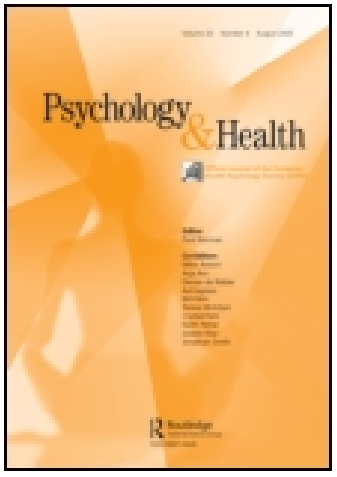

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Developmental trajectories of multisite musculoskeletal pain and depressive symptoms: The effects of job demands and resources and individual factors

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Objective: To investigate developmental paths in multisite musculoskeletal pain (MPS) and depressive symptoms (DPS) and the effects of job demands (JD), job resources (JR), optimism and health-related lifestyle on these paths. We expected to find four trajectories – Low Symptoms, High Pain, High Depression and High Symptoms – and hypothesised that high JDs, low JRs, low optimism and adverse lifestyle predict belonging to trajectories with high symptom levels.
Design: Data on Finnish firefighters (N = 360) were collected in 1996, 1999 and 2009. The effects of JDs (mental and physical workload), JRs (supervisory relations, interpersonal relations, task resources), optimism and lifestyle (alcohol consumption, smoking, physical exercise, sleeping) on MPS and DPS were assessed. Latent class growth modelling and multinomial logistic regression were applied.
Results: Three trajectories emerged: Low Symptoms; High Pain; and High Depression. In a multivariable model, high mental workload (OR 2.9, 95% CI 1.5–5.5), poor interpersonal relations (2.6, 1.4–5.0), sleeping problems (2.7, 1.4–5.2) and low optimism (2.0, 1.0–3.7) predicted belonging to High Depression. Alcohol consumption (2.4, 1.4–4.1) and sleeping problems (2.1, 1.3–3.6) were related to High Pain.
Conclusions: Different developmental paths in MPS and DPS are possible. Partly different factors predict the development of pain and depressive symptoms.

Keywords: depressive symptoms; pain; job demands; job resources; personal resources; firefighters

Introduction

Musculoskeletal pain and depression are common health problems in current work life, and cause a high amount of sickness absence (Andersen, Mortensen, Hansen, & Burr, 2011; Munce, Stansfeld, Blackmore, & Stewart, 2007) and work disability (Saastamoinen et al., 2012). Musculoskeletal pain can be located in one or multiple sites of the body. Multisite musculoskeletal pain is found to have more harmful consequences than

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single-site pain (e.g. Haukka et al., 2013; Øverland, Harvey, Knudsen, Mykletun, & Hotopf, 2012). Depression refers to a way of reacting to challenges that are perceived as impossible, a melancholy mood state, or to a clinical mental disorder (Gruenberg & Goldstein, 2003). Typical depressive symptoms are sadness, irritability, hopelessness, feelings of failure and social withdrawal (e.g. Beck, 1970; Beck et al., 1988). Some studies show that pain and depression may develop together (e.g. Bair, Robinson, Katon, & Kroenke, 2003; Demyttenaere et al., 2007). For example, population surveys in 17 European countries showed that pain in multiple sites was associated with a fourfold risk of depression (Gureje et al., 2008). However, pain and depression do not always coexist (e.g. Magni, Moreschi, Rigatti-Luchini, & Merskey, 1994), and thus they might also have different developmental paths over time.

Recently, the study of multisite pain (MSP) and its determinants has gained more attention (Grotle & Croft, 2010), and several work characteristics and lifestyle factors have been found to associate with MSP (e.g. Coggon et al., 2013; Haukka, Ojajärvi, Takala, Viikari-Juntura, & Leino-Arjas, 2012; Kamaleri, Natvig, Ihlebaek, Saltyte Benth, & Bruusgaard, 2008). Similarly, risk factors and protective factors of depression are widely investigated (e.g. Bonde, 2008; Hölzel, Härter, Reese, & Kriston, 2011).

Consistent evidence suggests that high job demands are related to musculoskeletal pain (Hauke, Flintrop, Brun, & Rugulies, 2011; Macfarlane et al., 2009) and depression (Bonde, 2008; Netterstrøm et al., 2008). Obviously, high job demands, such as a heavy workload, may act as psychosocial stressors at work and cause psychological strain, and consequently, increase the likelihood of depressive symptoms. Similarly, high mental workload may lead to constant overload and eventually increase musculoskeletal pain. In particular, in work environments with both high physical and mental work load, such as firefighting, musculoskeletal pain problems and depressive symptoms may be apparent. However, the effects of job resources, such as supervisory support, co-worker support and job control on pain are still controversial (for reviews, see Bongers, Kremer, & ter Laak, 2002; Hartvigsen, Lings, Leboeuf-Yde, & Bakketeig, 2004; Hauke et al., 2011). In terms of depression, findings regarding the protective effects of job resources are more consistent (for reviews, see Netterstrøm et al., 2008; Stansfeld & Candy, 2006). Lifestyle factors, such as alcohol consumption, smoking, physical exercise and sleeping problems, may also play a role in the development of pain and depression (e.g. Kamaleri, Natvig, Ihlebaek, Saltyte Benth, & Bruusgaard, 2009; Lopresti, Hood, & Drummond, 2013; Shiri et al., 2010).

