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Construction and validation of the Short Inventory to Monitor Psychosocial Hazards

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SUMMARY

Since ten years the Belgian legislator recognizes the importance of psychosocial well-being at the work place by withholding it in the law on well-being of 1996. Although the legislator emphasizes the importance of implementing a risk control cycle for all of the domains of the law of 1996, the application of this cycle remains difficult within the domain of psychosocial well-being. Especially, monitoring of psychosocial hazards is extremely difficult. It is a problem where both the SOBANE strategy and research with surveys have not been able to deal with.

In particular with regard to survey research some statistical issues need to be tackled in order to be able to monitor psychosocial hazards at the workplace. While constructing the Short Inventory to Monitor Psychosocial hazards we have been dealing with these problems by developing the measurement model in LISREL and estimating the exposure rate to psychosocial hazard with latent class models.

The fact that the selection of scales of the VBBA was theoretical driven as well as determined by the pratical assessebility of these hazards lead in combination with the application of high brow statistical techniques to a monitoring instrument for psychosocial hazards that offers future research the opportunity to investigate more thouroughly the relationships with other domains of the law of 1996. Using this tool may possibly allow not only researchers but also practioners and policymakers to take in the future an integrative approach to well-being at work.

Keywords: psychosocial hazard, stress, latent class analysis and monitoring.

RÉSUMÉ

Avec la loi sur le bien-être, qui date déjà de 1996, le législateur reconnaît depuis plus de 10 ans que la charge psychosociale et le stress au travail co-déterminent le bien-être au travail.

Bien que le législateur insiste sur la mise en oeuvre d'un cycle de contrôle du risque, ceci se fait difficilement dans le domaine de la charge psychosociale au travail. Surtout, la manière dont le monitoring des risques psychosociaux doit être fait est une question névralgique où ni la stratégie SOBANE ni la recherche par questionnaire n'ont trouvé une solution satisfaisante.

La recherche par questionnaire pose certains problèmes statistiques pour le monitoring des risques psychosociaux. Ces problèmes ont été abordés lors de la construction du SIMPH (Short Inventory to Monitor Psychosocial Hazards) en développant un modèle de mesure dans LISREL et en estimant l'étendue des risques par l'analyse des classes latentes.

Grâce à une bonne sélection des échelles du VBBA à partir de la théorie, et en tenant compte de la maniabilité de ces concepts sur le terrain et par une combinaison de deux techniques statistiques sophistiquées, nous avons développé un instrument de monitoring de la charge psychosociale sur le lieu de travail qui ouvre la possibilité pour des recherches futures d'établir des relations avec les autres domaines de bien-être au travail.

Ainsi, il sera probablement possible à l'avenir pour les chercheurs, les acteurs de terrain et les responsables politiques de travailler à une politique intégrale du bien-être.

Mots-clés : charge psychosociale, stress.

SAMENVATTING

Met de welzijnswet die al dateert van 1996 erkent de wetgever al meer dan 10 jaar dat psychosociale arbeidsbelasting en werkstress het welzijn van de werk co-determineren. Hoewel de wetgever aandringt op het implementeren van een risicocontrole cyclus ligt dat moeilijk in het domein van de psychosociale arbeidsbelasting. Vooral hoe psychosociale risico's gemonitored moeten worden vormt hierbij een knelpunt waar noch de SOBANE strategie noch het vragenlijstonderzoek een eenvoudige oplossing voor hebben. Met betrekking tot het vragenlijst onderzoek stellen zich enkele statistische problemen. Bij de constructie van de Short Inventory to Monitor Psychosocial Hazards hebben

we deze statisiche problemen aangepakt door het meetmodel in LISREL te ontwerpen en de schatting van de omvang van de risico's over te laten aan latente klassen analyse.

Dankzij een goede theoretische gestuurde selectie van schalen uit de VBBA en door rekening te houden met de manipuleerbaarheid van deze constructen op het terrein en door een combinatie van twee hoogstaande statistische technieken hebben we een monitoringinstrument ontwikkeld voor psychosociale arbeidsbelasting op de werkplek dat het mogelijke maakt om in toekomstig onderzoek de relaties met de andere welzijnsdomeinen hard te maken. Daarmee wordt het in de toekomst wellicht mogelijk voor onderzoekers, praktijkmensen en beleidsmakers om te werken aan een integraal welzijnsbeleid.

Trefwoorden: psychosociale arbeidsbelasting, stress, latente klassenanalyse en monitoring.

