

Associations Between Positive Changes in Perceived Work Characteristics and Changes in Fatigue

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Little is known about the natural course of fatigue among employees. An adequate understanding of its development and risk factors is important to prevent chronic health complaints and absenteeism. This longitudinal study investigated associations between positive changes in perceived work characteristics (ie, a decrease in job demands, an increase in decision latitude, and an increase in social support) and changes in fatigue by performing hierarchical regression analyses. The work characteristics of the demand–control–support model were selected as predictors. The outcome measures emotional exhaustion and psychologic distress were investigated as secondary outcomes. The results showed that, compared with a stable work situation, positive changes in perceived social support, decision latitude, and psychologic job demands went together with a decrease in fatigue. Similar results were found for the secondary outcomes emotional exhaustion and psychologic distress. (J Occup Environ Med. 2004;46:866–875)

Fatigue is a commonly found problem among general practitioner patients^{1–3} and in the general population.^{4–6} The severity of fatigue follows a continuous distribution.^{1,5–7} In the literature, a distinction is made between acute fatigue and prolonged fatigue.^{8–10} Acute fatigue is task-specific and tends to disappear after taking some rest. Prolonged fatigue is assumed to be the result of a cumulative process that could occur if the individual is continuously exposed to 1 or more stressors while there are no or inadequate opportunities to recover.¹⁰ Prolonged fatigue is not task-specific and compensation mechanisms such as having some rest or switching to different methods of working are ineffective to reverse it on short notice.¹¹ Prolonged fatigue refers to a debilitating state, which could have negative effects on the quality of life.^{8,12,13} Another distinction found in the literature is that between explained and unexplained fatigue.¹³ If fatigue cannot be explained by a medical condition, the fatigue is referred to as unexplained. Swain notes that “. . . in present-day society, significant, prolonged fatigue commonly occurs in the absence of chronic medical illness.”¹³ A recent study in a working population showed that general, prolonged, unexplained fatigue was a risk factor of sickness absence, particularly long-term sickness absence.¹⁴ It will be clear that, practically, high social and economic costs are involved here if one is aware of the fact that approximately 22% of

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an employee population could be regarded as (explained and unexplained) fatigue “cases” in 1998.¹⁵ Seen from the perspective of preventing more chronic types of fatigue and sickness absenteeism, therefore, it is important to study the risk factors that could be involved in the course of fatigue at work. In this article, the subject of study is the course of general, prolonged, and unexplained fatigue that has lasted for 2 weeks.

Still, little is known about the factors that could affect the course of this fatigue among employees. A well-known work stress model making specific statements about the relation between work characteristics and—the etiology of—health complaints is the demand–control (D-C) model,¹⁶ which was later developed into the demand–control–support (DCS) model.^{17,18} The model is based on combined effects of work characteristics. One of the hypotheses in the D-C model is that work situations that are characterized by high job demands and poor decision latitude (“high-strain jobs”) will have a greater likelihood of developing stress reactions than work situations characterized by low job demands and a great deal of decision latitude (“low-strain jobs”). Then the support variable was added to the D-C model: in addition to decision latitude, social support at work was also thought to reduce the negative effects of job demands.^{17,18} The empiric evidence of interaction effects thus far has not been unambiguous, although direct effects of DCS work characteristics on stress reactions have frequently been demonstrated.¹⁹ A study conducted within the same research framework as the present study demonstrated a strong relation between DCS work characteristics and fatigue.²⁰ Although the DCS model primarily predicts the etiology of health complaints, it could also be that its hypotheses can be generalized to include the course of health complaints. Thus, in the present study, positive changes in

DCS work characteristics are assumed to be associated with a reduction in health complaints.

The purpose of the study was to examine the relation between positive changes in perceived work characteristics and changes in fatigue. A deliberate choice was made to include 2 measurements rather than a single measurement of both the independent and dependent variables in the analyses. The difference between both designs is that in the latter cross-sectional design, so-called “third” variables that were not included in the study design might have unintended effects on the study outcome. In a study design based on intraindividual changes, however, the influence of *stable* third variables is eliminated.^{21,22} For this reason, and because we wanted to study changes, we preferred the latter study design. Still, however, the potential disturbing influence of *unstable* third variables cannot be ruled out in the present study.