In addition, the individual's personal resources may be important in the development of pain and depression. There is some evidence that individual resources, such as optimism, are related to less pain and lower depression (Cannella, Lobel, Glass, Lokshina, & Graham, 2007). Optimism has been found to be related both to physical and psychological well-being (Scheier & Carver, 1992). However, longitudinal evidence is still scarce.

Thus far, knowledge regarding the developmental paths of pain and depression is limited. Through a person-centred approach, it is possible to identify important individual differences that cannot be found using standard variable-based approaches (e.g. multivariate analysis or structural equation modelling). Recently, such a person-centred approach was applied in investigating the course of low back pain (Dunn, Jordan, & Croft, 2006), the development of multisite pain (Haukka et al., 2012) and burnout and depression (Ahola, Hakanen, Perhoniemi, & Mutanen, 2014). However, to our

knowledge, the person-centred approach has not previously been applied to the investigation of the coexistence of pain and depressive symptoms. In addition, no previous studies seem to exist on the effects of work-related demands and resources, and individual factors on the co-development of pain and depressive symptoms.

Theoretically, the Job Demands-Resources (JD-R) model (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001) offers an explanation for the association between work characteristics and health problems, in our case, the developmental paths of pain and depressive symptoms. The JD-R model assumes that psychosocial work conditions can be divided into two characteristics: job demands and job resources. The basic assumption of the JD-R model is that these two work characteristics may evoke two different, albeit related, processes: a health-impairment process from job demands to ill-health, and a motivational process from job resources to positive organisational outcomes, such as commitment and performance. Indeed, empirical evidence supports the assumptions of these two related processes (for overviews, see Hakanen & Roodt, 2010; Schaufeli & Taris, 2014). Recent research has shown that lack of job resources may also have a negative effect on the health and well-being of employees (e.g. Airila, Hakanen, Punakallio, Lusa, & Luukkonen, 2012; Parzefall & Hakanen, 2010) in the same way as job demands. Personal resources are also included in the JD-R model, as they may have similar effects to those of job resources (Xanthopoulou, Bakker, Demerouti, & Schaufeli, 2007).

Based on previous research and the JD-R model, we formulated our study hypotheses. First, we hypothesise that the development of pain and depressive symptoms is favourable (i.e. low levels of both symptoms are found) for most firefighters, and thus, one large trajectory *Low Symptoms* will emerge (*Hypothesis 1a*). This assumption is based on previous findings indicating that the majority of firefighters tend to have rather low levels of musculoskeletal pain (e.g. Sluiter & Frings-Dresen, 2007) and depressive symptoms (e.g. Fullerton, Ursano, & Wang, 2004; Lalić, Bukmir, & Ferhatović, 2007). As depressive symptoms and musculoskeletal pain are nevertheless apparent among firefighters (e.g. Huizink et al., 2006; Morren, Dirkzwager, Kessels, & Yzermans, 2007), we assume that a smaller trajectory with a high level of depressive symptoms (*High Depression*) and another with a high level of musculoskeletal pain (*High Pain*) will also emerge (*Hypotheses 1b and 1d*). In addition, in line with previous studies arguing for the co-occurrence of pain and depression (e.g. Bair et al., 2003; Demyttenaere et al., 2007), we assume (*Hypothesis 1d*) that there is a trajectory group with high levels of both symptoms (*High Symptoms*). Concerning the relationships between job demands, job resources and optimism − following the assumptions of the JD-R model − we hypothesise that high levels of job demands and low levels of job resources and optimism at baseline predict belonging to the trajectory groups with high levels of pain and depressive symptoms (*Hypothesis 2*).

Methods

Participants

The data consisted of a questionnaire study among Finnish firefighters conducted in 1996, 1999 and 2009. Initially, the study was launched to examine health and work ability among firefighters and their prerequisites for work in highly demanding tasks in fire and rescue services. The intervals between data collections were due to practical

decisions and financial arrangements. The study was approved by the Ethics Committee of the HUS Hospital District.

In 1995, a stratified sampling of all permanent Finnish operative male firefighters (n = 3512) was conducted based on a registers of the three trade unions of Finnish firefighters. The sampling was stratified according to the amount of firefighters in the area and their age. In 1996, a questionnaire was sent to 1124 professional firefighters in Finland, and was returned by 76% (N = 835). In 1999, a follow-up questionnaire was sent to 1106 participants of the sample selected in 1996, who either had or had not responded. The response rate was 72% (N = 794). In 2009, 1061 questionnaires were sent to firefighters regardless of previous response status, and 68% returned the questionnaire (N = 721). The research process is displayed in Figure 1.

The study population consisted of the firefighters who responded to the questionnaires in 1996 (T1), 1999 (T2) and 2009 (T3), and were still employed in their profession (n = 360). All participants were men. At baseline, the sample was representative of Finnish firefighters in terms of age, region and occupational titles. In 2009, the average age of the study population was 48.7 (range 35–62, SD = 5.4). Mean work experience in fire and rescue services was 25.5 years (range 3–39, SD = 5.7).

