Health Psychology
2011, Vol. 30, No. 3, 268–275


0278-6133/11/$12.00 DOI: 10.1037/a0023138

# Work-Based Predictors of Mortality: A 20-Year Follow-Up of Healthy Employees

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***Objectives:*** This study investigated the effects of the Job-Demand-Control-Support (JDC-S) model's components, workload, control, peer and supervisor social support, on the risk of all-cause mortality. Also examined was the expectation that the above work-based components interact in predicting all-cause mortality. The study's hypotheses were tested after controlling for physiological variables and health behaviors known to be risk factors for mortality. ***Main Outcome Measure:*** The design used was prospective. Baseline data were obtained from healthy employees ($N = 820$) who underwent periodic health examinations in 1988. Follow-up data on all-cause mortality were obtained from the participants' computerized medical file, kept by their HMO, in 2008. The baseline data covered socioeconomic, behavioral, and biological risk factors in addition to the components of the JDC-S model. During the period of follow-up, 53 deaths were recorded. Data were analyzed using Cox regressions. ***Results:*** Only one main effect was found: the risk of mortality was significantly lower for those reporting high levels of peer social support. The study found two significant interactions. Higher levels of control reduced the risk of mortality for the men and increased it for the women. The main effect of peer social support on mortality risk was significantly higher for those whose baseline age ranged from 38 to 43 but not for the older than 43 or the younger than 38 participants. ***Conclusion:*** Peer social support is a protective factor, reducing the risk of mortality, while perceived control reduces the risk of mortality among men but increases it among women.

*Keywords:* Job Demand-Control-Support model, all-cause mortality, survival analysis, supervisor support, peer support

*Supplemental materials:* http://dx.doi.org/10.1037/a0023138.supp

The expanded job strain model, consisting of the three major components of job demands, control, and support (Karasek & Theorell, 1990) and hereafter referred to as the *JDC-S model*, has been playing a focal role in studies investigating the effects of work-related psychosocial factors on morbidity and mortality (de Lange, Taris, Houtman, & Bongers, 2003). The JDC-S model continues to occupy a central place in research on job stress and health despite the emergence of other models in this area (de Lange et al., 2003). In the JDC-S model, *job demands* are psychological job demands, primarily defined as referring to perceived workload; *job control* refers to the perceived freedom permitted the worker in deciding how to meet these demands; *social support* refers to "overall levels of helpful social interaction available on the job from both coworkers and supervisors" (Karasek & Theorell, 1990, p. 69). The JDC-S model expects job demands to positively affect psychological and physiological strains and job control and social support to negatively affect them (Van Der Doef & Maes, 1998, 1999). Additionally, the JDC-S model expects the effects of job demands on these strains to be moderated by job control and by work-based social support (de Lange et al., 2003; Van Der Doef & Maes, 1998, 1999). The current study examined both the direct (main) and interactive (moderating) effects of the JDC-S model on all-cause mortality.

The JDC-S model has been found to predict the incidence and prevalence of cardiovascular disease (CVD; see Belkic, Landsbergis, Schnall, & Baker, 2004; Steenland et al., 2000) and to predict cardiovascular mortality (Kivimaki et al., 2006); it was therefore expected to influence all-cause mortality. A literature search led to the identification of six prior prospective studies conducted on apparently healthy employees that used either the earlier JDC model or its extended version (the JDC-S model tested in the current study) to predict all-cause mortality. Three studies used only the JDC model and therefore were less relevant to the current study (Eaker, Sullivan, Kelly-Hayes, D'Agostino, & Benjamin, 2004; Lynch, Krause, Kaplan, Tuomilehto, & Salonen, 1997; Tsutsumi, Kayaba, Hirokawa, & Ishikawa, 2006), and three past studies used the full JDC-S model. Amick et al. (2002) found, in examining the main (additive) effects of the JDC-S model, that only low levels of control on the job substantially increased the hazard of death (odds ratio [OR] = 1.43, confidence interval [CI] = 1.13–1.81). The second study (Hibbard & Pope, 1993) found that work support was the only significant predictor of all-cause mortality

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We would like to gratefully acknowledge the financial support for this study from the Israel Science Foundation, Grant 788/09.