Another observation that can be made about the purpose of this study is that it investigated only the effect of *positive* or *favorable* changes in work characteristics as seen from the DCS model perspective. This decision was based on the high “face value” of the relation between positive changes in work characteristics and a reduction in fatigue. Another reason to study positive changes only is that positive and negative changes in work characteristics could differ in the power of their effects or in the period of time required before any effects can be measured.²³ Trying to find at the same time effects of both positive and negative changes in a single variable thus could lead to biased effect parameters.

The present study’s main hypothesis refers to the question of whether positive changes in DCS work characteristics (ie, an increase in decision latitude, a reduction in job demands, and an increase in social support) are associated with a reduction in fatigue. A stable work situation (absence of change), on the other hand,

is assumed to be associated with fatigue scores that remain unchanged or else with a less substantial reduction in fatigue complaints than is found in case of positive changes in work characteristics. Apart from the main outcome fatigue, 2 other health measures were included as secondary outcomes, ie, emotional exhaustion and psychologic distress. This was done to get a more complete picture of health developments and to state whether changes in work characteristics have any differential effects on the conceptually different, although highly interrelated, psychologic outcome measures.^{24,25} The second hypothesis, therefore, is whether an increase in decision latitude, a reduction in job demands, and an increase in social support, respectively, are associated with a reduction in emotional exhaustion and with a reduction in psychologic distress.

Methods

The Maastricht Cohort Study

In 1998, a large-scale epidemiologic study was started by Maastricht University to investigate fatigue among employees. The Maastricht cohort study is part of a national research program on “fatigue at work.” The Maastricht cohort study has been designed to establish the prevalence and incidence of fatigue among employees, to identify the risk factors involved in both its etiology and course, and to investigate how fatigued employees are treated and supported. The results are meant to produce specific suggestions for prevention measures and policymaking.²⁶ In May 1998, the baseline questionnaire was sent out to a heterogeneous population of nearly 27,000 employees. The respondents came from 45 companies and organizations. All sectors were represented in the study. Once every year the respondents received an extensive questionnaire to measure both risk factors (work, home, personality) and outcome measures (sickness

absence, fatigue, secondary health outcomes) in great detail. In addition, a brief questionnaire was sent out to the respondents twice a year to measure only outcome measures in detail. The respondents were followed during a period of 3 years. At baseline a total of 12,140 respondents participated in the study (a response rate of 45%).

Taris noted that nonresponse rates of 30% to 40% are not unusual nowadays.²⁷ In the Maastricht cohort study, the extensiveness of the baseline questionnaire on work and health, that employees received at the home address, might have put people off from participation in the study. Second, although the study self-evidently was based on voluntary participation, the 3-year follow-up period might have held back potential participants who were asked to fill out a total of 9 questionnaires. Third, the fact that potential participants were asked to give their written informed consent for participation, which included the collection of their sickness absence data on the basis of organizational records, might have held them back from participation. A nonresponse analysis revealed that, in comparison with respondents, baseline nonrespondents reported less often having experienced fatigue complaints and less often having been sick-listed in the last 4 months before the baseline measurement. No differences were found between respondents and nonrespondents regarding subjective general health, gender, age, and education.

Two extensive measurements were used in the present study, ie, the baseline measurement (T_0) and the extensive measurement 1 year later (T_3). Seasonal effects are neutralized by administering follow-up measurements during the same time of year.²⁸ One-year follow ups are frequently applied in occupational-psychologic studies.²³ At T_3 , ie, 1 year after T_0 , a total of 9655 respondents completed the questionnaire (79.5% of the initial number of re-

spondents). A comparison between the respondents who participated at T_0 only and those who participated at both T_0 and T_3 showed that young and lower educated employees, who reported a relatively poor fatigue state and a relatively high recent sickness absence rate at baseline, had discontinued participation at T_3 .²⁶

Because variety in fatigue and other characteristics in cohort participants was still guaranteed, explanatory analyses are not likely to be affected to a great extent by selection bias as a result of initial or follow-up nonresponse.

