

Self-Control Demands at Work and Psychological Strain: The Moderating Role of Physical Fitness

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The present study examined the moderating (buffering) influence of physical fitness on the positive relation between job-related self-control demands and psychological strain. Data from 819 participants were obtained during a voluntary medical checkup. Physical fitness was assessed by a well-established measure of maximal oxygen uptake (expressed as milliliters of oxygen consumed per kilogram of body weight per minute); all other study variables were assessed by validated self-report measures. Hierarchical moderated regression analyses provided support for the prediction that physical fitness buffers the adverse impact of self-control demands on various indicators of psychological strain (burnout, ego depletion, need for recovery). For employees with low levels of physical fitness, the adverse impact of self-control demands on strain was much more pronounced than for those with high levels of physical fitness. The moderating effect of physical fitness suggests preventive interventions, which promote fitness and health, as a stress buffer especially among employees who have to meet high self-control demands at work.

Keywords: strength model of self-control, resources, buffer effect, job strain

For many jobs, particularly those in the services sector, self-control demands (SCDs) are an integral part of the work role (Cascio, 2003). In particular, in nearly all occupational and organizational contexts, employees have to flexibly adapt their behavior according to changing time schedules, social norms, and organizational rules. In the services sector, employees' job

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role requires them to effectively anticipate and fulfill customers' needs as well as to regulate their emotions, to create an organizationally desired facial and body posture display. On a more abstract level, the increasing utilization of communication technologies and constant dynamics of globalization put high demands on goal-directed action control, in terms of attentional regulation and efficient information processing. Such demands cannot be met by rigid, automatic, and habitual behavioral patterns, but rather call for volitional self-control (e.g., Diestel & Schmidt, 2012). Self-control involves inhibiting, modifying, or overriding spontaneous and automatic reactions, urges, emotions, and desires that would otherwise interfere with goal-directed behavior and impede goal achievement (Baumeister, Heatherton, & Tice, 1994). Demands on self-control cause people to change the way they would spontaneously think, feel, or behave. That is, employees are required to engage in self-control when they have to follow certain rules, create specific impressions, or concentrate on complex tasks without allowing distraction.

Recent results from both basic and applied research have repeatedly revealed that self-control as a volitional act produces psychological costs, which manifest in strain experience (see Hagger, Wood, Stiff, & Chatzisarantis, 2010, for an overview). To explain this finding, different forms of SCDs have been proposed to draw on and deplete a common limited regulatory resource (Muraven & Baumeister, 2000). In addition, sustained periods of high SCDs are psychologically draining and predict burnout symptoms, over longer time intervals (Schmidt & Diestel, 2015). The idea that dealing with SCDs is costly or "ego-depleting" derives from the strength model of self-control (Baumeister, Vohs, & Tice, 2007). This model conceptualizes self-control as a deliberate and effortful process that consumes limited energy resources.

The main aim of the present study was to examine whether and to what extent physical fitness may function as a protective buffer against the adverse influences of SCDs. The buffering function of physical fitness in the relation between SCDs and psychological strain has been suggested by recent research on the physiological underpinnings of ego depletion. This research has identified blood glucose as the physical manifestation of the limited energy resource on which acts of self-control rely (Gailliot & Baumeister, 2007). Acts of self-control, such as suppressing emotions or stereotypes, have been shown to reduce blood glucose levels, and restoring glucose levels using drinks with high glucose concentrations appears to facilitate self-control (Gailliot, Plant, Butz, & Baumeister, 2007).

Glucose as the energy resource of self-control suggest the assumption of physical fitness as a potential moderator of the positive relations of SCDs with psychological strain and impaired well-being, because physical fitness has been shown to improve the transfer of glucose from the blood into the cells (Goodyear & Kahn, 1998). More specifically, physical fitness goes

along with a decrease in insulin resistance, which is an indicator for the amount of insulin an individual requires to metabolize glucose (Lebovitz, 2001). Consequently, individuals with high insulin resistance require higher amounts of insulin and, thus, are less efficient in transferring glucose from blood into cells. In contrast, low insulin resistance indicates that less insulin is required to metabolize glucose. Thus, insulin resistance indicates the degree of efficiency of an organism to use blood glucose. Because many studies have provided evidence that physical fitness is related to decreased insulin resistance (Bell et al., 2007; Imperatore, Cheng, Williams, Fulton, & Gregg, 2006), individuals with high physical fitness and, hence, low insulin resistance should be more efficient at metabolizing blood glucose into cells than individuals with low physical fitness (and high insulin resistance).