INTRODUCTION

Ten years ago, the Belgian Legislator recognized psychosocial hazards as determinants of psychosocial well-being of employees in the law on well-being at the workplace (24). By urging employers to implement a risk control cycle for each of the domains of this law, the Belgian legislator translated the European Directive 89/391 into the Belgian judicial system. This directive obliges the Member States to adopt the control cycle into their judicial system, in order to minimize in a systematic way the exposure to occupational risks at the workplace. To bring this directive into practice, Cox (1,2) proposed the following control cycle to assess hazards: a) identification of hazards; b) assessment of associated risk; c) implementation of appropriate control strategies; d) monitoring of effectiveness of control strategies; e) reassessment of hazard/risk and f) review of information needs and training needs of workers exposed to hazards.

Although this approach is very appealing, applying a control cycle with standardized questionnaires in order to measure psychosocial hazards, like the JCQ (10), WOCCQ (24) or the QEEW (19) can be cumbersome. This is due to several issues:

1) ***Identification of hazards***. In occupational health psychology (OHP), many measurement models are based on the assumption that respondents' responses to items are measured on an interval or ratio scale. The estimates of measurement models or factor models are based on the assumption that the responses to these questions follow a normal distribution. In many cases in OHP, however, these assumptions cannot be met. Moreover, in some cases it is less appropriate to perform a traditional factor analysis, because the resulting factor is a continuum. One cannot always assume that all items are ordered on a continuum for all respondents involved (5). Research (17) showed that the choice of a statistical technique should be dependent on the measurement level of the indicators, the difficulty to agree with items and the power of the items to discriminate between problem cases and non-problem cases. As a consequence, the position of a respondent on a given psychosocial hazard might not longer be uniquely identified. Therefore, using traditional statistical techniques to obtain an estimate of exposure to these hazards, is not straightforward (13,14).

2) ***Analysis of hazards***. In order to analyze hazards, and to correlate causes with consequences, a variety of psychosocial hazards are combined in a statistical model in order to determine the weight of the explanatory variables. However, the use of occupational hazard questionnaires in a structural modeling framework (which is suitable to perform a risk analysis), is often associated with a vast amount of error correlations between indicators of different occupational hazards, needed to obtain a sufficient statistical fit. Hence, identifying risks becomes difficult, since occupational causes are no longer uniquely identified by a specific set of items.

3) ***Monitoring psychosocial hazards***. The ordinal nature of the items and the unequal item properties are not the only reasons why it is difficult to evaluate the successfulness of an intervention. The skewness of psychosocial hazards add to this problem. With a highly skewed psychosocial hazard, a vast amount of employees have to shift across a certain threshold[1] before a statistically significant change can be achieved. With ordinal measures, the use of such ordinary parametric statistical techniques is inherently associated with a violation of the assumptions to apply these techniques. If item properties are unequal, the position of a respondent on the latent variable is not longer uniquely identified. This seriously hampers attempts to evaluate change at the individual (and consequently at an aggregate) level.

4) ***Reassessment of psychosocial hazards***. Fitting models in a structural equation modeling (SEM) framework enables us to model measurement errors. SEM acknowledges that we do not measure psychosocial hazards in a perfect way. Using SEM enables to analyze the association between causes and consequences, and also allows analyzing how changes in causes, due to an intervention, are related to changes in consequences. However, in practice, measurement error is set to zero since most researchers report factor or sumscores.

In order to identify, analyze and monitor psychosocial risks, we developed the *Short Inventory to Monitor Psychosocial Hazards* (SIMPH). In this contribution, the construction and validity of this inventory will be reported and discussed.

THE DEVELOPMENT OF THE SHORT INVENTORY TO MONITOR PSYCHOSOCIAL HAZARDS

Construction of the SIMPH: principles

For the development of the SIMPH, we started with 42000 respondents, who filled out the QEEW. This questionnaire measures psychosocial risks. For each risk, a measurement scale was developed using the Mokken Scaling Program (version 2). Construct validity as well as reliability has been analyzed (20). This resulted in more than 200 items for the

1 e.g. a pre-defined amount of the standard deviation, a cut-off point based upon a Repetitive Operation Characteric curve (10) see e.g.: Notelaers, De Witte & van Veldhoven, 2005).

