). To elucidate these mechanisms, possible mediating physiological systems or risk factors for adverse health in burned-out employees should be investigated.

We will use the concept of *allostatic load*—a broad comprehensive measure of biological risk encompassing multiple regulatory systems—and investigate whether this concept can be considered a mediating physiological system between burnout and adverse health. McEwen (1998) has proposed the allostatic load concept to describe how daily stress is related to health and disease. The central aim of the present study is to explore whether burnout is associated with allostatic load as an index of bodily disregulation due to chronic stress.

Relationships between Burnout and Physical Health

Burnout is usually defined as a three-dimensional syndrome, characterized by *exhaustion* (the draining of energy), *cynicism* (the development of negative, cynical attitudes towards one's work), and *reduced professional efficacy* (the belief that one is no longer effective in fulfilling one's job responsibilities; Maslach et al., 2001). Although some discussion exists about the constituting elements of burnout, there is consensus about exhaustion as being its hallmark (Kristensen, Borritz, Villadsen, & Christensen, 2005; Shirom et al., 2005). Burnout is primarily associated with high job demands and poor job resources and can be found among employees in a wide range of occupations (Bakker, Demerouti, & Schaufeli, 2002; Schaufeli & Enzmann, 1998). The syndrome has been found to

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be an independent risk factor for myocardial infarction (MI; Appels & Schouten, 1991), infections (e.g., common cold; Mohren, Swaen, Kant, Van Amelsfoort, Borm, & Galama, 2003), and type 2 diabetes (Melamed, Shirom, & Froom, 2003).

Several researchers have proposed that the relationship between burnout and physical health is mediated by (stress) physiological mechanisms (see Melamed, Shirom, Toker, Berliner, & Shapira, 2006). Specifically, three such mechanisms have been suggested.

First, the relationship between burnout and physical health may be mediated by *metabolic* processes. It has, for example, been shown that burnout is a risk factor for coronary heart disease (CHD) because of elevated cholesterol levels and high glucose levels (Melamed, Kushnir, & Shirom, 1992; Shirom, Westman, Shamai, & Carel, 1997). The study of Grossi, Perski, Evengard, Blomkvist, and Orth-Gomer (2003) showed that women with burnout showed higher levels of glycosylated hemoglobin (HbA1C) than their non-burned-out counterparts. HbA1C is an integrated estimate of glucose metabolism during preceding weeks.

A second physiological process through which burnout may influence physical health is the process of *micro-inflammation* (among other things measured by C-reactive protein [CRP]). It has been shown that burnout in women (but not in men) is positively associated with micro-inflammation, expressed by elevated concentrations of CRP (Toker, Shirom, Shapira, Berliner, & Melamed, 2005).

Third, a more direct reflection of the role of stress and its potential effects on health is a disregulated *hypothalamic-pituitary-adrenal-axis* (HPA-axis), usually measured through cortisol. Studies that examined the relationship between burnout and cortisol have, however, produced inconsistent findings. Elevated cortisol levels during a working day (Melamed, Ugarten, Shirom, Kahana, Lerman, & Froom, 1999) or in the first hr after awakening (De Vente, Olff, Van Amsterdam, Kamphuis, & Emmelkamp, 2003; Grossi, Perski, Ekstedt, & Johansson, 2004) have been reported among those relatively high in burnout. In contrast, lower cortisol levels after awakening (Mommersteeg, Keijsers, Heijnen, Verbraak, & Van Doornen, 2006b; Pruessner, Hellhammer, & Kirschbaum, 1999) have also been reported, whereas other recent studies did not find any difference in cortisol day-levels between burned-out individuals and healthy controls (De Vente et al., 2003; Grossi et al., 2003; Moch, Panz, Joffe, Havlik, & Moch, 2003; Mommersteeg, Heijnen, Verbraak, & Van Doornen, 2006a).

Taken together, there is some evidence that burnout is related to physical health and that at least three mediating mechanisms may be involved. Unfortunately, the majority of studies has only focused on the effects of burnout on specific, individual (stress) physiological mechanisms, whereas many different physiological systems, probably in concert, might be involved in this relationship. A focus on individual physiological indicators does not address the possibility that the risk is conferred through a complex of interrelated physiological disregulations. Therefore, in order to further understand the relationship between burnout and physical health, the current study uses an index that takes different regulatory systems into account. At the core of this index lies the concept of allostatic load (Seeman, Singer, Rowe, Horwitz, & McEwen, 1997), a broad comprehensive measure of biological risk encompassing multiple regulatory systems, thus reflecting a multicomponent view of physiological risk.