Study Population

People with long-term physical and psychologic illnesses were excluded from the analyses. They were those who made explicit mention of having a long-term illness at T_0 and/or T_3 and/or who marked 1 of the illnesses (eg, asthma, cancer, psychiatric condition) specified in the follow-up question ($T_0 + T_3$; $n = 4058$). Pregnant women were also excluded from the analyses ($T_0 + T_3$; $n = 181$). These 2 categories are likely to perceive fatigue, and possibly their work situation as well, differently from "healthy" employees. Also, as a result of other factors such as medication, their physical condition could affect both the level of their fatigue scores and their fatigue development in ways that are not found among other employees. Finally, the study population did not include employees who were sick-listed for more than 1 month at the time of administering the questionnaire ($T_0 + T_3$; $n = 468$). This was done because they might have distorted views of their work situation as a result of long-term sickness absence or because of work-related sickness absence. The implication of the applied exclusion criteria and panel design is that a large group of workers was excluded in advance; however, a more accurate assessment of the relation between health and work can be achieved if disturbing external influences are removed. Af-

ter applying the exclusion criteria, 6108 respondents were left. The study involved a panel group with a follow up of 1 year who did not have any missing values on the study variables at both T_0 and T_3 . As a result, the final study population included 5256 employees. A Pearson correlation analysis showed that the correlations between the study variables for the group of those who did not have any missing values ($n = 5256$) hardly differed, if at all, from the correlations found when respondents with missing values were also included ($n = 6108$). Thus, excluding respondents with missing values did not seem to have any effect on the relations between the study variables.

Measures

Outcome Measures

Fatigue. Fatigue was measured by using the Checklist Individual Strength (CIS), a 20-item questionnaire. Respondents indicated on a 7-point Likert scale how they generally felt during the past 2 weeks. The questionnaire has 4 subscales: subjective fatigue (8 items), reduction in motivation (4 items), reduction in activity (3 items), and reduction in concentration (5 items). Adding the 4 subscales leads to scores ranging from 20 to 140. Higher scores imply a higher degree of fatigue. The CIS was tested extensively in clinical settings,^{29,30} and it was validated in a pilot study among employees.³¹ Cronbach's alpha ($n = 5256$) was 0.93 at T_0 and 0.94 at T_3 .

Emotional Exhaustion. Emotional exhaustion was assessed with the Dutch version of the Maslach Burnout Inventory-General Survey (MBI-GS).^{32,33} The emotional exhaustion scale has 5 items, which all refer specifically to the work situation. Items are scored on a 7-point frequency scale. Scale scores vary between 0 and 6. Higher scores imply a higher degree of emotional exhaustion. Cronbach's alpha ($n = 5256$) was 0.87 at T_0 and 0.89 at T_3 .

Psychologic Distress. Psychologic distress was measured by using a Dutch translation of the General Health Questionnaire (GHQ-12).^{34,35} Originally, the GHQ was developed to measure mild, nonpsychotic psychiatric diseases within the general population. The list covers elements such as fear, chronic stress, and depression. Respondents are asked to identify which complaints they had during the past few weeks. Items are scored on a 4-point scale. In this study, the Likert scoring method was applied (0, 1, 2, 3). As a result, the continuous total score for the 12 items ranged from 0 to 36. Higher scores imply higher levels of psychologic distress. Cronbach's alpha ($n = 5256$) was 0.86 at T_0 and T_3 .

Work Characteristics

Decision Latitude. The concept of decision latitude is a combination of 2 concepts: the amount of skill used in executing tasks (skill opportunities) and decision authority, ie, discretion in planning and executing tasks and in taking decisions (decision-making opportunities).³⁶ The entire decision latitude scale consists of 9 items. Its score ranges from 24 to 96. Cronbach's alpha ($n = 5256$) was 0.81 at T_0 and 0.82 at T_3 .

Psychologic Job Demands. The scale of job demands has 5 items. Its range varies from 12 to 48. Cronbach's alpha ($n = 5256$) was 0.69 at T_0 and T_3 .

Social Support. The social support scale measures support from colleagues (4 items) and support from managerial staff (4 items). The items measure both socioemotional and instrumental support. Its range varies between 8 and 32. Cronbach's alpha ($n = 5256$) was 0.78 at T_0 and 0.79 at T_3 .

Work characteristics were measured by using a validated Dutch translation of the Job Content Questionnaire (JCQ).^{37,38} Items are scored on a 4-point scale ("totally disagree" to "totally agree"). Higher-scale scores imply higher levels of

decision latitude, job demands, and social support, respectively.

