Journal of Occupational Health Psychology
2016, Vol. 21, No. 2, 133–141

1076-8998/16/$12.00 http://dx.doi.org/10.1037/a0039900

What Happens at Work Stays at Work? Workplace Supervisory Social Interactions and Blood Pressure Outcomes

Jennifer H. K. Wong and E. Kevin Kelloway
Saint Mary's University

We investigated the relationship between workplace supervisory social interactions and blood pressure outcomes using hourly diary entries and ambulatory blood pressure data from an experience sampling study of 55 long-term care employees. After accounting for relevant cardiovascular controls, significant effects of supervisory interactions on cardiovascular reactivity and recovery were found. Multilevel analyses revealed that negatively perceived supervisory interactions predicted higher systolic blood pressure at work ($B = -1.59$, $p < .05$, N observations = 422). Using time-lagged hierarchical regression analyses, the average perceived valence of supervisory interactions at work predicted average systolic blood pressure recovery after work ($B = -14.52$, $p < .05$, $N = 33$). Specifically, negatively perceived supervisory interactions at work predicted poorer cardiovascular recovery after work. Suggestions for improving practices in organizations and in experience sampling research are discussed.

Keywords: social interactions, supervisory relationships, cardiovascular health, blood pressure

Interactions with supervisors in the workplace can be both a rich resource of social support (Eisenberger, Stinglhamber, Vandenberghe, Sucharski, & Rhoades, 2002) or a significant stressor (Kelloway, Sivanathan, Francis, & Barling, 2005) for employees. A growing body of literature has identified the effects of leadership style on a variety of health outcomes (for a review see Kelloway & Barling, 2010). Of particular note for the current study, negative supervisory work relationships play an important role in the etiology of stress-related cardiovascular disorders such as coronary heart disease (Kuper, Marmot, & Hemingway, 2002), myocardial infarction (Bosma, Peter, Siegrist, & Marmot, 1998), and cardiovascular mortality (Kivimäki et al., 2002). How these relationships influence the progressive development of such conditions remains unclear. In the current study we examined the effect of negative supervisory interactions on both cardiovascular reactivity and cardiovascular recovery.

In particular, we coupled an hourly diary study with measures of ambulatory blood pressure over a working day. Experience sampling with diaries has been used in organizational research to examine momentary moods and states (e.g., Fullagar & Kelloway, 2009; Ilies, Dimotakis, & Watson, 2010). The research design allows for subjective behaviors and experiences to be captured in real-time and eliminates the bias of retrospective recall (Shiffman, Stone, & Hufford, 2008). In the current context, the use of diaries allowed for the immediate recording of interactions with supervisors as they occurred during the working day.

Measures of in situ ambulatory blood pressure, both throughout the work shift and after work, served as our primary dependent measures. As such, we are able to examine both the immediate effect of supervisory interactions on health (i.e., cardiovascular reactivity) as well as cardiovascular recovery after work (i.e., the natural nocturnal drop in blood pressure in the evening; Van Egeren, 1992). The use of sampling in a field setting is particularly important for cardiovascular outcomes because laboratory measurement may not adequately capture the critical dips and highs of daily work experiences. Moreover, physiological measures may be reactive in highly controlled environments. In the phenomenon of "white-coat hypertension," the presence of physicians or researchers elevates blood pressure readings in normally healthy individuals (Pickering & Friedman, 1991).

Cardiovascular Measures and Their Implications for Health

The general model of a stress response is that the body exhibits the well-known "fight or flight" behaviors (Cannon, 1915). The biological changes that are associated with this response are the activation of the sympathetic and parasympathetic nervous systems, the release of epinephrine and norepinephrine, and a resulting increase in blood pressure to prepare the body for evolutionary-adaptive actions (Sapolsky, 1994). The allostatic load model of stress physiology posits three stages in the progression of stress (McEwen & Stellar, 1993; for a review see Ganster & Rosen, 2013). The initial adaptations to stress are primary allostatic load processes consisting of psychological, physiological, and psychosomatic changes in the central nervous system. Over time, continuous activation of primary allostatic load processes leads to secondary allostatic load processes, which are adjustments

This article was published Online First December 7, 2015.

Jennifer H. K. Wong and E. Kevin Kelloway, Department of Psychology, Saint Mary's University.

This article is based on data collected by the first author as a M.Sc. thesis under the supervision of the second author. We thank Lori Francis, Margaret McKee, and Catherine Loughlin for comments on an earlier version of this article and acknowledge the financial support of the Nova Scotia Health Research Foundation and the Social Sciences and Humanities Research Council of Canada for this research.

Correspondence concerning this article should be addressed to E. Kevin Kelloway, Department of Psychology, Saint Mary's University, 923 Robie Street, Halifax, NS, Canada, B3H 3C3. E-mail: kevin.kelloway@smu.ca

in the immune, cardiovascular, and metabolic systems as reactions to the excess or deficit in primary allostatic load indicators. At the final tertiary stage, chronic and severe adjustments of the secondary allostatic load indicators bring about eventual disease diagnosis, psychological disorders, and even mortality.

Cardiovascular disease has been identified as one well-established endpoint of workplace stress in several extensive reviews (Belkic, Landsbergis, Schnall, & Baker, 2004; Hemingway & Marmot, 1999; Kuper et al., 2002; Schnall, Landsbergis, & Baker, 1994). This relationship remains significant even when individual characteristics and health habits such as smoking, cholesterol, hypertension, exercise, alcohol consumption, and body mass index were taken into consideration (Kuper & Marmot, 2003). As well, individuals with job strain are more likely to have cardiovascular disease risk factors such as diabetes, smoking, being physically inactive, and being obese (Nyberg et al., 2013). The population attributable risk for job strain in developing coronary heart disease is 3.4% (Kivimäki et al., 2012).

Ambulatory blood pressure assessed reactively (i.e., right after exposure to the stressor) has a different implication of the stage of allostatic load process than blood pressure assessed as a recovery (i.e., after exposure to the stressor have subsided). The "reactivity hypothesis" posits that the pathogenesis from workplace stress to cardiovascular disease begins at the primary stage of the allostatic load model when the body reacts to the stressor by elevating blood pressure (Ganster & Rosen, 2013; Krantz & Manuck, 1984). Cardiovascular reactivity is transient because the elevated state of blood pressure may return to baselines when the stressor is gone. Therefore, although high cardiovascular reactivity signifies that the primary allostatic load process is activated, it does not necessarily mean that the prognosis of cardiovascular disease is definite. In the current study, we used momentary assessment of blood pressure to capture cardiovascular reactivity in response to supervisory interactions.