Of the respondents in 1996, 475 did not participate in the study in 2009. Statistical tests indicated that the drop-outs were significantly older (mean age 41.7 vs. 35.7 years), had lower education (primary school education 47.8% vs. 18.4%), had depressive symptoms slightly more often (mean 3.15 vs. 2.38), had a higher mental workload (mean 2.15 vs. 1.58), smoked more often (59.7% vs. 46.8%), had slightly lower physical activity (mean 2.65 vs. 2.79), had slightly more often sleeping problems (mean 8.09 vs. 7.39) and lower optimism (mean 2.53 vs. 2.70) than those who responded at all three times. In contrast, statistical tests revealed that the drop-outs and the participants

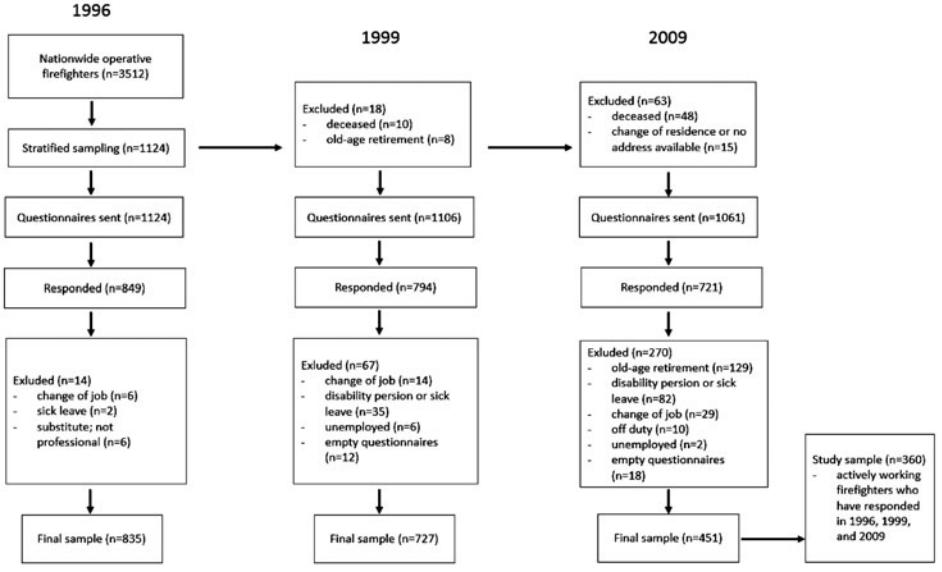

Figure 1. The research process.

did not significantly differ in relation to pain, physical workload, supervisory relations, interpersonal relations, task resources and alcohol consumption.

Measures

Outcome variable

The outcome variable was the co-occurrence of multisite musculoskeletal pain (MSP) and depressive symptoms (DPS). The MSP was measured using seven items adapted from the validated Nordic Musculoskeletal Questionnaire (Kuorinka et al., 1987). We measured pain in the neck, shoulders, forearms/hands, hips, knees and radiating and local pain in the low back. The question was: 'Estimate how many days altogether you have had … (i.e. neck) pain during preceding 12 months?' All items were rated on a five-point scale (1 = never, 2 = 1–7 days, 3 = 8–30 days, 4 = over 30 days, 5 = daily). If an answer was missing, it was defined as "never". The variable was categorised into two categories: '0 = no pain' (pain on 0–7 days), '1 = pain' (pain on more than 7 days). Finally, all seven dichotomised variables were summed and the sum score of MSP at all sites was calculated (0 = no pain –7 = pain in seven sites).

DPS were assessed by the Finnish version (Hänninen, 1989) of the Profile of Mood States questionnaire (POMS) (McNair, Lorr, & Droppelman, 1971). The construct validity of the scale has proven to be satisfactory (Peterson & Seligman, 2004). The short version of POMS includes 38 adjectives that reflect both positive and negative affective states. Respondents were requested to indicate how the specific items describe their state during the last week, rated on a five-point frequency scale (0 = not at all, 4 = very much). The depressive symptoms subscale consisted of seven items: miserable, sad, depressed, hopeless, blue, lonely and distressed. Cronbach's alpha was .89. Finally, the sum score of the DPS was calculated, covering a range from 0 to 28.

Determinants

Job demands were measured by mental and physical workload. Mental workload (e.g. Tuomi, Ilmarinen, Jahkola, Katajarinne, & Tulkki, 1991) consisted of three items: excessive demands of the job, responsibility of the job and fear of failure and mistakes at work. Items were rated on a five-point scale (0 = not at all, 4 = very much). Cronbach's alpha was .77. We formed a sum variable of the items (range 0–12) and categorised it by its median into low (<2) and high (≥2) mental workload. Physical workload was measured using four items adapted from Viikari-Juntura et al. (1996): working on one's knees, crouched or crawling; postures in which the back is bent; postures in which the back is twisted; and working with one's hand or hands above neck-shoulder level. All items were rated on a four-point scale (e.g. 1 = not at all, 4 = over an hour during the shift). Cronbach's alpha was .73. We formed a sum variable of the items (range 4–16) and dichotomised it by its median as low (<8) and high (≥8) physical workload.

Of job resources, we investigated supervisory relations, interpersonal relations and task resources, which were adapted from the Occupational Stress Questionnaire (Elo, Leppänen, Lindström, & Ropponen, 1992). Supervisory relations were elicited using five items covering supervisory support, supervisory control and relationships between employees and supervisors. An example item is 'Do you get support and help from

your supervisor when needed?' Interpersonal relations consisted of four items: conflicts between employees, conflicts between younger and older workers, cooperation in one's work-unit and relationships between employees. An example item is 'What are relations like between co-workers at your workplace?' Task resources included three items: decision-making on issues concerning one's tasks; being able to use one's knowledge and skills at work; and feedback on success in work tasks. All items were rated on a five-point scale (e.g. 1 = not at all, 5 = very much). Cronbach's alphas were .81 for supervisory relations, .74 for interpersonal relations and .67 for task resources. The sum scores were dichotomised at their median to create good (<10) and poor (≥10) supervisory relations, good (≥17) and poor (<17) interpersonal relations and high (≥10) and low (<10) task resources.