Statistical Analysis

Differential Scores

Change scores were calculated by standardizing the cross-sectional work characteristics at T_0 and T_3 . This was done by subtracting the population mean of the score and dividing this subtracted score by the standard deviation. The standardized scores on the work characteristics at T_0 and T_3 were then mutually subtracted.²¹ Standardization prevents that change scores are also determined by general changes in work characteristics. Furthermore, centering predictors could reduce colinearity between independent variables in regression analyses.³⁹ For decision latitude and social support, negative differential scores (below zero) implied positive change in 1 of the work characteristics, ie, increased decision latitude and increased social support. For the job demands variable, positive differential scores (above zero) implied a positive change in job demands, ie, a reduction of job demands. Higher absolute differential scores generally implied more positive change; lower differential scores (approaching zero) implied marginal positive change, which could be considered as approximately equaling a stable work situation.

Univariate Analyses

To improve our understanding of the data, several univariate analyses were carried out before conducting major multivariate analyses. Paired t tests were performed to examine any significant score developments on the study variables between T_0 and T_3 . Also, Pearson correlation coefficients were calculated for the study variables.

Multivariate Analyses

The relations between positive changes in work characteristics and changes in outcomes were investi-

gated by using hierarchical regression analyses. The first step in the regressions was to control for the covariates of age, level of education (dummies), gender (dummy), and a previous cross-sectional measure of the dependent variable involved.^{23,40} The static scores were associated quite strongly with the change scores. To distinguish between the effects of the 2 predictors, therefore, the second step was to add as covariates the static work characteristics at T_0 . The third step was to control for changes in the "other 2" work characteristics (depending on the work characteristic being the focus of attention in step 4). Step 3 made use of the total range of positive and negative differential scores, partly because these factors were included in the analyses as covariates only and partly because the study population would be seriously reduced if selection was based exclusively on positive changes found in *all 3* work characteristics. The focus of analysis is step 4, which was designed to identify the effect of positive change—as seen from the perspective of the DCS model—in 1 of the work characteristics (increased decision latitude, increased social support, and decreased job demands). It is emphasized that the effect of a positive change was established independently of either positive or negative changes in the other work characteristics as they were controlled in step 3.

The focus on positive change implied that, beforehand, a sample was selected that was subject to some positive change in 1 of its work characteristics (ie, the selection was based on getting a continuum from no change to maximum positive change). The result of the selection was that the 3 analyses for separate work characteristics focusing on a positive change in job demands, decision latitude, or social support, respectively, differed in the size of their subsamples.

Results

Univariate Analyses

The scores on work characteristics and health characteristics are reported in Table 1. At T₃, lower levels of job demands, social support, and decision latitude were reported as compared with T₀. However, the means and standard deviations make it clear that differences were only marginal, probably reaching significance as a result of the great number of respondents. As was mentioned earlier, general changes in mean group scores on work characteristics did not affect the results, because differential scores were not calculated until after standardization.

To make valid statements, the correlations between (static) work characteristics and (static) outcome measures should be similar at T₀ and T₃. This appeared to be the case (results not shown).

The correlations between the study variables are reported in Table 2. First, the results show that test-retest correlations were rather low for psychologic distress ($r = 0.43^{**}$) as compared with emotional exhaustion ($r = 0.72^{**}$) and fatigue ($r = 0.68^{**}$).

Second, static scores and changes in those scores appeared to be fairly strongly associated ($r = 0.47^{**}$ for social support, $r = 0.45^{**}$ for job demands, and $r = 0.40^{**}$ for deci-

sion latitude). Unfavorable scores on specific work characteristics were associated with more positive change in those work characteristics. For example, lower scores on social support at T₀ (little perceived social support) were associated with increased social support between T₀ and T₃. It is not strange to find this correlation; after all, the change scores are based on the static scores on work characteristics and ceiling effects probably influenced the results. The correlations involved did not seem to be strong enough to expect statistical problems as a result of overly strong associations between static scores and change scores if both types of predictors

TABLE 1

Means (M), Standard Deviations (SD) and Paired T-Tests for the Study Variables ($n = 5256$)

Variable	T ₀		T ₃		T-test
	M	SD	M	SD	
Fatigue	52.13	21.36	52.27	21.78	-.61
Emotional exhaustion	1.62	1.04	1.60	1.06	1.27
Psychological distress	10.64	4.41	10.73	4.41	-1.37
Social support	22.56	3.01	22.48	2.96	2.09*
Job demands	33.00	5.56	32.56	5.48	6.50***
Decision latitude	73.31	10.89	73.02	10.49	2.49*

T₀ refers to the measurement taken late May '98; T₃ refers to the measurement one year later, end of May '99.