Consequently, this mechanism should also facilitate coping with SCDs at work. More specifically, we hypothesized that physical fitness interacts with SCDs in predicting psychological strain in such a way that increasing levels of physical fitness will attenuate the adverse effects of SCDs on strain. Our hypothesis is grounded in a theoretical integration of two models, namely, the model of allostasis (McEwen, 2000) and the model of self-control strength (Muraven & Baumeister, 2000). Whereas the model of self-control strength expatiates upon the underlying psychological mechanisms of the costs of exerting volitional self-control, the model of allostasis elaborates on the physiological processes of chronically high stress, which is caused by constantly high SCDs. Our theoretical integration provides an explanation for why physical fitness as a promoter of blood glucose supply should prevent employees from being exhausted, even in cases of high SCDs. Because most moderators examined in past research were job characteristics (e.g., job control) or personality traits (e.g., extraversion), which are difficult to alter (Ilies, Dimotakis, & Watson, 2010), the present study contributes to this literature by focusing on a moderator (physical fitness) that is more easily influenced by employees.

In the following, we review the literature on self-control. Then, we discuss glucose as the limited energy resource of self-control. Finally, we integrate both lines of research and develop the hypothesis in more detail.

Psychological Costs of Self-Control

The most important finding on self-control in basic research is that exercising self-control can lead to impairments in cognitive and behavioral control and cause psychological strain (Muraven, Tice, & Baumeister, 1998). In a series of experimental studies that demanded two successive acts of self-control, self-control performance on the second act was consistently

impaired. The impairment was found even when quite different domains of self-control were involved. In these studies, acts of self-control involved regulating emotions and affective states, suppressing spontaneous and habitual impulses, overcoming inner motivational resistances, resisting interfering distractions, and updating working memory (see [Hagger et al., 2010](#), for an overview).

In addition, acts of self-control were found to cause increases in self-reported effort, tiredness, and exhaustion ([Muraven et al., 1998](#)) as well as increases in sympathetic arousal ([Robinson & Demaree, 2007](#)). On a physiological level, the exertion of self-control went along with increases in blood pressure and heart rate variability, indicating typical stress responses ([Segerstrom & Nes, 2007](#)). According to the model of allostasis ([McEwen, 2000](#)), such stress responses manifest in states of allostatic load, especially when stress activations are sustained and prolonged. Allostatic load refers to chronically high levels of stress mediators, such as cortisol and catecholamines, which cause considerable deficits in homeostatic regulation of insulin, lipids, and cardiovascular activities, in the long run. Such deficits increase the risk of psychological diseases, such as anxiety, depressive, and psychosomatic symptoms ([McEwen, 1998, 2000](#)). In support of this line of reasoning, a growing body of evidence has suggested that chronically high SCDs can lead to psychological strain (see [Baumeister, Gailliot, DeWall, & Oaten, 2006](#), for an overview). For example, [Oaten and Cheng \(2005\)](#) reported significant increases of anxiety, depressive symptoms, emotional distress, and psychosomatic complaints as a result of chronic exposure to high SCDs. Finally, in identifying the relevant brain regions, processes of self-control were found to be primarily located in the phylogenetically new structures of the frontal lobe of the cerebral cortex ([Miyake et al., 2000](#)).

To account for these observations, [Muraven and Baumeister \(2000\)](#) delineated the strength model of self-control. According to this model, different forms of self-control draw on a common regulatory resource, or self-control strength, which is limited and depleted in the process of exerting self-control. Consequently, acts of self-control reduce the strength available for subsequent self-control efforts. This state of diminished self-control strength is commonly referred to as “ego depletion” ([Baumeister, Vohs, & Tice, 2007](#)). Thus, self-control strength resembles a muscle, which is exhausted during prolonged exertion. Furthermore, the model also proposes that people, who frequently need to exert self-control without being able to replenish their self-control resource, run the risk of falling into a state of chronic resource depletion and, as a result, suffer from chronically high psychological strain.

Inspired by this model and given the increasing relevance of self-control in modern work settings ([Cascio, 2003](#)), recent research on occupational stress and health has also demonstrated that demands on self-control consti-

tute a major stressor at work. Applied research has adopted three forms of job-related SCDs and provided evidence on their cumulative impacts on psychological strain (Schmidt & Neubach, 2007). First, impulse control refers to the demand to inhibit spontaneous, impulsive response tendencies and affect states associated with, for example, injudicious expressions. Second, resisting distractions involves the requirement to ignore and resist distractions evoked by task-irrelevant stimuli, which would otherwise interfere with a successful accomplishment of tasks. Third, overcoming inner resistances relates to the requirement of overcoming motivational deficits to complete unattractive tasks, which cannot be postponed and evaded.

The three forms of SCDs were found to be relatively stable over time (12 and 24 months), indicating that SCDs constitute stable characteristics of a given job. In addition and on the basis of several samples from different occupational contexts, cross-sectional and longitudinal data have revealed that all three SCDs explained unique and additional amounts of variance in burnout, absenteeism, and other indicators of strain over and beyond that accounted for by several established work stressors, such as workload, role ambiguity, and lack of social support. Finally, job control as a job characteristic, which enables employees to exert goal-directed control over their task, and affective commitment as an emotionally driven psychological bond between employees and their organization, moderate (attenuate) the positive relation between SCDs and indicators of psychological strain (see Schmidt & Diestel, 2015, for an overview).

