

BMJ Open Development of the Prevent for Work questionnaire (P4Wq) for assessment of musculoskeletal risk in the workplace: part 1 – literature review and domains selection

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ABSTRACT

Objective This study aims to define appropriate domains and items for the development of a self-administered questionnaire to assess the risk of developing work-related musculoskeletal disorder (WMSD) and the risk of its progression to chronicity.

Design Literature review and survey study.

Setting and participants A literature review and a two-round interview with 15 experts in musculoskeletal pain were performed to identify the available domains for WMSD assessment.

Interventions and outcome To ensure quality, only validated questionnaires were included for the Delphi process. A three-round Delphi method, with three round steps, was used to select the most pertinent and relevant domains and items.

Results Nine questionnaires were identified through the expert discussion and literature review, comprising 38 candidate domains and 504 items. In the first round of the Delphi group, 17 domains reached more than 70% agreement and were selected. In the second round, 10 domains were rejected, while 11 were selected to complete the pool of domains. In the third and final round, 89 items belonging to 28 domains were defined as significant to develop a WMSDs risk assessment questionnaire.

Conclusions No specific risk assessment questionnaires for WMSDs were identified from the literature. WMSD risk of presence and chronicity can be defined by an assessment tool based on the biopsychosocial model and the fear-avoidance components of chronic pain. The present study provides the formulation and operationalisation of the constructs in domains and items needed for developing and validating the questionnaire.

INTRODUCTION

Work-related musculoskeletal disorders (WMSD) have been defined as ‘disorders of the muscles, nerves, tendons, joints, cartilage

Strengths and limitations of this study

- Based on the Delphi method with experts, the theory of the biopsychosocial nature of musculoskeletal problems and the fear-avoidance model of chronic pain provided a solid conceptual framework for the questionnaire development to assess the risk of work-related musculoskeletal disorder (WMSD).
- The Delphi panel included experts with different research and professional backgrounds: medical doctors, physical therapists, statistical methodologists, engineers of the ‘prevention and protection service’, and psychologists.
- The panel of experts is not homogeneously constructed, physiotherapists were over-represented and some figures were not involved as stakeholders, members of the compensation system and workers.
- The study aimed to collect an extensive array of domains including psychosocial, physical and fear-avoidance components of pain to reduce the risk of underestimation of WMSD predictors.
- This study operationalises the risk of WMSDs into domains and items that will permit the development and validation of the questionnaire for WMSDs.

and spinal discs associated with exposure to risk factors in the workplace’.¹ The European Agency for Safety and Health at Work reported in 2019 that three out of five workers suffer from musculoskeletal disorders, most commonly of the back and upper limb.² Furthermore, 60% of workers with a work-related health problem identified musculoskeletal disorders as the most serious ones.² It might be assumed that workers exposed to substantial physical stressors are at higher risk of being significantly more bothered by musculoskeletal pain. The sixth European



Working Conditions Survey showed that the prevalence of WMSD ranged from 49% to 69% and affected all the work activity categories.² As for most other painful conditions, women experience a slightly higher prevalence than men.² Prevalence of WMSD increases with age and workers with the lowest levels of education are more likely to report muscular pain as well as develop chronic symptoms.²

Musculoskeletal problems introduce a substantial burden on society and individuals.³ In 2016, musculoskeletal issues caused a loss in production equal to €17.2 billion in Germany alone translating to 30.4 billion in loss of gross value.⁴ Data from the USA show that WMSDs accounted for the largest proportion of workers' compensation claims and at least one-third of the loss of labour time.⁵ The 2020 report of the European Agency for Safety and Health at Work shows that musculoskeletal conditions are the second most prevalent cause of loss of disability-adjusted life years (DALY) (16% overall), only surpassed by cancer (25%). Individuals reporting musculoskeletal conditions have decreased health-related quality of life (HRQoL), including both its physical and the mental dimensions.⁶

Although it is not always possible to identify when musculoskeletal disorders are caused by workplace-related factors, differences in prevalence have been identified between workers and nonworkers. Pain is a complex and multifactorial event. Nevertheless, Jackson *et al* reported that the prevalence of chronic low back pain was 2.5 times higher in working than in nonworking populations, suggesting that work-related factors may contribute to the pain problem.⁷

The prevalence and impact of WMSDs on DALY, HRQoL as well as the economic burden justify preventive strategies. Evidence suggests that WMSDs causes are multifactorial and preventative strategies may be effective.⁴ A study from 2014 demonstrated lower prevalence rates of WMSDs in countries that had implemented preventative strategies and that large companies were more likely to provide prevention activities than small ones.⁸ As WMSDs are multifactorial in nature, prevention should address multiple factors, such as exposure to physical, psychosocial and organisational risks. Furthermore, to increase the efficiency of preventive actions, individuals at higher risk should be identified and targeted. Although not widely used so far, information technology (IT) allows for targeting not only companies or groups of workers but also individuals, directly via resources made available through personal devices, but this approach is not widely used.

