JOURNAL OF ORGANIZATIONAL BEHAVIOR, VOL. 19, 387–407 (1998)

Job characteristics and employee well-being: a test of Warr's Vitamin Model in health care workers using structural equation modelling

JAN DE JONGE[1] AND WILMAR B. SCHAUFELI[2]

[1] *Department of Work and Organizational Psychology, University of Nijmegen, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands*
[2] *Department of Social and Organizational Psychology, Utrecht University, P.O. Box 80140, 3508 TC Utrecht, The Netherlands*

Summary Warr's (1987) Vitamin Model was investigated in a representative sample of 1437 Dutch health care workers (i.e. nurses and nurses' aides). According to this model, it was hypothesized that three job characteristics (i.e. job demands, job autonomy, and workplace social support) are curvilinearly related with three key indicators of employee well-being (i.e. job satisfaction, job-related anxiety, and emotional exhaustion). Structural equation modelling (LISREL 8) was employed to test the comprehensive Vitamin Model. The results showed that the fit of the non-linear model is superior to that of the linear model. Except for the relationship between job autonomy and emotional exhaustion, the curvilinear relationships followed the predicted U-shaped or inverted U-shaped curvilinear pattern. Moreover, it appeared that the three job characteristics are differentially related with various indicators of employee well-being. In conclusion, this study partially supports the assertion of the Vitamin Model that non-linear relationships exist between job characteristics and employee well-being.

J. Organiz. Behav. **19**: 387–407 (1998)

Introduction

Many attempts have been made to develop theories, perspectives, and conceptual models that relate job characteristics with employee well-being (cf. Kahn and Byosiere, 1992). During the past decades, two theoretical frameworks have been particularly successful in generating and guiding empirical research: the Job Characteristics Model (Hackman and Oldham, 1980) and the Demand–Control–Support Model (Johnson and Hall, 1988; Karasek and Theorell, 1990). Although both models differ in scope and complexity, they assume *linear* relationships between job characteristics and indices of employee well-being. For instance, as hypothesized by both models, autonomy on the job is linearly associated with job satisfaction: the more autonomy a worker experiences the more satisfied (s)he is with the job.

Warr's (1987) Vitamin Model (VM) challenges this popular belief of linear relationships. Instead, the VM stipulates *non-linear* relationships between job characteristics and mental health outcomes, including employee well-being. To date a comprehensive empirical test of the VM still

CCC 0894–3796/98/040387–21$17.50

Received 21 July 1995
Accepted 20 September 1996

stands out, indicating that little can be said about the validity of the model. Therefore, the current article presents an overall test of Warr's model using structural equation modelling.

The Vitamin Model

Essentially, the VM holds that mental health is affected by environmental psychological features such as job characteristics in a way that is analogous to the non-linear effects that vitamins are supposed to have on our physical health. In addition to this central assumption of non-linearity, the VM builds on two other main features. First, job characteristics are grouped into nine categories that relate differently with mental health outcomes according to the type of 'vitamin' they represent. Second, a complex three-axial model of affective well-being, a core aspect of mental health, is postulated. Below the three key features of the VM are explained in greater detail.

Vitamins exert a particular influence on the human body. That is, vitamin deficiency produces bodily impairment and, consequently, may lead to physical illness ('deficiency disease'). Generally, vitamin intake initially improves health and physical functioning, but beyond a particular level of intake no further improvement is observed. Continued intake of vitamins may lead to two different kinds of effects, as shown in Figure 1.

First, a so-called constant effect might occur: health neither improves, nor noxious consequences are observed that impair the individual's physical health. According to Warr (1987, 1994), vitamins C and E have a suchlike effect on the human body. Therefore, the label CE ('Constant Effect') is used to denote this particular relationship. Second, an overdose of vitamins leads to a toxic concentration in the body ('hypervitaminosis'), which causes poor bodily functioning and ill-health. Among others, vitamins A and D are known to be toxic, when taken in large quantities. For that reason Warr has used the label AD ('Additional Decrement') to denote the inverted U-shaped curvilinear relationship as depicted in Figure 1. Warr (1987) argues that the effects of job characteristics upon mental health parallel the ways in which vitamins act upon the human body. Following this line of reasoning we could refer to Warr's vitamins as

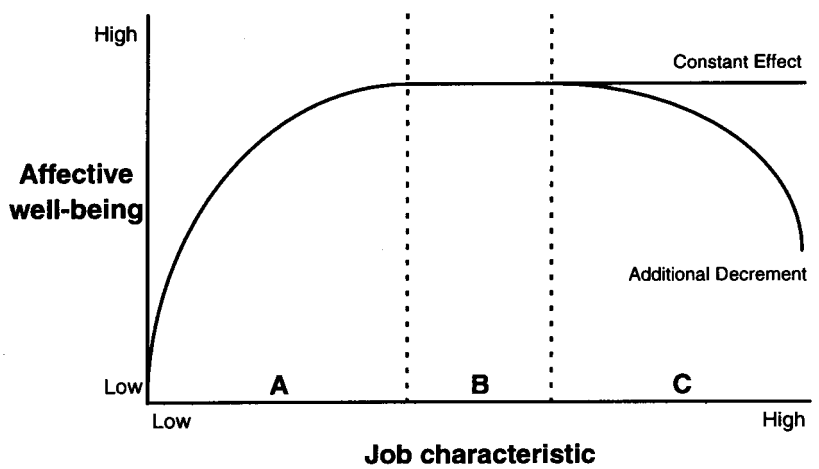


Figure 1. The relationship between job characteristics and affective well-being within the Vitamin Model (Reprinted from *Work, Unemployment, and Mental Health* by Peter B. Warr, 1987, p. 234, by permission of Oxford University Press)

'work vitamins'. According to Warr (1987), the presence of job characteristics initially has a beneficial effect on employee mental health, whereas their absence impairs mental health (segment A). Beyond a certain required level[1], vitamin intake has no positive effect anymore: a plateau has been reached and the level of mental health remains constant (segment B). Further increase of job characteristics (segment C) may either produce a constant effect (analogously to the vitamins C and E) or may be harmful and impair mental health[2], analogously to the vitamins A and D. As we shall see, the type of effect depends upon the particular job characteristic under consideration. Moreover, Warr (1994) maintains that the curvilinear AD pattern is likely to vary across different kinds of mental health outcomes. For example, a less pronounced mid-range plateau is expected for *job-related* well-being and an inverted U-shaped relationship is postulated. Finally, it seems plausible that the particular shape of a curve depends upon the particular kind of variables being studied. For instance, an inverted U-shape pattern is expected in case of job autonomy and job satisfaction, whereas a U-shaped curve is expected in case of job autonomy and emotional exhaustion.

After a thorough review of the literature Warr (1987, 1994) came up with nine features of jobs that act as potential determinants of job-related mental health. Not surprisingly, these characteristics include, amongst others, those that are featured in the Job Characteristics Model (Hackman and Oldham, 1980) and the Demand–Control–Support Model (Johnson and Hall, 1988; Karasek and Theorell, 1990). Warr (1987, 1994) assumes that six job characteristics (i.e. job autonomy, job demands, social support, skill utilization, skill variety, and task feedback) have effects similar to vitamins A and D. The remaining three job characteristics (i.e. salary, safety, and task significance) are supposed to follow the CE pattern.

It is important to know that the VM postulates that job characteristics influence mental health, rather than the process being initiated in the reverse sequence (Warr, 1994). Job autonomy, for instance, is assumed to follow the inverted U-shape or AD pattern: very high levels of job autonomy are potentially harmful for the employee's level of mental health since it implies uncertainty, difficulty in decision making, and high responsibility on the job (Warr, 1987). However, these suggested causal patterns have yet to be empirically confirmed or disconfirmed.

Job-related affective well-being

Warr (1987, 1994) distinguishes five components of mental health: (1) affective well-being; (2) competence; (3) autonomy; (4) aspiration; (5) integrated functioning. Psychological research mainly focuses on affective well-being as an indicator of *job-related* mental health. Following similar frameworks of Russell (1980) and Watson and Tellegen (1985), this job-related affective well-being is made up of two orthogonal dimensions of pleasure and arousal (see Figure 2). In addition, two separate axes were located diagonally: anxious–comfortable and depressed–actively pleased.

[1] There is no clear indication at present what dose of a vitamin is required to achieve this particular level. Doses will differ across the type of vitamin and across individuals (cf. Devlin, 1992).

[2] Warr's description of vitamin overdose is only partly correct. Hypervitaminosis is mostly a consequence of misuse of vitamin preparations. Vitamin intake by food hardly ever causes hypervitaminosis. Only fat-soluble vitamins (i.e. A, D, E, and K) have the potential for toxicity, because they cannot be excreted easily. On the other hand, water-soluble vitamins like B and C are readily excreted once their concentration surpasses the renal threshold. In other words, toxicities are quite rare in this particular case (cf. Devlin, 1992).