Allostasis and Allostatic Load

Allostasis ("maintaining stability, or homeostasis, through change") refers to the process of adaptation to stress of the neuroendocrine system, autonomic nervous system, and immune system (Sterling & Eyer, 1988). When activated as a result of stressors (e.g., job demands), allostatic responses promote adaptation to stress (McEwen, 2003). However, in case stress responses are not turned off after duty, or are overused by excessive challenge, their long-term effects may be damaging, and may lead to cumulative wear and tear on the body's physiological systems. This condition is called allostatic load (McEwen, 1998), and is the price the individual has to pay for being forced to adapt to chronic challenges and adverse environments. For instance, it has been found that job demands are positively related to allostatic load, whereby this effect appeared to be stronger in older participants (Schnorpfeil, Noll, Schulze, Ehlert, Frey, & Fischer, 2003). In a longitudinal study, higher baseline allostatic load scores were found to predict an elevated incidence of cardiovascular disease, as well as an increased risk for decline in physical and cognitive functioning (Seeman et al., 1997).

In order to study the concept of allostatic load, most researchers use a multi-system summary measure. The original operationalization comprised assessments of ten biological parameters, including cortisol, dehydroepiandrosterone (DHEAS), epinephrine, norepinephrine, systolic and diastolic blood pressure (SBP and DBP), waist-hip ratio (WHR), cholesterol, HbA1C, and high-density lipoprotein (HDL; Seeman et al., 1997). These parameters reflect functioning of the HPA-axis, sympathetic nervous system, cardiovascular system, and metabolic processes. Recently, other operationalizations of allostatic load have been used, by adding glucose to the original operationalization while eliminating HbA1C, DHEAS, and cortisol (Kubzansky, Kawachi, & Sparrow, 1999), or by adding body-mass index (BMI), CRP, tumor necrosis factor alpha (TNF-α), and albumin to the original operationalization (Schnorpfeil et al., 2003).

As already mentioned, burnout is primarily caused by high job demands; and high job demands, in turn, are positively related to an index of allostatic load. Therefore, and together with the above-mentioned constellation of findings, it is to be expected that burnout is positively associated with an index of allostatic load. In the present study, we will test this hypothesis by comparing burned-out managers with healthy controls working for the same company. We selected the burned-out group based on their score on all three scales of the Maslach Burnout Inventory (cf. Schaufeli, Bakker, Schaap, Kladler, & Hoogduin, 2001). In an additional analysis, we compared exhausted managers with healthy controls regarding their allostatic load because exhaustion is considered to be the core dimension of burnout (Brenninkmeijer & Van Yperen, 2003; Maslach et al., 2001; Shirom et al., 2005).

Method

Participants and Procedure

The sample included 338 managers employed at a Dutch Telecom Company. They filled in a questionnaire on employee health and well-being, and participated in a voluntary medical check-up that was carried out by an independent Occupational Health Service. The survey was sent through surface mail along with a cover letter to the home addresses of 450 managers, of which 338 returned the completed survey in a prestamped envelope (response rate = 75%). In the cover letter, the managers were asked to contact the Occupational Health Service in order to make an appointment for a general medical health check up. In total, 321 managers (response rate = 71%) made this appointment and completed the check-up. Due to their small number ($n = 31$), women were excluded from the analyses. The mean age of the final sample ($n = 290$) was 43 years ($SD = 8.0$); 58.9% completed at least college. All participants underwent the medical health check-up during working hours, and they did not receive any monetary reward for participation.

Measures Questionnaire

Burnout was measured with the Dutch version (Schaufeli & Van Dierendonck, 2000) of the Maslach Burnout Inventory—General Survey (MBI-GS; Schaufeli, Leiter, Maslach, & Jackson, 1996). The Dutch MBI-GS includes fifteen items and taps three subscales, namely *exhaustion* (five items; e.g., "I feel mentally exhausted because of my work"; $\alpha = .87$), *cynicism* (four items; e.g., "I doubt the significance of my work"; $\alpha = .78$), and *professional efficacy* (six items; e.g., "I can effectively solve the problems that arise in my work"; $\alpha = .77$). All items are scored on a 7-point scale ranging from 0 (*never*) to 6 (*every day*). High scores on exhaustion and cynicism and low scores on professional efficacy are indicative of burnout.

Physiological Indicators

The employee survey also contained questions about the managers' medical history, and their cigarette and alcohol consumption. At the medical check up, anthropometric (e.g., length, weight) data were obtained. SBP and DBP were measured after 5 min of rest in a seated position, and calculated as the average of two consecutive blood readings. Blood samples for assays of CRP, cholesterol, HDL, HbA1C, and glucose were also obtained during this session, and processed according to standard laboratory procedures.