Previous literature suggests that clinical and nonclinical interventions can effectively reduce absenteeism and the disability related to WMSDs.⁹ In particular, a multidisciplinary approach seems the cornerstone to collect good outcomes.¹⁰ An early diagnostic assessment, psychosocial interventions (eg, multifaceted interventions with education and training sessions with experts to discuss topics related to workplace mental health and social marketing

campaign),¹¹ workplace factors management (eg, workplace barrier removal, safety at work, management of aversive workplace factors and promotion of appetitive factors)¹² and providing educational contents on musculoskeletal pain³ have shown effective to reduce the incidence of WMSDs and absenteeism related to it.

The present study is a part of the 'Prevent for Work' (P4W) Project, funded by the European Commission in the framework of the Erasmus+ programme. It is an initiative to increase the awareness, collect and make available high-quality evidence in the field, develop and make available educational content and courses for professionals and the general population to prevent the occurrence of WMSDs. One of the milestones of the project included the development of a questionnaire (the P4Wq) to detect factors related to the development of WMSDs and, thus, to identify individuals at risk in order to target these individuals for prevention efforts.

This study describes the first phase of development of a self-administered questionnaire (P4Wq) to assess the risk of developing WMSDs and the risk of WMSD evolution into chronicity. The questionnaire is intended not only to be used in clinical studies, occupational studies but also to orientate individuals regarding their degree of risk as a first step to deliver preventive actions, including those that can be provided through personal IT devices.

The study aims to define appropriate domains and items for risk factors of nontraumatic WMSDs to make them available to create a risk assessment questionnaire for adult working population.

METHODS

Design

This study uses a Delphi group method^{13 14} to identify the domains and items to be included in the questionnaire. The questionnaire is conceived as self-administered, applicable to the general adult working population, to include physical, psychological and social aspects of risk, to be short (less than 25 questions) and administrable through an IT solution on a mobile device.

The study design was agreed on by the research group over two formal consensus meetings regarding which factors should be incorporated into the domains construct. It should provide a high ability to capture the risk of developing WMSDs and eventually the risk developing persistent symptoms. The first round was conducted online, but the second round was held face-to-face in November 2019 to summarise and gain a final consensus. After the discussions, notes were summarised to reflect the conclusions.

Field of application

For the purpose of this study research, wounds, sprains, thermal lesions, fractures or WMSD caused by slips, sprains, blunt trauma, vehicle accidents or similar, falls, electricity, biological contamination or radiation were not included. The questionnaire should (1) identify subjects

at risk of developing WMSDs and (2) identify the subset of subjects at risk of WDMS evolution into chronicity.

Creation of initial domain and item library

After the second round of discussion, three researchers (NG, FL and PeBe) performed a systematic search of the literature to identify validated self-administered questionnaires to assess work conditions, musculoskeletal problems and work-related musculoskeletal conditions. Furthermore, the literature review aimed to reveal previous questionnaire based on a biological and psychosocial approach. The databases MEDLINE, CINAHL, EMBASE, Cochrane Register, OTseeker and ScienceDirect were searched for articles in any language from their inception to January 2020. The first group of terms included *musculoskeletal pain, myalgia, neck pain, back pain, work-related muscle pain, shoulder pain, musculoskeletal pain, discomfort, injury, stress, fatigue, pain, disorder, syndrome, strain, cumulative trauma, cumulative trauma disorders, overuse, workload, neuropathic pain, disability, exposure, discomfort, symptoms, rupture, damage, depression, neuralgia, injuries, tendinitis, multiple trauma, neuropathy, overuse syndrome, joint, cartilage, distress, damage, weakness, illness, trauma, disability, diseases, pain, symptom, dysfunction*. The second group of terms included *questionnaire, survey, self-assessment, form, aetiology, diagnosis, evaluation, exposition, high risk, risk, incidence, perception, prediction, prevention, prognosis, prospective, retrospective, observational, factor, assessment, scoring, system, algorithm, self-report, survey, questionnaires, tool, instrument, threshold, primary prevention, screening, detection, secondary prevention, scale, rating, epidemiology, control, measurement, surveillance, hazard, model, absenteeism, return to work, sick leave, self-report, sickness absence, physiopathology, pilot projects, cost-benefit analysis, quality of life*. The identified questionnaires were summarised and a list of potential domains for the 'P4Wq' questionnaire was created. Additionally, a list of items was generated to reflect how previous self-administered questionnaires had operationalised the included domains.

