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Sharon Toker [a] , Ifat Gavish [b] & Michal Biron [c]

[a] Faculty of Management , Tel Aviv University , Tel Aviv, Israel

[b] Department of Psychology , Tel Aviv University , Tel Aviv, Israel

[c] Graduate School of Management , Haifa University , Haifa , Israel

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Job Demand–Control–Support and diabetes risk: The moderating role of self-efficacy

Sharon Toker[1], Ifat Gavish[2], and Michal Biron[3]

[1]Faculty of Management, Tel Aviv University, Tel Aviv, Israel
[2]Department of Psychology, Tel Aviv University, Tel Aviv, Israel
[3]Graduate School of Management, Haifa University, Haifa, Israel

Work-related stressors, including high demands and low control, play a significant role in the aetiology of diabetes. Nevertheless, most studies focus on main effects, and few consider individual differences that may moderate the stress–health association. Drawing from the Job Demands–Control-–Support (JDC-S) model, this study addresses this gap by testing how baseline levels of JDC-S affect an increase in two risk factors for diabetes—glycated haemoglobin (HbA1C) and fasting plasma glucose (FPG)—and by investigating the moderating role of self-efficacy. Participants ($N = 1618$) were Israeli employees who attended two consecutive routine health examinations. All were free of diabetes at baseline. JDC-S and self-efficacy were assessed at baseline (T1), and HbA1C and FPG were assessed at T1 and T2. Data were analysed with logistic and linear regressions, controlling for well-established diabetes risk factors. High demands and low support predicted an increase in HbA1C and FPG. In addition, high self-efficacy interacted with high demands and with low control in the prediction of an increase in HbA1C and FPG. Although employees with high self-efficacy might function well at work, overloading them may harm their physical health. Similarly, incongruence between employees' sense of ability and the control given to them at work may result in physical impairment.

Keywords: Diabetes; Glucose; HbA1C; Job–Demand–Control–Support; Self-efficacy.

Diabetes is a group of complex metabolic disorders, characterized by hyperglycaemia and caused by defects in insulin secretion, insulin action, or both. Considered as the most troublesome epidemic of the twenty-first century (Shaw, Sicree, & Zimmet, 2010), diabetes has been associated with a two- to fourfold increase in the risk of developing cardiovascular diseases (CVD) and a fourfold increase in mortality from CVD (Haffner & Cassells, 2003). Moreover, chronic hyperglycaemia leads to long-term complications that involve the visual, renal, and neuronal systems (American Diabetes Association, 2010).

Two measurements can be used to diagnose diabetes in a patient: (1) the level of fasting plasma glucose (FPG), which refers to the concentration of sugar in the blood after an overnight fast, and (2) the ratio of glycated haemoglobin (haemoglobin A1C, or HbA1C) to total haemglobin. Glycated haemoglobin forms when glucose binds to haemoglobin in the erythrocyte, in a nonenzymatic glycosylation process (Rahbar, 2005). The level of HbA1C reflects glucose metabolism over the 120 days prior to measurement. According to the American Diabetes Association (2010), cutoff points of FPG > 100 mg/dl or HbA1C $> 5.7\%$ are considered as thresholds for the identification of people at risk for diabetes. Compared to FPG, HbA1C is a less sensitive but more specific criterion, and thus using both criteria provides a clearer picture of the patient's actual risk for diabetes.

As diabetes is considered to be a chronic illness, researchers and practitioners invest substantial effort in preventing the onset of disease through the

Correspondence should be addressed to Sharon Toker, Faculty of Management, Tel Aviv University, Ramat Aviv, Tel Aviv, Israel 69978. Email:tokersha@post.tau.ac.il

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development of early screening processes and the identification of risk factors. As part of this effort, researchers have examined the role of work-related stressors in the aetiology of diabetes (Lloyd, Smith, & Weinger, 2005). The most widely used models for investigating the stress–health linkage are the Job–Demand–Control model (JDC; Karasek, 1979) and its extended version, the Job–Demand–Control–Support model (JDCS; Belkic, Landsbergis, Schnall, & Baker, 2004; de Lange, Taris, Kompier, Houtman, & Bongers, 2003; Karasek & Theorell, 1990). The JDC-S model refers to employees' perceptions of three working conditions: *job demands*, job requirements that primarily reflect perceived workload; *control*, which refers to the freedom permitted the worker in deciding how to meet these demands; and *social support*, which refers to "overall levels of helpful social interaction available on the job from both co-workers and supervisors" (Karasek & Theorell, 1990, p. 69). The JDC-S model expects physiological and psychological strain to be positively affected by demands and negatively affected by control and social support (Van Der Doef & Maes, 1998, 1999). Additionally, the JDC-S model expects the effect of demands on strain to be moderated by control and support (de Lange et al., 2003).

Interestingly, however, the results of many prospective studies have failed to support the aforementioned propositions (for reviews see Bakker & Demerouti, 2007; de Lange et al., 2003). In an attempt to explain the mixed findings of previous studies, researchers have accentuated the importance of assessing individual differences when studying the stress–health relationship (Jex, Bliese, Buzzell, & Primeau, 2001). Specifically, there has been an emphasis on formulating models that include self-efficacy—a generalized, stable, and broad sense of ability to deal effectively with stressful situations (Mercadante, Prentice-Dunn, Jacobs, & Rogers, 1982; Salanova, Peiró, & Schaufeli, 2002; Schaubroeck & Merritt, 1997; Schwarzer & Jerusalem, 1995). Yet such efforts have been limited to the JD-C model. With the increasing evidence that supportive behaviours at work have health-related implications (Rees & Hardy, 2004; Uchino, Cacioppo, & Kiecolt-Glaser, 1996) and the growing recognition that self-efficacy can be changed (through training, positive efficacy cues, etc.; see Biron & Bamberger, 2010; Maurer, Lippstreu, & Judge, 2008), the relevance of self-efficacy to the extended, JDC-S model warrants further investigation. The current study aims to address this by testing the effect of baseline levels of demands, control, and support on subsequent levels of HbA1C and FPG, and examining the moderating role of general self-efficacy in these relationships.