Being a fat-soluble vitamin, E has the potential for toxicity. However, it does appear to be least toxic of fat-soluble vitamins (Devlin, 1992). Thus, strictly speaking, vitamin E appears to possess AD features rather than CE features.

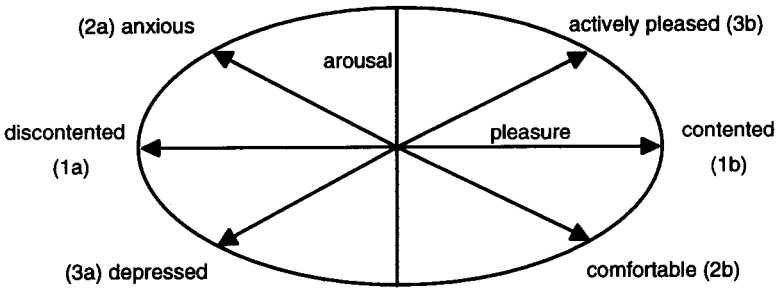


Figure 2. Three principal axes of affective well-being (Reprinted from *Work, Unemployment, and Mental Health* by Peter B. Warr, 1987, p. 41, by permission of Oxford University Press)

In order to measure affective well-being empirically three axes are used: (1) discontented–contented; (2) anxious–comfortable; (3) depressed–actively pleased. The vertical arousal dimension is not considered to be an empirical indicator of well-being and is therefore not labelled. Negative aspects of affective well-being are shown at the left-hand side of Figure 2, whereas positive aspects are depicted at the right-hand side. The elongated shape of Figure 2 suggests that the pleasure dimension is more important than the arousal dimension in constituting affective well-being.

Warr (1990a) has developed measurement scales of all aspects of mental health, including job-related affective well-being (see also Sevastos, Smith and Cordery, 1992). The scales for job-related affective well-being cover the full range of the two principal axes (numbers 2 and 3 in Figure 2), and seem to be psychometrically quite acceptable. Consistent with the position of the axes in Figure 2, the scores on the dimensions of affective well-being are expected to be positively correlated; that is, the angles between the axes are less than 90 degrees. In occupational settings, the first axis (i.e. discontented–contented) has mostly been operationalized through measures of job satisfaction, but measures of job attachment and organizational commitment have been used as well (Warr, 1987). The second axis (i.e. anxious–comfortable) is usually tapped through measures of job-related anxiety, job-related tension, and job-related strain. Finally, the third axis (i.e. depressed–actively pleased) is assessed by such measures as occupational burnout, job-related depression, job boredom, and fatigue.

Empirical support for the Vitamin Model

In presenting a sound summary of empirical evidence with respect to several aspects of the VM, Warr (1987, 1994) showed that his nine job characteristics do act *in isolation* as predicted by the model. But as far as we know, a comprehensive empirical test of parts of the VM is lacking (see also Warr, 1994).

In recent years, a few cross-sectional studies have investigated the proposed patterns of the VM (e.g. Fletcher and Jones, 1993; De Jonge, Schaufeli and Furda, 1995; Parkes, 1991; Warr, 1990b; Xie and Johns, 1995). Most notably Warr's own study among nearly 1900 employees confirmed the postulated curvilinear relationships (Warr, 1990b). Significant curvilinear relationships were found between job demands on the one hand, and job satisfaction, job-related anxiety, and job-related depression on the other. Regarding job autonomy, a curvilinear association was shown with job satisfaction. The latter relationship was the only one found to be significant in the study of Fletcher and Jones (1993) in a large heterogeneous sample of about 1300 men. Parkes (1991),

however, did *not* find any curvilinear relationship in her sample of almost 600 civil servants. Contrarily, De Jonge *et al*. (1995) found four out of 12 curvilinear relationships in their study among about 250 health care professionals. Firstly, they demonstrated a similar curvilinear relationship between job demands and job satisfaction as reported by Warr (1990b). Secondly, a curvilinear association was found between job autonomy and emotional exhaustion, an occupational burnout component. Finally, two curvilinear relationships were found between social support and particular aspects of job-related burnout (i.e. emotional exhaustion and reduced personal accomplishment). However, these curvilinear patterns did not match expectations: instead of a U-shaped ('AD') curve, an inverted U-shape was found. Xie and Johns (1995) examined curvilinear relationships between job scope and several strains in their study among more than 400 full-time employees. They found a U-shaped curvilinear relationship between self-reported job scope and burnout (i.e. emotional exhaustion).

Taken together, the results of the few studies that have—partially—tested the VM are mixed and inconclusive. Job demands and job autonomy seem to be related curvilinearly to some aspects of employee mental health in a way as predicted by the model, whereas the effect of workplace social support does not follow the model. Most importantly, however, all studies have failed to take account of the possible multifaceted ways in which job characteristics may affect job-related well-being (cf. Fletcher, 1991; Warr, 1987, 1994).

Aim of the present study

The purpose of this article is to test Warr's comprehensive Vitamin Model empirically. In other words: do job characteristics act like psychological 'vitamins', in ways as predicted by the model, as shown in Figure 1? Because of their theoretical and practical relevance three job characteristics are included in this study: (1) job demands, (2) job autonomy, and (3) workplace social support. There is considerable empirical evidence for the importance of these three job characteristics in relation to employee well-being (for more extensive reviews see: Ganster and Schaubroeck, 1991; Karasek and Theorell, 1990; Schnall, Landsbergis and Baker, 1994; Warr, 1987).

In addition, one aspect of the VM deserves particular attention; the multidimensional view of affective well-being which is a crucial aspect of mental health. In the present study the three axes that constitute affective well-being (see Figure 2) are represented by (1) job satisfaction, (2) job-related anxiety, and (3) occupational burnout, respectively.

According to Warr (1994), in order to test the VM adequately, a large sample of employees and a wide range of values of job characteristics are required. Non-linearity is expected to be more pronounced in studies among jobs that produce extreme scores on job characteristics. Therefore, we tested the VM in a relatively heterogeneous and large sample of health care workers; that is, nursing and nursing-like professionals. Several authors have pointed out that these professionals are quite suitable for testing this kind of conceptual models (e.g. Fox, Dwyer and Ganster, 1993; Ganster and Fusilier, 1989; De Jonge, Janssen and Van Breukelen, 1996). For example, because of different types of health care areas and different specialties, nurses and nursing-like workers are a relatively heterogeneous group. In addition to this, nurses and nurses' aides have stressful jobs that are characterized by high workload and low job autonomy. Consequently, burnout is a serious problem in today's nursing profession (e.g. Cordes and Dougherty, 1993; Schaufeli and Janczur, 1994).

Finally, Warr (1994) stated that multivariate and simultaneous tests of the VM are badly needed. We will therefore employ a comprehensive structural equation model that allows for a simultaneous test of various aspects of the model.

Hypotheses

In line with the Vitamin Model, we hypothesize that job characteristics (i.e. job demands, job autonomy, and workplace social support) are curvilinearly associated with three dimensions of affective well-being (i.e. job satisfaction, job-related anxiety, and occupational burnout). As mentioned before, both inverted U-shaped and U-shaped ('AD') patterns are expected depending upon the variables being studied.

Since gender and age may confound the results, both variables are included in the model as well. For instance, women tend to report greater job satisfaction than men, and they also tend to report more psychosomatic symptoms (e.g. Rosenfield, 1989; Sevastos *et al.*, 1992; Warr, 1987, 1990b). Similarly, Kasl (1989) noted that age may play an important role: older people report more health problems than younger people do. In addition, Karasek and his team (e.g. Karasek and Theorell, 1990; Schwartz, Pieper and Karasek, 1988) argued that age is negatively related to job strain. Moreover, they showed that job characteristics were systematically related to demographic variables like gender and age. For example, it should not be surprising that (1) older women tend to have less demanding jobs, (2) an older and probably more experienced nurse will have greater job autonomy, and (3) men's average levels of job autonomy are markedly higher than women's levels.

Method

Procedure and subjects

A random sample of 16 institutions was drawn from all general hospitals including a psychiatric unit and all combined nursing homes[3] ($N = 218$) in the Netherlands. These institutions (i.e. eight hospitals and eight nursing homes) participated voluntarily in the present study. In order to achieve a relatively heterogeneous group of health care providers, different kinds of units were asked to participate in the study: intensive care units (ICUs), psychiatric units, internal units, and surgical units in hospitals, and somatic units and psycho-geriatric units in nursing homes.