Delphi group

A Delphi group of experts in the field of WMSDs was formed, including the members of the research team and external experts on invitation.¹⁵ The group was composed of 15 participants with different backgrounds and expertise, including ten physiotherapists (PH, PBL, VD-G, MH, TSP, DC, SWMC, VJ, GPYS, MH), two orthopaedic surgeons (PeBe and FL) one psychologist (SJL), one engineer (MDC) and one research methodologist (JHV).

The Delphi panel was given two tasks, first to rank the identified domains according to relevance and to select those items considered most relevant for each of these domains.¹⁶

A total of three electronic surveys were conducted. The results at the end of each round were summarised before the next round, thereby reducing the number of

items the expert panel was asked to review and rate for relevance.

- ▶ In the first round, the experts received an electronic survey including all the domains identified in the literature search. They indicated their preference for inclusion of each of the identified domains. The relevance of each domain was ranked on a 5-point Likert scale (1—strongly disagree to include this domain; 2—disagree to include this domain; 3—neither agree or disagree to include this domain; 4—agree to include this domain and 5—strongly agree to include this domain). For each domain, three related questions were presented to describe its content and its relevance better. The responses were aggregated into two categories (1 to 3 into 'not include' and 4 to 5 into 'include'). According to previous studies,^{16 17} all the domains that received 70% or higher agreement as 'include' were included. Similarly, domains rated as 'not include' by 70% or more were rejected. All experts had the chance to provide comments and suggestions for each domain and proposals for additional domains that were deemed necessary and not currently represented in the list of domains and items.
- ▶ In the second round, domains with an 'include' agreement between 50% and 70% were submitted again. The participants could choose to 'include this domain' or 'reject this domain'. After this round, domains with an agreement of 70% or higher as 'include' were included along with the results of round 1.
- ▶ In the third round, the Delphi panel received an electronic survey containing all the included domains. For each domain, all the items related were presented. The expert panel was asked to rank the items from most relevant to least relevant. After summarising all the answers, the three most relevant items from each domain were included in the final item pool.

Finally, three researchers (NG, FL, PeBe) summarised the results, analysed the item pool, the expert suggestions and the rejected items in order to evaluate whether relevant items were lost and eventually included those relevant items in the final pool. A flowchart of the process, including the Delphi panel, is seen in [figure 1](#). The study was conducted in accordance with Standards for QUality Improvement Reporting Excellence SQUIRE V.2.0 guidelines.¹⁸

Patient and public involvement

For this study, patients' priorities, experience and preferences were not involved in the design of the study, forming the aims, statistical strategies or data syntheses. Study findings will be disseminated on a publicly available platform (websites and on social media).

RESULTS

The preliminary literature research failed to identify a questionnaire suitable for the purpose and use of our initiative, with the characteristics of being short,

Figure 1. Descriptive Workflow.