THE JDC-S MODEL AND HBA1C AND FPG

The physiological pathways leading from psychological stress to impaired health involve various mechanisms, some of them related to glucose and insulin secretion. According to Juster, McEwen, and Lupien (2010), prolonged exposure to work- and nonwork-related stress leads to wear and tear of the body, in part through activation of the sympathetic nervous system and the hypothalamus-pituitary-adrenal (HPA) axis. The HPA axis regulates the secretion of cortisol (McEwen, 1998), a hormone that has been shown to be strongly associated with glucose metabolism; high levels of cortisol have been linked to abnormal glucose levels and insulin resistance (Anagnostis, Athyros, Tziomalos, Karagiannis, & Mikhailidis, 2009). In addition, stressors may trigger the release of catecholamines (such as epinephrine and norepinephrine) or inflammation biomarkers (such as C-reactive protein), resulting in changes in hepatic glucose output, insulin secretion, and insulin sensitivity (Black, 2003; McEwen, 2007).

To date, the evidence for an association between HbA1C levels and the JDC-S model is based on cross-sectional studies conducted among relatively small samples ($n < 270$). HbA1C was found to be associated with higher levels of job demands but not with control or support in a sample of 142 blue-collar women (Hansen, Kaergaard, Andersen, & Netterstrom, 2003), with job strain (defined as the ratio between demands and control) and lower levels of support in a sample of 268 blue-collar men (Kawakami et al., 2000), and with low levels of control and support in a sample of 234 white-collar men and women (Feldman & Steptoe, 2003). Similarly, associations between the JDC-S model and FPG levels have been documented mainly in cross-sectional studies (e.g., Norberg et al., 2007). There was, however, one longitudinal study that found, among women (but not men), an association between future FPG and the interactive term of high demands and low control; nevertheless, no main effects of demands, control, or support were observed (Heraclides, Chandola, Witte, & Brunner, 2009).

Although the work just reviewed sheds some light on the association between the JDC-S model and diabetes risk factors, it has three main limitations. First, most of the studies were based on a cross-sectional design, and therefore could not test for the possibility that initial levels of HbA1C or FPG influence employees' perceptions of their working conditions. Moreover, as it takes time for exposure to stress to produce effects on the wear and tear of the body, an increase in HbA1C or FPG between baseline and follow-up examinations may be an indication that such destructive processes are occurring. Given that HbA1C is considered to be a stable measure of sugar levels in the blood, an increase in HbA1C may indicate that the balance has been interrupted. It is therefore important to find out whether the components of the JDC-S model not only are associated with but also predict an increase in HbA1C or FPG over time. A second limitation of previous studies, specifically those focusing on HbA1C, stems from the use of relatively small samples ($n = 142$ to 268), which may have limited researchers' ability to find significant associations or use a variety of control variables. Third, most studies have used dichotomized scores of perceived demands, control, and social support, a procedure with known limitations (Irwin & McClelland, 2003; MacCallum, Zhang, Preacher, & Rucker, 2002). In an effort to overcome the limitations of past research, the current study (1) uses a prospective design, which allows us to relate baseline levels of JDC-S—directly and indirectly—to changes in HbA1C and FPG measurements over time; (2) uses a large sample of employees; and (3) employs continuous scores for measuring JDC-S. Formally, we propose the following:

Hypothesis 1a: The level of job demands will predict an increase in HbA1C and in FPG between a baseline examination (T1) and a follow-up examination (T2), and the levels of control and support will each negatively predict this increase.

Hypothesis 1b: Demands will interact with control in the prediction of HbA1C and FPG, such that the effect of demands on an increase in HbA1C or in FPG from T1 to T2 will be stronger among employees perceiving lower levels of control.

Hypothesis 1c: Demands will interact with support in the prediction of HbA1C and FPG, such that the effect of demands on an increase in HbA1C or in FPG from T1 to T2 will be stronger among employees perceiving lower levels of support.

SELF-EFFICACY AS A PROTECTIVE FACTOR

Another gap in the literature exists regarding possible variables that may moderate the JDC-S–health relationship. Indeed, whereas interactions among the components of the JDC-S model have been examined in relation to diabetes risk factors, other, personal variables have not been considered as moderators. In particular, Jex and colleagues (2001) called for more research to investigate the role of self-efficacy in the relationship between JDC-S and health.

Self-efficacy is defined as "[b]eliefs in one's capabilities to mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands" (Wood & Bandura, 1989, p. 408). Although self-efficacy can be understood as being domain specific, some researchers have conceptualized it as a general, stable and broad sense of ability to deal effectively with stressful situations (Mercadante et al., 1982; Schwarzer & Jerusalem, 1995). According to the latter approach, self-efficacy can be generalized across various domains of functioning in which people judge how efficacious they are (Luszczynska, Scholz, & Schwarzer, 2005). Importantly, self-efficacy has been found to relate to a broad range of emotional and attitudinal outcomes (e.g., positive emotional states, enhanced satisfaction, and engagement; see Bandura & Wood, 1989; McAuley, Talbot, & Martinez, 1999). In particular, and as we explain in detail later, past studies have shown self-efficacy to affect one's health both directly and synergetically.