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and only among the women (OR = .80, CI = .70–1.00). The third study (Astrand, Hanson, & Isacsson, 1989) found the highest risk of mortality was in the category of low control and low support (hazard ratio [HR] = 1.5, CI = 1.0–2.1). None of these three studies tested interactive effects implied by the JDC-S model using continuous variables or differentiated between peer and supervisor social support.

The extended JDC-S model includes supervisor and coworker social support as major job characteristics having direct effects on different aspects of mental and physical health and also reducing the elevated levels of mortality risk associated with higher levels of workload (e.g., Karasek & Theorell, 1990). Most studies on the JDC-S model simply summed up the different sources of social support to create a total social support scale (e.g., Belkic et al., 2004). Past reviews of prospective studies which examined the influence of the JDC-S model on stress-related mental disorders (Nieuwenhuijsen, Bruinvels, & Frings-Dresen, 2010) and on psychological well-being (Hausser, Mojzisch, Niesel, & Schulz-Hardt, 2010) suggested that it is important to distinguish between peer and supervisor social support, the former more often having larger effect sizes in predicting mental health outcomes.

Following the above rationale and evidence, Hypothesis 1 expected high levels of workload and low levels of control to be associated with elevated levels of mortality. Karasek and Theorell (1990) suggested that under high levels of decision latitude or control, work-related stress is likely to be interpreted as a challenge and that control therefore moderates the effects of workload on morbidity and mortality. The empirical support for the expected interaction in past qualitative (Eller et al., 2009) and quantitative (Kivimaki et al., 2006) studies is inconsistent. Still, following the above rationale, Hypothesis 2 expected that the higher the level of baseline control, the lower the effect of workload on the risk of mortality. Hypothesis 3a expected that the higher the level of baseline social support, the lower the risk of mortality, with the effect being less pronounced for supervisor social support than for peer social support. Analogously to the second hypothesis, Hypothesis 3b expected that the higher the level of baseline social support, the lower the effects of workload on higher risk of mortality, with the effect being less pronounced for supervisor social support than for peer social support.

Past reviews of prospective studies linking the JDC-S model with mental health morbidity and with psychological well-being provide general support to the expectation that the effects hypothesized above may be moderated by age and sex In a review of 20 years of empirical research on the JDC-S model, Van der Doef and Maes (1999) state that in a relatively large number studies based on female samples, no support was found for hypotheses derived from it, whereas in male or mixed-sex samples, there was general support for the additive (main) effects postulated by it. A recent systematic review of epidemiological evidence suggests that the impact of the JDC-S model on the risk of depression is stronger among men (Bonde, 2008).Therefore, the current study systematically tested on an exploratory basis the possible moderating effects of age and sex on the main effects hypothesized above.

# Method

## Participants

The study's initial sample consisted of 1,042 employees referred to a screening center in Israel by their employers for routine periodic or pretenure health examinations. Those who were referred to the center by a physician because of suspected physical or mental health problems were excluded from participating. Employers who send their employees for periodic health examination at the center include some of the country's largest firms in finance, insurance, public utilities, health care, and manufacturing. Other investigators, who systematically compared the sociodemographic characteristics of samples that they drew from the center's database with the general Jewish population of the country, concluded that the examinees were representative of the adult Jewish workforce (Shirom, Westman, Shamai, & Carel, 1997). The participants reported working on the average 8.8 hr per day, and about one third (33%) of them were women. Most of them (80%) were married with children, 45% had at least a secondary education (12 years of formal education). Their mean age at baseline was 41.60 (*SD* = 9.34). Most participants (73%) were full-time employees, having worked on the average for 9.86 years for their current employer, and 55% of them were rank-and-file employees.