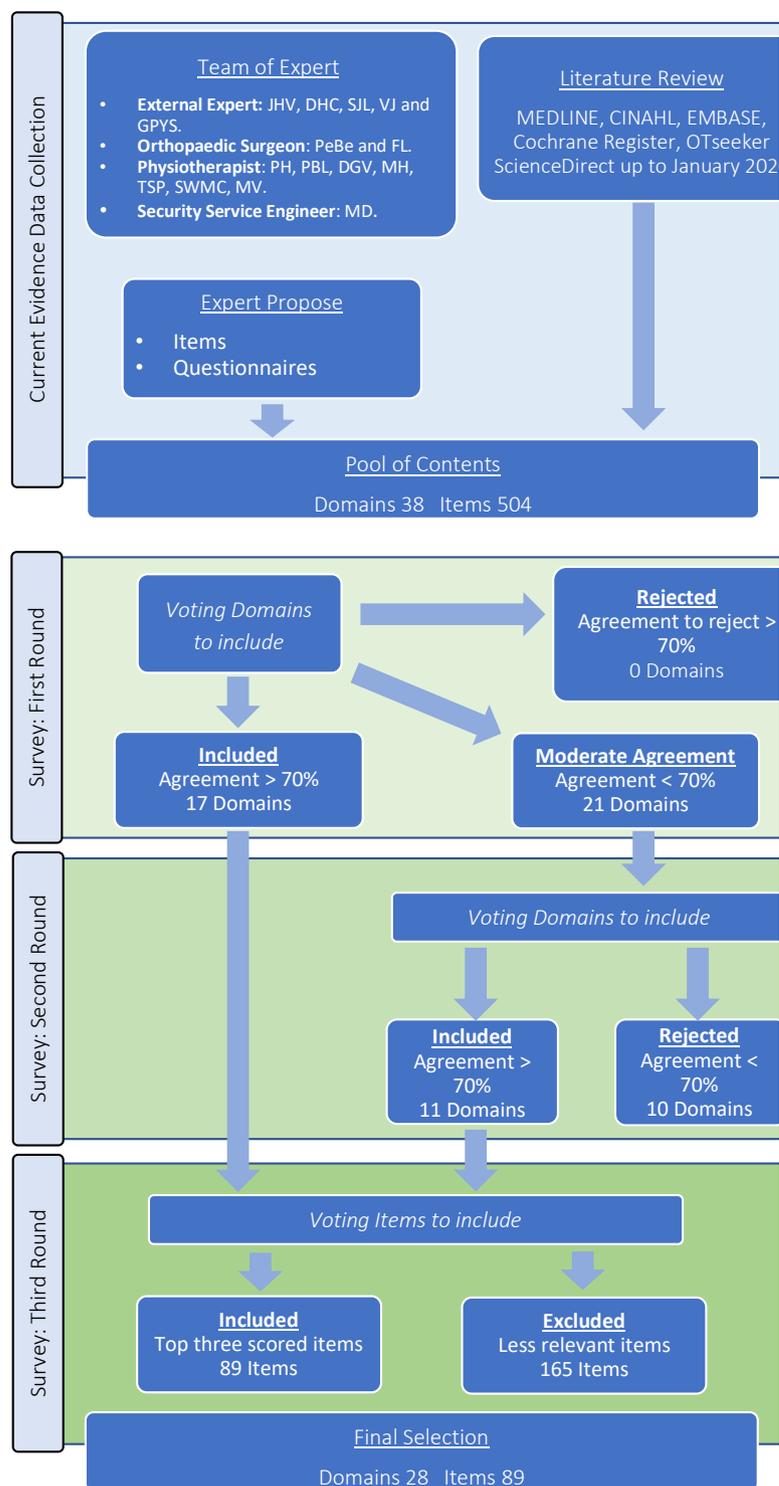


Figure 1 Flowchart of the steps of the Delphi process. DHC, David Høyrup; DGV, Doménech García; Víctor, Christiansen; FL, Francesco Langella; GPYS, Grace P Y, Szeto; SJL, Steven J, Linton; JHV, Jorge Hugo Villafañe; MV, Morten Villumsen, MH, Morten, Høgh; PeBe, Pedro, Berjano; PH, Pablo, Herrero; PBL, Pablo, Bellosta-Lopez; SWMC, Steffan Wittrup McPhee, Christensen; VJ, Venerina, Johnston; TSP, Thorvaldur Skuli, Palsson; MD, Mauro, Delle Chiaie.

self-administered, multidomain, aiming to assess the risk of presenting WMSDs and their evolution into chronicity. For this reason, the development and validation of a new assessment tool remain pertinent.

According to the previous researches,^{19–21} heavy physical work, high psychosocial work demands and the presence of comorbidities were risk factors that had at least reasonable evidence for the development of WMSDs. Smoking and body mass index were considered risk factors too. Regarding mechanical factors, they found that the most frequently reported ones with reasonable evidence were excessive repetition, awkward postures and heavy lifting.

The literature review showed how both mechanical demands at work as well as personal and psychosocial factors, contribute to new incidence of WMSDs (though with variable distribution depending on the kind and anatomical region involved).

A systematic review of longitudinal studies by Kraatz *et al*²² found ‘evidence for an incremental effect of different psychosocial work factors (in addition to the effect of physical job factors)’ for the presentation of neck and shoulder disorders. The contribution of psychological risk factors to the development of WMSDs and their chronicity have been identified by previous authors.²³

These data from longitudinal studies suggest that the phenomenon of WMSDs is better interpreted using the biopsychosocial model²⁴ as a framework. This model assumes that both biological and psychosocial causes (and their interaction) explain better than a simplified model the clinical presentation of the symptoms. According to previous researches,^{25–27} the development and chronicity of WMSDs are influenced by physical activities and/or working postures and working conditions in the workplace. Additionally, the risk of chronicity of musculoskeletal conditions (which is an important determinant of the social and economic burden caused by WMSDs) has shown to be well predicted by models that incorporate the fear-avoidance component of pain.²⁸ However, fear-avoidance is probably not the only factor influencing disability and chronicity. This study has provided a large array of domains including both psychosocial and physical factors in order to reduce the risk of underestimation of predictors of WMSD. The modulation of intensity and evolution into chronicity of pain are explained by the result of interactions between the pain sensation and patient’s emotional elaboration, leading to fear, avoidance, disuse and disability, decreasing the threshold of pain. This further supports the need to adapt our conceptual framework and measurement tool to both physical and psychosocial aspects of the individual experience.