Alcohol consumption, smoking, physical exercise and sleeping problems were measured as indicators of lifestyle. Alcohol consumption was measured using a single-item question on the frequency of alcohol consumption with an eight-point scale (1 = never, 8 = daily or almost daily), and categorised into low (<6, i.e. less than once a week) and high (≥6, i.e. once a week or more frequently) alcohol consumption. Smoking habits were elicited using a dichotomous (yes–no) question on current smoking. Physical exercise was assessed through a single-item question on the frequency of leisure-time exercise activity, using a three-point scale (1 = not at all, 2 = occasionally, 3 = frequently), categorised into low (<3) and high (3) physical activity. Sleeping problems were measured by a four-item scale of sleep problems derived from the Basic Nordic Sleep Questionnaire (Partinen & Gislason, 1995): difficulties in falling asleep during the past three months; sleeping well during the past three months; awaking too early in the morning and not being able to fall back asleep during the past three months; and extreme tiredness during daytime. All items were rated on a five-point scale (1 = not at all, 5 = daily/almost daily) except sleeping well, which was measured using a three-point scale (1 = well, 3 = moderately, 5 = poorly). The measure has been used in many epidemiological studies (e.g. Jansson-Fröjmark & Lindblom, 2008; Linton, 2004), and found to be fairly reliable (e.g. Biering-Sorensen, Biering-Sorensen, & Hilden, 1994). Cronbach's alpha was .76. The sum score was dichotomised using the median to create low (<8) and high (≥8) sleeping problems.

Optimism was a single-item question from the validated Work Ability Index Questionnaire (Tuomi, Ilmarinen, Jahkola, Katajarinne, & Tulkki, 1998): 'Have you recently felt full of hope for the future?'. The original five-point scale (0 = never, 4 = often/always/continuously) was categorised into low (<3) and high (≥3) optimism. The single-item indicator of optimism has found to practically be as valid and useful as indicators with several items (e.g. Carver et al., 1994). In all determinants, missing cases were few, and thus, no deletion or imputation has been conducted.

Statistical analyses

Differences in study variables between respondents and non-respondents and between trajectory groups were tested with Chi-square tests for categorical variables and the Kruskall-Wallis test for continuous, non-normally distributed variables. In addition, several primary analyses (e.g. distribution, Pearson′s correlations, Chi-square tests, *t*-tests, exploratory factor analysis) have been conducted in previous phases of this longitudinal

study among Finnish firefighters (reports in Finnish available from the corresponding author on request).

To test our hypotheses, we applied latent class growth modelling (LCGM) (Jones & Nagin, 2007; Nagin, 1999) to identify latent pain-depression trajectories. LCGM is a semi-parametric statistical technique used to identify distinct subgroups of individuals following a similar pattern of change over time (Andruff, Carraro, Thompson, Gaudreau, & Louvet, 2009). As such, LCGM takes into account different time lags of the data. A SAS procedure called PROC TRAJ (Singer, 1998) was used to identify latent trajectories. The parameters of the multitrajectory models were estimated by maximum likelihood estimation, and the censored normal model distribution was used.

To decide on the adequate number of latent classes, we used different criteria: (i) Bayesian Information Criterion (BIC) statistics (the closer the BIC value is to 0, the better the model); (ii) Akaike Information Criterion (AIC) statistics (the lower the AIC, the better the model); (iii) posterior probabilities (each trajectory should hold an approximate group membership probability of at least 5%); and (iv) the usefulness and clarity of the latent classes in practice (see also Andruff et al., 2009).

In order to investigate the relationship between the latent classes and antecedents in 1996, we used multinomial logistic regression models. The associations are presented as odd ratios and their 95% confidence intervals (95% CI). All models were adjusted with age. Our model-building strategy was as follows. First, we estimated models with one predictor in time. After this, all significant predictors were simultaneously included in the same model. To obtain our final model, we eliminated from the full model all the variables that were not significant at the critical level of .05 in relation to either of the examined trajectories. All analyses were performed using SAS (version 9.2) software.

Results

Trajectories of pain and depressive symptoms

Table 1 shows the fit criteria for comparing the solutions of the different number of latent pain-depression classes. Altogether, trajectory models with one to four trajectories were tested. We first tested a model with one trajectory following a quadratic (2) shape.

Table 1. Fit criteria for pain and depression symptoms with a different number of latent classes.

No. of trajectories	Shape	AIC	BIC	Latent class proportions (%)	Posterior probabilities
1	2	−4266.70	−4282.25	100	–
1	1	−4266.54	−4278.20	100	–
2	2-2	−4170.15	−4199.30	52/48	.89/.90
2	1-1	−4169.43	−4190.80	52/48	.90/.90
3	2-2-2	−4120.46	−4163.21	49/32/19	.91/.86/.85
3	1-1-2	−4116.87	−4151.85	49/32/19	.91/.86/.85
4	2-2-2-2	−4101.93	−4158.28	35/27/32/5	.87/.81/.88/.89
4	1-1-1-2	−4095.95	−4140.64	28/26/33/12	.82/.80/.89/.85

Notes: Shape 1 = linear, 2 = quadratic; AIC = the Akaike Information Criterion; BIC = the Bayesian Information Criterion.

Then we compared this model with two quadratic trajectories (2-2). Based on the BIC and AIC, the two-trajectory model proved to be better. Next, we continued adding the number of trajectories and deleting the non-significant components of each trajectory. The BIC statistics revealed that a four-trajectory model (1-1-1-2) was the best fitting model. However, two depression groups followed practically the same path (i.e. no distinction was found). Therefore, in order to have a clear and useful number of trajectories (see Andruff et al., 2009), we chose a three-trajectory model (1-1-2) with acceptable posterior probabilities for all three groups ranging from .85 to .91.