In total, the initial sample consisted of 1806 health care workers from 64 units, including registered nurses, student nurses, nurses' aides, activity therapists, secretaries, and kitchen staff. Self-report questionnaires were filled in and returned by 1489 respondents (82 per cent response rate). Thirteen employees from non-caring professions (e.g. activity therapists and secretaries) were excluded from the final sample, since the content of their jobs differs greatly from that of health care providers. In addition, only workers who had been employed for more than 3 months were included in the final sample, in order to ensure valid and reliable observations of the work situation (cf. Katz, 1978a,b). Both restrictions reduced the final sample to 1437 'real' and 'experienced' health care providers.

Eighty-three per cent of the respondents were women; ages ranged from 17 to 59 years (mean = 30.7, $S.D. = 8.4$). The mean work experience was 10.2 years ($S.D. = 7.2$), and 46 per cent of the respondents worked full-time.

[3] Combined nursing homes are nursing homes with somatic units as well as psycho-geriatric units.

Measures

Demographic variables

Demographic variables (i.e. gender and age) are included as control variables that can be expected to confound relationships between job characteristics and outcome variables (e.g. Karasek and Theorell, 1990; Kasl, 1989; Schaufeli and Van Dierendonck, 1994).

Job demands

Job demands are measured by an 8-item questionnaire (5-point response scale ranging from 1 'never' to 5 'always') that includes a wide range of qualitative and quantitative demanding aspects of the job, such as working under time pressure, working hard, strenuous work, and job complexity. The job demands scale has been well-validated in Dutch samples of health care workers (e.g. Boone and De Jonge, 1996; De Jonge, Landeweerd and Nijhuis, 1993; Vermaat, 1994).

Job autonomy

Job autonomy is assessed by the Maastricht Autonomy Questionnaire (MAQ; De Jonge, 1995; De Jonge, Landeweerd and Van Breukelen, 1994), which consists of 10 Likert items with a 5-point response scale ranging from 1 'very little' to 5 'very much'. The MAQ measures the worker's opportunity of freedom, inherent in the job, to determine a variety of task elements, such as method of working, amount of work, and work goals. The results of a study among 249 Dutch health care workers confirmed the validity as well as the reliability of the MAQ (cf. De Jonge *et al*., 1994; Vermaat, 1994). More specifically, the postulated one-factor structure had been confirmed, the coefficient alpha was 0.86, and the test–retest reliability was 0.66 (8-month time interval).

Workplace social support

Workplace social support is measured by a 10-item scale of total work-related social support (from the senior nursing officer as well as from colleagues). The scale was derived from a Dutch questionnaire on organizational stress ('Vragenlijst Organisatie Stress-Doetinchem'—VOS-D; Bergers, Marcelissen and De Wolff, 1986). A 4-point response scale was used, ranging from 1 'never' to 4 'always'.

Job satisfaction

Job satisfaction is assessed by a single item (i.e. 'I am satisfied with my present job') that was scored on a 5-point rating scale, ranging from 1 'strongly disagree' to 5 'fully agree'. It has been shown that a global rating of overall job satisfaction is an inclusive measure of general job satisfaction (e.g. Scarpello and Campbell, 1983; Weaver, 1980). De Jonge (1995) showed a test–retest reliability for this item of 0.55 (1-year time interval).

Job-related anxiety

Job-related anxiety is measured by means of a scale of the Dutch Organizational Stress Questionnaire ('Vragenlijst Organisatie Stress'—VOS; Reiche and Van Dijkhuizen, 1979), asking respondents how they generally felt at work. The subscale consists of four items with a response

scale ranging from 1 'never' to 4 'always'. The items reflect feelings of anxiety, nervousness, tenseness, and restlessness, respectively.

Emotional exhaustion

Emotional exhaustion is measured by a subscale of the Dutch version of the Maslach Burnout Inventory: the MBI-NL (Schaufeli and Van Dierendonck, 1993, 1994). Emotional exhaustion is the burnout dimension that is closest to more traditional job strain variables (cf. Maslach, 1993; Shirom, 1989). In its original form, the scale consists of nine items, scored on a 7-point scale (ranging from 0 'never' to 6 'always'). Because of insufficient factorial validity in earlier studies, the original item 16 ('Working with people directly puts too much stress on me') is eliminated in the Dutch version of the MBI (cf. Byrne, 1991; Schaufeli and Van Dierendonck, 1993).

Data analysis

Covariance structure modelling (CSM) with full-information maximum likelihood (FIML) estimation was used to assess the fit of the proposed Vitamin Model. CSM is a multivariate technique which combines methodological and statistical contributions from the psychometric theory as well as the econometric theory (Diamantopoulos, 1994; Scott Long, 1983). Basically, covariance structure models consist of an integration of two models: (1) the measurement or factor-analytic model, which reduces observed variables to a smaller number of latent factors; and (2) the structural equation model, which defines (causal) relationships among these latent factors (cf. Jöreskog and Sörbom, 1989; Scott Long, 1983). The present article simplifies the covariance structure model by assuming that the latent and observed variables are identical (i.e. each construct had only one operationalization). In other words, there are no specified measurement models in the analyses. The corresponding analyses were performed using the LISREL 8 computer program (Jöreskog and Sörbom, 1993).

Bollen and Scott Long (1993) as well as Jöreskog (1993) recommend a mixture of fit-indices in order to assess the overall fit of the model: the chi-square statistic (χ^2) and the LISREL adjusted goodness-of-fit index (AGFI; Jöreskog, 1993); the root mean square error of approximation (RMSEA; Browne and Cudeck, 1993; Steiger, 1990); the non-normed fit index (NNFI; Bentler and Bonett, 1980), and the cross-validation index (CVI; Browne and Cudeck, 1993; Cudeck and Browne, 1983). For a detailed description of these fit indices, see Jöreskog (1993) or Browne and Cudeck (1993).

Values of AGFI greater than 0.90, and RMSEA of about 0.08 or less indicate a reasonable fit of the model, whereas values equal to or greater than 0.95 (AGFI) or less than 0.05 (RMSEA) indicate a close fit (Browne and Cudeck, 1993; Verschuren, 1991). The major disadvantage of the chi-square statistic and the AGFI is that their value depends on sample size (Marsh, Balla and McDonald, 1988). Therefore, we computed also the NNFI which is hardly affected by sample size. The NNFI indicates the *incremental* fit of a particular model as compared to an independent model, a so-called null model (M_0) that assumes zero relationships between the variables. Bentler (1990) argued that the value of the NNFI should be greater than 0.90. Models with a poorer fit can usually be improved by relaxing parameters which were fixed to a specific value *a priori* (e.g. zero).

First of all, gender (dummy variable) and age were introduced into the structural model as potential confounders; therefore, they have to be labelled as exogenous variables (cf. Bollen, 1989, p. 126), and all other variables have to be labelled as endogenous variables (i.e. job characteristics and affective well-being). In addition, the VM suggests non-linear relationships between job characteristics and affective well-being. Such relationships are appropriately modelled by

including a linear as well as a squared term of a particular exogenous variable (Bollen, 1989; Kenny and Judd, 1984). This was done by performing two analytic steps (cf. Aiken and West, 1991; Jaccard, Turrisi and Wan, 1990): (1) the three exogenous variables (i.e. job demands, job autonomy, and social support) were mean-centred in order to prevent multicollinearity; (2) the squared terms of the exogenous variables were computed from these centred variables.

Next, three structural models were fitted to the data in two steps. First, a model M_1 without non-linear effects was specified, followed by a model M_2 with non-linear effects. Accordingly, Warr's VM, as described in our hypotheses, is tested against the null hypothesis (H_0) that there are *no* non-linear relationships. Different nested models can be compared by a likelihood ratio test (cf. Bentler and Bonett, 1980; Jöreskog and Sörbom, 1993). The difference between competitive models has a chi-square distribution with the number of degrees of freedom equal to the difference between the degrees of freedom of the separate models. Critical values of the chi-square distribution are taken as evidence whether or not H_0 has to be rejected. Second, the specified models M_1 and M_2 are compared with the null model (M_0). Eventually, the best fitting model is respecified in order to improve its fit.

Finally, in order to examine the robustness of the final model, a cross-validation procedure was followed that has been suggested by Browne and Cudeck (1993). According to this procedure, our sample is randomly split into a calibration sample ($n_1 = 719$) and a validation sample ($n_2 = 718$). In order to ensure that hospital workers and nursing home workers are equally represented in both subsamples, the parent-sample was stratified accordingly. Within each stratum (i.e. type of institution), all respondents were randomly assigned to the calibration sample or to the validation sample. No significant differences between the two split-samples were found with respect to demographic characteristics. More specifically, a double cross-validation in combination with a so-called 'fixed-weights strategy' was employed (cf. Cudeck and Browne, 1983; Diamantopoulos, 1994; MacCallum, Roznowski, Mar and Reith, 1994). That is, both split-sample covariance matrices are used to fit the proposed model and are mutually cross-validated. The fixed-weights strategy implies that only those parameters which represent the model-structure will be constrained (i.e. all linear and non-linear weights). All variances and covariances (including error and residual terms) are allowed to be re-estimated. The rationale for this approach is that in CSM theoretical weights are assumed to be identical for every individual in the population. In other words, those weights would characterize the individuals in the population, as well as those in any given sample, and, therefore, would not be affected by sampling (cf. MacCallum and Tucker, 1991). On the other hand, (co)variances reflect (co)variation within a given group and, hence, are affected by sampling.