The result of the consensus meetings what that traits predisposing to WMSD risk can be measured by two groups of factors: (1) *physical factors*, including perceived mechanical loads, physical or postural effort requirements at the workplace and ergonomics and (2) *psychosocial factors*, including psychological well-being at the workplace, known psychosocial predictors of back,

musculoskeletal pain presentation, chronicity and self-perceived health.

The research group considered that physical factors can be measured by a combination of the following candidate domains, which have been previously described in the literature on musculoskeletal pain and WMSDs: *force exertion*,²⁹ *dynamic loads*,²⁹ *static loads*,²⁹ *repetitive loads*,²⁹ *ergonomic environment*,²⁹ *worker physical condition*.³⁰

Similarly, the psychosocial factors can be measured by a combination of the following previously described domains: *quantitative work demands*,²⁹ *cognitive work demands*,^{31 32} *demands for hiding emotions at work*,³¹ *sensory work demands*,³¹ *influence at work*,³¹ *possibilities for development at work*,³¹ *degree of freedom at work*,^{31 33} *commitment to the workplace*,^{31 32 34} *predictability*,³¹ *role clarity at work*,^{31 32} *role conflicts at work*,^{31 32} *quality of leadership at work*,^{31 32} *social support at work*,^{31–33} *feedback at work*,³¹ *social relations at work*,^{31 32} *sense of community at work*,³¹ *insecurity at work*,^{31 33} *job satisfaction*,³¹ *general health*,³¹ *mental health*,³¹ *vitality*,³¹ *behavioural stress*,³¹ *somatic stress*,³¹ *cognitive stress*,³¹ *sense of coherence*,³¹ *problem-focused coping*,³¹ *selective coping*,³¹ *resignation coping*,³¹ *kinesiophobia*,³⁵ *pain catastrophising*.³⁶

To select the most appropriate domains and items, a discussion and selection process was conducted by the Delphi panel. Confirmation of the research hypothesis will later be tested in a validation process, which will be the scope of a different study.

Domain and item selection

Nine questionnaires were identified from the literature search and group feedback. After elimination of repeated domains and items, a database of 38 potential domains (table 1) with 504 corresponding items was constructed. Questionnaires assessing the identified domains are displayed in table 2.

In the first round with the Delphi panel, 17 candidate domains reached more than 70% agreement and were selected. No candidate domains had 70% or higher agreement to reject and no domain was, therefore, rejected in round 1. The remaining 21 candidate domains were moved to a second round in the Delphi process. In the second round, 11 candidate domains gained 70% or higher agreement and were added to the pool. In the third round, 89 items belonging to 28 domains were selected and moved to the next phase. Table 3 details how the physical and psychosocial components of the Patient Reported Outcome Measures (PROMs) construct are operationalised into measurable items.

DISCUSSION

WMSDs are complex conditions that can directly impact DALY and HRQoL as well as being a substantial socio-economic burden. This study aimed at identifying the necessary domains for assessing WMSDs. The study findings indicate that 28 domains covering two factors are required to permit the development of a questionnaire WMSD risk assessment. Prevention has shown to be effective in

**Table 1** Initial pool domains

D number	Domains	Questionnaire	Selected in first round	Selected in second round	Rejected
1	Quantitative work demands	COPSOQ	X		
2	<i>Cognitive work demands</i>	COPSOQ; ERI; QPS - N			X
3	<i>Demands for hiding emotions at work</i>	COPSOQ			X
4	Sensory work demands	COPSOQ	X		
5	Influence at work	COPSOQ	X		
6	Possibilities for development at work	COPSOQ	X		
7	Degree of freedom at work	COPSOQ; JCQ		X	
8	Meaning of work	COPSOQ		X	
9	<i>Commitment to the workplace</i>	COPSOQ; ERI; N-QPS			X
10	<i>Predictability</i>	COPSOQ; QPS - N			X
11	<i>Role clarity at work</i>	COPSOQ; QPS - N			X
12	Role conflicts at work	COPSOQ; QPS - N; JCQ;		X	
13	<i>Quality of leadership at work</i>	COPSOQ; QPS - N			X
14	Social support at work	JCQ; COPSOQ	X		
15	<i>Feedback at work</i>	COPSOQ			X
16	Social relations at work	COPSOQ; QPS - N		X	
17	Sense of community at work	COPSOQ		X	
18	Insecurity at work	COPSOQ; JCQ; ERI	X		
19	Job satisfaction	COPSOQ; ERI; ÖMPQ	X		
20	General health	COPSOQ; NMQ; ÖMPQ	X		
21	Mental health	COPSOQ	X		
22	Vitality	COPSOQ		X	
23	Behavioural stress	COPSOQ	X		
24	Somatic stress	COPSOQ;	X		
25	Cognitive stress	COPSOQ	X		
26	Sense of coherence	COPSOQ		X	
27	Problem-focused coping	COPSOQ; ERI		X	
28	<i>Selective coping</i>	COPSOQ			X
29	<i>Resignation coping</i>	COPSOQ			X
30	Kinesiophobia	ÖMPQ; TSK	X		
31	Catastrophising	ÖMPQ; PCS	X		
32	Force exertion	DMQ		X	
33	Dynamic loads	DMQ	X		
34	Static loads	DMQ	X		
35	Repetitive loads	DMQ	X		
36	Ergonomic environment	DMQ		X	
37	Vibration	DMQ		X	
38	<i>Climate</i>	DMQ			X