Allostatic Load

The allostatic load index was constructed using the following eight physiological indicators: SBP, DBP, BMI, CRP, cholesterol, HDL, HbA1C, and glucose. Plasma levels of cholesterol and HDL were included as measures of lipid status and HbA1C is an integrated measure of glucose metabolism over the past weeks. SBP, DBP, cholesterol, HDL, and HbA1C were also included in the original operationalization of allostatic load, as introduced by Seeman et al. (1997). Additionally, and in line with Schnorpfeil et al. (2003), we included BMI as an indicator of adverse nutritional intake, and CRP as an indicator of inflammation. Furthermore, plasma level of glucose was included as an indicator of metabolic functioning, in line with the study of Kubzansky et al. (1999). This operationalization of allostatic load focuses on physiological indicators that are all related to abnormal metabolism and risk for cardiovascular disease (McEwen, 2000). In the allostatic load sequence, these indicators are called secondary outcomes, and they are supposed to be the result of primary mediators (e.g., cortisol, DHEAS, and catecholamines; McEwen, 2000). Because of this focus on secondary outcomes, without including primary mediators, our allostatic load index should be considered a proxy measure of allostatic load.

Two total scores on allostatic load were calculated following previously used definitions (e.g., Seeman et al., 1997). For the first allostatic load index, standard scores were calculated for each included physiological indicator, after which the allostatic load index was computed as the sum of the z-scores of each physiological indicator. In this way, the allostatic load score represents an index of the distance of each individual to the mean of the total sample. However, summing up levels of activity across systems may obscure the impact of elevations in a subset of systems that contribute to allostatic load (Seeman et al., 1997). Therefore, as a comparison, we also calculated a second allostatic load

score as the sum of the number of physical indicators for which the subjects fell into the highest-risk quartile based on the distribution of scores in the total sample. All analyses will be performed on both operationalizations of allostatic load.

Data Analysis

The presence of burnout was defined as having an individual score on the burnout questionnaire (MBI-GS), according to the following inclusion criteria: 1) exhaustion >= 2.2 and 2) either cynicism > 2.0, or professional efficacy <= 3.66. The clinical validity of these cut-off scores has been demonstrated in various Dutch studies using employees who receive professional psychotherapeutic treatment (Brenninkmeijer & Van Yperen, 2003; Roelofs, Verbraak, Keijsers, De Bruin, & Schmidt, 2005; Schaufeli et al., 2001). Thus, the 33 managers in the present study who fulfilled these criteria (the burned-out group) have burnout levels that are similar to those who receive psychotherapeutic treatment for their burnout complaints. The remainder of the sample was considered the control group (n = 257). Burnout prevalence in our study (11%) was slightly higher than burnout prevalence in the general Dutch working population (8%–11% in the period of 1997–2004, www.statline.nl).

Prior to the analyses, all study variables were tested for normality. The demographic variables and the burnout scales were normally distributed, allowing multivariate analysis of variance (MANOVA). The allostatic load indices and all physiological indicators also showed a normal distribution, except CRP, which was skewed to the right. However, transformations on CRP do not normalize the distribution; therefore, the raw values are used. Differences between the two groups on the physiological indicators are analyzed using MANOVA, and differences on the two allostatic load indices are tested with two separate analyses of variance (ANOVA).

As noted before, exhaustion is generally considered to be the core component of burnout. Therefore, additional (M)ANOVAs were performed to analyze differences between two newly formed extreme groups using only the scores on exhaustion as the inclusion criterion. Managers in the highest decile (exhaustion >= 2.78, $n = 29$) were defined as the exhausted group, whereas managers in the lowest decile (exhaustion <= .40, n = 45) were defined as the healthy control group. All analyses were performed using the statistical software package SPSS (version 11.5).

Results

Relations between Allostatic Load and Burnout

Demographic characteristics and mean scores and standard deviations (*SD*) of the burned-out and the control group on the burnout scales are displayed in Table 1. As can be seen in Table 1, none of the demographic characteristics (age, educational level, organizational tenure) differed between the burned-out and control group, Multivariate $F(df = 4) = .55$, nonsignificant (n.s.). As expected, both groups differed strongly from each other on all subscales of the MBI-GS, Multivariate F ($df = 3$) = 91.53, $p < .001$. The burned-out group scored substantially higher on exhaustion and cynicism, and lower on professional efficacy, than the control group (univariate values of the MANOVA are presented in Table 1).

The correlations between age, the burnout scales, both allostatic load indices, and the physiological variables used to calculate the allostatic load indices are presented in Table 2. No significant associations emerged between the burnout subscales on the one hand, and the allostatic load indices and the physiological indicators on the other hand, except for a negative relation between SBP and the exhaustion subscale, which may be a chance finding.