* $P < .05$; ** $P < .01$; *** $P < .001$.

TABLE 2

Pearson Correlations of the Variables Under Study ($n = 5,256$)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Fatigue T ₀	-													
Emotional exhaustion T ₀	.68**	-												
Psychological distress T ₀	.59**	.51**	-											
Social support at work T ₀	-.24**	-.24**	-.25**	-										
Job demands T ₀	.17**	.35**	.22**	-.17**	-									
Decision latitude T ₀	-.21**	-.17**	-.16**	.32**	.08**	-								
Age	-.01	-.01	.04**	-.11**	.04**	.08**	-							
Educational level	.00	-.02	.02	.07**	.05**	.33**	-.05**	-						
Gender	.02	.03*	-.02	-.10**	.07**	.14**	.19**	-.01	-					
Fatigue T ₃	.68**	.55**	.43**	-.19**	.14**	-.17**	.02	-.02	.05**	-				
Emotional exhaustion T ₃	.56**	.72**	.41**	-.19**	.28**	-.14**	-.01	-.03	.03*	.70**	-			
Psychological distress T ₃	.36**	.33**	.43**	-.14**	.16**	-.08**	.05**	.02	.01	.57**	.50**	-		
Difference social support at work	-.02	-.04**	-.06**	.47**	-.04**	.11**	.02	-.03*	.01	.07**	.06**	.08**	-	
Difference job demands	.02	.06**	.06**	-.08**	.45**	-.01	.04**	-.05**	-.01	-.07**	-.11**	-.08**	-.11**	-
Difference decision latitude	-.02	-.03*	-.02	.09**	.01	.40**	.04**	.00	.03*	.08**	.05**	.11**	.28**	.01

Note * $P < .05$; ** $P < .01$; gender was coded 0 = female; 1 = male. Educational level coded as 1 = low; 2 = medium; 3 = high. Differential scores of the work characteristics include negative as well as positive changes. A negative differential score (below zero) implied for the variables 'difference in social support at work' and 'difference in decision latitude' a positive change in these variables (i.e. increased support and decision latitude), whereas a positive differential score (above zero) implied for the variable 'difference in job demands' a positive change (i.e. decreased job demands).

were included in the regression model.

Third, the correlations between the change scores reported in Table 2 reveal that an increase in decision latitude was associated with an increase in social support ($r = 0.28^{**}$). A decrease in job demands was slightly associated with an increase in social support ($r = -.11^{**}$). Changes in decision latitude and changes in job demands were unrelated ($r = 0.01$).

Fourth, fatigue and emotional exhaustion were strongly related (T_0 : $r = 0.68^{**}$; T_3 : $r = 0.70^{**}$), and correlations between psychologic distress and fatigue were also quite high (T_0 : $r = 0.59^{**}$; T_3 : $r = 0.57^{**}$). The correlations between psychologic distress and emotional exhaustion were 0.51^{**} at T_0 and 0.50^{**} at T_3 .

Multivariate Analyses

Tables 3, 4, and 5 present the

results of hierarchical regression analyses. The standardized beta (β) values of the end model are presented; for the individual steps made in the regression analyses, the additional amount of variance explained (ΔR^2) is given. The results show that all the regression models had significant F tests; all the predictors combined made a significant contribution to the amount of variance to be explained in the 3 outcome measures. The relatively high amount of

TABLE 3
Hierarchical Regression Analyses in Four Steps, in a Population Displaying Between Maximum Positive Change in Decision Latitude and No Change at All, for the Relation Between Positive Change in Decision Latitude and the Dependent Variables of Fatigue, Emotional Exhaustion and Psychological Distress, Respectively ($n = 2790$)

Step	Variable	Fatigue T_3		Exhaustion T_3		Distress T_3	
		ΔR^2	β	ΔR^2	β	ΔR^2	β
1	Men (women = reference)	.45***	.03*	.51***	-.01	.16***	.00
	Education (low = reference)						
	Education medium		.01		-.02		.03
	Education high		.02		.00		.02
	Age		.03		.00		.03
	Fatigue/Exhaustion/Distress†		.64***		.68***		.37***
2	Decision latitude	.00**	-.10***	.00*	-.05**	.01**	-.09***
	Job demands		.09***		.14***		.16***
	Support		-.04*		-.03		-.05*
3	Difference job demands	.02***	-.12***	.04***	-.20***	.04***	-.18***
	Difference support		.08***		.07***		.10***
4	Difference decision latitude	.01***	.10***	.00***	.07***	.01***	.13***
	R ²	.48***		.56***		.22***	

* $P < .05$; ** $P < .01$; *** $P < .001$.