The 28 domains selected have **bold font**.

Domains rejected have *italic font*.

COPSOQ, Copenhagen Psychosocial Questionnaire; DMQ, Dutch Musculoskeletal Questionnaire; ERI, Effort-Reward Imbalance; JCQ, Job Content Questionnaire; ÖMSQ, Örebro Questionnaire; NMQ, Nordic Musculoskeletal Questionnaire; PCS, Pain Catastrophising Scale; QPS-N, General Questionnaire for Psychological and Social Factors at Work (QPS-Nordic); TSK, Tampa Scale for Kinesiophobia.

Table 2 Questionnaires extracted from the literature review

Name of the questionnaire (acronym)	Paper titles	Authors and year of publication	Field of application	Number of domains (D) and items (I)
Nordic Musculoskeletal Questionnaire (NMQ)	Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms	Kuorinka I <i>et al</i> 1987	Evaluation of musculoskeletal symptoms in an ergonomic or occupational health context.	D=3 I=42 +18
Pain Catastrophising Scale (PCS)	The Pain Catastrophising Scale: development and validation	Sullivan M.J.L. <i>et al</i> 1995	Prediction of physical and emotional distress in painful stimulations.	D=3 I=13
Örebro Questionnaire (ÖMSQ)	Can we screen for problematic back pain? A screening questionnaire for predicting outcome in acute and subacute back pain.	Linton S.J. <i>et al</i> 1998	Determinate the value of psychosocial variables in evaluating risk for developing chronic back pain problems.	D=6 I=24
Job Content Questionnaire (JCQ)	The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics.	Karasek R. <i>et al</i> 1998	Measurement of social and psychological characteristics of jobs.	D=8 I=41
Copenhagen Psychosocial Questionnaire (COPSOQ)	A new tool for assessing psychosocial factors at work: the Copenhagen Psychosocial Questionnaire	Kristensen T.S. <i>et al</i> 2000	Assessment of psychosocial factors at work, stress, well-being and personality factor of employees.	Long version D=30, I=141. Medium version D=26, I=95. Short version D=8, I=44.
General Questionnaire for Psychological and Social Factors at Work (QPS-Nordic)	Validation of the general Nordic questionnaire (QPS-Nordic) for psychological and social factors at work	Dallner M <i>et al</i> 2000	Provide an indicator of social and mental health in work environment	D=14 I=129
Dutch Musculoskeletal Questionnaire (DMQ)	Dutch Musculoskeletal Questionnaire: description and basic qualities	Hildebrandt VH <i>et al</i> . 2001	Assessment of musculoskeletal workload and associated potential hazardous working conditions or musculoskeletal symptoms in worker populations.	D=7 I=63
Effort-Reward imbalance (ERI)	The measurement of effort-reward imbalance at work: European comparisons	Siegrist J. <i>et al</i> 2004	Assessment of the psychological effects of balance between the efforts spent and rewards received at work.	D=5 I=22
Tampa Scale for Kinesiophobia (TSK)	Fear of movement and (re)injury in chronic musculoskeletal pain: Evidence for an invariant two-factor model of the Tampa Scale for Kinesiophobia across pain diagnoses and Dutch, Swedish and Canadian samples.	Roelofs J. <i>et al</i> 2007	Measure of fear of movement and (re)injury in subject with work-related musculoskeletal disease	D=2 I=11

Studies' aims, fields of application and validation papers extracted through the literature review. The articles are listed in chronological order. The whole number of domains extracted through the literature review is 72. Two or more questionnaires can investigate the same domain. The overall number of different domains is 38. The overall number of different items is 504.

reducing the prevalence of WMSDs and thereby also the burden. Countries that have implemented preventative strategies have seen a decreased prevalence of WMSDs compared with countries without or with less efficient strategies.²⁴

The P4W consortium was formed to develop evidence-based educational materials, courses and tools for the prevention of WMSDs, which can be applied at individual,

workplace and wider levels. Identification of the subjects and groups at higher risk is a requisite to increase the efficiency of preventive actions, and for this reason, the endeavour of developing and validating a short, self-administered, multi-domain risk assessment questionnaire has been undertaken.