Table 1. *Means and Standard Deviations (SD) of the Study Groups on the Demographic Variables and Burnout*

	Burned-out		Control		Exhausted		Non-exhausted	
	(n = 33) *Mean* (SD)	(n = 257) *Mean* (SD)	Univ. *F*	*p*	(n = 29) *Mean* (SD)	(n = 45) *Mean* (SD)	Univ. *F*	*p*
Demographics								
Age (years)	43.8 (7.7)	43.3 (8.0)	0.07	n.s.	42.6 (7.8)	44.6 (7.9)	1.26	n.s.
Educational level	5.2 (1.8)	5.5 (1.8)	0 .36	n.s.	5.3 (1.7)	5.3 (2.0)	0.06	n.s.
Secondary	54.5%	41.3%		48.2%	42.2%			
College	45.5%	56.0%		48.2%	55.6%			
Organizational tenure (years)	19.6 (10.4)	19.0 (10.8)	0.07	n.s.	19.0 (10.5)	21.2 (10.9)	0.57	n.s.
Contract (hr)	38.1 (1.8)	38.6 (1.6)	2.70	n.s.	38.3 (1.6)	38.6 (1.5)	1.56	n.s.
Burnout								
Exhaustion	2.99 (0.71)	1.19 (0.76)	168.1	< .001	3.41 (0.57)	0.24 (0.17)	1,230.1	< .001
Cynicism	2.50 (0.82)	0.84 (0.68)	167.1	< .001	1.82 (1.05)	0.54 (0.77)	36.3	< .001
Professional efficacy	3.52 (0.76)	4.47 (0.62)	65.5	< .001	3.83 (0.74)	4.70 (0.76)	23.9	< .001

Table 2. *Correlations between the Study Variables*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Age													
2. Exhaustion	−.05												
3. Cynicism	.03	.52**											
4. Professional efficacy	−.11	−.41**	−.51**										
5. SBP	.18**	−.12*	.00	−.03									
6. DBP	.32**	−.08	−.01	.04	.60**								
7. BMI	.23**	−.02	.00	−.06	.31**	.41**							
8. HbA1C	.30**	−.01	.03	−.08	.17**	.22**	.25**						
9. Cholesterol	.21**	−.03	−.01	−.02	.16**	.24**	.23**	.22**					
10. HDL	.07	−.11	−.06	−.07	.02	−.10	−.21**	−.06	−.29**				
11. Glucose	−.22	−.07	.00	−.03	.31**	.20**	.14*	.30**	.15**	−.01			
12. CRP	.00	.01	.04	−.02	.04	.12*	.00	.15**	−.11**	−.11	.10		
13. Allostatic load index (*z*-scores)	.31**	−.02	.03	−.01	.59**	.68**	.64**	.54**	.27**	−.49**	.50**	.26**	
14. Allostatic load index (quartiles)	.28**	−.02	.05	−.05	.49**	.58**	.56**	.45**	.30**	−.31**	.45**	.26**	.84**

*$p < .05$, **$p < .01$.

Table 3. *Means and Standard Deviations (SD) of the Study Groups on the Physiological Parameters and the Allostatic Load Indices*

	Burned-out		Control		Exhausted		Non-exhausted		
	($n = 33$) *Mean* (SD)	($n = 257$) *Mean* (SD)	Univ. *F*	*p*	($n = 29$) *Mean* (SD)	($n = 45$) *Mean* (SD)	Univ. *F*	*p*	Clinical cut-points
Physical Variables									
SBP (mmHg)	142.6 (13.6)	146.2 (16.0)	1.58	*n.s.*	142.7 (14.3)	147.5 (14.3)	1.96	n.s.	>140
DBP (mmHg)	88.6 (9.9)	89.1 (11.2)	0.06	n.s.	88.9 (12.1)	91.2 (11.0)	0.71	*n.s.*	>90
BMI (kg/cm^2)	26.1 (3.2)	26.1 (3.1)	0.02	n.s.	25.8 (3.2)	25.9 (3.0)	0.02	n.s.	>30
HbA1C (%)	5.23 (0.41)	5.24 (.38)	0.01	n.s.	5.25 (0.43)	5.24 (0.40)	0.01	n.s.	>7.0
Cholesterol (mmol/L)	5.65 (1.09)	5.75 (1.07)	0.23	n.s.	5.53 (1.01)	5.64 (1.10)	0.18	n.s.	>6.5
HDL (mmol/L)	1.30 (0.32)	1.32 (0.29)	0.22	n.s.	1.25 (0.25)	1.37 (0.34)	2.78	n.s.	<0.8
Glucose (mmol/L)	5.16 (1.21)	5.11 (1.11)	0.06	n.s.	4.96 (0.99)	5.14 (.96)	0.66	n.s.	>6.9
CRP (mg/L)	3.60 (1.91)	3.43 (1.49)	0.37	n.s.	3.64 (2.02)	3.71 (2.02)	0.02	n.s.	>6.0
Allostatic load index (*z*-scores)	−.19 (3.73)	−0.09 (4.16)	0.02	n.s.	−0.20 (3.74)	−0.15 (4.21)	0.00	n.s.	
Allostatic load index (quartiles)	2.03 (1.51)	1.72 (1.64)	1.04	n.s.	1.79 (1.57)	1.91 (1.68)	.09	n.s.	