Main effect of self-efficacy on health

A high sense of self-efficacy has been shown to be associated with positive health-related endpoints such as health behaviours (Luszczynska et al., 2005; Schwarzer, 2008) or reduced physiological stress response (O'Leary & Brown, 1995). Two main mechanisms have been proposed to explain these beneficial effects of self-efficacy (Bandura, 1997). First, some researchers have suggested that individuals with high self-efficacy are less vulnerable (i.e., more resilient) to stress because they have more control over specific behaviours necessary for handling stress and its health-related consequences (Arnold et al., 2005; Sarkar, Ali, & Whooley, 2007). Second, several studies have documented the importance of self-efficacy in behavioural regulation and motivation for behaviour change (e.g., Clark & Dodge, 1999; Grembowski et al., 1993). Accordingly, self-efficacy has been associated with improved glycaemic control (i.e., maintaining acceptable levels of HbA1C or FPG) among diabetic patients in numerous studies (e.g., Kavookjian et al., 2005; Mishali, Omer, & Heymann, 2011), as well as with a reduction in HbA1C among young adults with Type 1 diabetes (Johnston-Brooks, Lewis, & Garg, 2002). Self-efficacy has also been the target of various interventions aimed at reducing chronic disability among diabetic patients (Marks, Allegrante, & Lorig, 2005). Given that no study to date has associated self-efficacy with either HbA1C or FPG among apparently healthy employees, we do not expect self-efficacy to predict changes in either HbA1C or FPG over time.

Self-efficacy as a moderator in the demand–health association

Prior research suggests that employees who are loaded with demands, and at the same time feel they have the ability to successfully meet these demands (i.e., high self-efficacy), are likely to experience mental well-being (Siu, Lu, & Spector, 2007) and reduced psychological health symptoms (Van Yperen & Snijders, 2000). This stream of research draws from self-efficacy theory (Bandura, 1982, 1994), which suggests that self-efficacy plays a major role in how one perceives and respond to different situations: Individuals with high self-efficacy generally feel confident in handling diverse situations and view them as less threatening to the self (e.g., Pajares & Miller, 1994; Zimmerman, Bandura, & Martinez-Fons, 1992).

At the same time, employees with a combination of high demands and a high sense of self-efficacy may voluntarily take on heavier workloads, perhaps more than they can actually handle, which may lead them eventually to develop physical problems. This notion has been partially supported empirically: Among employees with low control, high job demands accompanied by high self-efficacy levels were associated with impaired physical health, including elevated diastolic and systolic blood pressure (Schaubroeck & Merritt, 1997) and self-reported susceptibility to infectious disease (Schaubroeck, Jones, & Xie, 2001). Other studies did not reveal significant interactions between job demands and self-efficacy in the prediction of somatic health complaints (Jimmieson, 2000) or immunoglobulin-A concentrations (Schaubroeck et al., 2001). As the present study focuses on physical health and not on mental well-being, we expect self-efficacy to interact with job demands (two-way interaction) and with both job demands and control (three-way interaction) in the prediction of HbA1C and FPG. In light of the aforementioned equivocal arguments, we posit the following moderation hypotheses, without specifying a priori the nature of the interaction (i.e., attenuation/amplification):

Hypothesis 2a: Self-efficacy will moderate the association between the level of job demands and an increase in HbA1C and FPG from T1 to T2.

Hypothesis 2b: The moderating effect of control on the demand–health association will vary as a function of self-efficacy.

Self-efficacy as a moderator in the control–health association

Litt (1988) suggested that high levels of control are beneficial only if the employee is confident that he can use the power that has been given to him (i.e., a high sense of self-efficacy). Therefore, distress is expected to occur when there is a ‘‘misfit’’ between the degree of control and that of self-efficacy. If employees feel that they are highly capable of doing their jobs but at the same time are not allowed to use their skills (high self-efficacy, low control), then they may become stressed, which may lead to unfavourable health responses. Several studies have provided initial empirical support for the notion that a misfit between low levels of control and high levels of self-efficacy can predict impaired health (e.g., diastolic and systolic blood pressure, see Schaubroeck & Merritt, 1997, and exhustion, see Salanova et al., 2002). In light of these findings, we expect lower baseline levels of control to be associated with an increase in HbA1C and FPG between T1 and T2, mainly among employees with high self-efficacy. We formally propose the following:

Hypothesis 3: Self-efficacy will moderate the association between low levels of control and an increase in HbA1C and FPG from T1 to T2, such that this association will be stronger among employees with a high sense of self-efficacy.

Self-efficacy as a moderator in the support–health association

The previous arguments suggest that individuals' perceptions of and modes of adaptation to environments are variable, depending on their levels of personal resources (Bandura, 2000). In other words, personal resources (e.g., self-efficacy) may determine how people comprehend the environment, conceptualize it, and react to it (Judge, Locke, & Durham, 1997). However, little is known about the integrative effect of personal/internal resources (e.g., self-efficacy) and organizational/external resources (e.g., support from coworkers and supervisor). We assume that people with a high sense of self-efficacy may perceive an unsupportive environment as less threatening and rely on their own capabilities. We therefore seek to extend this view to health outcomes, and propose the following:

Hypothesis 4: Self-efficacy will moderate the association between low levels of social support and an increase in HbA1C and FPG from T1 to T2, such that this association will be stronger among employees with a high sense of self-efficacy.

METHOD

Sample

Study participants ($N = 1791$) were apparently healthy employees who came to an Israeli medical centre between 2003 and 2009 for two consecutive routine health examinations (referred to here, respectively, as T1 and T2) and agreed to participate in the study. The mean time lag between T1 and T2 was 26 months ($SD = 13$). At T1 all participants were free of diagnosed CVD, cancer, diabetes, or stroke, and none was taking hypoglycaemic or insulin medications (either of which could affect participants' HbA1C or glucose levels). The participants who came for two consecutive visits represent 42% of the 4251 employees who had agreed to participate in the study at T1 (initial response rate was 91%). As the medical examinations were sponsored by the employers as a subsidized fringe benefit, attrition between T1 and T2 resulted mainly from changes of employment, fringe benefits, or healthcare provider. The employees who did not come back for an examination at T2 were more likely to be male, were younger, had higher BMI levels, smoked more, and spent less time in regular physical exercise activity. In the data analyses we controlled for these possible sources of attrition, as explained later.