**Table 3** Final domain and items

Included domain	Physical component	Psychosocial component	Items selected
1		Quantitative work demands (COPSOQ)	a. Do you have to work very fast? b. Is your workload unevenly distributed so it piles up? c. How often do you not have time to complete all your work tasks?
2		Sensory work demands (COPSOQ)	a. Does your work demand a great deal of concentration? b. Does your work demand your constant attention? c. Does your work require a high level of precision?
3		Influence at work (COPSOQ)	a. Do other people make decisions concerning your work? b. Do you have a large degree of influence concerning your work? c. Can you influence the amount of work assigned to you?
4		Possibilities for development at work (COPSOQ)	a. Do you have to do the same thing over and over again? b. Can you use your skills or expertise in your work? c. Does your work give you the opportunity to develop your skills?
5		Degree of freedom at work (COPSOQ)	a. Can you decide when to take a break? b. Can you take holidays more or less when you wish? c. Can you leave your work to have a chat with a colleague?
6		Meaning of work (COPSOQ)	a. Is your work meaningful? b. Do you feel that the work you do is important? c. Do you feel motivated and involved in your work?
7		Role conflicts at work (COPSOQ)	a. Are contradictory demands placed on you at work? b. Do you sometimes have to do things, which seem to you to be unnecessary? c. Do you do things at work, which are accepted by some people but not by others? d. Do you sometimes have to do things, which ought to have been done in a different way?
8		Social support at work (COPSOQ)	a. How often do you get help and support from your colleagues? b. How often do you get help and support from your immediate superior? c. How often is your immediate superior willing to listen to your work-related problems?
9		Social relations at work (COPSOQ)	a. Do you work isolated from your colleagues? b. Is it possible for you to talk to your colleagues while you are working?
10		Sense of community at work (COPSOQ)	a. Is there a good atmosphere between you and your colleagues? b. Is there good co-operation between the colleagues at work? c. Do you feel part of a community at your place of work?

Continued

Table 3 Continued

Included domain	Physical component	Psychosocial component	Items selected
11		Insecurity at work (COPSOQ) Are you worried about...	a. ... becoming unemployed? b. ... It being difficult for you to find another job if you become unemployed? c. ... having to give up your job for health reasons?
12		Job satisfaction (COPSOQ) How pleased are you with...	a. ... your job as a whole, everything taken into consideration? b. ... the people you work with? c. ... your work prospects?
13		General health (COPSOQ)	a. I seem to get sick a little easier than other people. b. I am as healthy as anybody I know. c. I expect my health to get worse. d. I need to see doctor and take medicine on a regular basis. *
14		Mental health (COPSOQ) How much of the time during the past 4 weeks...	a. ... have you felt so down in the dumps that nothing could cheer you up? b. ... have you been a very nervous person? c. ... have you felt calm and peaceful?
15		Vitality (COPSOQ) How much of the time during the past 4 weeks...	a. ... did you have a lot of energy? b. ... did you feel worn out? c. ... did you feel tired?
16		Behavioural stress (COPSOQ)	a. I have difficulty to relax or enjoy myself. * b. I have not been able to stand dealing with other people. c. I have found it difficult to be happy.
17		Somatic stress (COPSOQ) How much of the time during the past 4 weeks have you...	a. ... had stomach ache or stomach problems? b. ... had a tight chest or chest pains? c. ... had tension in various muscles? d. ... had difficulty to sleep? *
18		Cognitive stress (COPSOQ) How much of the time during the past 4 weeks have you...	a. ... had problems concentrating? b. ... had difficulty with remembering? c. ... had difficulty in taking decisions? d. ... found it difficult to think clearly?
19		Sense of coherence (COPSOQ)	a. I believe I can cope with most situations in life. b. I feel that what I do in my daily life is meaningful. c. I do not feel that I am able to influence my future to any great extent.
20		Problem-focused coping (COPSOQ)	a. Do you try to find out what you can do to solve the problem? b. Do you do anything to solve the problem?
21		Kinesiophobia (TSK)	a. I am afraid that I might injure myself if I exercise. b. Simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening. c. If I were to try to overcome it, my pain would increase.
22		Catastrophising (PCS)	a. I become afraid that the pain will get worse. b. I feel I ca not go on. c. It's terrible and I think it's never going to get any better.
23	Force exertion (DMQ) Do you in your work often have to...		a. ... lift heavy loads (more than 5kg)? b. ... pull or push heavy loads (more than 5kg)? c. ... lift with the load far from the body? d. ... lift in an awkward posture?