Because person-related moderating factors have gained less attention in previous research on job-related SCDs, the question arises whether factors could be identified in a person that might protect employees against the adverse effects of SCDs. The identification of such protective factors, often labeled as “psychological resources” (Hobfoll, 1989, 2002), is a dominant topic in current stress research, not the least due to their implications for preventive interventions.

Energy Basis of Self-Control

Accumulating evidence has suggested that self-control relies on some sort of limited energy resource, which becomes depleted with use (Hagger et al., 2010). In support of this notion, Gailliot et al. (2007) suggest blood glucose as one important facet of that energy resource. In particular, a series of experimental studies could demonstrate that (a) different acts of self-control reduce blood glucose levels, (b) low levels of blood glucose after an initial act of self-control go along with poor performance on subsequent self-control tasks, and (c) uptake of glucose can prevent observed ego-depletion effects that otherwise follow the exertion of self-control.

Findings from other studies have confirmed these observations (Beedie & Lane, 2012; Job, Walton, Bernecker, & Dweck, 2013). Accordingly, various acts of self-control (e.g., controlling attention, regulating emotions, resisting temptations and impulsivity) have been found to consume relatively large amounts of glucose. Conversely, low levels of glucose have been found to result in poor self-control performance across a wide range of control functions (e.g., coping with stress, regulating emotions, resisting impulsivity, abstaining from nicotine and alcohol consumption; see Gailliot & Baumeister, 2007, for an overview).

Although several scholars have cast strong doubts on the argument that blood glucose is the only underlying substrate of the limited self-control resource (Kurzman, 2010; Inzlicht, Schmeichel, & Macrae, 2014), theoretical extensions of the self-control strength model have proposed blood glucose as a physiologically influential element of self-control functioning (e.g., Beedie & Lane, 2012), because glucose has long been known to be a vital fuel for the brain (Laughlin, 2004). Glucose from the bloodstream is metabolized in brain regions and enables cerebral functioning by providing fuel for neurons to fire impulses. Although all cerebral functions need glucose, several studies have shown that effortful, self-controlled processes require more glucose than simpler, less effortful, or automatic processes (e.g., Benton, Parker, & Donohoe, 1996; Scholey, Harper, & Kennedy, 2001). Effortful and controlled processes are also more likely to be impaired by low glucose levels (McNay, McCarty, & Gold, 2001). In support of this argument, several experimental studies have found that executive functioning as the underlying mechanism of self-control (Hofmann, Schmeichel, & Baddeley, 2012) corresponds to the availability of blood glucose levels (Fairclough & Houston, 2004).

Besides the availability of glucose, the body's ability to use glucose efficiently is also important to cognitive functioning. Blood glucose is normally increased by eating. Then, the liver releases insulin to help store glucose for future use. There are, however, considerable interindividual differences in the efficient use and storage of glucose. One important difference characteristic is insulin resistance. Insulin resistance is an indicator of the amount of insulin an individual requires to metabolize glucose (Lebovitz, 2001). Individuals with high insulin resistance are less able than others to store and use glucose efficiently, whereas those with low insulin resistance are better able than others to use glucose in the brain when needed.

Although people differ in their insulin resistance, insulin resistance is not constant over time; rather, it fluctuates and can be altered. Multiple studies have provided evidence that physical activity and fitness are strong precursors of insulin resistance. For example, one study found a

decrease of insulin resistance after 8-weeks of supervised circuit-based exercise training (Bell et al., 2007). This decrease was associated with a significant improvement in cardiorespiratory fitness, as indicated by sub-maximal exercise heart rate responses. In a similar vein, other results have shown that physical activity and cardiovascular fitness are significantly negatively associated with insulin resistance. That is, increasing physical activity and cardiovascular fitness resulted in a decrease in insulin resistance (Imperatore et al., 2006). The protective role of physical activity and fitness in coping with strenuous stress situations was further confirmed by Perseghin et al. (1996), who found that, compared with low fitness, those with good physical condition are better able to metabolize blood glucose and are less vulnerable to stress, which results from high self-control effort.

The Present Study

Going beyond previous research and connecting the domains of SCDs and physical fitness as a relevant precursor, which influences the energy resource for self-control, we argue that physical fitness is a resource that facilitates coping with job-related demands on self-control in a way that prevents psychological strain. Our argument derives from the integration of the self-control strength model and its theoretical extension on the physiological role of blood glucose as well as the allostasis model. First, consistent with the self-control strength model, SCDs are a source of stress at work, which is proposed to draw on and deplete a limited regulatory resource. Second, the limited regulatory resource varies as a function of blood glucose supply, which is important for self-control functioning. Third, in line with the allostasis model, in cases of low physical fitness, the combination of an increased insulin resistance and chronically high SCDs is predicted to result in disproportionately high allostatic load, which becomes manifest in psychological strain, whereas physical fitness should reduce insulin resistance and, thus, should facilitate metabolizing blood glucose into the brain cells. Because physical fitness fosters processes of replenishing regulatory resources on the basis of enhanced blood glucose supply, we would expect SCDs to interact with physical fitness in predicting psychological strain. More specifically, we hypothesized that the adverse impact of SCDs would be attenuated (buffered) by increasing levels of physical fitness. In conclusion, we derive the following hypotheses.