For the purpose of the analyses, we excluded, of the 1719 participants, 14 participants taking hypoglycaemic or insulin medications at T2, as taking these medications may alter the levels of FPG and HbA1C. We also excluded 160 participants who had missing laboratory data (either glucose or HbA1C at T1 or T2). Thus, the final sample consisted of 1617 employees. Among these, 71% were men, and 33% had a managerial position. Participants were employed in a variety of occupations (36% high and low technology, 22% teaching or academia, 9% administration, 7% sales and services, 15% blue collar, 2% health care), and worked on average 50 hours a week ($SD = 9.9$). The mean age at T1 was 44 ($SD = 9.2$), and each participant had completed 16 years of education on average ($SD = 2.7$).

Procedure

The study's protocol was approved by the ethics committees of the medical centre. An interviewer recruited participants individually as they awaited their turns to be examined. All participants signed a written informed consent form, in which they agreed to complete the study questionnaire and share their health examination results with the researchers. In order to reduce the risk of social desirability bias, confidentiality was assured, and neither the medical staff nor the employer saw the questionnaire at any time.

Measures

The glycated haemoglobin (HbA1C) test was performed with an ADVIA 1650 chemistry analyser according to the manufacturer's instructions, using reagents, calibrators, and control materials from Bayer Diagnostics (Berkshire, UK). The concentrations of glycated haemoglobin and of total haemoglobin were measured, and the ratio was reported as percentage HbA1C. FPG was determined using an autoanalyser (Beckman Instruments, Fullerton, CA, USA). Both HbA1C and FPG were assessed twice (at T1 and T2).

Each patient's *perceived job demands* were measured using the six-item job demands scale included in the Job Content Questionnaire (JCQ; Karasek & Theorell, 1990, p. 346). Sample items: "I am required to work too fast"; "I do not have enough time to meet job demands" (Cronbach's $\alpha = .91$). *Perceived job control* was measured using the seven-item decision authority scale of the JCQ. Sample items: "My job enables me to make decisions on my own and to follow through with them"; "I am free to determine how to perform my work" (Cronbach's $\alpha = .91$). *Perceived social support* was assessed with an eight-item measure covering instrumental and emotional support from significant others at work (peers and superiors) based on a scale developed by French, Caplan, and Harrison (1982). For this measure, each respondent was asked to score the degree to which his or her peers/direct supervisor were easy to talk to, could be relied on when things got tough at work, and were willing to listen to the respondent (Cronbach's $\alpha = .88$). *General self-efficacy* was measured using the eight-item New General Self-Efficacy Scale (Chen, Gully, & Eden, 2001) (Cronbach's $\alpha = .91$). A sample item: "Even when things are tough, I can perform quite well." Participants responded to each survey item for each measure by marking a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). These psychological measures were assessed at baseline (T1).

Possible confounding factors. In the statistical analysis we controlled for several demographic and biomedical variables that have been found to be associated with either stress or diabetes. These include self-reported measures of age, gender, years of education, job seniority (holding a managerial position or not), organizational seniority (duration of employment in years), and physical exercise intensity (number of weekly hours customarily spent engaged in sport activities). We also controlled for body mass index (kg/m^2), measured by a nurse, and fasting blood triglycerides (assessed with a Roche/Hitachi 747 Analyser [Roche Diagnostics, Mannheim, Germany] and the Raichem Kit [Reagents Applications, San Diego, California, USA]). Finally, the time gap between T1 and T2 was calculated according to the number of months that had passed between the two visits to the medical centre. (For studies that have associated these possible confounding factors with risk of diabetes and with stress, see American Diabetes Association, 2010; Feldman & Steptoe, 2003; Kivimaki et al., 2006; Lyssenko et al., 2008; Panagiotakos, Pitsavos, Chrysohoou, & Stefanadis, 2005.)**.** Forty-six participants had missing values for education years, job seniority, or physical activity. We replaced these missing values with the mean value of each variable.

Statistical analysis

To examine the study's hypotheses, we ran linear and logistic hierarchical regressions. In the linear regressions, HbA1C and FPG were used as continuous variables, whereas in the logistic regressions the criterion was reaching a threshold for diabetes risk (either FPG $\geq$ 100 mg/dl or HbA1C $\geq$ 5.7%) among employees free of risk for diabetes at T1.

In the linear regressions, we first entered the control variables and level of either HbA1C or FPG measured at T1. This procedure reflects changes in either HbA1C and FPG from T1 to T2 (Twisk, 2003). By including baseline levels of our predictors in the analyses, we avoided the well-known problem of introducing an artefact by using change scores (Taris, Blanc, Schaufeli, & Schreurs, 2005). In the second step, we entered T1 levels of demands, control, support, and self-efficacy. To reduce the possibility of multicollinearity between the interaction term and its component predictors, the levels of demands, control, support, and self-efficacy were centred prior to the regression runs (Aiken & West, 1992). Next, we tested the possibility of nonlinear relationships between the predictors and the criterion by entering the quadratic terms of demands, control, support, and self-efficacy as suggested by Cortina (1993). In the last step, we systematically tested the following two-way interactions: Demands × Control; Demands × Self-efficacy; Control × Self-efficacy. In addition, we tested the following three-way interactions: Demands × Control × Support; Demands × Control × Self-efficacy. The quadratic and interaction terms were entered into the regression using the stepwise method.

In the logistic regressions, we excluded all participants who were at risk of diabetes at baseline (T1). In the first logistic regression, where we predicted new cases of HbA1C $\geq$ 5.7%, we excluded 244 employees (15%) with baseline HbA1C $\geq$ 5.7%, resulting in a sample of 1373 employees. Among this subsample, 235 employees (17.1%) reached the HbA1C $\geq$ 5.7% threshold at follow-up. In the second logistic regression, where we predicted new cases of FPG $\geq$ 100 mg/dl, we excluded 311 employees (19%) with baseline FPG $\geq$ 100 mg/dl, resulting in a sample of 1306 employees. Among the participants in this sample, 111 employees (8.5%) reached the FPG $\geq$ 100 mg/dl threshold at follow-up. We thus considered having crossed the threshold as "1" and not crossing as "0" in the logistic regressions. All other procedures used were identical to those used in the linear regression.