A fit function F is calculated using one of the subsamples when the model estimates were read in as fixed values. This fitting function, also called the two-sample cross-validation index (CVI), is a measure of the discrepancy between the fitted model estimates in the analysed sample and the covariance matrix of the other sample (Browne and Cudeck, 1993).

Results

Preliminary analysis

Prior to the LISREL analyses, the means (M), standard deviations (*S.D.*), internal consistencies (Cronbach's alpha), and zero-order Pearson correlations of the variables were calculated (see Tables 1 and 2). Missing observations were handled by listwise deletion. The Cronbach's alphas

Table 1. Means, standard deviations (*S.D.*) and internal consistencies (Cronbach's α) of the study variables

Measures	Calibration sample ($n = 665$)			Validation sample ($n = 667$)		
	Mean	*S.D.*	α	Mean	*S.D.*	α
Job demands	0.00	0.60	0.87	0.00	0.58	0.86
Job autonomy	0.00	0.55	0.81	0.00	0.58	0.82
Social support	0.00	0.35	0.79	0.00	0.34	0.79
Job demands^2	0.35	0.55	—	0.34	0.54	—
Job autonomy^2	0.30	0.45	—	0.33	0.46	—
Social support^2	0.12	0.18	—	0.11	0.15	—
Job satisfaction	3.94	0.90	—	3.95	0.82	—
Job-rel. anxiety	1.50	0.45	0.79	1.48	0.42	0.76
Emot. exhaustion	1.74	0.88	0.85	1.75	0.85	0.84

indicate acceptable reliabilities in both subsamples. Covariance matrices were performed in order to analyse the structural models.

Model-fit

The hypothetical structural model is shown in Figure 3. The parameters to be estimated are: (1) regression coefficients linking gender and age with job characteristics as well as mental health

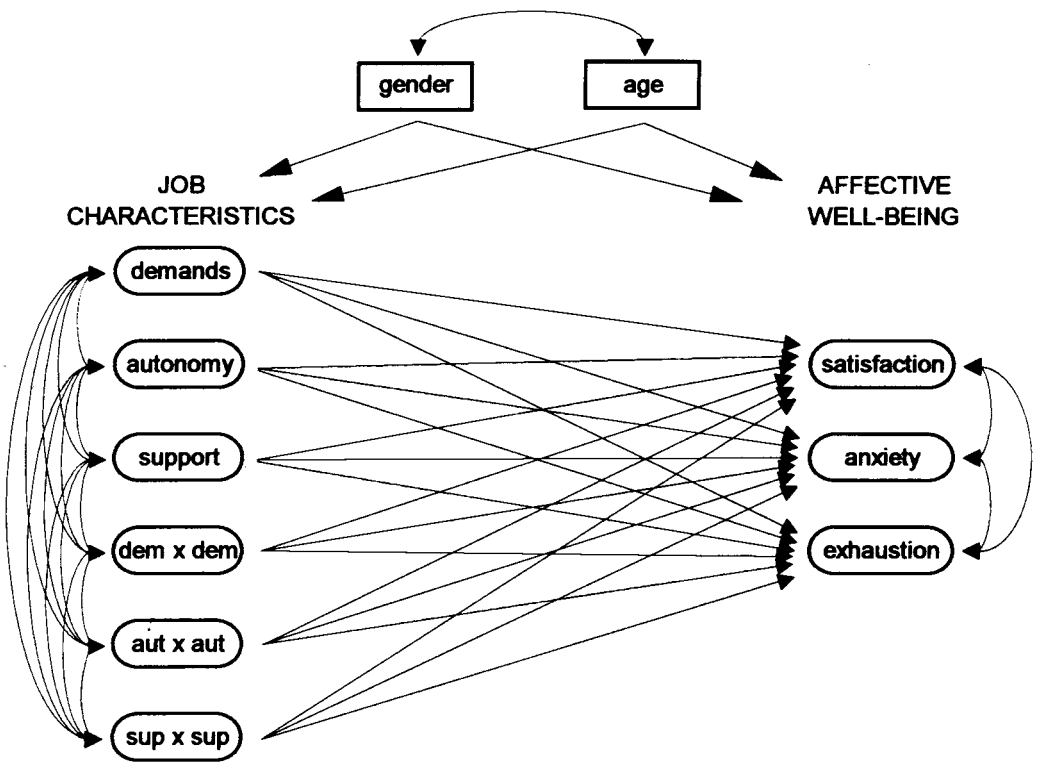


Figure 3. The hypothetical structural equation model

Table 2. Intercorrelations among the study variables (below diagonal: calibration sample, $n = 665$; above diagonal: validation sample, $n = 667$)

Measures	1	2	3	4	5	6	7	8	9	10	11
1 Gender*	—	−0.11†	0.08†	−0.17†	0.10†	0.05	−0.04	−0.04	0.05	−0.04	−0.01
2 Age	−0.14†	—	0.12†	0.09†	−0.09†	0.02	0.14†	0.05	−0.06	−0.02	−0.02
3 Job demands	0.03	0.03	—	−0.23†	−0.20†	0.08†	0.03	0.08†	−0.18†	0.18†	0.44†
4 Job autonomy	−0.16†	0.04	−0.29†	—	0.14†	−0.10†	0.04	−0.02	0.15†	−0.05	−0.10†
5 Social support	0.12†	−0.07	−0.15†	0.16†	—	−0.01	0.04	−0.14†	0.35†	−0.20†	−0.30†
6 Job demands^2	0.06	0.05	0.04	−0.04	0.04	—	0.12†	0.18†	−0.05	0.14†	0.05
7 Job autonomy^2	−0.05	0.19†	0.06	0.10†	−0.04	0.09†	—	0.09†	0.01	−0.08†	−0.06
8 Social support^2	0.05	−0.00	0.09†	−0.06	−0.22†	0.07	0.03	—	−0.13†	0.01	0.05
9 Job satisfaction	0.13†	−0.10†	−0.21†	0.11†	0.35†	−0.06	0.01	−0.22†	—	−0.17†	−0.33†
10 Job-rel. anxiety	0.00	0.01	0.20†	−0.09†	−0.22†	0.05	0.07	0.16†	−0.22†	—	0.46†
11 Emot. exhaustion	−0.01	−0.02	0.48†	−0.14†	−0.31†	0.02	−0.01	0.20†	−0.42†	0.45†	—

* Gender was coded 0 (males) and 1 (females).
† $p \leqslant 0.05$ (two-tailed).

Table 3. Goodness-of-fit indices of structural models and squared multiple correlations of affective well-being

Model	Chi-2 (*df*)	AGFI	RMSEA	NNFI	CVI	R^2 sat	R^2 exh	R^2 anx
Calibration sample ($n = 665$)								
Null model (M_0)	835.19* (55)	0.74	0.15	—	1.11	—	—	—
Linear model (M_1)	64.64* (15)	0.93	0.07	0.77	0.21	0.16	0.29	0.08
M_1-respecified	41.94* (14)	0.95	0.06	0.86	0.19	0.16	0.29	0.08
Non-lin. model (M_2)	29.11* (6)	0.91	0.08	0.73	0.23	0.19	0.31	0.09
M_2-respecified	6.41 (5)	0.98	0.02	0.98	0.22	0.19	0.31	0.09
Validation sample ($n = 667$)								
Null model (M_0)	736.13* (55)	0.77	0.14	—	1.26	—	—	—
Linear model (M_1)	42.75* (15)	0.95	0.05	0.85	0.29	0.15	0.25	0.07
M_1-respecified	30.83* (14)	0.96	0.04	0.90	0.25	0.15	0.25	0.07
Non-lin. model (M_2)	17.77* (6)	0.95	0.05	0.84	0.31	0.15	0.25	0.09
M_2-respecified	5.85 (5)	0.98	0.02	0.99	0.27	0.15	0.25	0.09
Total sample ($n = 1332$)								
Non-linear (M_t)	8.79 (5)	0.98	0.02	0.97		0.17	0.28	0.08

* $p \leqslant 0.01$.
sat, satisfaction; exh, exhaustion; anx, anxiety

outcomes (Γ matrix); (2) regression coefficients linking the job characteristics with the outcomes (B matrix); (3) covariances between the exogenous variables (Φ matrix); (4) residual covariances between the job characteristics (Ψ matrix). In addition, errors in equations predicting the four outcome variables (Ψ matrix) are allowed to correlate. Error caused by misspecification of the model would be reflected by these correlations. Such misspecifications might be caused by the existence of an additional variable that is not included in the model, but nevertheless is necessary to more fully explain the outcome variables (cf. MacCallum, Wegener, Uchino and Fabrigar, 1993; Scott Long, 1983).