All participants were continuously enrolled in Clalit Health Services (CHS, the country's largest HMO) from baseline (1988) to the end of the follow-up (end of 2008) or death. Using the 9-digit national identification number (ID) assigned at birth or immigration to each of the country's residents, the current study combined two datasets. The first dataset combined the results of the periodic health examinations, including the tests of physiological risk factors, and responses to two questionnaires completed during the examinations by all participants. The second dataset was the participants' medical records maintained by CHS. Participants (*N* = 37) whose baseline ID number was not identified in CHS medical records were excluded from the sample. Participants who either self-reported or were diagnosed by a center physician to have any chronic disease (*N* = 33), were also excluded from the sample. This exclusion criterion was applied because there is a body of evidence showing that chronic diseases, or medications taken to treat them, are likely to influence employees' assessments of their job characteristics (Hausser et al., 2010). Also excluded were 152 participants who had missing values on one or another of the study's predictors. Following the above exclusions, the final sample consisted of 820 participants.

## Procedure

The study was approved by the review boards of Tel Aviv University's Faculty of Management and CHS, and all participants gave their written informed consent to participate in the study. The screening center uses automatic multiphasic health testing and maintains a fairly large computerized database on examinees (Carel & Leshem, 1980). Uniform examination procedures and standardized measurement techniques were used throughout the gathering of the baseline data (1988). Participants completed the study's Time 1 (T1) questionnaire when they came to the center to undergo the periodic health examinations in 1988. While they were awaiting their turn for the clinical examination, the attending physician (M.D.) asked examinees to participate in the study by completing the study questionnaire, assuring them of the total confidentiality of the data obtained from them. About 95% volunteered to participate and completed the study questionnaire. At that time, they also completed a computerized questionnaire based on the Cornell Medical Index that included sociodemographic characteristics (Haessler, Holland, & Elshtain, 1974). Subsequently, all participants underwent a health examination that consisted of blood tests, a physical examination by a physician, ECG recording, and respiratory measurement of the lung function. At this stage, qualified nurses assessed the participants' weight, height, blood pressure, and pulse rate, and took samples for routine urinalysis. As all the participants were members of CHS from baseline till the end of 2008, when the follow-up was stopped, their computerized medical records were continuously updated by CHS from during this period. Based on CHS medical records, during the follow-up period of about 20 years, 53 participants died. For those who died during the follow-up period, the exact date of death was extracted from their computerized medical records.

## Measures

**Criterion.** Mortality data were based on the CHS's medical records because it is officially notified on each such event by each hospital and by the Ministry of the Interior; only all-cause mortality is officially reported to the country's health maintenance organizations, including the CHS. Therefore, the current study ascertained the full record of those who died of all causes between the date of their periodic health examination and the end of 2008. Days of follow-up were counted for each participant from the date of his or her health examination in 1988 to the date of death or the end of 2008, whichever occurred first.

**The JDC-S Model.** The psychosocial variables in the study were all constructed based on the study's questionnaire. Unless otherwise noted, all items in the study's questionnaire were measured on 5-point Likert-type scales. Multiple-item indices were constructed by combining single items that measured the same variable. Index reliability was gauged by Cronbach's alpha coefficient.

Workload (eight items, $\alpha = .88$) is a measure of subjective quantitative overload; the items are similar to those of the job demands scale of the Job Contents Questionnaire (JCQ) (Karasek & Theorell, 1990, p. 346). It was scored high for participants who reported that they were required to work too fast, too hard, had too much work to do, and had insufficient time to get the required work done. This measure has been used in several past studies (e.g., Shirom, Melamed, Rogowski, Shapira, & Berliner, 2009). Control (five items, $\alpha = .88$) included items assessing the two major dimensions of control, decision authority, and skill discretion, similar to those of the JCQ's decision authority scale (Karasek & Theorell, 1990, p. 337). It was scored high for participants who reported that they were able to use their initiative and had opportunities to decide how best to utilize their skills (skill discretion) and for those who reported that they have freedom to make decisions on how to accomplish the tasks assigned to them and what to do in their jobs. Peer social support and supervisor social support were gauged by two items each ($\alpha = .75$ and .78, respectively). Supervisor social support was scored high for participants who reported that (a) their immediate supervisor was helpful in solving problems, and (b) was available for consultation. Peer social support was scored high for participants who reported (a) that their immediate coworkers were helpful to them in solving problems, and (b) were friendly to them. The four items used to gauge social support are analogous to those used in the Swedish Demand-Control-Support Questionnaire, which is a brief measure of the JCQ widely used in the Scandinavian countries (Sanne, Torp, Mykletun, & Dahl, 2005). Additional information on the confirmatory factor analysis conducted to test the construct validity of the demand, control, and two social support measures is available from the American Psychological Association Website as supplemental material.