Continued



Table 3 Continued

Included domain	Physical component	Psychosocial component	Items selected
24	Dynamic loads (DMQ) Do you in your work often have to...		a. ... bend heavily with your trunk? b. ... twist heavily with your trunk? c. ... bent and twist with your trunk? d. ... lift the arms above shoulder height?
25	Static loads (DMQ) Do you in your work often have to...		a. ... work in a heavily bent posture for a prolonged time? b. ... work in uncomfortable postures? c. ... work in a heavily twisted posture for a prolonged time? d. ... work in a squatting or stooping posture for a prolonged time? *
26	Repetitive loads (DMQ) Do you in your work often have to...		a. ... work in the same postures? b. ... always make the same movements with your trunk? c. ... make small movements with hands/fingers at a high workplace?
27	Ergonomic environment (DMQ) Do you in your work often have to...		a. ... not enough room around you to perform your work properly? b. ... difficulty in exerting enough force because of uncomfortable postures? c. ... not enough room above you to perform your work without bending?
28	Vibration (DMQ)		a. Do you in your work experience noticeable mechanical vibrations or shocks? b. Do you carry vibrating tools during your work? c. Do you drive vehicles during your work?

Operationalisation table. Final domains and related final items are presented. Each domain has been attributed to either the physical or the psychosocial component of the Patient Reported Outcome Measures (PROMs).

*Items built from scratch for their unique characteristics.

Construct, construct/domain number; COPSQ, Copenhagen Psychosocial Questionnaire; DMQ, Dutch Musculoskeletal Questionnaire; PCS, Pain Catastrophising Scale; TSK, Tampa Scale for Kinesiophobia.

Assessing the risk of WMSDs

The expert group working as part of the Delphi panel initially agreed that the conceptual model underlying a risk assessment questionnaire should address both a physical and a psychosocial component of risk. This expert agreement is in line with the literature, which provides substantial evidence from longitudinal studies of the contribution of both a physical and a psychosocial components with regards to the risk of developing WMSDs.²¹ Furthermore, the psychosocial dimension has been shown to correlate with the prevalence of chronic musculoskeletal conditions.^{37 38}

During the domain selection process, both physical and psychosocial dimensions were presented to Delphi panel via the 38 potential domains identified through the literature search, of these domains, 6 were related to the physical dimension and 32 were with the psychosocial

dimension. The work of the panel resulted in 28 domains and 89 items that provide a framework to operationalise the underlying domain constructs. All but four of the final items were from previous self-administered validated questionnaires. This increases the strength of the results in two ways. First, the underlying concepts are in agreement with the results of the last decades of research in occupational and musculoskeletal health; second, the robustness of the P4Wq is expected to be high as the final product uses items from previous validated questionnaires. This approach has previously proven valid in the creation of simplified assessment tools in back disorders.^{39 40}

Methodological considerations and limitations

The different phases in the development of this questionnaire from definition of the construct to the list of items creation follow the international recommendations.^{41 42}

A well-accepted framework, the theory of biopsychosocial nature of musculoskeletal problems and the fear-avoidance model of chronic pain⁴¹ provides a solid conceptual framework for the assessment of the risk of developing chronic musculoskeletal pain and has undergone extensive research. The target population for the questionnaire (working adult individuals) and the concept that will be measured (risk of development of WMSDs) have been defined, and the measurement model is reported in accordance with the items included in the pool.

This study has some limitations. The factors associated with the risk of developing WMSDs and the factors associated with the risk of WMSDs evolution into chronicity are not necessarily the same. During this step of the framework construction process, the research was performed to be as inclusive as possible. Further studies will establish which factors have the most significant predictive capabilities for new diagnosis or evolution into chronicity. The Delphi panel included experts with different backgrounds regarding research and professional experience and was multidisciplinary. Still, one category of professionals (physical therapists) was overrepresented. Employers, members of the compensation system (society safety net and healthcare management) and stakeholders were not involved in the Delphi panel. This approach can potentially limit the infield application of the knowledge acquired.⁹ In particular, the workers' absence might cause limitations in terms of comprehensiveness of the items used. This limitation will be addressed in the validation phases by interviews, in which interviewees will be specifically asked about comprehensiveness.

CONCLUSIONS

No specific risk assessment questionnaires for WMSDs are currently available. The risk of developing WMSDs, which may potentially progress into chronic symptoms, is likely to be captured by an assessment tool that reflects both physical and psychosocial domains that include factors of the biopsychosocial model of disease and the fear-avoidance components of chronic pain. The present study provides a definition of the measurement construct and operationalises it into domains and items that will permit the development and validation of the questionnaire.

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