After being exposed to repeated high cardiovascular reactivity, the cardiovascular system adjusts by elevating blood pressure baselines (Ganster & Rosen, 2013). This adjustment is a secondary allostatic load process that is an adaptive response to continuous exposure to primary allostatic load indicators. This signifies that the individual have progressed onto the second stage of the allostatic load model, at which the chances for developing cardiovascular disease (i.e., third and final stage of the allostatic load model) is higher. At this point, the individual's capability to lower blood pressure even after the stressor is removed may also be hindered. The ability of the body to lower blood pressure in the absence of threat is critical in slowing down the development of cardiovascular disease because it indicates that the primary allostatic load indicator have return to its normal level of regulation. Indeed, there is a growing focus on the period after the stressor is removed as a sign of secondary allostatic load process (Ganster & Rosen, 2013; Steptoe & Marmot, 2006). A 3-year follow-up on participants' from a laboratory stressor task revealed that their baselines were predicted by their blood pressure during the recovery period in the laboratory immediately after the task 3 years prior, even after controlling for age, gender, socioeconomic status, body mass index, smoking, and blood pressure reactivity during the laboratory stressor (Steptoe & Marmot, 2005).

Within the organizational psychology literature, the daily recovery period after work is critically important because it is considered a time when the individual can rebuild personal resources. According to the job demand-resources model, these personal resources prepare the individuals for effectively handling stressors at workplace (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001), and there can be health consequences if the recovery period is not adequate (Sonnentag & Zijlstra, 2006). A review of the impact of social interactions at work showed that the effects extend beyond cardiovascular reactivity at work and can influence reactivity after work, which is by definition the recovery period from work (Heaphy & Dutton, 2008). Thus, to examine the progression into the second stage of the allostatic load model in the current study, we assessed cardiovascular recovery from supervisory interactions by aggregating measurements of blood pressure in the period after the work shift has finished.

Supervisory Influence on Subordinate's Health

Interpersonal relationships are an inevitable aspect of organizational life with well-documented influences on individual well-being (for a review see Reich & Hershcovis, 2011). Much of the recent work has focused on subordinate-leader relationships and the implications of these for subordinates' well-being (e.g., Kelloway & Barling, 2010; Mullen & Kelloway, 2011). A summary of the past three decades of leadership research established that supervisory behaviors have the ability to enhance or deteriorate subordinates' health (Skakon, Nielson, Borg, & Guzman, 2010). Positive and effective leadership behaviors, such as transformational leadership, have been associated with better subordinates' well-being (Gregersen, Vincent-Höper, & Nienhaus, 2014). Conversely, negative and ineffective leadership behaviors, such as abusive supervision, have been linked to poor well-being and somatic health complaints (Duffy, Ganster, & Pagon, 2002; Tepper, 2000). The influence of the supervisory relationship is not surprising given that leaders have direct (e.g., leadership styles) and indirect (e.g., injustice) effects on many organizational variables responsible for subordinates' health and well-being (Kelloway & Barling, 2010).

There are very few studies that have examine the influence of supervisors on their subordinates' blood pressure. Studies that investigated the impact of supervisory social interactions found that these interactions heighten cardiovascular responding. Face-to-face communications with supervisors were associated with higher systolic and diastolic blood pressure compared with resting baselines (Brondolo, Karlin, Alexander, Bobrow, & Schwartz, 1999). A quasi-experiment designed by Wager, Fieldman, and Hussey (2003) discovered that nurses had higher daily averages of systolic and diastolic blood pressure when working under the unfavorably perceived supervisor compared with a favorably perceived supervisor. Thus, both social interactions (Brondolo et al., 1999) and the valence of the interactions (Wager et al., 2003) influence cardiovascular reactivity. Therefore, in the current study we focused on the subordinates' assessment of the valence of interactions with supervisors as a predictor of cardiovascular reactivity and recovery.

The Current Study

We examined the associations between supervisory interactions and subordinates' cardiovascular outcomes using an experience sampling methodology. We focused only on systolic blood pressure rather than diastolic blood pressure because it is known to be a more reliable cardiovascular outcome in occupational stress studies (Theorell & Karasek, 1996), especially in studies that investigate psychosocial stressors (Karlin, Brondolo, & Schwartz, 2003). We hypothesized that:

> *Hypothesis 1:* The perceived valence of interactions with supervisors predicts cardiovascular reactivity such that negatively perceived interactions with supervisors are associated with higher momentary systolic blood pressure.

The ability for the body to recover from heightened cardiovascular reactivity at work by lowering blood pressure after work is a critical physiological recovery experience. Cardiovascular recovery is an indicator of the secondary stage of the allostatic load model as well as cardiovascular disease progression (McEwen & Stellar, 1993). To our knowledge, no studies to date have examined the impact of supervisory interactions on cardiovascular recovery from work, yet there is a study that looked at the lack of general social support on cardiovascular recovery. Reported racial isolation was associated with delayed systolic blood pressure recovery in the Whitehall Study (Steptoe & Marmot, 2006). Based on the allostatic load literature, we anticipated that cardiovascular outcomes in the period after work would follow the same relationship as cardiovascular reactivity to supervisory social interactions at work, manifesting in elevated levels when supervisory interactions were perceived as more negative. We captured cardiovascular recovery as an aggregation over time based on Steptoe and Marmot's (2006) recommendation for examining recovery as a rate instead of a single timepoint measure because the nature of the outcome is a function of time. Specifically, we hypothesized that:

> *Hypothesis 2:* The average perceived valence of interactions with supervisors at work predicts cardiovascular recovery such that negatively perceived interactions with supervisors are associated with higher average systolic blood pressure in the period after work.