Figures 2(a)–2(b) show the results of the final trajectory solution. Three distinct trajectories that differed from each other in their mean levels and changes in pain and depressive symptoms were identified: (a) Low Symptoms (n = 179, 49%), (b) High Pain (n = 115, 32%) and (c) High Depression (n = 66, 19%). The Low Symptoms trajectory consisted of those participants who had low levels of both symptoms. In this group, the feelings of depression remained stable throughout the 13-year follow-up, whereas the level of pain slightly increased between T2 and T3. The High Pain trajectory consisted of participants who had a high and increasing level of pain and a low level of depressive symptoms. The latent group labelled High Depression was characterised by a high level of depressive symptoms and a moderate level of pain. In this group, the level of depressive symptoms increased drastically between T1 and T2, and decreased thereafter, nevertheless remaining at a high level. In line with these results, hypotheses 1a–1c were supported, as both trajectory groups with low symptoms (H1a), high pain (H1b) and high depressive symptoms (H1c) were found. Instead, no trajectory with high levels of both symptoms emerged, and thus Hypothesis 1d was not supported.

The characteristics of the trajectory groups are presented in Table 2. Differences between groups were observed for mental workload, optimism, alcohol consumption,

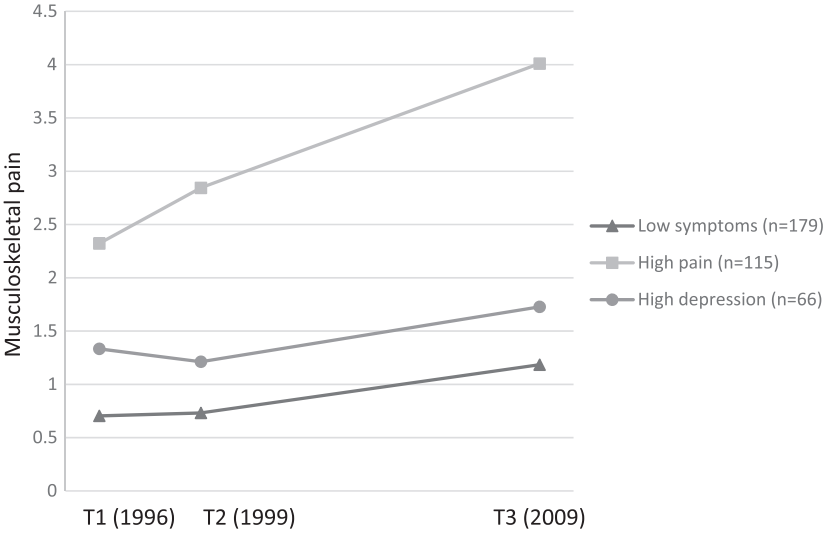

Figure 2a. Mean profiles for musculoskeletal pain.

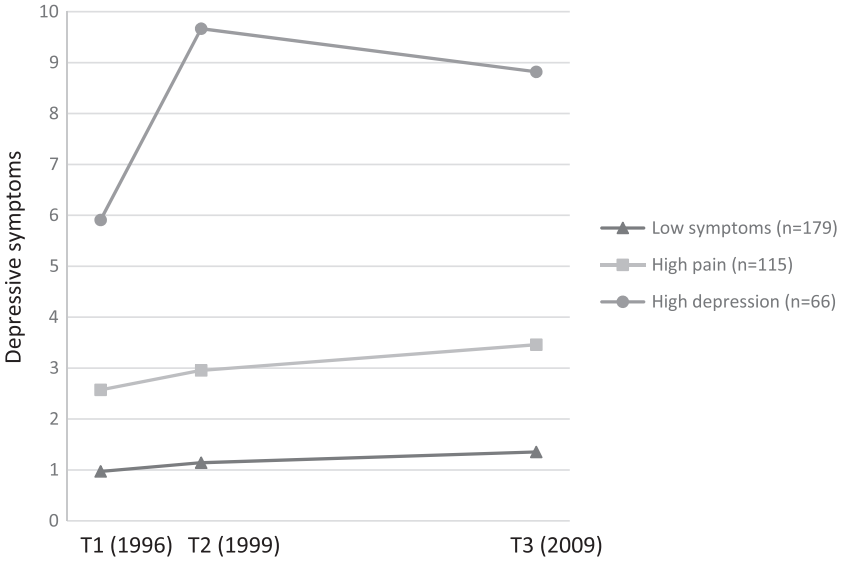

Figure 2b. Mean profiles for depressive symptoms.

sleeping problems and for all three JRs: supervisory relations, interpersonal relations and task resources. Moreover, differences between groups were found in terms of accident injuries and trauma experiences at baseline. More precisely, members of the High Pain trajectory had highest level of accident injuries, and the members of the High Depression group had higher level of trauma experiences than the members of the two other trajectories (data available from the corresponding author).

Relationships between antecedents and trajectories

Table 3 shows the results of the effects of job demands and resources, lifestyle, and optimism on the pain-depression trajectories. When High Depression was compared with the Low Symptoms trajectory, high mental workload predicted belonging to the former group (OR 4.48, CI: 2.45–8.18). The finding was similar when High Pain and Low Symptoms were compared. However, the association was minor (OR 1.80, CI: 1.09–2.96) compared to that of High Depression. Physical workload was a non-significant predictor in both comparisons.