**Control variables.** Age, sex, and educational level were taken from the computerized questionnaire and were validated by the participants' personal medical files. The inverse association between socioeconomic status (SES) and health is well-known: the higher the SES, the lower the prevalence and incidence of health problems, illness, disease, and death (Gallo & Matthews, 2003). Following this evidence, this study used a proxy measure of SES, educational attainment, as a control variable. Educational level ranged from 1 (primary education or less) to 5 (a first academic degree or above).

Health behaviors which have consistently been found (e.g., Mokdad, Marks, Stroup, & Gerberding, 2004) to predict all-cause mortality were used as control variables in the data analyses. For this study, information on health behaviors was obtained from the computerized questionnaire. The smoking index was constructed based on the number of cigarettes smoked per day and ranged from 1 (not smoking) to 5 (smoking more than a pack, 20 cigarettes per day). The exercise index was based on the self-reported number of weekly hours engaged in sport activities and ranged from 1 (less than 1 hr) to 5 (more than 5 hr). Consumption of alcoholic drinks was assessed by the frequency of drinking per week and ranged from 1 (none) to 2 (very infrequently) to 5 (drinking on a daily basis). The body mass index (BMI) used in the study was measured by the participant's weight (in kilograms) divided by the squared term of his or her height (in meters). Based on accumulated evidence (e.g., Belkic et al., 2004; Kivimaki et al., 2006), the current study also controlled for several physiological risk factors for mortality. Fasting blood samples were drawn from the participants in the morning, upon arrival at the Center. The levels of total cholesterol and triglycerides (in milligrams/deciliter) were determined using the Coulter "S' Counter, calibrated daily using the 4C Standard of Coulter Electronics. Fasting glucose was determined by the glucose oxidase method using an autoanalyzer (Beckman Instruments, Fullerton, CA). Arterial blood pressure (mmHg) was measured twice in the left arm, while sitting; both measurements were taken after a 1-hr rest. The average of two independent measurements was used to gauge diastolic and systolic blood pressures.

Several researchers (e.g., Ryff, Singer, & Dienberg Love, 2004) have recommended controlling for the effects of depression and anxiety when examining the cumulative effects of stress and strain on physical health. Depressive and anxiety symptoms were assessed based on the items of the Cornell Medical Index (Haessler et al., 1974). Depressive symptoms were gauged based on responses to seven dichotomous items, requesting participants to report yes (scale value of 1) if most of the time they recently felt sad, depressed, pessimistic, lonely, unsuccessful in life, lacking confidence in the future and unable to enjoy daily activities and no (= 0) otherwise ($\alpha = .70$). Anxiety symptoms were gauged based on responses to questions on whether most of the time they had recently felt tensed, anxious, angry, worried, and moody (1 = yes, 0 = no). For the anxiety symptoms scale, $\alpha = .90$. As yet another control variable, this study used self-reported past hospitalization (1 = yes, 0 = no).

## Analytic Methods

The first step in the data analyses was to test the possible bias of excluding from the analysis 152 participants with missing data on any of the predictors. Most of them ($n = 96$) did not respond to the items assessing social support, leading us to assume that in the current study missing cases are not random. The current study used logistic regressions to detect predictors of the dichotomous variable with 0 = responded to the social support items, and 1 = did not respond to the social support items. The only significant predictor was educational level, those with low levels of educational attainment being more likely not to respond to the social support variables. Educational level was used as a control variable in the data analyses.

Cox proportional hazard regression analysis was used to test the study's hypotheses. The time scale used in the Cox regressions was days of follow-up, from the date of arrival for the periodic health examination in 1988 to date of mortality or end of 2008, whichever occurred first. Average follow-up was approximately 20 years. Using STATA for the Cox regressions, the data analysis indicated that the proportional hazard assumption of the Cox regressions was indeed met. Unless otherwise noted, all predictors were used as continuous variables. The full multivariate model included the following baseline values, entered hierarchically: age, sex (dichotomy, 1 = men), educational level, representing predictors clearly anteceding the JDC-S model, workload, control, peer social support, supervisor social support, and the control variables. The control variables entered in the last step were total cholesterol, triglycerides, glucose, systolic and diastolic blood pressure, BMI, alcohol consumption, smoking, depressive symptoms, anxiety symptoms, and past hospitalizations.