Method

Participants

A total of 55 (51 women and four men) care workers participated in the study, recruited from nine care homes. The average age of the sample was 43 years (*SD* = 9 years, Range: 25–62 years). The majority of the participants are Caucasian (87.3%). Twenty percent of the sample had an education level of less than Grade 12, and 36% received a high school diploma, 36% attended college, and 8% received Bachelor degrees. The majority of the participants were personal care workers (72%), and the other 18% were care workers with a nursing designation. A typical day shift ranged from 5–12 hr, and hours worked per week varied from 8–56, likely because 27% of the sample were part-time workers and 17% of the sample worked in homecare, both of which have irregular weekly work hours. Care workers' work duties included participating in recreational activities with residents, tending to residents' medical conditions and hygiene, feeding residents meals and medications, and providing residents with mobility assistance. The average job tenure was 11 years (*SD* = 7 years, Range: 1 month–31 years). Thirty-three percent of the sample worked in specialized units (Alzheimer's, adult residential care). Two of the participants had been clinically diagnosed with high blood pressure and 26% of them were regular smokers. Average body mass index was 27.72 (*SD* = 4.69, Range: 17–46). Potential participants were excluded from the study if they reported being on antihypertensive or psychoactive medication that would interfere with blood pressure readings.

Equipment

Ambulatory systolic blood pressure measurements were collected using the Suntech Oscar 2 ambulatory blood pressure monitor (Suntech Medical Instruments, Raleigh, North Carolina). It is a light-weight (0.284 kg) device that uses oscillometry with step deflation to assess systolic blood pressure reading ("Oscar 2 Ambulatory Blood Pressure Monitor," Suntech Medical, 2012). The Suntech Oscar 2 is clinically validated by international standards and protocols (Goodwin, Bilous, Winship, Finn, & Jones, 2007; Jones, Bilous, Winship, Finn, & Goodwin, 2004).

Predata Collection Questionnaire

A questionnaire was administered to all participants prior to collecting the daily diary data. The questionnaire assessed participants' demographics, job history, medical history, and trait hostility. Hostility is a common control variable used in studies of blood pressure due to its strong positive association with cardiovascular disease (Barefoot, Dodge, Peterson, Dahlstrom, & Williams, 1989). Furthermore, by controlling for hostility in our analyses we accounted for the influence of it on the interpretation of supervisory interactions valence. Hostility was measured with the 27 items (α = .75) Cook-Medley Scale (Barefoot et al., 1989). Participants answered either 1 = *true* or 0 = *false* on each items. A sample item was "*It is safer not to trust anybody.*" A higher summed score on the Cook-Medley Scale indicated higher trait hostility.

Daily Diaries

Participants were also given a paper diary booklet to record down their experiences during the day. The diary entries consisted of questions assessing location (work, home, transit), posture (sitting, standing, walking, running), and consumption in the past hour (food, caffeine, cigarettes). Posture, food, caffeine, and nicotine consumption were used as control variables in the analysis for the cardiovascular reactivity hypothesis. These are commonly used control variables in other ambulatory blood pressure studies (e.g., Brondolo et al., 1999; Chen, Matthews, & Zhou, 2007; Steptoe, Brydon, & Kunz-Ebrecht, 2005). Perceived stress at home was also controlled for in the analysis for the cardiovascular recovery hypothesis using a single item measure with a 7-point Likert-type response scale of 1 = *very low*, 4 = *moderate*, and 7 = *very high*. A higher score on this single item measure indicated higher perceived stress.

The valence of supervisory interactions at work was assessed by asking for the occurrence and the rating of the valence of any social interactions with supervisors in the last 15 min before the blood pressure reading. A Likert-type scale of 1 to 5, with 1 =

negative, 3 = *neutral,* and 5 = *positive* was used for responding. If no supervisory social interactions occurred during the period assessed by the diary entry, the perceived valence was inputted as neutral at midscale by the first author, because the lack of the interaction evoked neither a negative nor a positive appraisal.[1] The use of single items is advantageous because it allows each diary entry to be brief, thus minimizing attrition rates. Acceptable reliability of single items in organizational research had been demonstrated for constructs traditionally measured by scales (Gilbert & Kelloway, 2014; Nagy, 2002; Wanous & Hudy, 2001). Participants recorded the time of their diary entries so each entry can be matched up with an ambulatory blood pressure reading from the same time of day.

Procedures

The study took place over the time span of a work-week in three phases. In the first phase, the first author met the participants at their workplace in the afternoon to teach participants how to use the ambulatory blood pressure monitor, to collect their predata collection questionnaire responses, and to take their average systolic blood pressure baselines over four readings. Participants were asked to not eat, drink caffeine, or smoke an hour before meeting the researcher so proper seated and standing baselines could be taken. In the second phase, participants were instructed to turn on the ambulatory blood pressure monitors on the data collection day upon waking up for the first systolic blood pressure reading of the day before going to work. The monitor was programmed to inflate every hour to take a reading during the day. A diary entry was completed after each hourly reading. The readings continued at work and after work and were terminated at night right before the participants went to bed. At the last phase, the first author collected the study materials, provided feedback, and compensated participants for their time.

Analyses

The dataset was cleaned for erroneous ambulatory systolic blood pressure readings and checked for multivariate outliers. Readings associated with an error message from the ambulatory blood pressure monitor were removed. There were no multivariate outliers; all Cook's Distance values were under 1. Intercorrelations of the multilevel model variables ($N = 422$) can be observed in Table 1.

Data pertaining to the hypothesis regarding individuals' experiences at work (cardiovascular reactivity) was analyzed using multilevel modeling with 422 observations from 55 participants ($M = 8$, $SD = 3$). Of the 422 work observations, 155 of them consisted of an interaction with a supervisor ($M = 3$, $SD = 3$). Missing data points and differences in the length of a waking day explained the variability in observations. For the 2-level mixed model, the covariance structure used for Level 2 (between-person) was variance components and for Level 1 (within-person) was first order autoregressive with homogenous variances. Control variables and ratings of the valence of supervisory interactions were entered as predictors in the random intercept model. Level 1 (within-person) control variables included posture, use caffeine, cigarettes, and consumption of food. An index variable also recorded the time period of the blood-pressure reading. Level 2 (between-person) control variables included age, body mass index, regular smoking habit (yes/no), trait hostility, systolic blood pressure baselines, shift type (dayshift/nightshift/graveyard/homecare), and level of education. All variables were standardized to aid interpretation of the results with the exception of timepoints and blood pressure readings. The estimates for the cardiovascular outcomes reflect the actual changes in blood pressure (mmHg) metrics.