RESULTS

Means, standard deviations, frequencies, and correlations among the study variables are displayed in Table 1. Results of bivariate analysis indicate a significant negative association between self-efficacy and HbA1C (at T1 and at T2). In addition, all control variables (except for education) were significantly associated with HbA1C or FPG.

The results of the multivariate analyses testing the hypotheses are presented in Tables 2 and 3. In each table we present the results of both linear and logistic regressions predicting an increase in HbA1C (Table 2) or in FPG (Table 3). None of the nonlinear terms was significant; we do not include these terms or the nonsignificant interactions in the tables (Cortina, 1993). In each linear regression, the criterion used was T2 HbA1C or T2 FPG, after controlling for the baseline (T1) levels of HbA1C or FPG. In each logistic regression, the criterion used was reaching a threshold for being diagnosed as having a diabetes risk (HbA1C $\geq$ 5.7% or FPG $\geq$ 100 mg/dl) among employees free of risk at baseline.

As expected, job demands predicted an increase in FPG from T1 to T2 (Table 3), linear regression, $\beta = .05$, $p < .05$, and in the logistic regression, support was associated with a decrease of 22% in the risk of crossing the threshold of HbA1C $\geq$ 5.7%, odds ratio (OR) = 0.79, CI = .62–1.00, $p = .051$ (Table 2). Control, however, was not significantly associated with an increase in HbA1C or FPG. Thus, Hypothesis 1a was partially supported. Hypotheses 1b and 1c were not supported, as neither control nor support had a significant role in moderating the association between job demands and either health-related criterion. On an exploratory basis we repeated this analysis using the ratio between job demands and control as an indicator of job strain, as well as the interactive term of Demands/control ratio × Self-efficacy. Whereas the interactive term was not significant, the demands/control ratio did predict an increase in glucose from T1 to T2, $\beta = .05$, $p < .05$, thus partially supporting Hypothesis 1b.

Hypothesis 2a, suggesting that self-efficacy would moderate the demand–health association, was supported with respect to both HbA1C (Table 2), linear regression, $\beta = .05$, $p < .01$, and FPG (Table 3), logistic regression, OR = 1.64, CI = 1.11–2.41, $p < .05$. To graphically illustrate the interaction we utilized a procedure similar to that recommended by Stone and Hollenbeck (1989). Specifically, we plotted three slopes of self-efficacy: one at one standard deviation below the mean, one at the mean, and one at one standard deviation above the mean (Figures 1 and 2). This procedure revealed a similar pattern for both health criteria: Among employees with high self-efficacy (mean and +1 *SD*), job demands predicted an

TABLE 1

Means, standard deviations, frequencies, and correlations (Pearson) on the measured variables ($N = 1618$)

	Mean	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1. HbA1C (T2)	5.42	0.41																
2. HbA1C (T1)	5.28	0.44	.66															
3. Glucose (T2)	90.06	10.80	.35	.30														
4. Glucose (T1)	90.90	10.27	.26	.26	.48													
5. Job demands (T1)	2.70	0.96	−.02	−.03	.02	−.02												
6. Perceived control (T1)	3.94	0.79	.00	.01	.01	.02	.08											
7. Social support (T1)	4.02	0.65	−.01	.02	.00	.04	−.16	.28										
8. Self−efficacy (T1)	4.19	0.55	−.06	−.06	−.04	−.02	.00	.37	.24									
9. Age (T1)	44.00	9.22	.32	.31	.29	.23	−.04	.04	−.08	−.22								
10. Gender (% men)	71%		.00	−.03	−.17	−.18	.00	−.14	−.03	−.13	.05							
11. Education (T1)	15.77	2.77	−.02	−.01	−.02	−.02	.01	.16	−.07	.06	.01	−.08						
12. Manager (T1, %)	66%		.01	.03	.06	.06	.13	.42	.03	.11	.14	−.17	.16					
13. Seniority(T1)	12.4	9.6	.17	.13	.17	.12	.06	−.02	−.01	−.15	.54	.15	−.14	.05				
14. BMI (T1)	26.24	4.03	.21	.21	.32	.27	−.02	.02	−.05	−.06	.25	−.17	−.02	.08	.11			
15. Triglycerides (T1)	116.06	80.07	.08	.10	.18	.18	.01	.05	−.01	−.04	.08	−.15	−.01	.09	.04	.24		
16. Physical activity (T1)	2.10	2.47	−.03	−.06	−.02	−.04	−.09	.05	.04	.09	.02	−.10	.00	.03	−.03	−.07	−.10	
17. Time gap (months)	26.38	12.88	−.05	−.14	−.11	−.07	−.05	−.05	.06	.05	−.24	.02	−.01	−.13	.01	−.07	−.03	−.02

TABLE 2
Linear regression and logistic regression, testing the direct and interactive associations of T1 job demands, perceived control, social support, and self-efficacy with T2 HbA1C

	T2 HbA1C Linear regression (N = 1617)			*T2 HbA1C Logistic regression (N = 1373)*	
	B	*SE*	*Beta*	*OR*	*95% CI*
Job demands	.00	.01	.00	1.03	.87–1.20
Perceived control	.00	.01	.00	1.09	.86–1.37
Social support	−.01	.01	−.02	.79*	.62–1.00
Self-efficacy	.02	.01	.02	1.14	.86–1.53
Job demands × Self-efficacy	.04	.01	.05**		
Model summary	Step 1: Control variables only, $R^2 = .46$** Step 2: Main effects, $\Delta R^2 = .00$ Step 3: Interactive effects, $\Delta R^2 = .002$**			Step 1: Control variables only, Nagelkerke $R^2 = .094$ Step 2: Main effects, Nagelkerke $R^2 = .10$	