Again, with the Low Symptoms trajectory as reference, poor interpersonal relations predicted belonging to High Pain (OR 1.72, CI: 1.06–2.79) and High Depression (OR 3.61, CI: 1.99–6.57). Poor supervisory relations (OR 2.76, CI: 1.52–5.01) and low task resources (OR 2.56, CI: 1.42–4.61) predicted belonging to High Depression, but not High Pain when compared with Low Symptoms. Of lifestyle factors, high alcohol consumption predicted belonging to High Pain (OR 2.40, CI: 1.45–4.00), whereas smoking and physical exercise were non-significant predictors in both contrasts. Sleeping problems predicted belonging both to High Pain (OR 2.41, CI: 1.47–3.95) and High Depression (OR 3.76, CI: 2.07–6.81) when compared with Low Symptoms.

Table 2. Distribution of subjects in the pain-depression trajectories.

	Range	*M*	SD	Low symptoms (*n* = 179)		High pain (*n* = 115)		High depression (*n* = 66)		*p* value*
MPS T1 (mean, SD)	0–7	1.34	1.28	0.70	0.93	2.32	1.18	1.33	1.19	<.0001
DPS T1 (mean, SD)	0–20	2.38	3.42	0.97	1.79	2.57	3.37	5.91	4.22	<.0001
Age T3 (mean, SD)	35–62	48.7	5.37	48.0	5.78	49.2	5.30	49.5	4.05	0.0947
Mental work load (*n*, %)	0–12	1.58	2.00							
Low				130	72.6	67	58.8	24	36.4	<.0001
High				49	27.4	47	41.2	42	63.6	
Physical work load (*n*, %)	4–16	7.00	2.15							
Low				102	58.3	55	48.2	31	47.0	0.138
High				73	41.7	59	51.8	35	53.0	
Supervisory relations (*n*, %)	5–25	10.42	3.79							
Good				104	58.8	55	47.8	22	33.3	0.002
Poor				73	41.2	60	52.2	44	66.7	
Interpersonal relations (*n*, %)	4–20	16.42	2.76							
Good				118	66.7	61	53.0	23	34.8	<.0001
Poor				59	33.3	54	47.0	43	65.2	
Task resources (*n*, %)	3–15	9.85	2.02							
High				109	61.2	65	57.0	26	40.0	0.012
Low				69	38.8	49	43.0	39	60.0	
Alcohol consumption (*n*, %)	1–8	5.69	1.42							
Low				86	48.0	31	27.0	23	34.8	0.001
High	0–1	0.47	0.50	93	52.0	84	73.0	43	65.2	
Smoking (*n*, %)										
No				97	54.2	56	49.1	38	57.6	0.512
Yes				82	45.8	58	50.9	28	42.4	
Physical exercise (*n*, %)	1–3	2.79	0.43							
High				148	82.7	87	77.0	49	75.4	0.328
Low				31	17.3	26	23.0	16	24.6	
Sleeping problems (*n*, %)	5–20	7.39	2.66							
Low				127	71.8	58	50.4	26	39.4	<.0001
High				50	28.2	57	49.6	40	60.6	
Optimism (*n*, %)	0–4	2.70	0.87							
High				116	66.3	64	55.7	27	40.9	0.001
Low				59	33.7	51	44.3	39	59.1	

NB: MPS multisite musculoskeletal pain; DPS depressive symptoms.
*Chi-square tests for categorical variables and Kruskall-Wallis for a continuous, non-normal variable.

Table 3. Antecedents of pain-depression trajectories. Multinomial regression analysis; age-adjusted odds ratios (OR) and their 95% confidence intervals (CI).

	High pain vs. Low symptoms		High depression vs. Low symptoms	
	OR	95% CI	OR	95% CI
Mental work load				
Low	1.00		1.00	
High	1.80	1.09–2.96	4.48	2.45–8.18
Physical work load				
Low	1.00			
High	1.49	0.93–2.40	1.57	0.89–2.78
Supervisory relations				
Good	1.00		1.00	
Poor	1.51	0.94–2.43	2.76	1.52–5.01
Interpersonal relations				
Good	1.00		1.00	
Poor	1.72	1.06–2.79	3.61	1.99–6.57
Task resources				
High	1.00		1.00	
Low	1.26	0.78–2.05	2.56	1.42–4.61
Alcohol consumption				
Low	1.00		1.00	
High	2.40	1.45–4.00	1.64	0.91–2.95
Smoking				
No	1.00		1.00	
Yes	1.15	0.71–1.85	0.80	0.45–1.43
Physical exercise				
High	1.00		1.00	
Low	1.32	0.73–2.38	1.42	0.71–2.84
Sleeping problems				
Low	1.00		1.00	
High	2.41	1.47–3.95	3.76	2.07–6.81
Optimism				
High	1.00		1.00	
Low	1.49	0.91–2.42	2.68	1.49–4.83

Similarly, low levels of optimism predicted group membership of High Depression (OR 2.68, CI: 1.49–4.83), but not High Pain.

Table 4 shows the final model in which all antecedents of pain-depression trajectories were analysed at the same time, with age also adjusted for. With Low Symptoms as reference, high levels of mental workload (OR 2.87, CI: 1.51–5.45), poor interpersonal relations (OR 2.63, CI: 1.39–4.97), sleeping problems (OR 2.72, CI: 1.44–5.15) and a low level of optimism (OR 1.97, CI: 1.04–3.72) predicted belonging to High

Table 4. Predicting of membership in pain-depression trajectories; final multivariable model. Multinominal regression analysis; odds ratios (OR) and their 95% confidence intervals (CI).