The means and standard deviations of the burned-out and the control group on the allostatic load indices and the individual physiological indicators are presented in Table 3. The hypothesis that the burned-out group would show higher levels of allostatic load was not supported; neither with respect to the scores on the individual physiological indicators, Multivariate $F(df = 8) = .36$, n.s., nor with regard to both allostatic load indices (univariate F-values given in Table 3). Controlling for potential confounders (smoking and level of physical activity) did not affect the results. Using a more select control group, defined on the basis of lowest decile scores on burnout, did not affect the results either (results not shown).

Relations between Allostatic Load and Exhaustion

No significant differences were observed between the exhausted and the non-exhausted group regarding the demographics, Multivariate $F(df = 4) = .62$, n.s.). However, as expected, there were significant differences on all the subscales of the MBI-GS, Multivariate $F(df = 3) = 408.35$, $p < .001$. The exhausted group scored substantially higher on exhaustion and cynicism, and lower on professional efficacy, than the control group (univariate values of the MANOVA are given in Table 1).

Table 3 shows the means and standard deviations of the exhausted and the non-exhausted (extreme deciles) managers on the allostatic load indices and the individual physiological indicators. As in the previous analysis, exhaustion was unrelated to the allostatic load indices. The two groups did not differ with regard to their scores on the individual physiological indicators either (Multivariate $F(df = 8) = .75$, n.s.). Again, controlling for smoking and level of physical activity did not affect these results.

Discussion

The central aim of the present study was to investigate the association between burnout and allostatic load as an index of objective physical health in male managers. Burned-out managers did not show a higher score on the measures of allostatic load as compared to healthy controls. Even the extremes of the exhaustion distribution did not differ on allostatic load. We only found a negative relation between exhaustion and SBP, although this may be a chance finding.

We focused on secondary outcomes, and did not include primary mediators in the allostatic load index. Therefore, the index should be considered a proxy measure of allostatic load, and the results need to be interpreted with some caution. It is relatively difficult to compare our results with those of other studies on burnout/(vital) exhaustion and allostatic load, because of differences in sample characteristics. First, our study group consisted of male managers, whereas other studies have investigated females (e.g., Grossi et al., 2003; Koertge, Ahnve, Schenck-Gustafsson, Orth-Gomér, & Wamala, 2003; Moch et al., 2003), or a mix of men and women (Toker et al., 2005). In this latter study, significant associations were found in women but not in men. Second, our study sample also seems to differ from other studies with regard to social economical status (SES). Women and non-managers may have less decision authority at work, which, in turn, may have negative effects on health. Male managers are high on the SES ladder, and are, therefore, probably exerting more control on their work and life. This may increase their chances for staying healthy.

Our findings seem to be in contrast with the suggestion in a recent review (Melamed et al., 2006) that allostatic load might be a mediating mechanism of the association between burnout and physical health. For some reasons, however, the basis of this suggestion

may be questionable. First of all, it is based on studies that have, for that matter, tested a small subset of parameters instead of a more complete allostatic load index. And, even more important, of the studies included in the review that reported positive associations between burnout or (vital) exhaustion and physical health parameters, the significancies occurred amid other subcomponents measured, which did not show significant associations. For example, Grossi et al. (2003) found burnout to be positively associated with HbA1C and TNF-α, but not with a wide range of other physiological measures, including CRP, BMI, DHEAS, progesterone, estradiol, cortisol, transforming growth factor beta (TGF-beta), and neopterin. In addition, Koertge et al. (2003) reported that vital exhaustion was associated with HDL, but not with cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL-C), very low-density lipoprotein cholesterol (VLDL-C), and apolipoprotein B. Furthermore, Moch et al. (2003) found only cortisol to be associated with burnout, whereas DHEAS, adrenocorticotrophic hormone (ACTH), aldosteron, catecholamines, growth hormone, prolactin, insulin, glucose, cholesterol, and HDL were also measured and did not show group differences. In short, the significant findings in these studies may either partly be chance findings, or point to the role of isolated physiological measures as mediators, but not to a role of allostatic load as an overarching mediating mechanism.

Furthermore, in two studies cited in the review that reported significant findings (Toker et al., 2005; Wirtz, Von Känel, Schnorpfeil, Ehlert, Frey, & Fischer, 2003), some variables that we used in our study (e.g., BMI, SBP, DBP) were used as control variables, and it appeared that the groups that were compared (exhausted versus non-exhausted) did not differ. Several other studies also reported no associations between burnout or exhaustion and physical health parameters, like BMI (Appels & Schouten, 1991; Grossi et al., 2003), blood pressure (Melamed et al., 1992), glucose, cholesterol, and HDL (Moch et al., 2003). This supports the conclusion of our study—that burnout is not associated with the allostatic load index as defined by secondary outcomes.