† Fatigue/Emotional exhaustion/Psychological distress at T_0 were added as covariates in the first, second and third columns, respectively.

TABLE 4
Hierarchical Regression Analyses in Four Steps, in a Population Displaying Between Maximum Positive Change in Job Demands and No Change at All, For the Relation Between Positive Change in Job Demands and the Dependent Variables of Fatigue, Emotional Exhaustion and Psychological Distress, Respectively ($n = 2378$)

Step	Variable	Fatigue T_3		Exhaustion T_3		Distress T_3	
		ΔR^2	β	ΔR^2	β	ΔR^2	β
1	Men (women = reference)	.45***	.04*	.52***	.03	.16***	.00
	Education (low = reference)						
	Education medium		.00		-.02		.03
	Education high		.02		.01		.07*
	Age		.02		.03*		.06**
	Fatigue/Exhaustion/Distress†		.64***		.68***		.35***
2	Decision latitude	.00	-.10***	.00**	-.07***	.01***	-.09***
	Job demands		.06***		.11***		.14***
	Support		-.04*		-.04*		-.09***
3	Difference support	.02***	.09***	.01***	.08***	.03***	.11***
	Difference decision latitude		.11***		.04*		.13***
4	Difference job demands	.01***	-.09***	.02***	-.16***	.01***	-.08***
	R ²	.48***		.55***		.22***	

* $P < .05$; ** $P < .01$; *** $P < .001$.

† Fatigue/Emotional exhaustion/Psychological distress at T_0 were added as covariates in the first, second and third columns, respectively.

TABLE 5

Hierarchical Regression Analyses in Four Steps, in a Population Displaying Between Maximum Positive Change in Social Support and No Change at All, For the Relation Between Positive Change in Social Support and the Dependent Variables of Fatigue, Emotional Exhaustion and Psychological Distress, Respectively ($n = 3180$)

Step	Variable	Fatigue T_3		Exhaustion T_3		Distress T_3	
		ΔR^2	β	ΔR^2	β	ΔR^2	β
1	Men (women = reference)	.47***	.03*	.54***	-.01	.18***	.00
	Education (low = reference)						
	Education medium		.02		-.01		.06*
	Education high		.02		-.01		.07**
	Age		.02		-.01		.04**
2	Fatigue/Exhaustion/Distress†		.65***		.70***		.38***
	Decision latitude	.00*	-.08***	.00	-.05**	.00**	-.09***
	Job demands		.09***		.13***		.14***
3	Support		-.04*		-.04**		-.05**
	Difference job demands	.02***	-.12***	.04***	-.21***	.04***	-.16***
4	Difference decision latitude		.09***		.06***		.12***
	Difference support	.00***	.08***	.00***	.07***	.01***	.08***
	R ²	.50***		.58***		.22***	

* $P < .05$; ** $P < .01$; *** $P < .001$.

† Fatigue/Emotional exhaustion/Psychological distress at T_0 were added as covariates in the first, second and third columns, respectively.

total variance explained and the differences in total explained variance between the outcome measures were produced mainly because an earlier measurement of the dependent variable was included in the analyses (see also the test-retest correlations of the outcome variables).

Women appeared to be more likely to have reduced fatigue scores 1 year later as compared with men. Demographic variables did not have any consistent effects on emotional exhaustion or psychologic distress (Tables 3, 4, and 5).

The multivariate regression analyses (step 4) showed that decreased job demands, increased decision latitude, and increased support resulted in significantly more reduced fatigue scores as compared with a situation that did not include any changes in work characteristics. Similar results were found for the effects of positive changes on the outcome measures of psychologic distress and emotional exhaustion. Remarkably, the emotional exhaustion reaction was particularly positive when a decrease in psychologic job demands was involved as compared with the reaction of emotional exhaustion to changes in the other work characteristics. The latter effect can also be said to be

great as compared with the relationship between a decrease in job demands and a reduction in fatigue or psychologic distress.