	High pain vs Low symptoms		High depression vs Low symptoms	
	OR	95% CI	OR	95% CI
Age	1.02	0.98–1.07	1.02	0.96–1.08
Mental work load				
Low	1.00		1.00	
High	1.39	0.81–2.38	2.87	1.51–5.45
Interpersonal relations				
Good	1.00		1.00	
Poor	1.40	0.83–2.34	2.63	1.39–4.97
Alcohol consumption				
Low	1.00		1.00	
High	2.42	1.43–4.11	1.42	0.75–2.70
Sleeping problems				
Low	1.00		1.00	
High	2.13	1.27–3.59	2.72	1.44–5.15
Optimism				
High	1.00		1.00	
Low	1.23	0.73–2.06	1.97	1.04–3.72

Depression. When High Pain was compared with Low Symptoms, alcohol consumption (OR 2.42, CI: 1.43–4.11) and sleeping problems (OR 2.13, CI: 1.27–3.59) were significant predictors. Thus, Hypothesis 2 was partly supported: high levels of job demands and low levels of job resources and personal resources at baseline predicted belonging to the trajectory groups of High Pain and High Depression. However, after including all the significant predictor variables in the same model, High Pain trajectory was not anymore predicted by any of the JDs or JRs.

Discussion

The aim of our study was to determine potential variability and differences between individuals in the development of pain and depressive symptoms. More precisely, we investigated how multisite musculoskeletal pain and depressive symptoms develop during a 13-year follow-up period; and whether firefighters form subgroups that show different developmental paths of MPS and DPS. In addition, we examined whether belonging to a particular trajectory would be associated with baseline JDs and JRs and individual factors.

Developmental paths of MSP and DPS

Our first major finding revealed that different developmental paths are possible for pain and depressive symptoms. As hypothesised, we found (i) a trajectory with low levels of

both health symptoms (Low Symptoms); (ii) a group with a high level of pain (High Pain); and (iii) a group with a high level of depressive symptoms (High Depression). The different developmental paths of pain and depressive symptoms were most evident in High Depression. In this trajectory, changes in DPS were evident, whereas the level of MSP remained rather stable throughout the follow-up, suggesting separate developments in these symptoms. As such, our results confirm prior assumptions of the possible distinct development of pain and depression (e.g. Magni et al., 1994). In contrast, in the High Pain trajectory, increases in both MPS and DPS were obvious throughout the study period, indicating parallel development of these symptoms. Overall, instead of changes in DPS in High Depression, we observed rather high stability in pain and depressive symptoms. Contrary to our hypothesis, we did not find a trajectory with high pain and high depressive symptoms. It is likely that firefighters with high levels of both symptoms dropped out from work and thus, the available data.

Effects of work characteristics and individual factors

The second major finding of our study indicated that job demands, job resources and individual factors were partly differently related to pain-depression trajectories. More precisely, both mental workload and all investigated job resources (i.e. supervisory relations, interpersonal relations and task resources) as well as individual factors (i.e. sleeping problems and optimism) were related to High Depression, whereas only some of these factors predicted belonging to High Pain. However, solely High Pain was predicted by alcohol consumption. These findings argue a partly different mechanism in the etiology of musculoskeletal pain and depressive symptoms. Consistent with our findings, some previous evidence also exists that pain and depression have at least partly different risk factors (e.g. Linton & Bergbom, 2011; Miller & Cano, 2009). Moreover, our study showed that the antecedents were more strongly related to High Depression than High Pain as the risk estimates were notably higher for High Depression.

In line with the JD-R model (Demerouti et al., 2001), we found that high mental workload – an indicator of job demands – was a significant predictor when comparing both High Depression and High Pain to Low Symptoms. This result confirms previous findings on the link between job demands and depression (e.g. Hakanen, Schaufeli, & Ahola, 2008), as well as job demands and pain (e.g. Bongers et al., 2002; Hauke et al., 2011). For example, in a longitudinal study conducted in Finland, high job demands were associated with a 12-month prevalence of depressive disorders among the working population (Virtanen et al., 2007). Similarly, high job demands predicted musculoskeletal pain in a three-year follow-up study among the working population in Norway (Sterud & Tynes, 2013). However, contrary to the prior findings (e.g. Christensen & Knardahl, 2010; Haukka et al., 2012, Neupane, Miranda, Virtanen, Siukola, & Nygård, 2013), high physical workload was not significantly related to pain-depression trajectories in our sample. This could at least partly be explained by the rather similar work tasks of the participants: difficult work postures were part of the job for all firefighters. Also health-based selection from employment and hence from our study material may have weakened the associations.

The current study also showed that job resources were significant predictors of trajectories, and this was particularly apparent in relation to High Depression. More

precisely, in investigating the predictors separately, we found that a lack of all examined job resources was related to High Depression, whereas only poor interpersonal relations were related to High Pain. In the final model, however, the variable on interpersonal relations was the only significant predictor among job resources, and furthermore, solely in relation to High Depression. Similarly, several longitudinal studies suggest that low social support from co-workers may be an important antecedent of depression (e.g. Paterniti, Niedhammer, Lang, & Consoli, 2002; Stoetzer et al., 2009). For example, Hakanen et al. (2008) found that a lack of job resources – including interaction with colleagues – may lead to burnout, and consequently to depressive symptoms. In the same way, poor co-worker relationships predicted a high prevalence of MPS in a two-year longitudinal study (Haukka et al., 2011). Along with these results, our findings clearly suggest that good relationships between co-workers can positively influence employee mental well-being. Obviously, good interpersonal relations are highly valued in firefighting, in which employees work long hours together in closely coordinated teams (see also Pillai & Williams, 2004). At least partly, salience of supervisory relations in fire departments may remain less influential, as good relationships among co-workers are highly appreciated. In fact, similar non-significant results on the relationship between supervisory support and pain have also been observed in other studies (e.g. Andersen, Haahr, & Frost, 2007; Sterud & Tynes, 2013). Task resources were protective of depressive symptoms when the predictors were analysed separately, but not any more in the multivariable model.