Analysis began with running a null model (with only the outcome in the model, no levels specified), the restricted model (levels specified, but without predictors), and then the random intercept model with predictors (Heck, Thomas, & Tabata, 2010). A random intercept model tests for the differences in intercept between participants, but assumes that the relationship between the predictor and outcome (slope) is the same for all individuals. The estimate of fit used was the −2 restricted log likelihood. Intraclass correlations were calculated for Level 2 (between-person) of the restricted model. Effect sizes were also calculated using the pooled variance method, which compares the percent variance accounted for by final random intercept model to the restricted model (Snijders & Boskers, 1999).

The data testing the hypothesis pertaining to participants' experiences after work (cardiovascular recovery) were analyzed using a time-lagged hierarchical regression analysis. Intercorrelations of the time-lagged model variables ($N = 33$) can be observed in Table 2. There were 192 after work observations ($M = 6$, $SD = 2$). The lack of after work observations in 13 of the participants explained the attrition of the sample, and nine of the participants were excluded by pairwise deletion due to missing data on the control variables. Cardiovascular recovery was defined as a decline in average systolic blood pressure after work. Time-lagged analysis is characterized by predicting the dependent variable outcome at Time 2 while controlling for the dependent variable outcome at Time 1 (Kelloway & Francis, 2012). Thus, average systolic blood pressure reactivity during work was added to the model at Step 1. Also entered at Step 1 were the between-person control variables of age, body mass index, regular smoking habit, trait hostility, systolic blood pressure baseline, shift type, and level of education. Furthermore, the average of perceived stress ratings after work was used as a Step 1 control variable to account for their potential impact on cardiovascular recovery after work. At Step 2, the average valence of supervisory interactions ratings from work was computed and used to predict average systolic blood pressure after work above and beyond Step 1 control variables.

Results

Cardiovascular Reactivity

The −2 restricted log likelihood values decreased from the null model ($-2LL = 5461.16$), the restricted model ($-2LL = 3537.08$), and the random intercept model ($-2LL = 2554.24$),

[1] We chose this strategy to retain statistical power in the analyses. Secondary sets of analyses were performed using the more conservative strategy of deleting cases in which no interactions with supervisors were reported. Both analyses showed the same pattern of effects although the effects in the cardiovascular recovery analyses were significant only using one-tailed tests because of reduced power.

Table 1
Correlations Between Multilevel Model Study Variables (N = 422)

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Work systolic blood pressure (mm Hg)	134.46	20.27														
2. Timepoint	4.02	2.87	−.14**													
3. Caffeine	.24	.43	−.04	−.19***												
4. Cigarette	.12	.32	.03	−.05	.15**											
5. Food	.29	.45	.09	.14**	.09	.06										
6. Gender	1.92	.27	−.22***	.05	.14**	−.01	.01									
7. Age (years)	42.70	9.09	.21***	.04	−.01	.13**	.02	.17***								
8. Tenure (months)	130.61	82.42	.09	.02	.01	.13**	.04	.03	.55***							
9. High blood pressure	.03	.18	.06	.02	.03	−.07	.07	.06	−.03	−.03						
10. Smoker	.26	.44	−.12*	−.03	.05	.57***	−.09	−.01	.13*	.16**	−.11*					
11. Body mass index	27.90	4.77	.11*	.05	.03	−.12*	−.01	−.13*	−.18**	.01	.04	−.29***				
12. Cook-Medley hostility	9.09	4.48	−.09	.05	−.04	.15**	.05	−.06	.08	−.19***	−.02	.11*	−.03			
13. Education	2.30	.86	−.01	.02	.10*	−.19***	.08	.03	−.24***	−.28***	.05	−.34***	.15**	−.01		
14. Systolic blood pressure baseline (mm Hg)	136.04	15.54	.62***	.02	−.11*	.03	.09	−.45***	.16**	.10*	.06	−.10	.12*	−.10	−.01	
15. Perceived valence of supervisor interactions	3.29	.81	−.03	−.06	−.13**	−.10*	−.02	−.04	−.11*	−.13**	−.03	−.12*	−.02	.02	−.24***	.03

* $p < .05$. ** $p < .01$. *** $p < .001$.

indicating that the random intercept model was a significantly better fit to the data than the restricted model, $\chi^2(16, N = 422) = 982.84$, $p < .001$. The ICC calculation from the restricted model showed the Level 2 (between-person) variance in systolic blood pressure was moderate (ICC = .48). The effect size for Level 2 (between-person) of the random intercept systolic blood pressure reactivity at work model was large at .86.

Results from the random intercept model predicting systolic blood pressure are presented in Table 3. Over the course of the work day, systolic blood pressure declined ($B = -1.09$, $p < .01$). Working day shifts compared to homecare shifts was associated with higher systolic blood pressure ($B = 9.56$, $p < .05$). Older participants had higher blood pressure readings than younger participants ($B = 4.11$, $p < .05$). Ambulatory systolic blood pressure was significantly associated with systolic blood pressure baselines ($B = 0.72$, $p < .001$). Finally, in support of Hypothesis 1, the relationship between the perceived valence of supervisory interactions and momentary systolic blood pressure was significantly negative ($B = -1.59$, $p < .05$); negatively perceived supervisory interactions predicted concurrent high systolic blood pressure.

Cardiovascular Recovery

Time-lagged hierarchical regression model of systolic blood pressure recovery after work was conducted using the average perceived valence of workplace supervisory interactions as a predictor. Results of this analysis are presented in Table 4. At Step 1 of the model, the combination of control variables significantly predicted systolic blood pressure after work (Adjusted $R^2 = .75$, $p < .001$). Within the control variables, lower body mass index ($B = -1.38$, $p < .05$) and higher average perceived stress at home ($B = 7.69$, $p < .01$) predicted higher average systolic blood pressure after work.

The average perceived valence of supervisory interactions at work explained an additional 7% variance in the model ($p < .05$). The average perceived valence of supervisory interactions significantly predicted systolic blood pressure after work ($B = -14.52$, $p < .05$); negatively perceived average supervisory interactions at work predicted higher average systolic blood pressure after work.