The effect of positive changes in work characteristics was examined independently of the initial values of work characteristics. The contributions made by the static scores continued to be significant in the end model. The direction of the effects of the static scores on DCS work characteristics proved to conform to the relevant hypotheses postulated by the DCS model: low levels of decision latitude, high job demands, and low levels of social support predicted higher levels of fatigue than did high levels of decision latitude, low job demands, and high levels of social support. It can be deduced from Tables 3, 4, and 5 that of the DCS work characteristics, generally, the static job demands variable, had the strongest effect on the outcome measures.

Discussion

The hypothesis that positive changes in work characteristics are associated with a decrease in fatigue was confirmed. The hypothesis that these positive changes in work characteristics were also associated with decreases in emotional exhaustion

and psychologic distress was confirmed as well. The effects of the changes in the work characteristics were stated independently of their baseline level. Thus, an association between changes in work characteristics and changes in fatigue was observed over and above the effect of the baseline levels of the work characteristics on a future change in fatigue. Hence, this study revealed a complex interrelationship between levels of work characteristics and changes in work characteristics on the one hand and changes in fatigue (and related mental health complaints) on the other hand. The results might point at a bidirectional relationship.

High correlations were found between the outcome measures (particularly between fatigue and emotional exhaustion). In combination with the homogeneity of the effects of the changes in the work characteristics on the outcomes, the question can be raised if the effects found for specific outcome measures were affected by this strong association. Additional control in the analyses for the other outcome measures, however, did not affect the conclusions. Furthermore, there is some evidence that fatigue

and psychologic distress represent different constructs.¹⁵

Fatigue and emotional exhaustion appeared to be outcome measures that were relatively stable in time, even though the study applied rather severe exclusion criteria that prevented, for example, employees with long-term illnesses from being included in the study population. Thus, on an individual level, fatigue and emotional exhaustion are quite persistent phenomena, even among a—healthy—population of workers. These results are in agreement with the conclusions drawn by Schaufeli and Enzmann, which were based on a number of studies reporting the stability of emotional exhaustion. They concluded that this stability “is quite high for a construct that is believed to be affected by current situational conditions.”²⁸ Based on the results of the present study, this conclusion also seems to be justified for fatigue. Psychologic distress proved to be far less stable. This is in agreement with the conclusion drawn by Lovibond, based partly on his own research efforts (using instruments similar to the GHQ), that emotional syndromes are quite variable in time.⁴¹ Related to the stability of the outcome measures, the baseline measurements of the outcome measures of fatigue and emotional exhaustion were found to have a rather dominant influence within the regression model. Still, despite this dominating influence, the positive changes in work characteristics were found to go together with a reduction in fatigue and emotional exhaustion.

Reduction in job demands had a particularly positive effect on the level of emotional exhaustion (see also references 28 and 42). Referring to psychologic health complaints, Karasek et al. stated that of the DCS work characteristics, job demands were especially associated with fatigue and burnout.⁴³ If this proposition is assumed to apply also to *positive changes* in job demands, then this is confirmed by the relatively strong association between re-

duction in job demands and decrease in emotional exhaustion. The proposition did not hold for fatigue; fatigue displayed about equally strong reactions to all 3 changes in work characteristics investigated.

There are 2 previous studies that investigated effects of intraindividual changes in the DCS work characteristics in a similar way as was done in the present study. In a study among clerical workers, a reduction in job demands was found to be associated with decreasing need for recovery.⁴⁴ In another study in a population of nursing and care staff, associations were found between increasing supervisor social support and decreasing job demands, on the one hand, and decreased emotional exhaustion, on the other.⁴⁵ Possibly, subtle differences in study design (eg, analyses, operationalizations) are connected with the fact that the present study did find effects of positive changes in *all 3* DCS work characteristics on fatigue and related mental health complaints. Moreover, the previously mentioned studies referred to specific occupational groups.