We also found that sleeping problems predicted a greater likelihood of belonging to both the High Depression and High Pain. Similar associations between sleep quality and pain (Kamaleri et al., 2008) as well as sleep and depression (Baglioni et al., 2011) have been found in previous studies. In particular, among firefighters who work long hours, adequate sleep is essential for maintaining good physical and mental health. Moreover, of the other lifestyle factors, high alcohol consumption was a significant predictor of High Pain. In contrast, none of the examined lifestyle factors predicted belonging to High Depression. Nevertheless, similar findings of the non-significant effects of lifestyle factors on pain and depression have been found previously (e.g. Haukka et al., 2012; Hölzel et al., 2011; Lebouef-Yde, 1999).

Finally, the current study showed that a lack of optimism predicted belonging to High Depression during a 13-year follow-up. This finding confirms previous studies on the effects of personal factors on psychological well-being (e.g. Cannella et al., 2007; Scheier & Carver, 1992). Therefore, our study lends support to the assumption that a high level of optimism as a personal resource may be salient in preventing DPS among employees.

To conclude, our results are in line with the JD-R model (Demerouti et al., 2001) which assumes that job demands are indicative of health problems. However, our study also confirms prior findings (e.g. Airila et al., 2012; Hakanen, Bakker, & Schaufeli, 2006) on the protective effects of job resources on health-related outcomes. In addition, the assumption of the JD-R model of the importance of personal resources (e.g. Xanthopoulou et al., 2007) for employee well-being was supported, as lack of optimism was related to belonging to the High Depression group.

In practice, when planning health-promoting workplace interventions in fire departments, both tools for decreasing job demands and increasing job resources, and promoting lifestyle are needed. For example, interventions targeting on interpersonal relations by improving communication skills via training sessions on team work and team

support and increasing communication between firefighters in all work shifts could be tried. The unpredictable nature of firefighters′ job is, however, challenging in implementing interventions, and therefore high involvement and commitment among management and staff is needed for successful interventions. In fact, previous findings indicate that interventions targeting psychosocial work characteristics are effective in preventing health problems of employees (e.g. Bourbonnais et al., 2006).

Strengths and limitations

The main strengths of our study lie in its longitudinal design and sophisticated statistical analyses. The 13-year study period with three measurement points allowed us to study the developmental paths over time and claim for at least some causality. We used a rather novel method, latent class growth modelling, to study intra-individual changes in pain and depressive symptoms over time. Thus, we focused on possible developmental paths in pain and depressive symptoms, which have received little attention so far. Moreover, we investigated several physical, psychosocial and individual antecedents of pain and depressive symptoms with validated measures.

This study has some limitations that should be noted. First, it was based on self-report measures, which may cause overestimation of the associations between study variables because of the common method variance. However, such bias is less likely in longitudinal studies (Doty & Glick, 1998). Second, some shortcomings in the measures could be identified. For example, optimism was measured with a single-item indicator which may diminish its reliability and validity. In previous studies, however, a single-item indicator of optimism has been used and found to be nearly as valid as indicators with several items (e.g. Carver et al., 1994) and similar single-item indicators have frequently been used as indicators, for example, of self-rated health (e.g. Lundberg & Manderback, 1996) and life satisfaction (e.g. Lucas & Donnellan, 2012). In addition, the internal consistency of task resources (.67) fell slightly below the recommended value of .7 (Nunnally, 1978), which may limit the interpretability of the results. To some extent, using a median split may have led to some loss of information, but by dichotomising the data in a predetermined manner we were able to have enough cases in both categories and avoid speculation about cut-points which could be even more random. Moreover, the measure of depressive symptoms (POMS) captured solely the emotional symptoms, not cognitive or physical symptoms of depression. We also assessed only depressive symptoms, not depression as such. However, depressive symptoms measured by POMS are strongly correlated with the well-established Beck Depression Inventory (Griffith et al., 2005). Third, there was a rather high number of drop-outs from the original sample. However, the differences between the participants and the drop-outs were rather minimal. For the most part, drop-out was probably due to retirement because of the low retirement age (55 years) among Finnish firefighters during the study period and early retirement schemes and personal retirement arrangements (under 55 years of age) which are still possible routes for retirement. Therefore, drop-out from the sample can be regarded as normal and as not causing any particular bias to the results. Finally, our study focused on only white male firefighters, and thus, the results can be generalised to other occupations, ethnic groups and women only with caution. It would be important to repeat this study in other occupational sectors, and among women, as well.

Conclusions

Our study contributes to the existing literature by applying a person-centred approach to examine the co-occurrence of MPS and DPS, and related JDs, JRs and PRs using a longitudinal sample of Finnish firefighters. Our results showed that different developmental paths in MPS and DPS are possible, and that pain and depressive symptoms may be independent of each other. We also found that job demands and resources, as well as individual factors were partly differently related to MPS and DPS. More precisely, both low levels of mental workload and sleeping problems, and high levels of job resources and optimism prevent the development of depressive symptoms, whereas high mental workload, poor interpersonal relations, alcohol consumption and sleeping problems predicted multisite musculoskeletal pain. Workplace interventions aimed at improving both the physical and psychosocial work environment are needed in order to maintain and improve the well-being of employees.

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