Hypotheses

Physical fitness moderates the positive relation between SCDs and emotional exhaustion (Hypothesis 1), depersonalization (Hypothesis 2), ego depletion (Hypothesis 3), and need for recovery (Hypothesis 4) in such a way that individuals with high physical fitness should report lower strain due to SCDs than individuals with low physical fitness. The positive relations between SCDs and all four indicators of psychological strain should be attenuated as a function of increasing physical fitness. We tested the hypotheses on the basis of an overall measure of SCDs (rather than facing specific measures such as impulse control, overcoming inner resistances and resisting distractions). This procedure was guided by the argument that, although SCDs constitute a multidimensional construct, different forms of SCDs are theoretically thought to draw on and deplete a common limited regulatory resource (Baumeister et al., 2007). Consequently, their integrative measurement reflects the total or cumulative demands on that limited resource (Diestel & Schmidt, 2011).

As strain outcomes, we chose burnout, ego depletion, and need for recovery. Past research has repeatedly shown that SCDs exert positive effects on both core dimensions of burnout: emotional exhaustion and depersonalization (Diestel & Schmidt, 2011; Zapf & Holz, 2006). To explain these effects, authors have argued that both burnout dimensions are very sensitive to decrements in the regulatory resource and thus may reflect overstraining by SCDs (Lam, Huang, & Janssen, 2010; Maslach, Schaufeli, & Leiter, 2001). Strong support for this argument has been provided by experimental findings that have demonstrated that deficits in self-control predict exhaustion and depersonalization (Van Der Linden, Keijsers, Eling, & Van Schaijk, 2005).

As short-term indicators of psychological strain, we also examined ego depletion and need for recovery. Ego depletion is a direct measure of feelings of regulatory resource depletion (Muraven & Baumeister, 2000), whereas need for recovery reflects the need to replenish drained resources (van Veldhoven & Broersen, 2003).

Method

Study Design and Participants

Data from 819 employees were collected during a voluntary medical checkup in cooperation with a German health care provider. Participants were invited by a letter from their management informing them about the aim of the checkup, the voluntary nature of participation, and medical confiden-

tiality. The aim of this checkup was to assess employees' physical and psychological health and to identify risk factors, which might impair well-being and health. From all invited individuals, nearly 50% participated in the checkup. All participants gave informed consent prior to inclusion in the study. Data collection was conducted by physicians with established and carefully validated medical and self-report procedures and instruments. Participants were employed in the financial sector and provided customer service and sold financial products. Thus, they interacted with clients on a regular basis. Additionally, to encourage customers to entrust their money to the financial institution, employees must control impulses to refrain from speaking and behaving in ways that create an atmosphere of distrust and insecurity. Employees also frequently deal with difficult customers, foremost when handling complaints. During these interactions, employees always have to remain friendly, even when responding to clients who behave rudely or in unfriendly manner. Their job descriptions imply that self-control is an integral part of participants' work role. The proportion of female participants was 45.67%, and age ranged from 31–64 years ($M = 48.21$ years, $SD = 5.60$). Twenty-two percent of participants held leadership positions. Participants' work week varied between 10 hours and 65 hours, with an average of 40.08 hours.

Measures and Instruments

Self-control demands. The SCDs measure comprises 10 items from an instrument that covers three facets of SCDs: impulse control (e.g., "My job requires me never to lose my temper"), resisting distractions (e.g., "In order to achieve my performance goals, I must not let myself be distracted"), and overcoming inner resistances (e.g., "Some of my tasks are such that I really need to force myself to get them done"; Schmidt & Neubach, 2007). All items are scored on a 5-point rating format, ranging from 1 (*not at all*) to 5 (*a great deal*). The item scores were averaged to form an overall measure of job-related SCDs that reflects the cumulative extent to which a given job causes employees to engage in self-control (Diestel & Schmidt, 2011).

Physical fitness. Physical or cardiovascular fitness was determined by a widely used exercise test on a braked bicycle ergometer. On the basis of sex, age, and body weight, participants were assigned to slowly increasing bicycle protocols. The main outcome was the workload attained when participants reached 100% of their predicted maximum heart rate. Workload is assessed in terms of estimated oxygen consumption (VO_2 max, expressed as milliliters of oxygen consumed per kilogram of body weight per minute; Cureton, Plowman, & Mahar, 2013). In the present analysis, estimated individual

VO₂max was further categorized according to sex- and age-specific norms provided by Heyward (1998). The norms ranged from 1 (*very poor*) to 6 (*superior*).