Table 3 summarizes the results of the nested models that include non-linear effects. The structural models were identified successfully; therefore, we are able to estimate the model parameters (cf. Diamantopoulos, 1994). Consider first the models without (M_1) and with non-linear effects (M_2) of the calibration sample. The hypothesis test shows that the difference between the two chi-squares is significant ($\Delta\chi^2 = 35.53,\ \Delta df = 9,\ p \leqslant 0.001$), indicating that H_0 is rejected. Thus, in the calibration sample the non-linear model has a better statistical fit than the linear model. Consider next the linear (M_1) and non-linear model (M_2) of the validation sample. Again, the likelihood ratio test exceeds the critical value ($\Delta\chi^2 = 24.98,\ \Delta df = 9$, $p \leqslant 0.01$), indicating that H_0 is rejected. Thus, the non-linear model fits significantly better than the linear model in the validation sample as well.

However, values of NNFI are still below 0.90, which means that the fit of the models can be further improved. The Modification Indices (MIs) of all four models revealed that one of the largest MIs refers to the fixed parameters connection age to the cross-product of job autonomy. Since age is significantly related to the cross-product of job autonomy (see Table 2), the corresponding parameter has been relaxed in all models, resulting in four respecified models (Table 3). It appears that the modified non-linear models (M_2-respecified) yield a non-significant chi-square

value, which means a statistically good fit. Moreover, all respecified models show acceptable fit values for AGFI, RMSEA, and NNFI, respectively.

Finally, we consider the cross-validation indices for the modified models in both subsamples. The results show that model M_1-respecified in the calibration sample has the smallest discrepancy function value (CVI = 0.19), indicating the most stable model.

Interpreting structural coefficients

Most importantly, the respecified non-linear models in *both* subsamples yield the best fit indices. Both models, however, do not appear to be the most stable across subsamples. Consequently, in order to interpret the estimated non-linear structural coefficients as reliably as possible, raw data of both subsamples were merged into a single covariance matrix ($n = 1332$), that includes the three job characteristics and their corresponding cross-products, the three outcome variables, and the two control variables. This overall non-linear model M_t shows a statistically good fit in terms of χ^2 and acceptable other fit indices (see Table 3). The magnitude of the squared multiple correlations (R^2) of the outcome variables ranged from 0.08 for job-related anxiety to 0.28 for emotional exhaustion.

Figure 4 represents the estimated structural coefficients of the modified non-linear model (M_2-respecified), based on the whole sample. It should be noted that only significant relationships between job characteristics and employee well-being (i.e. FIML coefficients) are shown[4]. Furthermore, there is one non-significant FIML coefficient in the model (i.e. the dotted line from job autonomy to emotional exhaustion) because of hierarchical statistical procedures (see below, cf. Bishop, Fienberg and Holland, 1975; Kleinbaum, Kupper and Muller, 1988).

A closer inspection of the non-linear model in Figure 4 reveals four significant non-linear relationships between: (1) job demands and anxiety; (2) job autonomy and emotional exhaustion; (3) social support and job satisfaction; (4) social support and emotional exhaustion, respectively.

In Figures 5 to 8 the significant non-linear effects are graphically represented according to the method described by Aiken and West (1991). Following hierarchical statistical principles, the regression equation consists of the squared term as well as the main term of a job characteristic. All other variables were assumed to have average levels and hence were not involved in the equations. Except for Figure 6, all other figures show the AD pattern as postulated by the VM. Since anxiety and emotional exhaustion are negative outcomes, the expected AD pattern is indicated by a U-shape instead of an inverted U-shape (Figures 5, 6 and 8). Contrary to expectations, the curvilinear pattern of job autonomy is somewhat different. Instead of a U-shaped curve, an inverted U-shaped curve is found: low and high levels of job autonomy are associated with relatively *low* levels of exhaustion.

Discussion

The main purpose of the present study is to provide empirical support for Warr's Vitamin Model (1987, 1994) by testing it comprehensively using structural equation modelling. More specifically,

[4] Not surprisingly, several significant relationships exist between (1) demographic variables and job characteristics, (2) demographic variables and outcomes; (3) job characteristics themselves, (4) outcomes themselves, (5) demographic variables themselves, and (6) error terms. For the sake of brevity, their size and magnitude are not shown in Figure 4. The relevant findings are available upon request from the authors.