All main effects were entered hierarchically, following the a priori order explained above. Among the control variables, the only significant predictor of mortality was total cholesterol. To avoid unnecessary adjustment—defined as controlling for variables that do not affect bias of the causal relation between exposure and outcome but may affect its precision (Schisterman, Cole, & Platt, 2009)—only total cholesterol is reported as a control variable. Two hypotheses (Hypotheses 1 and 3) concerned main effects of the JDC-S model on mortality. Following the testing of these main effects, the data analysis tested the interactive effects of workload with control (Hypothesis 2), peer social support and supervisor social support (Hypothesis 4). The data analysis also assessed the triple interactions of workload, control, and the two types of social support, but none was significant. To reduce multicollinearity, the data analysis used the centered values of the components of the JDC-S model in the Cox regression (Aiken & West, 1991). Thus, additional Cox regressions were used to systematically test the possibility that sex or age moderate the prediction of mortality by workload, control, and the two types of social support. Before testing an interaction, the quadratic terms included in the interaction were allowed to enter the regression.

# Results

## First-Order Correlations Among the Study's Variables

As can be seen in Table 1, the correlation between supervisor support and peer support was only .39, supporting the decision to distinguish between these two sources of social support. Additionally, while peer and supervisor social support were negatively correlated with workload, control was positively associated with it though the correlations were relatively low in magnitude. In addition, there were significant correlations between at least one component of the JDC-S model and a control variable. For example, BMI and glucose were positively correlated with both workload and control, and depressive symptoms was positively correlated with workload but negatively correlated with the other components of the JDC-S model.

## Main and Interactive Effects of the JDC-S Model on the Risk of Mortality

Table 2 provides the results of our tests of the study's hypotheses. As evident from Table 2, workload and control did not have a significant effect on the study's criterion nor did they interact in the prediction of all-cause mortality (see Table 2). Therefore, there was no support for the study's first and second hypotheses. However, Hypothesis 3a was supported because the risk of mortality was found to be lower for those reporting high levels of peer social support (HR = .59, .CI = 43–.81) but not for those reporting high levels of supervisor social support. However, Hypothesis 3b was not confirmed because no interactive effect of workload with either measure of social support was found.

As indicated above, in the current study tests were conducted of the possible moderating role of age and sex. A significant moderating effect was found: sex moderated the effects of control on all-cause-mortality. To understand the meaning of this interaction, subgroup analysis by sex was conducted. The subgroup analysis showed that while for the men control reduced the risk of all-cause mortality (HR = .48, .CI = .21–.99) it increased the risk of mortality for the women (HR = 1.70, CI = 1.07–2.71). A separate confirmatory factor analysis (CFA) supported the invariance of the measure of control across the two sex groups. In the CFA, a comparison was made between the women's measurement model with all factor loadings freely estimated and a model in which they were constrained to be equal in their weights to those of the men, using the $\chi^2$ difference test. The CFA led to the conclusion that the constrained model fitted the data perfectly ($\chi^2 = 19$, $df = 12$, $p = .09$) and was not significantly different from the unconstrained model ($\Delta\ \chi^2 = 12$, $\Delta df = 10$, $p > .05$). Therefore, it is unlikely that the finding on the interaction of control and sex in the prediction of mortality is because of sex differences in the interpretation of the items assessing control in the study's questionnaire.