Burnout. The two burnout dimensions of emotional exhaustion and depersonalization were measured using Büssing and Ferrar's (1992) German translation of the Maslach Burnout Inventory (Maslach & Jackson, 1986). Emotional exhaustion (eight items) refers to feelings of being overextended and drained by work demands (e.g., "I feel emotionally drained from my work"). Depersonalization (six items) is characterized by a detached, indifferent, and cynical attitude toward people with whom one has to interact at work (e.g., "I have become more callous toward people since I took this job"). All items are scored on a 6-point intensity rating scale (1 = *not at all* and 6 = *very strong*).

Ego depletion. We assessed ego depletion with four items related to participants' experiences with resource depletion and low will power (e.g., "I feel increasingly less able to focus on anything"). The scale was developed and validated by Bertrams, Unger und, and Dickhäuser (2011), who intended to assess the psychological state of ego depletion proposed by Muraven and Baumeister (2000). All items are scored using a 4-point intensity rating format (1 = *not at all* and 5 = *a great deal*).

Need for recovery. For measuring need for recovery, five items were used, which reflect the extent to which employees are incapable of expressing interest in other things and perceive a high requirement for a rest period to recover from straining activities (van Veldhoven & Broersen, 2003) (e.g., "Today, I cannot really show any interest in other people when I have just come home myself"). Again, all items are scored using a 4-point intensity rating format (1 = *not at all* and 5 = *a great deal*).

Control variables. To control for the possibility that biographical differences in the predictor or criterion measures might lead to distorted relationships, the following biographical background variables were assessed for each respondent: age (in years), gender (0 = *female*, 1 = *male*), working time (in hours per week), and leadership position (0 = *no leadership position*, 1 = *leadership position*).

Statistical Analyses

Before testing the hypotheses, confirmatory factor analyses (CFAs) were performed to inform on the distinctiveness of all study variables. The corresponding measurement models were evaluated using conventional fit indices (see Schermelleh-Engel, Moosbrugger, & Müller, 2003). Then, for testing whether physical fitness moderated the positive relations between SCDs and

psychological strain, hierarchical moderated regression analyses were performed separately for each criterion measure. In the first step, biographical variables (i.e., age, gender, working time, and leadership position) were introduced to control for their potential influences on the relations under consideration. In the second step, SCDs and physical fitness were jointly added to the equation to examine their unique main effects. Finally, an interaction term computed as the cross-product of SCDs and physical fitness was introduced. The test for the interaction effect is based on the variance explained by the cross-product over and above that accounted for by the main effects. To avoid biased estimations due to multicollinearity, both predictors were standardized prior to calculating the cross-product term (see Aiken & West, 1991).

Results

Means, standard deviations, intercorrelations, and internal consistencies (Cronbach’s alpha) of all study variables are presented in Table 1. As will be shown, all questionnaire measures revealed satisfactory consistencies.

Measurement Models

The construct validity of our measures was tested using CFA. All latent variables were integrated in one measurement model, to ensure that demands

Table 1
Means, Standard Deviations, Intercorrelations and Internal Consistencies of Study Variables

Variable	1	2	3	4	5	6	7	8	9	10
1. Age	—									
2. Gender ^a	.10	—								
3. Working time ^b	.14	.52	—							
4. Leadership position ^c	-.02	.27	.40	—						
5. Self-control demands	.05	-.02	.01	-.04	(.83)					
6. Vo ₂ max	-.12	-.32	-.21	-.13	-.09	—				
7. Emotional exhaustion	.01	-.01	.10	-.07	.45	-.10	(.88)			
8. Depersonalization	.01	.12	.11	.04	.32	-.13	.60	(.77)		
9. Ego depletion	.04	-.11	-.05	-.14	.35	-.08	.66	.44	(.79)	
10. Need for recovery	.04	-.05	.15	-.01	.41	-.16	.69	.44	.57	(.79)
<i>M</i>	48.21	0.54	40.08	0.22	3.16	3.31	2.17	1.63	1.51	1.84
<i>SD</i>	5.60	0.50	11.42	0.42	0.60	1.36	0.86	0.64	0.46	0.54

Note. N = 819. Internal consistency estimates (Cronbach’s alpha) are presented in parentheses on the diagonal. Numbers in boldface are *p* < .05 (two-tailed test). Vo₂max = maximal oxygen uptake.