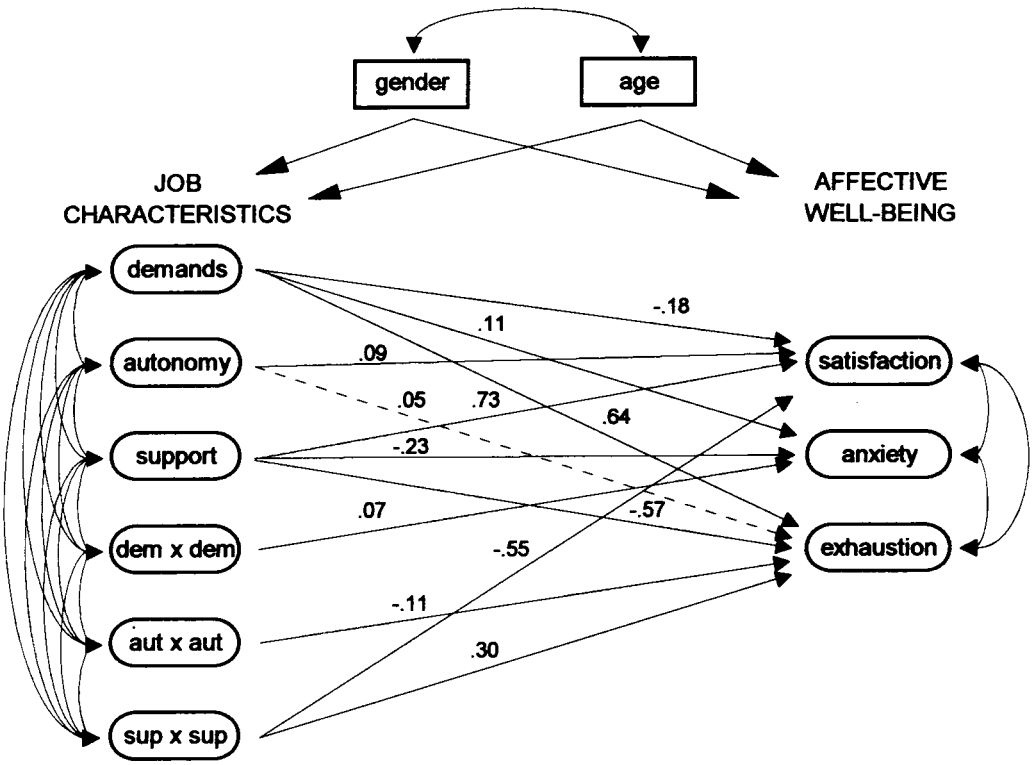


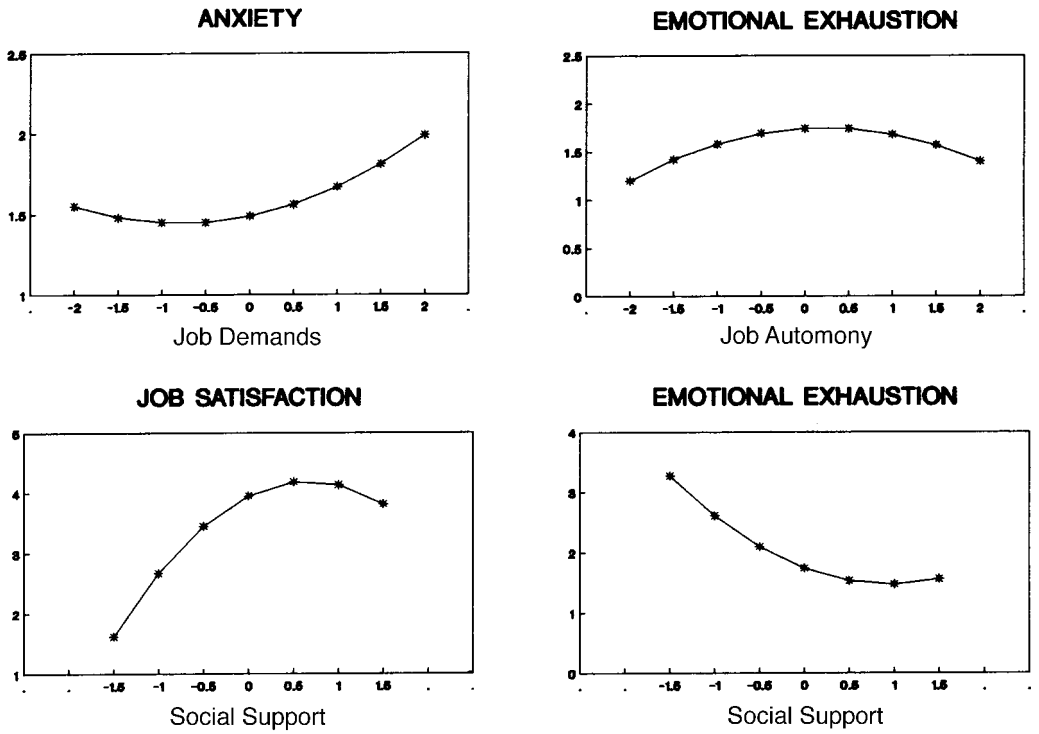
Figure 4. The ultimate structural equation model with significant FIML coefficients ($p \leqslant 0.05$, two-tailed; total sample: $n = 1332$)

it was hypothesized that three crucial job characteristics (i.e. job demands, job autonomy, and workplace social support) are curvilinearly related with three key aspects of job-related well-being (i.e. job satisfaction, job-related anxiety, and emotional exhaustion).

Model-fit

As postulated by the Vitamin Model, the fit of the structural equation model that includes non-linear relations between job characteristics and well-being is superior to the model that only includes linear relationships. Moreover, with one notable exception (i.e. the curvilinear relationship between job autonomy and emotional exhaustion) these non-linear relationships follow the expected U-shaped or inverted U-shaped AD pattern (see Figure 1). Finally, although the linear model was slightly more stable, the robustness of fit of the non-linear model is demonstrated because it was equally successfully fitted in two independent subsamples: a calibration sample and a validation sample. Consequently, the plausibility of the VM is confirmed by our results.

It should be emphasized, however, that the relative magnitude of the squared multiple correlations (R^2) is not very high, ranging from 0.08 for job-related anxiety to 0.28 for emotional exhaustion. In addition, the variance increments of the squared terms of the predictors are not very large either (1–2 per cent). On the other hand, it should be noted that these values are consistent with those obtained by other high quality occupational stress studies (cf. Karasek, 1989; Warr, 1990b; Xie and Johns, 1995).



Figures 5–8. Graphical representations of the non-linear relationships (total sample, $n = 1332$; y-axis, outcome variables, x-axis, centred job characteristics)

Unfortunately, four out of nine quadratic terms (i.e. 44 per cent) appeared to be significant. The validity of these findings is somewhat limited accordingly. In general, the power of statistical tests for higher order terms is expected to be low (cf. Aiken and West, 1991). Even under conditions of highly reliable measurement scales, and the use of structural equation modelling, the covariances between the product terms and their components might be affected by measurement error. This error might be the cause of unstable non-linear models. Another explanation could be that these results might be caused by a so-called 'healthy worker effect' (cf. Frese, 1985). Employees with adverse health reactions might be absent more frequently and thus be underrepresented in our sample. So, the relationship between job characteristics and mental health outcomes may be underestimated because of restriction of variance in the outcome variable(s).

Non-linear and linear representations

As far as the non-linear relationships are concerned, our findings agree with other similar studies. For instance, Warr (1990b) found a similar significant non-linear 'AD' relationship between job demands and job-related anxiety.

Job demands

In contrast, as in our study, several authors did *not* find non-linear relationships between job demands and the 'depressed–actively pleased' axis of affective well-being (e.g. Fletcher and Jones,

1993; De Jonge *et al*., 1995; Parkes, 1991). Thus, it seems that job demands are only *linearly* associated with indicators of job-related depression such as occupational burnout (e.g. emotional exhaustion). An explanation for this unexpected result may be some restriction of range in *experienced* workload. Generally, the experienced workload in health care is rather high; then because of financial cutbacks and higher care standards, more (complex) work has to be performed with less professionals. As a consequence, not many professionals are included who experience very low levels of job demands (i.e. 2 per cent scored less than 2). In other words, in terms of Figure 1, a great number of employees at the right-hand side (segment C) are included. Another explanation may be the reciprocity of the relationship between demands and exhaustion (e.g. De Jonge, 1995; Warr, 1994). It cannot be ruled out that emotionally exhausted people tend to perceive their workload as higher, which in turn may lead to more feelings of exhaustion. Accordingly, a linear pattern of association between job demands and occupational burnout is to be expected.

Finally, job demands are negatively, but only linearly, related with job satisfaction. Several investigators have also reported this significant association. For example, McLaney and Hurrell (1988) reported in their study among 765 health care workers a significant zero-order correlation of -0.20 between job demands and job satisfaction. In a similar vein, a study among 289 nurses and nurses' aides revealed that job demands were positively associated with job dissatisfaction (Landsbergis, 1988).

Job autonomy

The finding that job autonomy is non-linearly associated with emotional exhaustion (De Jonge *et al*., 1995) is replicated in the present study. However, compared to the earlier study, the shape of the curve is inverted: instead of moderate levels of autonomy being related to low levels of exhaustion, the present study reveals that moderate autonomy is related to *higher* levels of exhaustion. This particular result might be caused by the neglect of some important personal characteristics in this study, like 'need for autonomy'. It can be speculated that employees with a high need for autonomy, for instance, are likely to be less affected by high levels of job autonomy than those lacking this need (cf. Landeweerd and Boumans, 1994; Warr, 1994). Moreover, there is empirical as well as statistical evidence that the shape of a curve might change as a function of a moderator variable (Champoux, 1992; Jaccard *et al*., 1990). For example, in the case of low need for autonomy, job autonomy could be positively related to emotional exhaustion, whereas for high need for autonomy the resulting relationship between job autonomy and exhaustion could be curvilinear (representing an inverted U-shape). These results suggest that an incorporation or a resequencing of some variables in the model might be useful.

In addition, job autonomy has a small but significant linear relationship with job satisfaction. This finding is consistent with respect to prior job redesign research (e.g. Fried and Ferris, 1987; Loher, Noe, Moeller and Fitzgerald, 1985) and occupational stress research (e.g. Landsbergis, 1988; Parkes and Von Rabenau, 1993).

Workplace social support

Social support showed significant non-linear relationships with job satisfaction and emotional exhaustion, respectively. Both relationships followed the postulated AD pattern, and the latter corroborates a similar finding of De Jonge *et al*. (1995). A tentative explanation for these relatively strong non-linear relationships of social support is the nature of the work of nurses and nurses' aides. A first characteristic feature of their jobs is that workplace social support plays an important role in daily work, because for the most part nurses and nurses' aides work closely

together in teams (e.g. De Jonge and Landeweerd, 1993; Shinn, Rosario, Morch and Chestnut, 1984). A second characteristic feature is the relatively low level of job autonomy compared to other occupations. When the level of autonomy is rather poor, social and collective forms of 'control' may become more important (Boone and De Jonge, 1996; Johnson and Hall, 1994). So, it can be speculated that workplace social support plays a more significant role in these workers' well-being than job autonomy does.

Another finding of interest is the decreasing level of job satisfaction and the increasing level of emotional exhaustion at *high* levels of social support. This result provides some evidence for the 'stress-transfer' buffering theory of Karasek, Triantis and Chaudhry (1982). In the case of high social cohesion, the work group serves as a reservoir for moderating strain of any of its members. In other words, less strained workers absorb part of the problems of their more strained colleagues, equilibrating individual strain differences.

Finally, social support appeared to be positively related with job satisfaction, and negatively related with anxiety and emotional exhaustion, respectively. Similar plausible significant associations have frequently been observed in occupational research. A longitudinal study by Parkes (1982), for instance, revealed that changes in social support were positively associated with changes in job satisfaction and negatively associated with changes in anxiety and depression.