Additionally, age moderated the effects of peer social support on the study's criterion. As above, subgroup analysis was used to probe this interaction, running Cox regressions on the tertiles of age. It appears that age moderated the effects of peer social support

Table 1
*Means, SDs, and Correlations of the Study of Variables (N = 820)*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | — | | | | | | | | | | | | | | | | | |
| 2. Sex (0 = men) | .17* | — | | | | | | | | | | | | | | | | |
| 3. Educational attainment | .08* | .09* | — | | | | | | | | | | | | | | | |
| 4. Workload | .11* | .09* | .04 | — | | | | | | | | | | | | | | |
| 5. Control (perceived) | .23* | .19* | .20* | .14* | — | | | | | | | | | | | | | |
| 6. Supervisor support (SS) | −.08* | .03 | −.10* | −.14* | .14* | — | | | | | | | | | | | | |
| 7. Peer support (PS) | −.13* | −.06 | .02 | −.11* | −.02 | .39* | — | | | | | | | | | | | |
| 8. Total cholesterol | .33* | .12* | .06 | .01 | .13* | −.02 | −.03 | — | | | | | | | | | | |
| 9. Smoking Index | .01 | .04 | .20* | −.01 | .05 | −.11* | −.04 | −.05 | — | | | | | | | | | |
| 10. Exercise Index | .05 | .13* | .12* | .02 | .08* | .02 | .01 | −.01 | .08* | — | | | | | | | | |
| 11. Alcoholic Drinks Index | .10* | .26* | .18* | .02 | .13* | −.10* | −.09* | .02 | .44* | .06 | — | | | | | | | |
| 12. Body Mass Index | .30* | .18* | −.02 | .11* | .19* | .00 | −.09* | .29* | −.06 | .07* | .05 | — | | | | | | |
| 13. Triglycerides | .12* | .29* | −.02 | .04 | .11* | .04 | −.03 | .40* | −.12* | −.03 | −.01 | .36* | — | | | | | |
| 14. Glucose | .24* | .15* | .07* | .07* | .12* | .01 | −.04 | .19* | −.02 | −.01 | .05 | .20* | .12* | — | | | | |
| 15. Diastolic blood pressure | .39* | .22* | .04 | .03 | .10* | −.01 | −.02 | .26* | .02 | .07* | .08* | .27* | .21* | .22* | — | | | |
| 16. Systolic blood pressure | .33* | .20* | .05 | −.02 | .08* | −.01 | −.01 | .23* | .09* | .11* | .06 | .26* | .22* | .21* | .81* | — | | |
| 17. Depressive symptoms | .10* | −.03 | −.07* | .10* | −.08* | −.09* | −.08* | .04 | .10* | −.06 | .06 | .06 | −.03 | .04 | .03 | .03 | — | |
| 18. Anxiety symptoms | .02 | −.02 | −.06 | .16* | −.04* | −.16* | −.08* | .04 | .16* | −.06 | .20* | .05 | .01 | −.04 | .05 | .03 | .40* | — |
| Mean | 41.48 | 67% | 3.35 | 2.37 | 3.85 | 3.33 | 3.45 | 203.86 | 3.09 | 2.08 | 2.57 | 25.21 | 135.89 | 92.75 | 75.61 | 119.52 | .24 | .43 |
| *SD* | 9.33 | | 1.26 | .77 | .85 | 1.14 | 1.08 | 39.66 | 2.04 | 1.29 | 1.12 | 3.64 | 69.00 | 17.01 | 9.09 | 13.62 | .68 | .84 |

* $p < .05$.

on mortality risk in the second tertile, consisting of those aged 38–43 (HR = .42, .CI = .24–.74) - whereas in the other two tertiles, consisting of those younger than 38 (HR = .55, .CI = .23–1.35) and older than 43 (HR = .90, .CI = .59–1.38) the effect of peer social support on mortality risk was not significant.

To test the effect of the missing cases on the analyses reported in Table 2, the analyses were run again using a multiple imputation procedure. The pooled results (not reported) of the multiple imputations were similar to those reported in Table 2. For example, while Table 3 reports for peer social support in the basic model HR = .72 (CI = .55–.94), in the multiple imputation procedure the pooled estimate was .69 (CI = .54–.87). Therefore, it is unlikely that imputing missing values will change the results reported in Table 2.