^a Gender (0 = female, 1 = male). ^b Working time is in hours per week. ^c Leadership position (0 = no, 1 = yes).

and outcomes were separately evaluated. Because of the high number of items and associated problems with parsimony (Little, Cunningham, Shahar, & Widaman, 2002), we created parcels, which were used as manifest indicators of the measurement models. Because SCDs have been conceptualized as a multidimensional construct (Schmidt & Neubach, 2007), we applied the domain-representative method, by specifying a parcel for each of the three subscales of SCDs (impulse control, resisting distractions, and overcoming inner resistances; Kishton & Widaman, 1994). The parcels of the four outcomes (ego depletion, need for recovery, emotional exhaustion, and depersonalization) were created on the basis of the item-to-construct balance method that places lower loaded items with higher loaded items and, thus, minimizes the loading differences among the manifest variables (see Little et al., 2002). A five-factor model, which distinguished between all variables, yielded a satisfactory fit, $\chi^2(44) = 107.72$, $p < .01$, root mean square error of approximation (RMSEA) = .042, comparative fit index (CFI) = .987, standardized root mean square residual (SRMR) = .027. In contrast, other models that integrated the variables into factors provided a worse data fit (four-factor model with both burnout variables as one factor: $\chi^2(48) = 395.33$, $p < .01$, RMSEA = .094, CFI = .927, SRMR = .054; four-factor model with ego depletion and need for recovery as one factor: $\chi^2(48) = 250.21$, $p < .01$, RMSEA = .072, CFI = .958, SRMR = .036; and two-factor model with one strain factor: $\chi^2(53) = 640.44$, $p < .01$, RMSEA = .116, CFI = .877, SRMR = .065).

Analysis of Main and Interaction Effects

The results of the hierarchical moderated regression analyses are summarized in Tables 2 and 3. After controlling for biographical characteristics, SCDs and physical fitness yielded significant main effects for all outcomes, with signs corresponding to expectations. The direct impacts were positive for SCDs and negative for physical fitness. More important, however, the two-way SCDs \times Physical fitness interaction additionally accounted for significant amounts of variance in all criterion measures. Following recommendations provided by Spector and Brannick (2011), we also performed comparative regression analyses without the inclusion of biographical characteristics as control variables to determine whether their addition influenced relations among the main study variables. The results revealed no changes in the main and interactive effects of SCDs and physical fitness on the outcomes (with the exception of the main effect of physical fitness on ego depletion, which was not statistically significant). Thus, the possibility that the main results could be attributed to the control variables was ruled out.

Table 2
Regression Results (β Values) for Emotional Exhaustion and Depersonalization*

Variable	Emotional exhaustion			Depersonalization		
	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Age	-.01	-.04	-.04	-.01	-.04	-.04
Gender ^a	-.06	-.07	-.07	.08	.06	.07
Working time ^b	.15**	.15**	.15**	.09*	.09*	.09*
Leadership position ^c	-.09*	-.08*	-.08*	.00	.00	.00
Self-control demands		.44**	.43**		.32**	.31**
VO ₂ max		-.06	-.06		-.07	-.07
SCDs × VO ₂ max			-.09**			-.08*
R ² (ΔR^2)	.02 (.02)	.22 (.20)	.23 (.01)	.02 (.02)	.13 (.11)	.14 (.01)
F for change in R ²	4.49**	107.31**	8.56**	4.15**	51.61**	5.48*

Note. N = 819. SCD = self-control demand; VO₂max = maximal oxygen uptake.

^a Gender (0 = female; 1 = male). ^b Working time is in hours per week. ^c Leadership position (0 = no; 1 = yes).

* p < .05. ** p < .01.

To facilitate the interpretation of the interaction patterns, the interactions were plotted according to recommendations by Aiken and West (1991). Values of the predictors were chosen 1 SD above and below the means. Then, for each criterion measure, simple regression lines were generated by inserting these values into the regression equations. The resulting plots are depicted in Figure 1. As can be seen, SCDs and physical fitness had a comparable interactive influence on all outcomes, the form of which clearly confirmed the hypothesized buffer function of physical fitness. For employees with low levels of fitness, the adverse impact of SCDs was much more pronounced than for employees with high levels of physical fitness.

Table 3
Regression Results (β Values) for Ego Depletion and Need for Recovery

Variable	Ego depletion			Need for recovery		
	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Age	.04	.02	.01	.02	-.01	-.01
Gender ^a	-.10*	-.12**	-.11**	-.15**	-.18**	-.18**
Working time ^b	.04	.04	.04	.19**	.18**	.18**
Leadership position ^c	-.12**	-.12**	-.12**	-.01	-.01	-.01
Self-control demands		.33**	.32**		.39**	.38**
VO ₂ max		-.09**	-.09**		-.15**	-.15**
SCDs × VO ₂ max			-.10**			-.10**
R ² (ΔR^2)	.03 (.03)	.15 (.12)	.16 (.01)	.03 (.03)	.21 (.18)	.22 (.01)
F for change in R ²	5.89**	58.64**	9.70**	6.30**	93.15**	10.63**

Note. N = 819. SCD = self-control demand; VO₂max = maximal oxygen uptake.

^a Gender (0 = female; 1 = male). ^b Working time is in hours per week. ^c Leadership position (0 = no; 1 = yes).

* p < .05. ** p < .01.