2 This enables one to link psychosocial hazards to individual health and safety records. It also enables us to monitor employees periodically.

measurement of 27 psychosocial risks. For use on the internet and in particular in the course of a periodical medical examination of employees[2], we need a questionnaire that can be completed in about 15 minutes. The questionnaire has been shortened in two ways. First, the number of psychological traits was reduced. Secondly, we reduced the number indicators (items) per trait. Three types of criteria were used in this reduction process:

a) ***Theoretical criteria:*** does the psychosocial hazard reflect theoretical constructs relevant to current models in occupational health psychology?

b) ***Practical criteria:*** can the psychosocial hazard be influenced in practice, by e.g. job redesign? Has the selected hazard sufficient power to discriminate between organizations or departments?

c) ***Methodological criteria:*** the construct validity, internal validity and external validity of the scales.

These criteria lead to the selection of 11 constructs: pace of work, emotional workload, participation, job autonomy, learning possibilities, skill use, social support, role conflict, role ambiguity, pleasure at work and need for recovery.

The reduction of the number of items within the psychosocial hazards was mostly based on methodological considerations. To enable a straightforward analysis of hazards, items should not load on other constructs and items should not correlate with items measuring other concepts within the framework of the SIMPH, when one uses SEM. To enable both a clear estimation of the exposure to psychosocial hazards and a sensitive monitoring system, an acceptable latent class model should be attained for each of the factors.

Data and methods

The 42000 respondents filled out the QEEW between 1999 and 2005 in approximately 400 Belgian organizations interested in a comparative (benchmark) screening of their employees. After the selection of the psychosocial scales according to the principles mentioned above, samples of about 2000 respondents were drawn from the benchmark of 42000 respondents, allowing an exploratory and a confirmatory analysis of the item reduction steps in LISREL (8). In LISREL, the indicators are conceived as ordinal measures. Hence, a polychoric correlation matrix and an asymptotic covariance matrix were estimated in PRELIS (8). Given these matrices, the model is estimated in LISREL with the Weighted Least Square estimation method (8).

Latent Gold (21) was used on order to classify employees in latent groups or classes. These groups are ordered according to their exposure to a psychosocial hazard (14, 15, 16, 17). To account for the huge number of observations which affect the fit statistics, 10 samples of about 800 observations were drawn, in order to decide whether the estimated number of classes in the exploratory step could be confirmed.

Results

The resulting SIMPH questionnaire consists of only 36 items (a reduction of 250 % in comparison to the original QEEW-scales). The first nine factors refer to causes or 'stressors'. All items are rated on a 4-point scale (response categories: always, often, sometimes and never). The other two factors reflect consequences or 'strains'. These items are rated with a dichotomous answering category (response categories: yes and no). The psychosocial scales and their items are the following:

1. **Pace of work (WH):** 'Do you have to work extra hard in order to complete a task?', 'Do you work under time constraints?' and 'Do you have to hurry at work?'.
2. **Emotional workload (EB):** 'Is your work load heavy from an emotional viewpoint?', 'Are you confronted in your work with elements which affect you personally?' and 'Does your work put you in emotional situations?'.
3. **Varied work (AW):** 'Is your work varied?', 'Does your work require personal input?' and 'Does your work make sufficient demands on your skills and capacities?'.
4. **Skill use (LM):** 'Do you learn new things in your work?' and '*Does your work give you the impression that you achieve something?*' (with a double loading of 'Does your work make sufficient demands on your skills and capacities?', also loading on the previous factor).
5. **Social support (RC-RL):** 'If necessary, can you ask your colleagues for help?', 'In your work, do you feel appreciated by your colleagues?', 'If necessary, can you ask your direct boss for help?', and 'In your work, do you feel appreciated by your direct boss?'.
6. **Role conflict (PW):** 'Do you receive contradictory instructions?', 'Do you have to do your work in a way which differs from the method of your choice?', 'Do you have conflict with your colleagues about the content of your tasks?' and 'Do you have conflict with your direct boss about the content of your tasks?'.
7. **Role ambiguity (OW):** 'Do you know exactly what other people expect of you in your work?', 'Do you know exactly what your tasks are?' and 'Do you know exactly what you can expect from the other people in your department?'.
8. **Participation (PAR):** 'Can you participate in decisions affecting areas related to your work?', 'Can you consult satisfactorily with your direct boss about your work?' and 'Can you participate in deciding what does and what does not pertain to your tasks?'.
9. **Autonomy (ZIW):** 'Do you have an influence on the pace of work?', 'Can you interrupt your work if you find it necessary to do so?' and 'Can you decide on the order of priorities for your work activities?'.
10. **Pleasure at work (PIW):** 'Mostly, I am pleased to start my day's work', 'I still find my work stimulating, every day on the go', 'I have to continually overcome my resistance in order to do my work'. (Two additional items: '*I do my work because I have to, and that says it all*' and '*I really enjoy my work*').
11. **Recovery need (HERB):** 'I find it difficult to relax at the end of a working day', 'Because of my job, at the end of the working day I feel really exhausted', 'I find it difficult to concentrate in my free time after work' and 'Generally, I need more than an hour before I feel completely recuperated after work'. (Additional item: '*During the last part of the working day, a feeling of tiredness prevents me from doing my work as well as I normally would*').