Discussion

The present study revealed a substantial effect of supervisory relationships on both cardiovascular reactivity and cardiovascular recovery. Negatively perceived interactions with supervisors were concurrently associated with higher ambulatory systolic blood pressure. In addition, negatively perceived supervisory interactions at work predicted higher average systolic blood pressure after work. Both relationships remained after controlling for demographics, personality, and health habits control variables typically used in cardiovascular research studies. As well, the average systolic blood pressure reactivity at work was controlled for in the time-lagged regression model. This eliminates the potential confound that delayed cardiovascular recovery was caused by heightened cardiovascular reactivity during the work shift from the interpretation of the results (Steptoe & Marmot, 2006). Both analyses controlled for systolic blood pressure at baseline accounting for the potential influence of that secondary allostatic load indicator (Ganster & Rosen, 2013).

Table 2
Correlations Between Time-Lagged Hierarchical Regression Model Study Variables (N = 33)

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. Average home systolic blood pressure (mm Hg)	135.35	18.70												
2. Gender	1.88	.33	−.34											
3. Age (years)	41.58	10.08	.11	.16										
4. Tenure (months)	119.15	76.07	.12	−.03	.53**									
5. High blood pressure	.03	.17	.09	.07	−.06	−.09								
6. Smoker	.15	.36	−.15	−.10	−.03	−.18	−.08							
7. Body mass index	28.04	3.79	−.09	−.19	−.25	−.04	−.05	−.25						
8. Cook-Medley hostility	8.97	4.19	.01	−.09	.12	−.19	−.13	.23	−.07					
9. Education	2.30	.88	−.02	.02	−.27	−.28	.14	−.15	.19	−.03				
10. Systolic blood pressure baseline (mm Hg)	137.85	17.75	.79***	−.46**	.16	.19	.05	−.12	.11	−.09	−.11			
11. Average work systolic blood pressure (mm Hg)	136.82	15.00	.74***	−.34	.27	.16	.09	−.28	.17	−.22	−.06	.89***		
12. Average perceived stress at home	2.57	1.18	.43*	.19	.04	−.16	.07	.22	−.06	.40*	−.19	.16	.10	
13. Average perceived valence of supervisor interactions	3.34	.40	.04	−.07	.07	.20	−.15	−.25	−.09	−.20	−.35*	.34	.36*	−.20

* $p < .05$. ** $p < .01$. *** $p < .001$.

These results suggest that negative supervisory interactions can be detrimental to health because of heightened cardiovascular reactivity at work and delayed cardiovascular recovery after work. Both outcomes are considered to be allostatic load indicators at the primary and secondary stage, respectively, and cardiovascular disease risk factors (McEwen & Stellar, 1993). Although momentary cardiovascular reactivity does not necessarily signifies disease onset, the likelihood for cardiovascular complications increases when this high level of systolic blood pressure is sustained to the point that the cardiovascular system shifts to adapt to it. Hence, the ability for the body to return systolic blood pressure back to baselines when the stressor of negative supervisory interactions is no longer present is a critical recovery experience. Our findings show that supervisors have the ability to influence subordinates' health outside of the work setting by delaying the recovery of elevated blood pressure at work. This delay suggests the body is progressing along the stages of the allostatic load model (McEwen & Stellar, 1993), and the chances that subordinates will develop cardiovascular diseases are increased.

Table 3
Workplace Interactions and Cardiovascular Reactivity Model Summary (N = 422)

Parameters	Systolic blood pressure	
	B (*SE*)	95% CI
Intercept	30.10 (20.36)	[−11.30, 71.49]
Timepoint	−1.09 (.32)**	[−1.72, −.46]
Posture		
Sitting	.03 (2.29)	[−4.48, 4.54]
Standing	2.41 (2.21)	[−1.93, 6.75]
Caffeine	−2.69 (2.10)	[−6.82, 1.44]
Cigarette	5.03 (3.25)	[−1.37, 11.43]
Food	.84 (1.80)	[−2.71, 4.39]
Shift type		
Day	9.56 (4.40)*	[.66, 18.46]
Evening	6.21 (4.79)	[−3.51, 15.93]
Graveyard	11.00 (6.01)	[−1.11, 23.11]
Gender	1.16 (4.87)	[−8.76, 11.08]
Age[a]	4.11 (1.82)*	[.39, 7.84]
Tenure	−.02 (.02)	[−.06, .02]
High blood pressure	6.31 (5.86)	[−5.59, 18.21]
Smoker	−1.81 (4.72)	[−11.33, 7.71]
Body mass index[a]	−.23 (1.34)	[−2.97, 2.52]
Cook-Medley hostility[a]	−2.24 (1.48)	[−5.25, .76]
Education	1.36 (1.82)	[−2.34, 5.07]
Systolic blood pressure baseline	.72 (.09)***	[.54, .91]
Perceived valence of supervisor interactions[a]	−1.59 (.68)*	[−2.93, −.24]

Note. Posture consisted of sitting, standing, and walking; walking was the dummy-coded comparison group to the rest. Shift type consisted of day, evening, graveyard, and homecare shifts; homecare was the dummy-coded comparison group to the rest. Gender was coded as man = 1 and woman = 2.
[a] Standardized.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Potential Limitations

There are several potential limitations to the study that should be considered while interpreting the results. First, the fairly small number of people participating in our study places important limitations around the generalizability of our findings. We note that our data are consistent with previous research that has examined the effect of supervision on cardiovascular outcomes, nonetheless, characteristics of the sample may have interacted with the effects of interest and it remains for future research to examine how well these effects generalize to a broader population. For example, our sample was exclusively of long-term care workers, thus current findings may not generalize to workers in other occupational groups. Furthermore, the average age of participants was relatively young compared with other research studies conducted in long-term care settings, and we excluded data from individuals taking psychoactive or hypertensive medications. Although these observations suggest more limits to the generalizability of the current findings, they also suggest that our tests may be overly conservative as they are based on a sample with a restricted range of blood pressure. We also note that the sample for the

Table 4
Workplace Interactions and Systolic Blood Pressure Recovery Model Summary (N = 33)