Finally, the suggestion of Melamed et al. (2006) was based on studies that used the Shirom-Melamed Burnout Measure (see Shirom, 2003) and the measure of vital exhaustion (Appels, Hoppener, & Mulder, 1987) to define burnout, which conceptualize burnout only as the depletion of different energetic resources, neglecting the other dimensions of burnout as measured with the MBI. Furthermore, the MBI, as used in our study, is the most widely used instrument to assess burnout (Schaufeli & Enzmann, 1998).

The null findings of our study cannot be due to the size of the study population because its size is similar to other studies (e.g., Koertge et al., 2003; Schnorpfeil et al., 2003). It is also unlikely that they are due to the way of selecting the groups because we used clinical cut-off scores to identify burnout, and the burnout levels of our burned-out group are similar to individuals who receive psychotherapeutic treatment for burnout. It could be argued, though, that burnout levels in our burned-out sample were still not high enough to show physiological disturbances. All managers were working at time of the measurement, and might have been in the 'allostatic state' phase of the allostatic load sequence (McEwen, 2004) and not yet in the 'allostatic load' or 'allostatic overload' phase. The allostatic state refers to altered and sustained activity levels of the primary mediators (McEwen, 2004), which we did not measure. Maybe, if one is still capable of going to work, the physiological effects, as measured by secondary outcomes, are not, at least not yet, that prominent. Physiological effects could be delayed compared to the psychological experience of suffering from burnout. It would, therefore, be interesting to study allostatic load in a more 'severe' burned-out group; that is, for example, among those on sick leave.

Although it can be argued that our burned-out sample is 'too healthy', twelve managers in the burned-out group (36%) were, after visiting the Occupational Health Service, sent home for several weeks to recover, which implies the seriousness of their burnout. Besides, it remains remarkable that other studies, in which less extreme burnout or exhausted groups were examined (defined by quartile scores in a healthy, employed sample), reported significant results (Grossi et al., 2003; Wirtz et al., 2003).

It could be, however, that our null findings need to be qualified by the fact that our study population was too young (mean age 43 years) to already show the cumulative effects of stress and burnout on allostatic load. Schnorpfeil et al. (2003) reported an association between job demands and allostatic load in somewhat older employees (>45 years), but not in younger employees (<30 years and 30–45 years). The physiological challenge, as represented by allostatic load, seems to increase with age (Seeman et al., 1997) up through the 60s, and then to level off (Crimmins, Johnston, Hayward, & Seeman, 2003). The summary index of allostatic load may thus not be able to detect more serious, negative health outcomes due to chronic stress until later in the life-course (Mellner, Krantz, & Lundberg, 2005).

Limitations

Our study has a cross-sectional design, which does not allow drawing conclusions about temporal relations between burnout, allostatic load, and physical health. A test of longitudinal relationships thus still stands out.

Another limitation of our study is that it has been carried out among working employees, which implies

that the more severe cases either are on sick leave or have left their job altogether (the so-called *healthy worker effect*). We used clinical cut-off scores to identify burnout, which led to a group with burnout levels similar to those in individuals who receive psychotherapeutic treatment, and even 12 managers in the burnout group left on sick-leave based on their burnout complaints. But we cannot exclude that physiological effects will be observed in even more severe cases.

A final potential limitation of our study may be that we did not measure primary mediators as part of the operationalization of allostatic load (e.g., DHEAS, cortisol, and catecholamine levels), which are perhaps more sensitive. However, men, if anything, show in general higher values of the so-called secondary allostatic load parameters than women (Kinnunen, Kaprio, & Pulkkinen, 2005; Seeman, Singer, Ryff, Love, & Levy-Storms, 2002). This suggests that males may have a higher risk profile for the metabolic syndrome, whereas women more often deviate with respect to primary mediators (Kinnunen et al., 2005; Seeman et al., 2002). Considering this, we optimized the probability of finding differences by our operationalization of allostatic load in terms of secondary outcomes, and yet we did not find positive results. Furthermore, even for the most crucial primary mediator, i.e., cortisol, the evidence for deviations in even more severe cases of burnout is weak or even absent (Langelaan, Bakker, Schaufeli, Van Rhenen, & Van Doornen, 2006; Mommersteeg et al., 2006a).

Conclusion

This study showed that the possible pathways leading from burnout to physical health complaints are not reflected in the proxy index of allostatic load, as defined in our study. More specifically, it seems that the physical health correlates of burnout and exhaustion cannot be explained by secondary outcomes of the allostatic load sequence, which are close to disease endpoints. Apparently, at least in employed male managers of this age, the psychological effects of burnout are not visible yet in the allostatic state of the body.

References

Appels, A., Hoppener, P., & Mulder, P. (1987). A questionnaire to assess premonitory symptoms of myocardial infarction. *International Journal of Cardiology, 17*, 15–24.

Appels, A., & Schouten, E. G. W. (1991). Burnout as a risk factor for coronary heart disease. *Behavioral Medicine, 17*, 53–59.