TABLE 3
Linear regression and logistic regression, testing the direct and interactive associations of T1 job demands, perceived control, social support, and self-efficacy with T2 FPG

	T2 glucose: Linear regression (N = 1617)			*T2 glucose: Logistic regression (N = 1306)*	
	B	*SE*	*Beta*	*OR*	*95% CI*
Job demands	.52	.24	.05*	.91	.73–1.14
Perceived control	−.50	.35	−.04	.84	.62–1.13
Social support	.38	.38	.02	1.15	.82–1.62
Self-efficacy	.18	.47	.01	1.24	.82–1.89
Job demands × Self-efficacy	—	—	—	1.64*	1.11–2.41
Perceived control × Self-efficacy	−.90	.39	−.05*	—	—
Model summary	Step 1: Control variables only, $R^2 = .30$** Step 2: Main effects, $\Delta R^2 = .002$ Step 3: Interactive effects, $\Delta R^2 = .002$*			Step 1: Control variables only, Nagelkerke $R^2 = .076$ Step 2: Main effects, Nagelkerke $R^2 = .080$ Step 3: Interactive effects, Nagelkerke $R^2 = .091$	

*$p < .05$. All steps included the following control variables: T1 HemA1C, age, gender, education years, managerial position, seniority at work (in years), body mass index, triglycerides, weekly physical activity hours and the time gap between T1 and T2. The sample used for the logistic regression is smaller ($N = 1380$) due to the exclusion of all participants with baseline levels of FPG ≥ 100 mg/dl.

increase in HbA1C from T1 to T2 (Figure 1) and a 65% increased risk of crossing the threshold of FPG ≥ 100 mg/dl at T2 (Figure 2). Simple slope analysis confirmed that the association between demands and T2 HbA1C was significant at high levels of self-efficacy, $B = -0.02$, $SE = 0.02$, $p = .04$, and nonsignificant at mean, $B = 0.00$, $SE = 0.01$, $p = .91$, and low, $B = 0.02$, $SE = 0.01$, $p = .08$, levels of self-efficacy. A similar trend was found when the likelihood of T2 FPG ≥ 100 mg/dl was used as an outcome: workload was a significant predictor at high levels of self-efficacy, OR = 1.54, 95% CI = 1.06–2.22, $p = .02$, and nonsignificant at mean levels of self-efficacy, OR = 0.76, 95% CI 0.49–1.17, and low levels of self-efficacy, OR = 0.64, 95% CI = 0.41–1.00, $p = .056$. Hypothesis 2b was not supported, as the three-way interaction of Self-efficacy × Control × Demands was not statistically significant.

Hypothesis 3, suggesting that self-efficacy moderates the control-health association, was supported with respect to FPG (Table 3), linear regression, $\beta = -.05$, $p < .05$. As Figure 3 indicates, among participants with high levels of self-efficacy, lower levels of control were associated with larger increases in FPG. Simple slope analysis confirmed that the negative association between the level of control and the increase in FPG was significant at high levels of self-efficacy (mean +1 *SD*), $B = -1.36$, $SE = 0.55$, $p = .01$, and nonsignificant at medium, Mean self-efficacy, $B = -0.50$, $SE = 0.35$, $p = .15$, or low levels (mean −1 *SD*), $B = 0.35$, $SE = 0.50$, $p = .47$, of self-efficacy.

Hypothesis 4 was not supported, as self-efficacy had no interaction effect with social support.

DISCUSSION

This study contributes to the stress and health literature by showing, for the first time, how high levels of general self-efficacy coupled either with higher job demands or with lower levels of perceived control predict an increase in two risk factors for diabetes, namely, HbA1C and FPG. Results suggest that among people who are confident in their abilities, low levels of control lead to the development of physiological strain. Likewise, employees who experience an overload of job demands, but at the same time are confident in their abilities, may keep overloading themselves up to a point where negative physiological symptoms develop. These prospective results were obtained in a large cohort of apparently healthy employees, from a wide range of occupations, followed for 2 years on average, after controlling for physiological and behavioural covariates of diabetes. Additional methodological strengths of the present study include the use of continuous scores as the

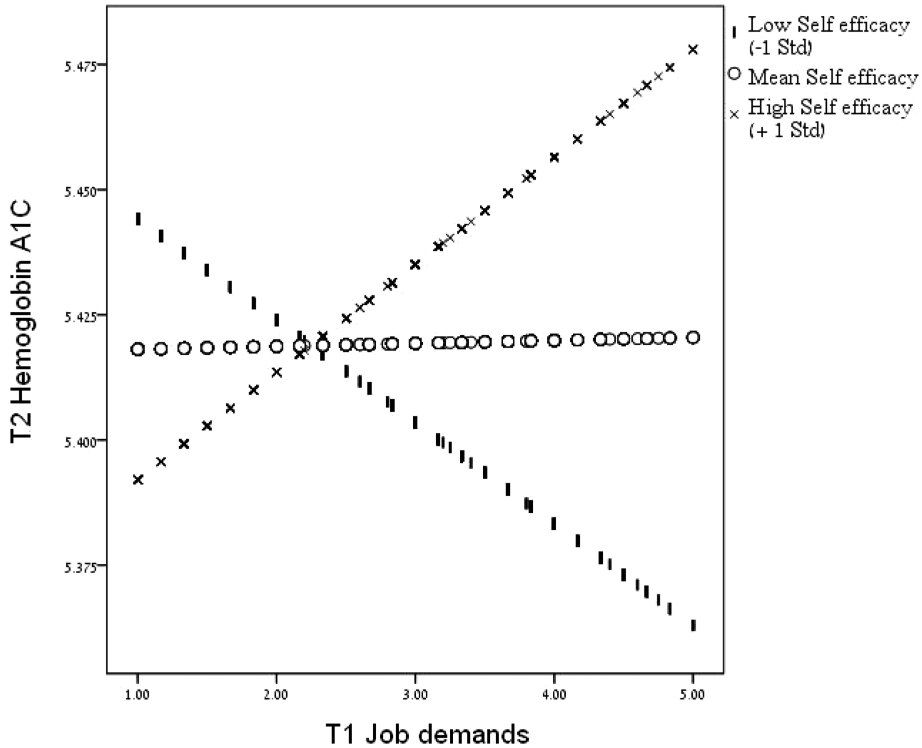

Figure 1. Interaction of job demands and self-efficacy in the prediction of T2 HbA1C.