Study Limitations

First, using questionnaires—and only questionnaires—could have affected the power of relations as a result of self-report bias resulting from common variance of methods, cognitive consistency, social desirability, overlap between dependent and independent variables, and so on.⁴⁶ In this respect, it should be observed, however, that the study made exclusive use of measuring instruments that were thoroughly validated.^{31,43} Karasek et al.⁴³ also stated on this point that the JCQ items^{37,38} were phrased as objectively as possible, focusing on reporting rather than on a cognitive assessment of work characteristics. Apart from self-report bias, (other) third variables that were not included in the study could also have affected the power of the relations investigated.^{23,40} However, stable third vari-

ables such as negative affectivity^{43,47} hardly played a role in the present study because it focused on the effects of intraindividual changes.²¹

Second, changes in the work situation were operationalized as positive changes in perceived work characteristics. Clearer indications on the practical implications of the present study would have been present if supplementary, independent ratings of changes in work characteristics would have been assessed and linked to the self-report data on fatigue and secondary health outcomes.⁴⁸ It is, however, impossible to obtain these supplementary, independent ratings on all participants in a large-scale study such as the Maastricht cohort study.²⁶ The exclusive reliance on self-report data entails that it remains unclear whether the changes in the perceived work characteristics reflect objective changes in work characteristics or whether measured changes primarily reflect changes in work attitude. Thus, based on the present study, it is impossible to say whether work-oriented interventions (“job redesign”¹⁷) or individual-oriented interventions (eg, cognitive behavior therapy) are effective in reducing fatigue and related mental health complaints. As for individual-oriented interventions, for example, it was demonstrated that, in a population of employees experiencing burnout symptoms, a changed perception of the work situation was sufficient to have a positive and long-term effect on psychologic health or absenteeism, even if this was not accompanied by actual changes in work characteristics.⁴⁹ To obtain more clarity on this subject, a (quasi)experimental research could be initiated on the basis of the present study results. In this research, the relationships between objective and subjective changes in work characteristics and changes in fatigue could be further explored.

Third, although a longitudinal design was applied, it was not possible to draw conclusions about cause-and-effect relations. This is because

measurement of the independent variables (ie, changes in work characteristics) did not precede measurement of the outcome measures.⁴⁰ As already stated, theoretically, relations are possible in both directions.^{23,28} Positive changes in work characteristics could lead to working conditions that involve fewer health hazards while offering more opportunities to recover during task performance, resulting in reduced fatigue. Alternatively, it is possible that high fatigue causes employees to entertain—more—negative views about the workplace. Furthermore, it is also possible that employees with lower levels of fatigue will be better able to adjust the objective work situation so as to meet their wishes or else will be offered more promotion opportunities so that they will perceive greater positive—objective—changes in their work than fatigued workers.^{23,50,51} In a longitudinal study, for example, it was found that depressed workers changed jobs and got promoted less frequently.⁵¹ Moreover, depressed workers who changed jobs appeared to experience smaller positive effects as a result of changing jobs in terms of improved work characteristics than did workers with less depressed feelings who changed jobs.⁵¹

A fourth limitation of the present study is that it focused on DCS work characteristics. Several authors have criticized the conceptualization and operationalization of DCS work characteristics.¹⁹ Measuring instruments were said to overlap in terms of conceptualization. Furthermore, other work characteristics might also play some role in the etiology and course of health complaints.¹⁹ Future studies investigating the course of fatigue might improve our understanding of the effects of more differentiated measures of work characteristics such as different types of support and other sorts of job demands such as physical job demands and emotional job demands.

Fifth, even though sufficient variety in exposure and outcomes ap-

peared still present, a more general limitation of the present study is that it cannot be ruled out that selective initial and follow-up nonresponse (see “Methods”) have affected the results of the present study.

Sixth, significant relationships were established between positive changes in work characteristics and changes in fatigue and related mental health complaints. However, the amount of additional explained variance for individual positive changes (ie, the last step in the separate hierarchical regression models) was very low; it varied between 0% and 2%. It is therefore likely that, next to work characteristics, other factors play a role in the course of fatigue and related mental health complaints. Intervening in a combination of several sorts of predictors might then be more effective than solely in work characteristics.

Overall Conclusion

The complex relationships that were found between levels of work characteristics and positive changes in work characteristics on the one hand, and changes in fatigue, emotional exhaustion, and psychologic distress on the other hand, emphasize the complexity of the course of fatigue as a subject of study. The course of fatigue among workers is still relatively virgin territory and requires additional study.

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