Figure 1. Measurement model of the Short Inventory to Monitor Psychosocial Hazards.

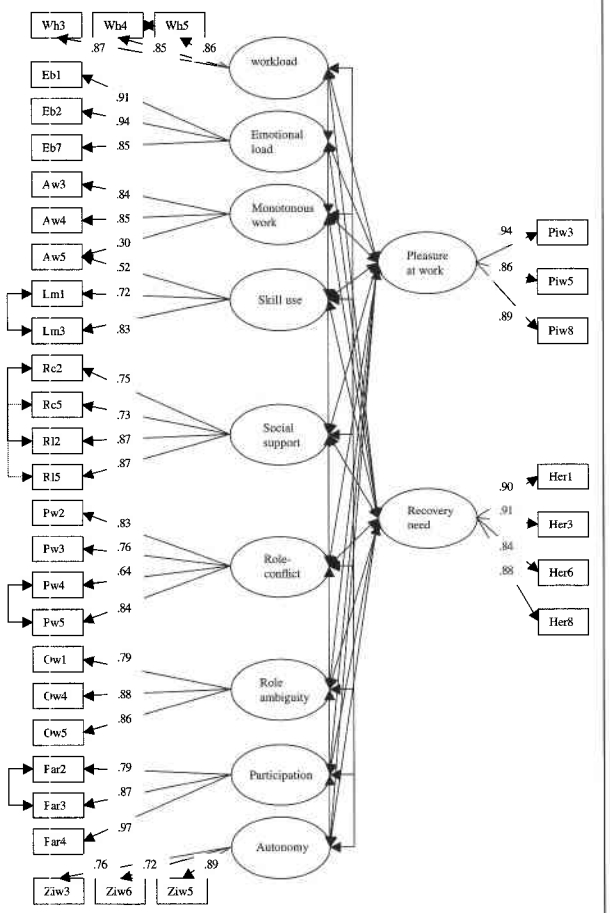

Table 1. Statistical Fit of measurement model		
	Exploratory sample	Confirmatory sample
Minimum Fit Function Chi-square (WLS estimation)	2051,37	2157
Degrees of Freedom	496	496
RMSEA	0,051	0,052
P-Value for test of Close Fit		
(p(RMSEA) < 0,05)	0,20	0,10
Independence CAIC	38527,82	35520,93
Model CAIC	3135,44	3247,82
Saturated CAIC	5096,75	5124,48
Goodness of Fit (GFI)	0,97	0,97

The confirmatory analysis (cf. figure 1) shows that all indicators only load on one psychosocial latent variable, except for 'Does your work make sufficient demands on all your skills and capacities?' that, due to considerations of the length of the questionnaire, was allowed to load on two latent variables. Note that the discriminatory power was rather low in this case: the correlation between skill use and diversity is 0.87 (cf. table 2) and rises above .90 when this item does not load on the two latent variables.

The fit statistics of LISREL in table 1 show that the confirmatory sample with a X^2 of 2157 and 496 degrees of freedom is not significant. Joreskog (8) however advises to inspect the statistics of close fit. An appropriate (so called close fit) fit is attained: P (RMSEA<0.05) equals 0.10 which is satisfactory for a large sample. The GFI for the model is 0.97 and the model CAIC of 3247.8 is smaller than the CAIC of the saturated (5124.5) and the independence model (35520.9). These statistics yield that the measurement model is satisfactory.

As noted, the measurement model shows a minor drawback. One indicator is used to measure two latent variables. And some indicators were allowed to correlate with each other due to reasons like similar item wording (r<0,2). However, since all other indicators show sufficient high loadings on the corresponding latent variables. Since the correlations between the latent variables cannot be visualized in the measurement model (figure 1), they are printed in the next table, which also includes the reliability of the measures on the diagonal (Cronbach α).