Bakker, A. B., Demerouti, E., & Schaufeli, W. B. (2002). Validation of the Maslach Burnout Inventory—General Survey: An internet study. *Anxiety, Stress and Coping, 15*, 245–260.

Brenninkmeijer, V., & Van Yperen, N. (2003). How to conduct research on burnout: Advantages and disadvantages of a unidimensional approach to burnout. *Occupational and Environmental Medicine, 60 (Suppl. 1)*, 16–21.

Crimmins, E. M., Johnston, M., Hayward, M., & Seeman, T. (2003). Age differences in allostatic load: An index of physiological dysregulation. *Experimental Gerontology, 38*, 731–734.

De Vente, W., Olff, M., Van Amsterdam, J. G. C., Kamphuis, J. H., & Emmelkamp, P. M. G. (2003). Physiological differences between burnout patients and healthy controls: Blood pressure, heart rate, and cortisol responses. *Occupational and Environmental Medicine, 60*, i54–i61.

Grossi, G., Perski, A., Ekstedt, M., & Johansson, T. (2004). The morning salivary cortisol response in burnout. *Journal of Psychosomatic Research, 56*, 566–567.

Grossi, G., Perski, A., Evengard, B., Blomkvist, V., & Orth-Gomer, K. (2003). Physiological correlates of burnout among women. *Journal of Psychosomatic Research, 55*, 309–316.

Halbesleben, J. R. B., & Buckley, M. R. (2004). Burnout in organizational life. *Journal of Management, 30*, 859–879.

Kinnunen, M. L., Kaprio, J., & Pulkkinen, L. (2005). Allostatic load of men and women in early middle age. *Journal of Individual Differences, 26*, 20–28.

Koertge, J. C., Ahnve, S., Schenck-Gustafsson, K., Orth-Gomér, K., & Wamala, S. P. (2003). Vital exhaustion in relation to lifestyle and lipid profile in healthy women. *International Journal of Behavioral Medicine, 10*, 44–55.

Kristensen, T. S., Borritz, M., Villadsen, E., & Christensen, K. B. (2005). The Copenhagen Burnout Inventory: A new tool for the assessment of burnout. *Work & Stress, 19*, 192–207.

Kubzansky, L. D., Kawachi, I., & Sparrow, D. (1999). Socioeconomic status, hostility, and risk factor clustering in the normative aging study: Any help from the concept of allostatic load? *Annals of Behavioral Medicine, 21*, 330–338.

Langelaan, S., Bakker, A. B., Schaufeli, W. B., Van Rhenen, W., & Van Doornen, L. J. P. (2006). Do burned-out and work-engaged employees differ in the functioning of the hypothalamic-pituitary-adrenal axis? *Scandinavian Journal of Work, Environment and Health, 32*, 339–348.

Leiter, M. P., & Maslach, C. (2001). Burnout and health. In A. Baum, T. A. Revenson, & J. Singer (Eds.), *Handbook of Health Psychology* (pp. 415–426). Mahwah, NJ: Erlbaum & Associates.

Maslach, C., Schaufeli, W. B., & Leiter, M. P. (2001). Job burnout. *Annual Review of Psychology, 52*, 397–422.

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *New England Journal of Medicine, 338*, 171–179.

McEwen, B. S. (2000). Allostasis and allostatic load: Implications for neuropsychopharmacology. *Neuropsychopharmacology, 22*, 108–124.

McEwen, B. S. (2003). Mood disorders and allostatic load. *Biological Psychiatry, 54*, 200–207.

McEwen, B. S. (2004). Protection and damage from acute and chronic stress: Allostasis and allostatic overload and relevance to the pathophysiology of psychiatric disorders. *Annals of the New York Academy of Sciences, 1032*, 1–7.

Melamed, S., Kushnir, T., & Shirom, A. (1992). Burnout and risk factors for cardiovascular disease. *Behavioral Medicine, 18*, 53–60.

Melamed, S., Shirom, A., & Froom, P. (2003). Burnout and risk of type 2 diabetes mellitus (DM) in Israeli workers. Paper presented at the Work, Stress & Health Conference. Toronto, Ontario, Canada.

Melamed, S., Shirom, A., Toker, S., Berliner, S., & Shapira, I. (2006). Burnout and risk of cardiovascular disease: Evidence, possible causal paths, and promising research directions. *Psychological Bulletin, 132*, 327–353.

Melamed, S., Ugarten, U., Shirom, A., Kahana, L., Lerman, Y., & Froom, P. (1999). Chronic burnout, somatic arousal and elevated salivary levels. *Journal of Psychosomatic Research, 46*, 591–598.

Mellner, C., Krantz, G., & Lundberg, U. (2005). Medically unexplained symptoms in women as related to physiological stress responses. *Stress and Health, 21*, 45–52.