## Using Control Variables in Testing the Study's Hypotheses

Following the rationale described above, only the control variable of total cholesterol was included in Table 2, because it was found to be the only significant predictor of mortality after the sociodemographic predictors and the JDC-S model components entered the Cox regression. To test the validity of this decision, the impact on the results reported in Table 2 of forcing all the control variables to enter the Cox regression was examined. There were many minor changes in the HRs and their CIs largely because missing data on the additional control variables reduced the number of events to 49 and the total number of cases to 782. However, all the significant results reported in Table 2 remained significant. For peer social support, HR = .64* (CI = .46–.90); for peer social support X age, HR = 1.03* (CI = 1.01–1.06); for control X sex, HR = 2.66* (CI = 1.18–6.03); and the two significant control variables, age and total cholesterol, remained significant. Therefore, it can be concluded that this analysis largely supported our above decision concerning the nonsignificant control variables (the detailed results are available from the first author upon request). Additionally, when total cholesterol entered the regression reported in Table 2, it did not have any significant effect on the other predictors. Therefore, it is highly unlikely that total cholesterol is a mediator of the effects of the JDC-S model on mortality, thus supporting the results of a recent study on blood lipids and the JDC-S model (Shirom et al., 2009).

## Discussion

This study sought to augment the current knowledge about the effects of the JDC-S model on mortality in the following ways. First, it tested both the additive and interactive effects of the JDC-S model on all-cause mortality while defining the model's components as continuous variables. Second, its design called for testing the differential effects of peer social support and supervisor social support on the study's criterion. Third, it tested the extent to which the predicted main effects of the JDC-S model were contingent on sex and age. In so doing, it responded to the call that health psychologists consider working conditions as predictors of health (Terborg, 1998).

A major contribution of the current study is in finding that among the components of the JDC-S model, peer social support, which could represent how well a participant is socially integrated

Table 2
*Multivariate Cox Regression Model Predicting Mortality by the Job Demand-Control-Support Model and Covariates*

| | Model 1: Main effects only | | Model 2: Interactions and a control variable added | |
|---|---|---|---|---|
| | | 95% CI | | 95% CI |
| Predictor | HR | Lower limit–upper limit | HR | Lower limit–upper limit |
| Age | 1.07* | 1.04–1.10 | 1.08* | 1.05–1.11 |
| Sex (0 = men) | 1.69 | .83–3.36 | 1.84 | .81–4.19 |
| Educational attainment | .84 | .68–1.07 | .86 | .69–1.07 |
| Workload | .80 | .56–1.13 | .78 | .55–1.10 |
| Control | 1.28 | .89–1.88 | .54 | .28–1.09 |
| Supervisor support | .79 | .61–1.03 | .79 | .61–1.03 |
| Peer support | .72* | .55–.94 | .59* | .43–.81 |
| Peer support × age | | | 1.03* | 1.01–1.06 |
| Control × sex | | | 3.04* | 1.36–6.78 |
| Total cholesterol | | | 1.02* | 1.01–1.03 |

*Note.* $N = 820$; number of events = 53; number of cases excluded because of missing data = 152. HR = hazard ratio; CI = confidence interval; −2LL = −2 log likelihood statistic test. Model 1 $\chi^2 = 67.52^*$, −2LL = 647.1; Model 2 $\chi^2 = 75.85^*$, −2LL = 623.3; $\Delta\chi^2 = 8.33^*$.
* $p < .05$.

in his or her employment context, is a potent predictor of the risk of all-cause mortality. In contrast, supervisor social support did not predict the risk of mortality. Effects of peer or informal social support at work on mortality have been found in past studies (Litwak et al., 1989; Mookadam & Arthur, 2004). An additional (unexpected) finding that may be considered to be a meaningful addition to the literature is that the effect of control on mortality risk was positive for the men but negative for the women.

In the current study, no support was found for the expected main effects of workload and control on the risk of mortality. Two out of the three studies that examined the impact of the earlier version of the JDC-S model, the JDC model, on total mortality did not find such effects either (Eaker et al., 2004; Tsutsumi et al., 2006). Possibly, the measure of workload used in the current study does not capture the multiple types of stress that characterize the participants' jobs. The interaction found between sex and control in predicting the risk of mortality provides a statistical explanation for the failure to support the hypothesis on the main effect of control. The diametrically opposite effects of control for the men and women, reducing the risk of mortality for the men and elevating it for the women, cancelled each other out when the main effect of control was examined. Therefore, there is support for this study's expectation regarding the main effect of control on mortality but only for the men. Because of contextual differences in the type of jobs occupied by men and women, high levels of control are more typically found in male jobs (Waldenstrom & Harenstam, 2008). Specifically, there is a body of evidence supporting the expectation that low control is a risk factor for stress-related disorders among men but not among women (Nieuwenhuijsen et al., 2010).