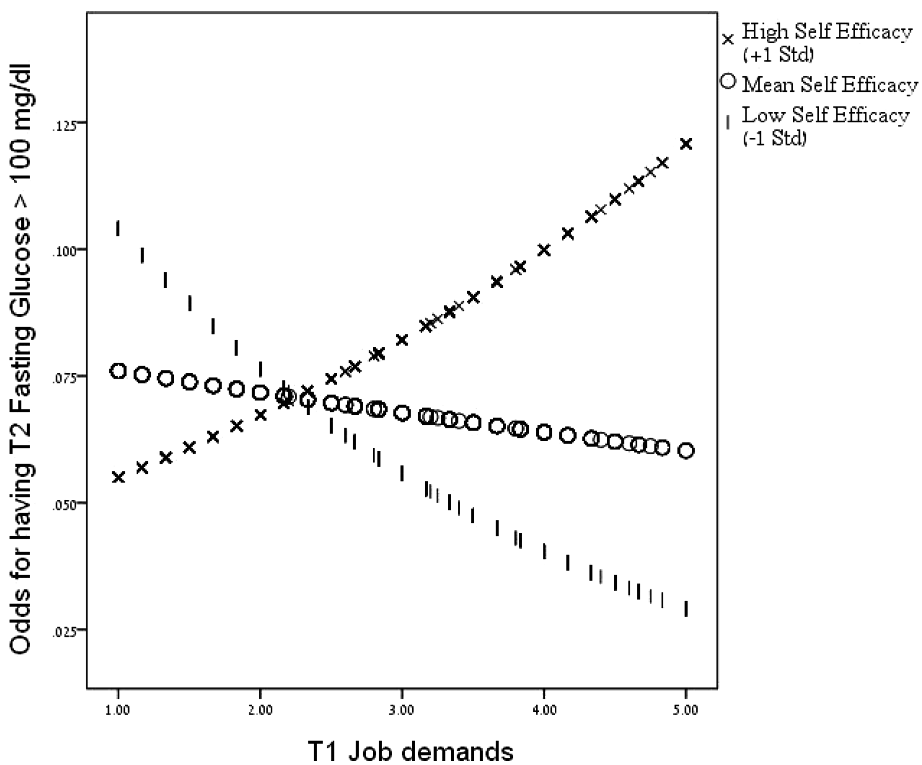

Figure 2. Interaction of job demands and self-efficacy in the prediction of the likelihood of surpassing the FPG threshold of >100 mg/dl between T1 and T2.

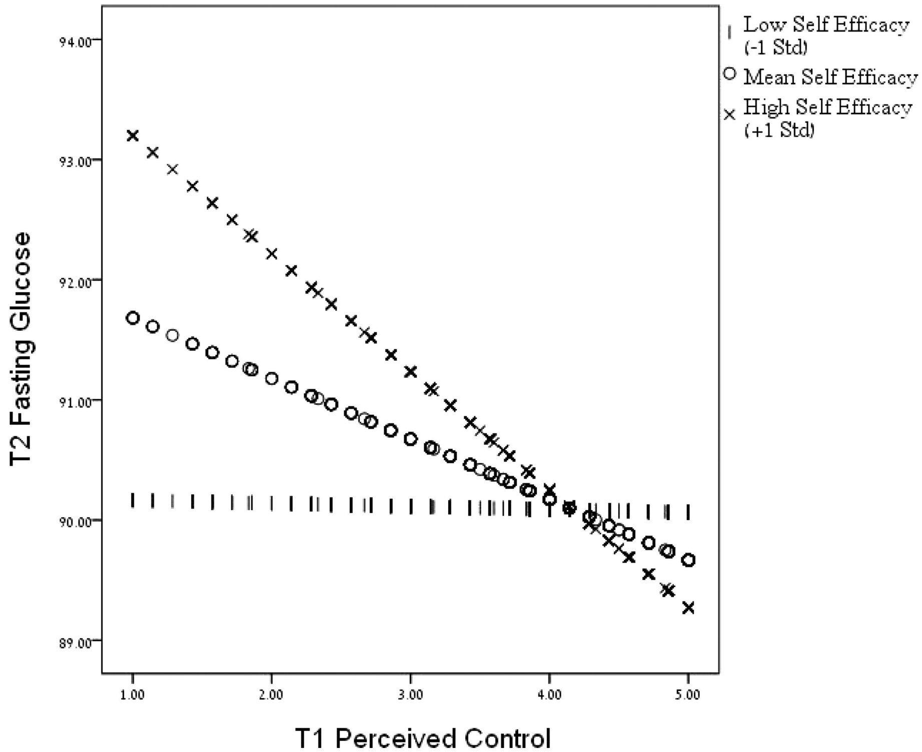

Figure 3. Interaction of perceived control and self-efficacy in the prediction of T2 fasting glucose.

study's predictors, analysing the data using both linear and logistic regressions in order to better capture changes in diabetes risk factors during follow-up, and the use of two different risk factors of diabetes that were only moderately correlated ($r = .26$–$.35$).