Predictors	Average home systolic blood pressure			
	B (SE)	β	*t*	95% CI
Step 1				
Shift type				
Day	3.56 (6.60)	.09	.54	[−10.30, 17.42]
Evening	.39 (8.35)	.01	.05	[−17.17, 17.94]
Graveyard	−8.36 (9.07)	−.13	−.92	[−27.40, 10.69]
Gender	−15.08 (7.69)	−.27	−1.96	[−31.24, 1.07]
Age	−.10 (.31)	−.06	−.34	[−.75, .54]
Tenure	.02 (.03)	.08	.58	[−.05, .09]
High blood pressure	−.95 (11.29)	−.01	−.08	[−24.67, 22.78]
Smoker	−2.30 (7.19)	−.05	−.32	[−17.40, 12.79]
Body mass index	−1.38 (.50)	−.28	−2.74*	[−2.44, −.32]
Cook-Medley hostility	−.52 (.62)	−.12	−.83	[−1.84, .79]
Education	3.69 (2.52)	.17	1.47	[−1.60, 8.99]
Systolic blood pressure baseline	.30 (.25)	.29	1.94	[−.23, .84]
Average work systolic blood pressure	.44 (.33)	.35	1.35	[−.25, 1.13]
Average perceived stress at home	7.69 (1.91)	.49	4.03**	[3.68, 11.71]
Adjusted R^2 = .75, F(14, 18) = 7.85***				
Step 2				
Average perceived valence of supervisor interactions	−14.52 (5.16)	−.31	−2.81*	[−25.40, −3.63]
Adjusted R^2 = .82, F(15, 17) = 10.68***				
ΔR^2 = .07, F(1, 17) = 7.92*				

Note. Shift type consisted of day, evening, graveyard, and homecare shifts; homecare was the dummy-coded comparison group to the rest. Gender was coded as man = 1 and woman = 2.
* $p < .05$. ** $p < .01$. *** $p < .001$.

time-lagged regressions was small ($N = 33$), again this observation suggests a limit to generalizability although we would further note that a small sample in this case resulted in a very conservative statistical tests which, nonetheless, identified significant effects.

The use of an experience sampling methodology allowed us to test longitudinal models of cardiovascular reactivity and recovery. Although this is an improvement over cross-sectional data, causal inferences remain tenuous. Furthermore, we only sampled one work day, which may not have accounted for the potential need for acclimatization and for participants who were experiencing an atypical work day (e.g., unusually high workload and stress). The use of single-item measures of quality of supervisory interactions for the hourly diaries may be another limitation of the study, as the type of constructs best suited for single-item are general and global (i.e., job satisfaction; Nagy, 2002). It is left to future research to exclude potential alternate explanations and to expand on the generalizability of current findings by obtaining a larger sample from other occupations, and by sampling over several days with multi-items measures.

Implications for Research and Practice

We believe that the strongest implication for future research emerging from our data is the need to understand the mechanisms through which supervisory interactions affect cardiovascular reactivity and recovery. We suggest that the effects of rumination may provide an avenue of explanation for these effects. Persistent negative thoughts are considered to be the mechanism by which cardiovascular recovery is delayed, possibly by evoking arousal from memories of the stressor (Brosschot, Pieper, & Thayer, 2005; Glynn, Christenfeld, & Gerin, 2002; Niven, Sprigg, Armitage, & Satchwell, 2013). The permanency and power difference of a supervisory position in an organization may also be perceived as a lack of control of situation for employees working under an unfavorable supervisor. While disagreements with peers can be resolved relatively quickly, confronting a superior may be more difficult and only ameliorable by a physical transfer of the employees themselves.

Our results also have implications for organizational practice. It is clear from our data, and from a larger corpus of findings (for a review see Mullen & Kelloway, 2011) that organizational leaders have substantial effects on subordinates' well-being. Leadership development activities aimed at improving the quality of leadership would be, in this context, an integral part of a healthy workplace strategy and would result in enhanced employee well-being (Kelloway & Barling, 2010). Moreover, although our focus was on negative supervisory interactions, our findings are consistent with data suggesting that positive interactions with supervisors enhance employees' mood and well-being (Kelloway, Weigand, McKee, & Das, 2013). An organizational focus on improving quality of interactions with supervisors would seem to offer considerable potential for enhancing employees' well-being.

Summary and Conclusion

Using an experience sampling methodology coupled with the assessment of ambulatory blood pressure monitoring, we examined the effect of supervisory interactions with cardiovascular reactivity and cardiovascular recovery. Both of our hypotheses were supported with negatively valenced supervisory interactions being associated with higher systolic blood pressure both immediately and during the postwork period. These results support the importance of organizational leadership as an influence on individual well-being and have implications for both future research and organizational practice. Our results also suggest a fruitful methodology for examining the interplay between social psychological and biological components of health in organizational contexts can enhance our understanding of occupational health psychology.

References

Barefoot, J. C., Dodge, K. A., Peterson, B. L., Dahlstrom, W. G., & Williams, R. B., Jr. (1989). The Cook-Medley hostility scale: Item content and ability to predict survival. *Psychosomatic Medicine, 51,* 46–57. http://dx.doi.org/10.1097/00006842-198901000-00005

Belkic, K. L., Landsbergis, P. A., Schnall, P. L., & Baker, D. (2004). Is job strain a major source of cardiovascular disease risk? *Scandinavian Journal of Work, Environment & Health, 30,* 85–128. http://dx.doi.org/10.5271/sjweh.769

Bosma, H., Peter, R., Siegrist, J., & Marmot, M. (1998). Two alternative job stress models and the risk of coronary heart disease. *American Journal of Public Health, 88,* 68–74. http://dx.doi.org/10.2105/AJPH.88.1.68

Brondolo, E., Karlin, W., Alexander, K., Bobrow, A., & Schwartz, J. (1999). Workday communication and ambulatory blood pressure: Implications for the reactivity hypothesis. *Psychophysiology, 36,* 86–94. http://dx.doi.org/10.1017/S0048577299961565

Brosschot, J. F., Pieper, S., & Thayer, J. F. (2005). Expanding stress theory: Prolonged activation and perseverative cognition. *Psychoneuroendocrinology, 30,* 1043–1049. http://dx.doi.org/10.1016/j.psyneuen.2005.04.008