The current study found no support for the hypothesized interactive relationships among the components of the model and all-cause mortality. This negative finding is in agreement with the main findings of several major reviews of the effects of the JDC-S model on psychological well-being (de Lange et al., 2003; Hausser et al., 2010). It has been argued that for the interactive hypothesis to receive support one should focus on the specific dimensions of control and social support which are qualitatively relevant to the job demands under study (e.g., de Jonge & Dormann, 2006). However, in the current study control over the pace of work and freedom to decide on the order of tasks in one's job appear highly relevant to the qualitative workload assessed, and still there was no support for the hypothesized interaction.

The effect of peer social support on the risk of mortality was found to be significantly higher for those in the 38–45 age bracket than in the older and younger age brackets. This finding supports Uchino's (2004, p. 73) expectation that, assuming stability of social support across time, it may have accumulating effects, thus predicting physical health more powerfully as one become older. The finding that among those older than 43 there is no significant effect of peer social support on mortality risk could be because of the healthy worker effect that is expected to become more powerful among the older participants. Supporting this argument, a study that used the JDC-S model to predict cardiovascular heart disease found that the inclusion of older employees in the cohort diluted the associations among the components of the model and this health outcome (Kivimaki, Theorell, Westerlund, Vahtera, & Alfredsson, 2008).

The current study has several limitations. First, it did not provide a direct test of the implicit assumption that T1 assessment of the psychosocial work characteristics actually reflected long-term exposure to them. However, longitudinal studies on the JDC-S model have generally found moderate to high stability coefficients on its components (de Lange et al., 2003; Shirom et al., 2008), thus supporting the above assumption. Still, future research should replicate the study's findings in a full panel design. Second, in the current study socioeconomic status (an important determinant of morbidity and mortality) was assessed only by educational attainment; future researcher may consider directly assessing income as a control variable. Third, while the measures used to assess the components of the JDCS model have been used in earlier research, there is clearly a need for validation studies of these measures. This is particularly true with regard to the two measures of social support used in the current study, each of which is based on only two items. Fourth, the current study did not investigate the possible mechanisms that may link peer social support at work and all-cause mortality. Possible mechanisms linking high demands, low control and low support at work with mortality include increased activation of the hypothalamic-pituitary-adrenocortical system, activation of the sympathetic nervous system, sleep difficulties and insufficient recovery following exposure to work-related stress (Melamed, Shirom, Toker, Berliner, & Shapira, 2006). It is also possible that the JDC-S model is associated with morbidity and mortality because it leads to inflammatory and immune system responses (Shirom et al., 2008). Future research may investigate these possible mechanisms.

The current study has a number of strengths. Because of the complete ascertainment of death among the participants, bias caused by sample attrition was minimized. Additionally, baseline data on physiological, psychological, and behavioral risk factors for mortality and morbidity were tested as possible confounders in the analyses. Most of these potential confounders, including depressive symptoms, anxiety, smoking and exercise behaviors, body weight, and blood lipids and glucose may represent pathway variables between the JDC-S model and the risk of mortality. Therefore, this study tested the possibility that the only control variable found to be a significant predictor of the risk of mortality, total cholesterol, is a mediator and did not find support for this possible mechanism.

Future researchers should systematically check the possibility that the effects of the JDC-S model on morbidity and mortality are contingent upon the sociodemographic variables of age and sex. Future research may also consider the use of experimental designs to compare the effects of peer and supervisor social support on physiological risk factors for morbidity and mortality such as blood lipids. Additionally, future research should follow a life-course approach to the relationships between the JDC-S model and mortality, assessing lifetime exposure to the model's components. Our findings may have some important implications for the design of worksite health promotion interventions. Increasing peer social support and—albeit for the men only—increasing perceived control could, in principle, lower the risks of mortality for those participating in these interventions.

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