Differential associations

The validity of the three-axial framework of affective well-being has been established in this study on job characteristics. A closer inspection of the findings indicates that different aspects of well-being are differentially associated with various job characteristics. For instance, variations in job demands are more likely to bear upon axis 3 (i.e. 'depressed–actively pleased') than on both other axes. This result confirms the role of job demands as 'stressors' that have an impact on the individual's mood rather than on his or her level of anxiety or satisfaction. More particularly, our results agree with the burnout literature that shows consistent and rather substantive relationships, especially between emotional exhaustion and measures of job demands such as perceived stress, workload, and time pressure (Schaufeli and Buunk, 1996). Additionally, variations in job autonomy are related with axis 1 (i.e. 'discontented–contented') and axis 3 (i.e. 'depressed–actively pleased') rather than with axis 2 (i.e. 'anxious–comfortable'). In line with more general notions of depression, Warr (1990b) argued that job-related depression is thought more likely to be related to loss or deprivation. In occupational research, job characteristics such as job autonomy are considered important at levels representing deprivation, because they often exist in low quantities. This line of reasoning is also consistent with Karasek's (1979) study. His two survey studies showed that the highest levels of depression were particularly observed in employees who experienced low levels of job control.

Finally, variations in workplace social support are somewhat more strongly associated with axis 1 (i.e. 'discontented–contented') than with both other axes. Nonetheless, all three axes showed meaningful relationships with social support. In the literature, several theories can be found which distinguish the different roles of workplace support (cf. Johnson, 1989). On the most basic level, social support satisfies a human need for companionship and group affiliation, thereby promoting feelings of satisfaction. Moreover, workplace support may also serve as a resource to reduce the impact of job demands, and may lead to lower levels of anxiety and emotional exhaustion.

In brief, different job characteristics are more or less important in relation to different aspects of employee well-being.

Limitations

Unfortunately, the present study shares some limitations with other similar studies. For instance, our study was cross-sectional and relied exclusively on self-report measures, which precludes causal interpretation of the relationships between job characteristics and employee well-being.

Nevertheless, the implication of the present study seems to be important for future research in the field of organizational behavior. The Vitamin Model has successfully challenged the popular belief of the existence of linear relationships between job characteristics and mental health outcomes on which various psychological models are built such as the Job Characteristics Model and the Demand–Control–Support Model.

References

Aiken, L. S. and West, S. G. (1991). *Multiple Regression: Testing and Interpreting Interactions*, Sage Publications, Newbury Park, California.

Bentler, P. M. (1990). 'Comparative fit indices in structural models', *Psychological Bulletin*, **107**, 238–246.

Bentler, P. M. and Bonett, D. G. (1980). 'Significance tests and goodness of fit in the analysis of covariance structures', *Psychological Bulletin*, **88**(3), 588–606.

Bergers, G. P. A., Marcelissen, F. H. G. and De Wolff, Ch.J. (1986). *VOS-D. Vragenlijst Organisatiestress-D: handleiding* [VOS-D. Work stress questionnaire Doetinchem], Katholieke Universiteit, Nijmegen.

Bishop, Y. M. M., Fienberg, S. E. and Holland, P. W. (1975). *Discrete Multivariate Analysis: Theory and Practice*, MIT Press, Cambridge.

Bollen, K. A. (1989). *Structural Equations with Latent Variables*, Wiley, New York.

Bollen, K. A. and Scott Long, J. (1993). 'Introduction'. In: Bollen, K. A. and Scott Long, J. (Eds) *Testing Structural Equation Models*, Sage, Newbury Park, California, pp. 1–9.

Boone, H. and Jonge, J. de (1996). 'De relatie tussen verpleegsystemen en werkkenmerken: een exploratieve studie' [The relationship between nursing systems and job characteristics: an exploratory study], *Verpleegkunde: Nederlands-Vlaams wetenschappelijk tijdschrift voor verpleegkundigen*, **11**(2), 74–85.

Browne, M. W. and Cudeck, R. (1993). 'Alternative ways of assessing model fit'. In: Bollen, K. A. and Scott Long, J. (Eds) *Testing Structural Equation Models*, Sage, Newbury Park, California, pp. 136–162.

Byrne, B. M. (1991). 'The Maslach Burnout Inventory: Validating factorial structure and invariance across intermediate, secondary, and university educators', *Multivariate Behavioral Research*, **26**(4), 583–605.

Champoux, J. E. (1992). 'A multivariate analysis of curvilinear relationships among job scope, work context satisfactions, and affective outcomes', *Human Relations*, **45**(1), 87–111.

Cordes, C. L. and Dougherty, T. W. (1993). 'A review and an integration of research on job burnout', *Academy of Management Review*, **18**(4), 621–656.

Cudeck, R. and Browne, M. W. (1983). 'Cross-validation of covariance structures', *Multivariate Behavioral Research*, **18**, 147–167.

De Jonge, J. (1995). 'Job Autonomy, Well-being, and Health: A study among Dutch health care workers', PhD thesis, Datawyse, Maastricht.

De Jonge, J., Janssen, P. P. M. and Van Breukelen, G. J. P. (1996). 'Testing the Demand–Control–Support Model among health care professionals: a structural equation model', *Work and Stress*, **10**(3), 209–224.

De Jonge, J. and Landeweerd, J. A. (1993). 'Toetsing van de job demand-control benadering bij werknemers in de gezondheidszorg: een secundaire data-analyse' [Testing the job demand-control approach among health care workers: a secondary analysis], *Gedrag en Organisatie*, **6**(2), 79–92.

De Jonge, J., Landeweerd, J. A. and Van Breukelen, G. J. P. (1994). 'De Maastrichtse Autonomielijst: achtergrond, constructie en validering' [The Maastricht Autonomy Questionnaire: background, construction and validation], *Gedrag en Organisatie*, **7**(1), 27–41.

De Jonge, J., Landeweerd, J. A. and Nijhuis, F. J. N. (1993). 'Constructie en validering van de vragenlijst ten behoeve van het project ''autonomie in het werk'' ' [Construction and validation of the questionnaire for the 'job autonomy project'], *Studies bedrijfsgezondheidszorg nummer 9*, Rijksuniversiteit Limburg, Maastricht.

De Jonge, J., Schaufeli, W. B. and Furda, J. (1995). 'Werkkenmerken: psychologische arbeidsvitamines?' [Job characteristics: psychological work vitamins?], *Gedrag en Organisatie*, **8**(4), 231–248.
Devlin, T. M. (1992). *Textbook of Biochemistry: With Clinical Correlations*, Wiley-Liss, New York.
Diamantopoulos, A. (1994). 'Modelling with LISREL, a guide for the uninitiated', *Journal of Marketing Management*, **10**, 105–136.
Fletcher, B.(C.) (1991). *Work, Stress, Disease, and Life Expectancy*, Wiley, Chichester.
Fletcher, B.(C.) and Jones, F. (1993). 'A refutation of Karasek's demand–discretion model of occupational stress with a range of dependent measures', *Journal of Organizational Behavior*, **14**, 319–330.
Fox, M. L., Dwyer, D. J. and Ganster, D. C. (1993). 'Effects of stressful job demands and control on psychological and attitudinal outcomes in a hospital setting', *Academy of Management Journal*, **36**(2), 289–318.
Frese, M. (1985). 'Stress at work and psychosomatic complaints: A causal interpretation', *Journal of Applied Psychology*, **70**(2), 314–328.
Fried, Y. and Ferris, G. R. (1987). 'The validity of the Job Characteristics Model: A review and meta-analysis', *Personnel Psychology*, **40**, 287–322.
Ganster, D. C. and Fusilier, M. R. (1989). 'Control in the workplace'. In: Cooper, C. L. and Robertson, I. T. (Eds) *International Review of Industrial and Organizational Psychology*, Wiley, Chichester, pp. 235–280.
Ganster, D. C. and Schaubroeck, J. (1991). 'Work stress and employee health', *Journal of Management*, **17**, 235–271.
Hackman, J. R. and Oldham, G. R. (1980). *Work Redesign*, Addison-Wesley, Massachusetts.
Jaccard, J. R., Turrisi, R. and Wan, C. K. (1990). *Interaction Effects in Multiple Regression*, Sage, Newbury Park, California.
Johnson, J. V. (1989). 'Control, collectivity and the psychosocial work environment'. In: Sauter, S. L., Hurrell Jr., J. J. and Cooper, C. L. (Eds) *Job Control and Worker Health*, Wiley, Chichester, pp. 56–74.
Johnson, J. V. and Hall, E. M. (1988). 'Job strain, work place social support, and cardiovascular disease: A cross-sectional study of a random sample of the Swedish working population', *American Journal of Public Health*, **78**(10), 1336–1342.
Johnson, J. V. and Hall, E. M. (1994). 'Social support in the work environment and cardiovascular disease'. In: Shumaker, S. A. and Czajkowski, S. M. (Eds) *Social Support and Cardiovascular Disease*, Plenum Press, New York, pp. 145–167.
Jöreskog, K. G. (1993). 'Testing structural equation models'. In: Bollen, K. A. and Scott Long, J. (Eds) *Testing Structural Equation Models*, Sage, Newbury Park, California, pp. 294–316.
Jöreskog, K. G. and Sörbom, D. (1993). *LISREL 8: User's Reference Guide*, Scientific Software International, Chicago.
Kahn, R. L. and Byosiere, P. (1992). 'Stress in organizations'. In: Dunette, M. D. and Hough, L. M. (Eds) *Handbook of Industrial and Organizational Psychology*, Vol. 3, Consulting Psychologists Press, Palo Alto, CA, pp. 571–650.
Karasek Jr., R. A. (1979). 'Job demands, job decision latitude, and mental strain: Implications for job redesign', *Administrative Science Quarterly*, **24**, 285–307.
Karasek, R. (1989). 'Control in the workplace and its health-related aspects'. In: Sauter, S. L., Hurrell Jr., J. J. and Cooper, C. L. (Eds) *Job Control and Worker Health*, Wiley, Chichester, pp. 129–159.
Karasek, R. A. and Theorell, T. (1990). *Healthy Work: Stress, Productivity and the Reconstruction of Working Life*, Basic Books, New York.
Karasek, R. A., Triantis, K. P. and Chaudhry, S. S. (1982). 'Coworker and supervisor support as moderators of associations between task characteristics and mental strain', *Journal of Occupational Behaviour*, **3**, 181–200.
Kasl, S. V. (1989). 'An epidemiological perspective on the role of control in health'. In: Sauter, S. L., Hurrell Jr., J. J. and Cooper, C. L. (Eds) *Job Control and Worker Health*, Wiley, Chichester, pp. 161–189.
Katz, R. (1978a). 'Job longevity as a situational factor in job satisfaction', *Administrative Science Quarterly*, **23**, 204–223.
Katz, R. (1978b). 'The influence of job longevity on employee reactions to task characteristics', *Human Relations*, **31**, 703–725.
Kenny, D. A. and Judd, C. M. (1984). 'Estimating the nonlinear and interactive effects of latent variables', *Psychological Bulletin*, **96**(1), 201–210.