Table 2. Lisrel correlation matrix and Reliabilities (Cronbach a)											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1 No pace of work	(0.82)										
2 No emotional workload	0.43	(0.76)									
3 Participation	0.14	0.24	(0,84)								
4 Job autonomy	0.29	0.29	0.60	(0,72)							
5 Diversity	-0.17	-0.09	0.56	0.37	(0,70)						
6 Skill use	-0.08n	0.12	0.76	0.51	0.87	(0.68)					
7 Social support	0.27	0.35	0.75	0.54	0.39	0.64	(0.74)				
8 No role ambiguity	0.27	0.30	0.72	0.58	0.37	0.60	0.77	(0.73)			
9 No role conflict	0.49	0.55	0.58	0.53	0.18	0.39	0.67	0.69	(0.71)		
10 Recovery need	-0.58	-0.52	-0.23	-0.23	-0.10n	-0.18	-0.38	-0.32	-0.48	(0.78)	
11 Lack pleasure	-0.05n	-0.26	-0.56	-0.27	-0.60	-0.81	-0.6	-0.45	-0.51	0.41	(0.61)a

Off-diagonal: correlations with t-values > 1.96. Diagonal: Cronbach's α. n: not significant

The reliability of the measures is measured by calculating Cronbach α. The Cronbach's α of 10 out of 11 measures exceed.65, which is satisfactory with only 3 polytomous indicators for a latent variable (23). Only two Cronbach α's are beneath the threshold of.70: skill use and (lack of) pleasure.

The latent variables are highly correlated compared to previous reported correlations. Two reasons may account for these differences. First, all items (and scales) are treated as ordinal measures. Second, in the analysis presented in this paper, the complete measurement model has been accounted for. Hence, measurement error was not set to zero. Contrary to a principal components analysis in SPSS, LISREL estimates the correlations simultaneously with the factor loadings and the error variances. A look to the correlation matrix shows that 32 correlations are below the value of 0.50, which underlines the discriminant validity of the scales of the SIMPH (25). Twelve correlations vary between 0.50 and 0.60. This does not undermine the discriminant validity of the SIMPH. However, 11 correlations exceed the value of 0.60 which may threaten the discriminant validity of the SIMPH 4. A closer look however reveals that most of these correlations refer to psychosocial hazards which operationalize Karasek's decision latitude dimension (11): participation, job autonomy, diversity and skill use. Other associations are in line with some of the assumptions of the Job Demand – Resources model (18) (e.g. the correlation between social support and decision latitude. The strong negative correlation of diversity and skill use with lack of pleasure fits the assumptions of Hackman & Oldman's (6) Job Characteristics Model. These results suggest that the SIMPH shows sufficient discriminant validity.

We can estimate the exposure to psychosocial hazards with Latent Gold (21), a program for categorical data analysis. This program allows to estimate the amount of latent classes needed to explain the association between the indicators of a latent variable. An essential fit measure to assess the number of latent classes, is the Bayesian Information Criterion (BIC). Magidson & Vermunt (13) agree with other scholars (7, 12) that the latent class model corresponding to the lowest BIC is to be preferred. Additionally, the L^2 (a measure of badness of fit which follows a X^2 distribution), needs to be non-significant ($p > .05$).

Items with polytomous items can easily be analyzed, in order to obtain an identifiable statistical model. Problems arise when one wants to analyze dichotomous items (e.g. strains), due to a lack of degrees of freedom. Therefore, additional items were introduced (see the results section). These items were not necessary to estimate the measurement model in LISREL, but are needed for classification purposes.

For each of the psychosocial hazards of the SIMPH, a four latent class model was associated with the lowest BIC in more than 8 out of the 10 samples. Moreover, these four latent class cluster model always yield a significant L^2 value ($p > .05$).

The latent profile outputs report the association between the items and the latent variable by means of conditional probabilities (the probability that a particular response is linked to a latent class). These outputs also indicate that latent clusters can be ordered according to the exposure to a given psychosocial hazard. Table 3 gives an example of a latent profile output. This might illustrate the meaning of a latent cluster.

Table 3. Need for recovery: cluster size, conditional probabilities to answer 'no' to the indicators and average conditional probabilities

	Latent Clusters			
	no exposure	**low exposure**	**high exposure**	**very high exposure**
Cluster Size (%)	44	19	18	19
Indicators				
...difficult to relax end day	0,97	0,82	0,43	0,10
...because of job, exhausted end day	0,92	0,19	0,28	0,01
...difficulty to concentrate in free time after work	0,98	0,99	0,6	0,17
...need more than hour to recuperate completely	0,95	0,53	0,38	0,03
...during the last part of working day to tired to work as usual	0,93	0,70	0,72	0,36
average conditional probability	0,95	0,64	0,48	0,13