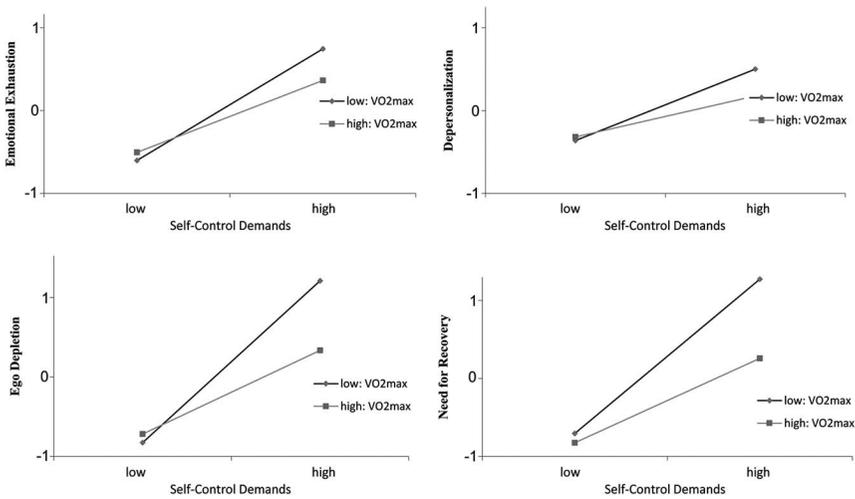


Figure 1. Interaction effects of self-control demands and physical fitness on burnout symptoms, ego depletion, and need for recovery (for reasons of comparability, all outcomes were standardized). VO_{2max} = maximal oxygen uptake.

Discussion

On the basis of the propositions of self-control research that (a) SCDs are a source of stress at work drawing and depleting a limited regulatory resource, the availability of which depends on blood glucose supply, and (b) physical fitness decreases insulin resistance and thus facilitates metabolizing blood glucose into the brain cells, the present study examined a moderating (buffering) influence of physical fitness (as indicated by VO_{2max}) on the positive relations between SCDs and indicators of psychological strain (i.e., burnout, ego depletion, and need for recovery). Data obtained from participants during medical checkups provided support for the hypothesized buffering effect of physical fitness. The findings lend support to the notion that physical fitness functions as a protective resource in coping with SCDs and in preventing associated high levels of psychological strain. Emotional exhaustion, depersonalization, ego depletion, and need for recovery did reflect significant interactive effects of SCDs and physical fitness in such a way that the adverse effects of SCDs were attenuated with increasing levels of physical fitness.

On the basis of our findings, our research offers several theoretical and practical contributions to existing knowledge. First, we theoretically and empirically integrated two issues of research on self-control that have recently been discussed in the literature: adverse effects of high job-related demands on self-control and glucose as one important facet of the limited

energy resources on which acts of self-control rely (Gailliot & Baumeister, 2007). Therefore, we were able to demonstrate that underlying processes of allostatic load, blood glucose supply, and the protective function of physical fitness do not only apply to experimental research, but are also relevant for occupational and organizational settings. While a large body of empirical evidence has drawn on psychological aspects at work (e.g., job control, social support, affective commitment) to identify moderators of the adverse effects of job demands on psychological strain, the present results indicate that physiological mechanisms of insulin resistance and metabolizing blood glucose are relevant for scholarly understanding of volitional and goal-directed regulation of attention, emotions, behavioral patterns, and motivational tendencies at work. In particular, physical fitness facilitates blood glucose supply and, therefore, helps replenishing limited resources, which are taxed by job-related SCDs. As a valuable personal resource, physical fitness enables, at least in part, the efficient use of blood glucose and limited resources, when facing SCDs at work.

Second, from a medical point of view, our findings extend the scholarly scope on the protective function of physical fitness. Primarily, past research has revealed that (compared with low fitness) those with good fitness are better able to recover from strenuous physical activities, because of enhanced muscle glucose utilization (Perseghin et al., 1996). However, as the present interaction patterns indicate, physical fitness also prevents psychological strain and associated risks of psychological diseases. Therefore, besides its relevance for decreased vulnerability to physical stress, physical fitness is an important precursor for psychological resistance or resilience to psychological stress.

Third, as a relatively stable personality trait, self-control capacity, which refers to one's ability to exert self-control over spontaneous and habitual response patterns, motivational tendencies, and emotions (Tangney, Baumeister, & Boone, 2004), also buffers the adverse effects of SCDs on psychological strain (Schmidt & Diestel, 2015). In explaining this finding, several authors have argued that high self-control capacity enables effective allocation and efficient conservation of limited resources when facing SCDs (Hobfoll, 2002; Muraven, Shmueli, & Burkley, 2006). That is, compared with low trait self-control, those with high self-control capacity are better capable of planning, coordinating, and monitoring their self-control processes through an effective investment and an efficient recovery of limited resources. In line with the notion that blood glucose influences the functioning of the limited resource capacity, our results on moderating effects of physical fitness provide empirical support for the argument about conservation of resources. More specifically, given the proposition that physical fitness enhances metabolizing and utilizing blood glucose, we were able to identify an underlying process of the beneficial effects of high self-control capacity,

which is positively related to physical activities (Tangney et al., 2004) and develops through repeated physical exercise (Oaten & Cheng, 2006).