Cannon, W. B. (1915). *Bodily changes in pain, hunger, fear and rage: An account of recent researches into the function of emotional excitement*. New York, NY: D. Appleton & Co. http://dx.doi.org/10.1037/10013-000

Chen, E., Matthews, K. A., & Zhou, F. (2007). Interpretations of ambiguous social situations and cardiovascular responses in adolescents. *Annals of Behavioral Medicine, 34,* 26–36. http://dx.doi.org/10.1007/BF02879918

Demerouti, E., Bakker, A. B., Nachreiner, F., & Schaufeli, W. B. (2001). The job demands-resources model of burnout. *Journal of Applied Psychology, 86,* 499–512. http://dx.doi.org/10.1037/0021-9010.86.3.499

Duffy, M. K., Ganster, D. C., & Pagon, M. (2002). Social undermining in the workplace. *Academy of Management Journal, 45,* 331–351. http://dx.doi.org/10.2307/3069350

Eisenberger, R., Stinglhamber, F., Vandenberghe, C., Sucharski, I. L., & Rhoades, L. (2002). Perceived supervisor support: Contributions to perceived organizational support and employee retention. *Journal of Applied Psychology, 87,* 565–573. http://dx.doi.org/10.1037/0021-9010.87.3.565

Fullagar, C. J., & Kelloway, E. K. (2009). "Flow" at work: An experience sampling approach. *Journal of Occupational and Organizational Psychology, 82,* 595–615. http://dx.doi.org/10.1348/096317908X357903

Ganster, D. C., & Rosen, C. C. (2013). Work stress and employee health: A multidisciplinary review. *Journal of Management, 39,* 1085–1122. http://dx.doi.org/10.1177/0149206313475815

Gilbert, S., & Kelloway, E. K. (2014). Using single items to measure job stressors. *International Journal of Workplace Health Management, 7,* 186–199. http://dx.doi.org/10.1108/IJWHM-03-2013-0011

Glynn, L. M., Christenfeld, N., & Gerin, W. (2002). The role of rumination in recovery from reactivity: Cardiovascular consequences of emotional states. *Psychosomatic Medicine, 64,* 714–726.

Goodwin, J., Bilous, M., Winship, S., Finn, P., & Jones, S. C. (2007). Validation of the Oscar 2 oscillometric 24-h ambulatory blood pressure monitor according to the British Hypertension Society protocol. *Blood Pressure Monitoring, 12,* 113–117. http://dx.doi.org/10.1097/MBP.0b013e3280acab1b

Gregersen, S., Vincent-Höper, S., & Nienhaus, A. (2014). The relation between leadership and perceived well-being: What role does occupational self-efficacy play? *Journal of Leadership Studies, 8,* 6–18. http://dx.doi.org/10.1002/jls.21318

Heaphy, E. D., & Dutton, J. E. (2008). Positive social interactions and the human body at work: Linking organizations and physiology. *The Academy of Management Review, 33,* 137–162. http://dx.doi.org/10.5465/AMR.2008.27749365

Heck, R. H., Thomas, S. L., & Tabata, L. N. (2010). *Multilevel and Longitudinal Modeling with IBM SPSS*. New York, NY: Routledge Academic.

Hemingway, H., & Marmot, M. (1999). Psychosocial factors in the aetiology and prognosis of coronary heart disease: Systematic review of prospective cohort studies. *British Medical Journal, 318,* 1460–1467. http://dx.doi.org/10.1136/bmj.318.7196.1460

Ilies, R., Dimotakis, N., & Watson, D. (2010). Mood, blood pressure, and heart rate at work: An experience-sampling study. *Journal of Occupational Health Psychology, 15,* 120–130. http://dx.doi.org/10.1037/a0018350

Jones, S. C., Bilous, M., Winship, S., Finn, P., & Goodwin, J. (2004). Validation of the OSCAR 2 oscillometric 24-hour ambulatory blood pressure monitor according to the International Protocol for the validation of blood pressure measuring devices. *Blood Pressure Monitoring, 9,* 219–223. http://dx.doi.org/10.1097/00126097-200408000-00007

Karlin, W. A., Brondolo, E., & Schwartz, J. (2003). Workplace social support and ambulatory cardiovascular activity in New York City traffic agents. *Psychosomatic Medicine, 65,* 167–176. http://dx.doi.org/10.1097/01.PSY.0000033122.09203.A3

Kelloway, E. K., & Barling, J. (2010). Leadership development as an intervention in occupational health psychology. *Work and Stress, 24,* 260–279. http://dx.doi.org/10.1080/02678373.2010.518441

Kelloway, E. K., & Francis, L. (2012). Longitudinal research and data analysis. In R. R. Sinclair, M. Wang, & L. Tetrick (Eds.), *Research methods in occupational health psychology: Measurement design and data analysis* (pp. 374–394). New York, NY: Elsevier.

Kelloway, E. K., Sivanathan, N., Francis, L., & Barling, J. (2005). Poor leadership. In J. Barling, E. K. Kelloway, & M. Frone (Eds.), *Handbook of workplace stress* (pp. 89–112). Thousand Oaks, CA: Sage. http://dx.doi.org/10.4135/9781412975995.n5

Kelloway, E. K., Weigand, H., McKee, M., & Das, H. (2013). Positive leadership and employee well-being. *Journal of Leadership & Organizational Studies, 20,* 107–117. http://dx.doi.org/10.1177/1548051812465892

Kivimäki, M., Leino-Arjas, P., Luukkonen, R., Riihimäki, H., Vahtera, J., & Kirjonen, J. (2002). Work stress and risk of cardiovascular mortality: Prospective cohort study of industrial employees. *British Medical Journal, 325,* 857–861. http://dx.doi.org/10.1136/bmj.325.7369.857

Kivimäki, M., Nyberg, S. T., Batty, G. D., Fransson, E. I., Heikkilä, K., Alfredsson, L., . . . Theorell, T. (2012). Job strain as a risk factor for coronary heart disease: A collaborative meta-analysis of individual participant data. *The Lancet, 380,* 1491–1497. http://dx.doi.org/10.1016/S0140-6736(12)60994-5