Interestingly, although we observed the expected main effects of job demands on an increase in FPG and of social support on a decrease in the risk for crossing the HbA1C threshold, our results do not support the predictions made by the JDS-C model regarding the interactive effects of demands, control, and support. We did find, however, in an exploratory analysis that an increase in glucose from T1 to T2, was predicted by the demand–control ratio (i.e., an indicator of job strain). As this is the first attempt to directly tie the JDC-S model with an increase in risk factors for diabetes during follow-up, this study suggests that changes in FPG and HbA1C are probably not very strongly affected by the combination of high demands and low control or low support. Similarly, past prospective studies that measured other indicators of physical problems, such as CVD, blood pressure, fertility, or mental health, failed to support the multiplicative effects of the components of the JDC-S model (for a review of 45 longitudinal studies, see de Lange et al., 2003). Nevertheless, two components of the JDC-S model were associated in the present study with an increase in HbA1C and FPG when levels of self-efficacy were taken into account. These findings add to the literature that accentuates the importance of assessing individual differences when studying the stress–health relationship (Jex et al., 2001).

The significant interaction found between self-efficacy and control supports the notion that a *misfit* between an individual's levels of control and of self-efficacy may lead to negative outcomes, which is in line with the Person–Environment fit (P-E fit) theory (Edwards, Caplan, & Harrison, 1998). The present results may suggest that job redesign interventions aimed at enhancing employees' well-being by allowing them to control their work should specifically target employees with high self-efficacy, who have the ability to use the control given to them. Such an approach might prevent these employees from feeling frustrated and unutilized. In a similar manner, coaching programmes aimed at increasing self-efficacy among employees should be accompanied by an effort to increase participants' control over their work environment so that these employees may actually apply their sense of ability.

The second major finding of this study—the enhancing effect of self-efficacy on the association between job demands and HbA1C and FPG—is consistent with findings of earlier studies (Salanova et al., 2002; Schaubroeck et al., 2001; Schaubroeck & Merritt, 1997). Employees with high self-efficacy may feel capable of handling every assignment (Bandura, 1997) and are potentially less likely to feel overloaded and report that they are required to work too fast or that they don't have enough time to meet job demands. Furthermore, employees with high self-efficacy report higher mental well-being (Siu et al., 2007) and may be more satisfied with their jobs because of their sense of competence (Judge, Thoresen, Bono, & Patton, 2001). Their high sense of self-efficacy may even encourage them to take on more challenges at work and prove that they can successfully meet these demands until exhaustion occurs (Salanova et al., 2002). At the same time, studies have shown that under conditions of high demands, high self-efficacy does not lead to better performance (e.g., Brown, Jones, & Leigh, 2005). Therefore, employers should be aware of the possibility that employees with high self-efficacy may potentially overload themselves up to the point of physical exhaustion and thus develop physical problems.

We did not find a significant interaction between self-efficacy and social support in the prediction of changes in diabetes risk. With almost no prior studies to rely on, our findings suggest that lack of social support is by itself an important predictor of health impairments, and that this effect might not depend on personal capabilities such as self-efficacy.

Limitations and future research directions

This study should be considered in light of its limitations, which also offer suggestions for future research. First, these findings should be replicated in more diverse samples, as the study's sample of employees undergoing periodic health examinations may not be representative of the general population. Most participants were highly educated employees who exhibited generally good health behaviour patterns and may, therefore, have been more resilient to the effects of job demands, perceived control, general self-efficacy, and social support on diabetes risk factors, as suggested by past studies that associated higher socioeconomic status with lower levels of HbA1C (Feldman & Steptoe, 2003). Nevertheless, any such attenuation of the variance would serve only to reduce the magnitude and significance of the associations observed, thus suggesting that, if anything, our findings may be conservative.

Second, the size of the effects found in the present study is relatively small. This can be attributed, in part, to the duration of the follow-up period, which was relatively short with an average of 26 months, during which 17.3% and 8.8% employees crossed the threshold of risk for developing diabetes (HbA1C and FPG, respectively). Given the high prevalence of diagnosed Type 2 diabetes in the adult population in Israel (11.2% among those aged 45–64, see Health Survey 2003–2004, Ministry of Health, Israel) we expect to find an even higher percentage of employees at risk during a longer follow-up period and potentially stronger associations with the study's predictors. Furthermore, despite the large sample used in this study, multicentre studies should be conducted in order to raise the statistical power and rule out Type 2 errors (Maxwell, 2004).

Third, although we attempted to control for a wide variety of behavioural and physiological factors, there are additional factors that could account for the study's findings. These may include personality attributes such as active coping style (Jex et al., 2001), self-esteem, locus of control, and neuroticism (Judge, Erez, Bono, & Thoresen, 2002). Neuroticism has been associated in past studies with glycaemic control among Type 2 diabetic subjects (Lane et al., 2000) as well with job stress, as a component of core self-evaluation (Bruborg, 2008). Likewise, genetic factors may influence both personality (Markon, Krueger, Bouchard, & Gottesman, 2002; Smillie, 2008) and health, and may therefore affect how employees perceive their work environment as well as their physiological reactivity to stress. Additionally, future studies should consider including environmental factors such as objective workload (i.e., quantity of assignments in a given time); organizational support for a healthy lifestyle (e.g., removing vending machines from stressful workplaces, initiating weight control programmes); and socioeconomic status or economic hardship, which may influence both job and health factors.

CONCLUSION

This study examined whether the JDC-S model is associated with problematic metabolic symptoms (i.e., increases in two risk factors for diabetes) and whether general self-efficacy moderates this relationship. The results suggest that among employees with high general self-efficacy, high job demands and low perceived control may result in an increase in HbA1C and FPG and thus potentially lead to future diabetes among apparently healthy employees, even in a relatively short follow-up period. It would be helpful in future research to examine whether individual differences such as self-efficacy coping strategies and personality factors (other than self-efficacy) moderate the JDC-S- health relationship.

The results of this study also suggest that employers should be aware of the possibility that although employees with high self-efficacy may potentially function well at work, overloading them may harm their physical health. Similarly, incongruence between employees' sense of ability and the control given to them at work may result in physical problems. It is therefore important to increase the level of control through interventions such as job redesign. It is also important to routinely screen employees in highly demanding jobs, as both employees and employers may benefit from primary prevention of diabetes.

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