Moch, S. L., Panz, V. R., Joffe, B. I., Havlik, I., & Moch, J. D. (2003). Longitudinal changes in pituitary-adrenal hormones in South African women with burnout. *Endocrine, 21*, 267–272.

Mohren, D. C. L., Swaen, G. M. H., Kant, I. J., Van Amelsfoort, L. G. P. M., Borm, P. J. A., & Galama, J. M. D. (2003). Common infections and the role of burnout in a Dutch working population. *Journal of Psychosomatic Research, 55*, 201–208.

Mommersteeg, P. M. C., Heijnen, C. J., Verbraak, M. J. P. M., & Van Doornen, L. J. P. (2006a). Clinical burnout is not reflected in the cortisol awakening response, the day-curve or the response to a low-dose dexamethasone suppression test. *Psychoneuroendocrinology, 31*, 216–225.

Mommersteeg, P. M. C., Keijsers, G. P. J., Heijnen, C. J., Verbraak, M. J. P. M., & Van Doornen, L. J. P. (2006b). Cortisol deviations in people with burnout before and after psychotherapy; A pilot study. *Health Psychology, 25*, 243–248.

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

Roelofs, J., Verbraak, M., Keijsers, G. P. J., De Bruin, M. B. N., & Schmidt, A. J. M. (2005). Psychometric properties of a Dutch version of the Maslach Burnout Inventory–General Survey (MBI-DV) in individuals with and without clinical burnout. *Stress and Health, 21*, 17–25.

Schaufeli, W. B., Bakker, A. B., Schaap, C., Kladler, A., & Hoogduin, C. A. L. (2001). On the clinical validity of the Maslach Burnout Inventory and the burnout measure. *Psychology & Health, 16*, 565–582.

Schaufeli, W. B., & Enzmann, D. (1998). *The burnout companion to study and practice: A critical analysis*. London: Taylor & Francis.

Schaufeli, W. B., Leiter, M. P., Maslach, C., & Jackson, S. E. (1996). Maslach Burnout Inventory—General Survey. In C. Maslach, S. E. Jackson, & M. P. Leiter (Eds.), *The Maslach Burnout Inventory: Test manual* (3rd ed., pp. 22–26). Palo Alto, CA: Consulting Psychologists Press.

Schaufeli, W. B., & Van Dierendonck, D. (2000). *Handleiding van de Utrechtse Burnout Schaal (UBOS) [Manual Utrecht Burnout Scale]*. Lisse, The Netherlands: Swets & Zeitlinger.

Schnorpfeil, P., Noll, A., Schulze, R., Ehlert, U., Frey, K., & Fischer, J. E. (2003). Allostatic load and work conditions. *Social Science & Medicine, 57*, 647–656.

Seeman, T. E., Singer, B. H., Rowe, J. W., Horwitz, R. I., & McEwen, B. S. (1997). Price of adaptation—allostatic load and its health consequences. MacArthur studies of successful aging. *Archives of Internal Medicine, 157*, 2259–2268.

Seeman, T. E., Singer, B. H., Ryff, C. D., Love, G. D., & Levy-Storms, L. (2002). Social relationships, gender, and allostatic load across two age cohorts. *Psychosomatic Medicine, 64*, 395–406.

Shirom, A. (2003). Job-related burnout. In J. C. Quick & L. E. Tetrick (Eds.), *Handbook of occupational health psychology*. (pp. 245–265). Washington, DC: American Psychological Association.

Shirom, A., Melamed, S., Toker, S., Berliner, S., & Shapira, I. (2005). Burnout and health review: Current knowledge and future research directions. In G. P. Hodgkinson, & J. K. Ford (Eds.), *International Review of Industrial and Organizational Psychology* (Volume 20, pp. 269–309). Palo Alto, CA: Consulting Psychologists Press.

Shirom, A., Westman, M., Shamai, O., & Carel, R. S. (1997). The effects of work overload and burnout on cholesterol and triglycerides levels: The moderating effects of emotional reactivity among male and female employees. *Journal of Occupational Health Psychology, 2*, 275–288.

Sterling, P., & Eyer, J. (1988). Allostasis: A new paradigm to explain arousal pathology. In: S. Fisher & J. Reason (Eds.), *Handbook of Life Stress, Cognition and Health*. (pp. 629–649). New York: John Wiley & Sons.

Toker, S., Shirom, A., Shapira, I., Berliner, S., & Melamed, S. (2005). The association between burnout, depression, anxiety, and inflammation biomarkers: C-reactive protein and fibrinogen in men and women. *Journal of Occupational Health Psychology, 10*, 344–362.

Wirtz, P. H., Von Känel, R., Schnorpfeil, P., Ehlert, U., Frey, K., & Fischer, J. E. (2003). Reduced glucocorticoid sensitivity of monocyte interleukin-6 production in male industrial employees who are vitally exhausted. *Psychosomatic Medicine, 65*, 672–678.