Kleinbaum, D. G., Kupper, L. L. and Muller, K. E. (1988). *Applied Regression Analysis and Other Multivariable Methods*, 2nd edn, PWS-KENT Publishing Company, Boston.

Landeweerd, J. A. and Boumans, N. P. G. (1994). 'The effect of work dimensions and need for autonomy on nurses' work satisfaction and health', *Journal of Occupational and Organizational Psychology*, **67**, 207–217.

Landsbergis, P. A. (1988). 'Occupational stress among health care workers: A test of the job demands–control model', *Journal of Organizational Behavior*, **9**, 217–239.

Loher, B. T., Noe, R. A., Moeller, N. L. and Fitzgerald, M. P. (1985). 'A meta-analysis of the relation of job characteristics to job satisfaction', *Journal of Applied Psychology*, **70**, 280–289.

MacCallum, R. C., Roznowski, M., Mar, C. M. and Reith, J. V. (1994). 'Alternative strategies for cross-validation of covariance structure models', *Multivariate Behavioral Research*, **29**(1), 1–32.

MacCallum, R. C. and Tucker, L. R. (1991). 'Representing sources of error in the common-factor model: Implications for theory and practice', *Psychological Bulletin*, **109**, 502–511.

MacCallum, R. C., Wegener, D. T., Uchino, B. N. and Fabrigar, L. R. (1993). 'The problem of equivalent models in applications of covariance structure analysis', *Psychological Bulletin*, **114**(1), 185–199.

Marsh, H. W., Balla, J. R. and McDonald, R. P. (1988). 'Goodness-of-fit indexes in confirmatory factor analysis: The effect of sample size', *Psychological Bulletin*, **103**(3), 391–410.

Maslach, C. (1993). 'Burnout: a multidimensional perspective'. In: Schaufeli, W. B., Maslach, C. and Marek, T. (Eds) *Professional Burnout: Recent Developments in Theory and Research*, Taylor & Francis, Washington, pp. 19–32.

McLaney, M. A. and Hurrell Jr., J. J. (1988). 'Control, stress, and job satisfaction in Canadian nurses', *Work and Stress*, **2**(3), 217–224.

Parkes, K. R. (1982). 'Occupational stress among student nurses: A natural experiment', *Journal of Applied Psychology*, **67**, 784–796.

Parkes, K. (1991). 'Locus of control as moderator: An explanation for additive versus interactive findings in the demand–discretion model of work stress?' *British Journal of Psychology*, **82**, 291–312.

Parkes, K. R. and Von Rabenau, C. (1993). 'Work characteristics and well-being among psychiatric health-care staff', *Journal of Community & Applied Social Psychology*, **3**, 243–259.

Reiche, H. M. J. K. I. and Van Dijkhuizen, N. (1979). *Vragenlijst Organisatie Stress: Test-Handleiding* [Organizational Stress Questionnaire: test-manual], Katholieke Universiteit, Nijmegen.

Rosenfield, S. (1989). 'The effects of women's employment: Personal control and sex differences in mental health', *Journal of Health and Social Behavior*, **30**, 77–91.

Russell, J. A. (1980). 'A circumplex model of affect', *Journal of Personality and Social Psychology*, **39**, 1161–1178.

Scarpello, V. and Campbell, J. P. (1983). 'Job satisfaction: are all the parts there?' *Personnel Psychology*, **36**, 577–600.

Schaufeli, W. B. and Buunk, A. P. (1996). 'Burnout'. In: Schabracq, M. J., Winnubst, J. A. M. and Cooper, C. L. (Eds) *Handbook of Work and Health Psychology*, Wiley, Chichester, pp. 311–346.

Schaufeli, W. B. and Van Dierendonck, D. (1993). 'The construct validity of two burnout measures', *Journal of Organizational Behavior*, **14**, 631–647.

Schaufeli, W. B. and Van Dierendonck, D. (1994). 'Burnout, een begrip gemeten: de Nederlandse versie van de Maslach Burnout Inventory' [Burnout, a measured concept: the Dutch version of the MBI], *Gedrag en Gezondheid*, **22**(4), 153–172.

Schaufeli, W. B. and Janczur, B. (1994). 'Burnout among nurses: A Polish–Dutch comparison', *Journal of Cross-Cultural Psychology*, **25**, 95–113.

Schnall, P. L., Landsbergis, P. A. and Baker, D. (1994). 'Job strain and cardiovascular disease', *Annual Review of Public Health*, **15**, 381–411.

Schwartz, J. E., Pieper, C. F. and Karasek, R. A. (1988). 'A procedure for linking psychosocial job characteristics data to health surveys', *American Journal of Public Health*, **78**(8), 904–909.

Scott Long, J. (1983). *Covariance Structure Models: An Introduction to LISREL*, Sage, Newbury Park, California.

Sevastos, P., Smith, L. and Cordery, J. L. (1992). 'Evidence on the reliability and construct validity of Warr's (1990) well-being and mental health measures', *Journal of Occupational and Organizational Psychology*, **65**, 33–49.

Shinn, M., Rosario, M., Morch, H. and Chestnut, D. E. (1984). 'Coping with job stress and burnout in human services', *Journal of Personality and Social Psychology*, **46**, 864–876.

Shirom, A. (1989). 'Burnout in work organizations'. In: Cooper, C. L. and Robertson, I. (Eds) *International Review of Industrial and Organizational Psychology*, Wiley, Chichester, pp. 25–48.
Steiger, J. H. (1990). 'Structural model evaluation and modification: An interval estimation approach', *Multivariate Behavioral Research*, **25**, 173–180.
Vermaat, K. (1994). *Flexibele Werklastbeheersing in de Verpleging* [Flexible workload control in nursing], Limburg University, Maastricht.
Verschuren, P. J. M. (1991). *Structurele Modellen tussen Theorie en Praktijk* [Structural models between theory and practice], Het Spectrum, Meppel.
Warr, P. (1987). *Work, Unemployment, and Mental Health*, Clarendon Press, Oxford.
Warr, P. (1990a). 'The measurement of well-being and other aspects of mental health', *Journal of Occupational Psychology*, **63**, 193–210.
Warr, P. B. (1990b). 'Decision latitude, job demands, and employee well-being', *Work and Stress*, **4**(4), 285–294.
Warr, P. (1994). 'A conceptual framework for the study of work and mental health', *Work and Stress*, **8**(2), 84–97.
Watson, D. and Tellegen, A. (1985). 'Toward a consensual structure of mood', *Psychological Bulletin*, **98**(2), 219–235.
Weaver, C. N. (1980). 'Job satisfaction in the United States in the 1970s', *Journal of Applied Psychology*, **65**(3), 364–367.
Xie, J. L. and Johns, G. (1995). 'Job scope and stress: can job scope be too high?', *Academy of Management Journal*, **38**(5), 1288–1309.