The body of the table contains conditional probabilities (the probability that a particular answer is associated with a specific latent class) to answer 'no' to five items, listed at the left of the table. A brief look at the table shows that these probabilities decrease almost monotonously when moving from the left to the right of table 2. The average conditional probability to reject the items (response 'no') for respondents which are 'not exposed' to recovery need is 0.95. That of the 'low exposed' group is 0.60, and that of the 'high exposed' group is 0.43. The average conditional probability of the 'very high exposed' employees is 0.15. This suggests that the clusters can be ordered according to their exposure to recovery need. The size of the clusters is as follows: 44 % of the respondents in the Belgian Benchmark are not exposed to recovery need, 19 % are 'low exposed', 18% are highly exposed and 19 % are very high exposed.

Similarly, latent class allows to estimate the exposure to all other psychosocial hazards of the SIMPH. Table 4 contains these results for the Belgian Benchmark. We also report the results regarding pleasure at work.

Table 4. Exposure to psychosocial hazards at work (percentages)				
Psychosocial hazards	No exposure	Low exposure	High exposure	Very high exposure
Work pace	7,05	51,7	32,8	8,48
Emotional workload	32	54,3	10,5	3,17
Low task diversity	17,6	45	31,2	6,25
Lack of skill utilization	10,4	38,5	40,4	10,6
Lack of social support	15,6	43,1	34,6	6,72
Lack of participation	11,2	32,3	43,9	12,6
Lack of autonomy	18,5	38,7	31,6	11,2
Role conflict	35	24,5	33,9	6,59
Role ambiguity	30,3	51,2	15,7	2,76
Lack of pleasure	72,3	9,19	12,9	5,66

Because the figures in table 4 are univocal, we will not fully describe the content of Table 4. Note however that the groups which is 'very highly exposed' to a given psychosocial hazard ranges between 2.8 % (role ambiguity) and 12.6 % (lack of participation).

The use of a latent class framework results in a non-arbitrary estimation of the exposure rates. This rate allows to weight the identification of hazards, the first step in the control cycle, and enables the identification of employees at higher risk. Moreover, it provides a starting point to evaluate interventions and to monitor exposure to psychosocial hazards. By dividing the distribution after the intervention (time 2) by the distribution before the intervention (time 1), the resulting odds ratios show how the exposure to psychosocial hazards evolved.

DISCUSSION AND PRACTICAL USE OF THE SIMPH

Applying the control cycle to psychosocial hazards involves (a) the estimation of the exposure to hazards in order to identify risk groups, (b) the analysis of hazards in order to identify the causes of a lack of well-being at the work place and (c) a monitoring system in order to evaluate preventive measures. Although these principles are quite straightforward, putting these principles in practice by means of widely used standardized questionnaires, proves not to be straightforward at all. To answer these needs, we developed a Short Inventory to Monitor Psychosocial Hazards in such a way that the statistical challenges associated with these principles can be met. As illustrated in table 3, estimating the prevalence of (or the exposure to) psychosocial hazards becomes rather easy. This prevalence for each psychosocial hazard corresponds to the distribution of the employees across the latent classes.

The factorial structure of the SIMPH (confirmatory analysis in LISREL) suggests that the SIMPH allows to simultaneously analyze the relationships between causes of distress and consequences ('strains'). However, some questions may arise concerning the construct validity and the internal reliability of the SIMPH. Many of the items of the QEEW-scales are dropped in the corresponding SIMPH-scales. This might suggest that the construct validity of the SHIP is lower than that of the QEEW-scales. The correlations between the original QEEW-scales and the corresponding SIMPH scales are however very high (on average above 0.85). This indicates that both types of scales indeed measure the same psychosocial hazards.

Concerning the psychometric quality of the SIMPH, we can conclude that its scales show sufficient reliability. At the same time, the SIMPH has a sufficient factorial discriminant structure. However, there is room for improvement regarding both issues. To achieve higher reliability, items have been added to measure lack of pleasure. The reliability rose to 0.78 with two additional items. In order to increase the reliability of the SIMPH, we could combine 'skill use' and 'variety' into the construct 'skill utilization'(9). This scale with 5 items has a reliability of 0.77. Because the high correlation between skill use and variety indicates the existence of a single construct, the factorial structure of the SIMPH could be reassessed. This could lead to a slightly new version of the SIMPH (version 2). In doing so, it appears relevant to add psychosocial hazards which are implemented in 'new' occupational health theories, such as mental workload (see for instance the DISC model (3) and job insecurity (4).

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