Krantz, D. S., & Manuck, S. B. (1984). Acute psychophysiologic reactivity and risk of cardiovascular disease: A review and methodologic critique. *Psychological Bulletin, 96,* 435–464. http://dx.doi.org/10.1037/0033-2909.96.3.435

Kuper, H., & Marmot, M. (2003). Job strain, job demands, decision latitude, and risk of coronary heart disease within the Whitehall II study. *Journal of Epidemiology and Community Health, 57,* 147–153. http://dx.doi.org/10.1136/jech.57.2.147

Kuper, H., Marmot, M., & Hemingway, H. (2002). Systematic review of prospective cohort studies of psychosocial factors in the etiology and prognosis of coronary heart disease. *Seminars in Vascular Medicine, 2,* 267–314. http://dx.doi.org/10.1055/s-2002-35401

McEwen, B. S., & Stellar, E. (1993). Stress and the individual. Mechanisms leading to disease. *Archives of Internal Medicine, 153,* 2093–2101. http://dx.doi.org/10.1001/archinte.1993.00410180039004

Mullen, J., & Kelloway, E. (2011). Occupational health and safety leadership. In J. Quick & L. E. Tetrick (Eds.), *Handbook of occupational health psychology* (2nd ed., pp. 357–372). Washington, DC: American Psychological Association.

Nagy, M. S. (2002). Using a single-item approach to measure facet job satisfaction. *Journal of Occupational and Organizational Psychology, 75,* 77–86. http://dx.doi.org/10.1348/096317902167658

Niven, K., Sprigg, C. A., Armitage, C. J., & Satchwell, A. (2013). Ruminative thinking exacerbates the negative effects of workplace violence. *Journal of Occupational and Organizational Psychology, 86,* 67–84. http://dx.doi.org/10.1111/j.2044-8325.2012.02066.x

Nyberg, S. T., Fransson, E. I., Heikkilä, K., Alfredsson, L., Casini, A., Clays, E., . . . the IPD-Work Consortium. (2013). Job strain and cardiovascular disease risk factors: Meta-analysis of individual-participant data from 47,000 men and women. *PLoS ONE, 8,* e67323. http://dx.doi.org/10.1371/journal.pone.0067323

Pickering, T., & Friedman, R. (1991). The white coat effect: A neglected role for behavioral factors in hypertension. In P. McCabe & N. Schneiderman (Eds.), *Stress, coping and disease* (pp. 35–49). Hillsdale, NJ: Erlbaum Inc.

Reich, T. C., & Hershcovis, M. (2011). Interpersonal relationships at work. In S. Zedeck (Ed.), *APA handbook of industrial and organizational psychology: Vol. 3. Maintaining, expanding, and contracting the organization* (pp. 223–248). Washington, DC: American Psychological Association. http://dx.doi.org/10.1037/12171-006

Sapolsky, R. M. (1994). Individual differences and the stress response. *Seminars in Neuroscience, 6,* 261–269. http://dx.doi.org/10.1006/smns.1994.1033

Schnall, P. L., Landsbergis, P. A., & Baker, D. (1994). Job strain and cardiovascular disease. *Annual Review of Public Health, 15,* 381–411. http://dx.doi.org/10.1146/annurev.pu.15.050194.002121

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4,* 1–32. http://dx.doi.org/10.1146/annurev.clinpsy.3.022806.091415

Skakon, J., Nielson, K., Borg, V., & Guzman, J. (2010). Are leaders' well-being, behaviours and style associated with the affective well-being of their employees? A systematic review of three decades of research. *Work and Stress, 24,* 107–139. http://dx.doi.org/10.1080/02678373.2010.495262

Snijders, T. A. B., & Bosker, R. J. (1999). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. London, UK: Sage.

Sonnentag, S., & Zijlstra, F. R. (2006). Job characteristics and off-job activities as predictors of need for recovery, well-being, and fatigue. *Journal of Applied Psychology, 91,* 330–350. http://dx.doi.org/10.1037/0021-9010.91.2.330

Steptoe, A., Brydon, L., & Kunz-Ebrecht, S. (2005). Changes in financial strain over three years, ambulatory blood pressure, and cortisol responses to awakening. *Psychosomatic Medicine, 67,* 281–287. http://dx.doi.org/10.1097/01.psy.0000156932.96261.d2

Steptoe, A., & Marmot, M. (2005). Impaired cardiovascular recovery following stress predicts 3-year increases in blood pressure. *Journal of Hypertension, 23,* 529–536. http://dx.doi.org/10.1097/01.hjh.0000160208.66405.a8

Steptoe, A., & Marmot, M. (2006). Psychosocial, hemostatic, and inflammatory correlates of delayed poststress blood pressure recovery. *Psychosomatic Medicine, 68,* 531–537. http://dx.doi.org/10.1097/01.psy.0000227751.82103.65

Suntech Medical. (2012). *Oscar 2 ambulatory blood pressure monitor*. Retrieved from http://www.suntechmed.com/bp-devices-and-cuffs/ambulatory-blood-pressure-monitoring/oscar-2

Tepper, B. J. (2000). Consequences of abusive supervision. *Academy of Management Journal, 43,* 178–190. http://dx.doi.org/10.2307/1556375

Theorell, T., & Karasek, R. A. (1996). Current issues relating to psychosocial job strain and cardiovascular disease research. *Journal of Occupational Health Psychology, 1,* 9–26. http://dx.doi.org/10.1037/1076-8998.1.1.9

Van Egeren, L. F. (1992). The relationship between job strain and blood pressure at work, at home, and during sleep. *Psychosomatic Medicine, 54,* 337–343. http://dx.doi.org/10.1097/00006842-199205000-00009

Wager, N., Fieldman, G., & Hussey, T. (2003). The effect on ambulatory blood pressure of working under favourably and unfavourably perceived supervisors. *Occupational and Environmental Medicine, 60,* 468–474. http://dx.doi.org/10.1136/oem.60.7.468

Wanous, J. P., & Hudy, M. J. (2001). Single-item reliability: A replication and extension. *Organizational Research Methods, 4,* 361–375. http://dx.doi.org/10.1177/109442810144003

Received November 25, 2014
Revision received June 22, 2015
Accepted July 17, 2015 ■