Fourth, because the main predictors of the study were assessed with methods that, by their nature, share little common method variance, the found SCDs \times Physical fitness interaction can claim to reflect valid relations rather than common method artifacts (Spector, 1994). Finally, with physical fitness as a moderator of the positive relation between SCDs and psychological strain, the present study suggests a personal resource easy to be influenced (increased) by preventive interventions.

Physical fitness as a resource can be influenced by individuals and organizations alike. On the one hand, our results indicate that individuals working in jobs with high SCDs should maintain a high physical fitness through regular exercise. On the other hand, organizations may increase employees' physical fitness by offering them opportunities to exercise (e.g., fitness club membership, exercise classes, cooperative sport teams). Strengthening the physical fitness of service employees is not at least important, because SCDs are an integral component of many jobs in the services sector and, thus, cannot be reduced.

Limitations and Avenues for Future Research

Our research is subject to several limitations. First, most study variables were assessed with self-report measures. Scholars often cast doubt on self-report data because even interactions may partially reflect semantic overlaps (Spector, 1994). To address this issue, we used with VO_2 max an indicator of physical fitness from another source and, thus, limited the possibility of mutual contamination of the constructs. However, future research should consider behavioral indicators, such as absenteeism, to assess strain and impaired well-being (e.g., Diestel & Schmidt, 2011).

Second, the correlational design of the study does not permit any causal conclusions. Although a particular causal order of the variables was supposed, other causal directions or even reciprocal relations could be possible. For example, an alternative, reverse causal interpretation of the results might rest on the assumption that high levels of experienced strain let employees perceive SCDs as more threatening than employees experiencing less strain. Although there is empirical evidence that strain can predict increases in stressor levels (see Ford et al., 2014), several longitudinal studies have provided strong empirical arguments against this reverse causation hypothesis. For example, drawing on a cross-lagged panel design, research has demonstrated that SCDs predict burnout and absenteeism over longer periods. However, the lagged effects of burnout and absenteeism on SCDs at a later point in time were not statistically significant (Diestel & Schmidt, 2012).

Third, it might be argued that the incremental variance explained by the SCDs \times Physical fitness interaction seems rather low (1% of variance in each outcome). However, moderator effects are so difficult to detect in field studies that, even those explaining as little as 1% of the total variance, should be considered important (Evans, 1991). Furthermore, the size of any interaction is attenuated by measurement error when interaction terms are formed by multiplying variables, as is required in regression analysis (Aiken & West, 1991). Last but not least, as reported by McClelland and Judd (1993), field study interactions typically account for about 1–3% of variance. Thus, the additional variance explained by the interaction in the present study is not only statistically significant, but also practically and theoretically relevant.

Fourth, one may question the assumption that the observed interaction effect of physical fitness is specific for SCDs. Future studies should provide a more thorough test of this assumption by contrasting SCDs with other job stressors, which cannot be expected to interact with physical fitness because those stressors do not deplete limited regulatory resources (like SCDs do), but rather cause strain through other mechanisms. The underlying mechanism of the buffer function of physical fitness can further be isolated by using a more proximal marker of the limited energy resource on which acts of self-control draw. One possible candidate for such a direct measure could be the assessment of individual insulin resistance. Another approach of improving the validity of conclusions could be the exclusion of alternative explanations. For example, physical fitness is long known to be associated with positive affect, which may facilitate coping with SCDs (Fredrickson, 2001; Muraven, Gagné, & Rosman, 2008). By including a measure of positive affectivity, future studies should control for and rule out its influence on the relations under examination.

In addition, several circumstances might have limited the generalizability of the present results. The sample comprised employees from a single occupational field, the financial sector. Furthermore, the recruitment process, especially the voluntariness of participation, may have self-selected participants in a way that, for example, only those who felt in need of a medical checkup participated in the study. This might explain why the mean age of our sample was relatively high (the youngest participants were older than 30 years). Possibly, due to their age older, people would benefit more from a health status screening than younger people. However, such self-selection mechanisms would be typical for situations, which can be voluntarily approached (or avoided).

Finally, the three forms of job-related SCDs we assessed are not an exhaustive list of self-control requirements in work settings. Rather, the selection of these forms was guided by demand characteristics that evolved in basic research on self-control, on the one hand, and their increasing

relevance in real-world contexts, on the other. Future research should expand this list by using other forms of job-related SCDs.

Conclusion

Drawing on the strength model of self-control, according to which different acts of self-control draw on and deplete a limited energy resource (like blood glucose), the present study demonstrated that physical fitness is a personal resource, which buffers the adverse influence of SCDs on various indicators of psychological strain (i.e., burnout symptoms, ego depletion, and need for recovery). More specifically, for employees with low levels of physical fitness, the positive relations between SCDs and strain were more pronounced than for employees with high levels of physical fitness. These findings suggest corresponding preventive interventions to strengthen physical fitness, especially among employees, who have to meet high SCDs at work.

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