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# **A Review of Psychosocial Models for the Development of Musculoskeletal Disorders and Common Psychosocial Instruments**

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### **Author's contribution**

*The sole author designed, analysed, interpreted and prepared the manuscript.*

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## **ABSTRACT**

**Aims:** While the biomechanical factors causing musculoskeletal disorder (MSDs) are well defined, the psychosocial dimension of MSDs is complex and affected by personal, organizational and environmental elements. There is an impetus to understand how psychosocial risk factors contribute to the manifestation of MSDs and systematically present the strengths and constraints of various instruments in assessing psychosocial risk factors.

**Study Design:** This article critically reviews various models linking psychosocial constructs to MSDs and various instruments for evaluating psychosocial risk factors.

**Methodology:** This article reviews the most pertinent literature which presents and discusses the connection of psychosocial domains with the development of MSDs as well as the common instruments used for evaluation of psychosocial factors.

**Results:** It shows an intricate connection between psychosocial and biomechanical aspects compounded by organizational, individual and environmental factors. Psychosocial factors particularly psychological demand, decisional latitude, level of social support and work organization result in stress which produces strain and physiological deterioration hence MSDs. Different psychosocial risk factors have also been found to evoke MSDs in different body parts. Overarching cognitive and psychological aspects consisting of work demands, maneuver margins and work

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recognition have also been proposed in examining the psychosocial dimension of MSDs. Instruments for measuring psychological constructs are often subjective and rely on personal reflections. Some instruments assess multiple psychosocial factors while other assess specific attributes. These instruments share a common shortcoming of treating risk factors across different workplaces as homogenous.

**Conclusion:** Refinement of the instruments and development of sector-specific instruments are beneficial for more reliable evaluation of psychosocial risk factors.

*Keywords: Ergonomic; musculoskeletal disorders; organizational; psychosocial; strain; stress.*

## 1. INTRODUCTION

Studies demonstrate that the development of musculoskeletal disorders (MSDs) is not only closely related to the physical aspect but the psychosocial aspect of ergonomic risk factors. Psychosocial risks concern how work is organized, designed and managed, and encompass issues such as work demands, control at work, social relationship and effort-reward imbalance. It is often manifested as fatigue, headaches, low productivity, absenteeism, sleep disturbance, edginess and inclination to injury [1]. Bergh et al. highlighted the significant impact psychosocial risks have on the health and safety performance of the oil and gas industry, and promulgated integration of sustainable psychosocial risk management into the larger organizational operations via the development of performance indicators [1,2].

Hope et al. found risk perception and safety climate to significantly affect sleep quality [3]. Risk perception and safety climate, in turn, are affected by factors such as authentic leadership [4], management commitment [5] and personal traits of employees [6]. Risk perception is determined by how a person discerns the likelihood and severity of a hazard and is often subjective. It has strong relation to health and well-beings of employees. Perception of sustained risks by employees yields negative health outcomes by affecting vigilance and producing unnecessary anxiety [7]. Safety climate, on the other hand, implies the overall perception of employees towards safety at workplaces and indicates how they perceive management's commitment to safety [8]. Nielson et al. demonstrated that authentic leadership is linked to lower risk perception via promoting safety climate, mainly by means of social exchanges [7]. In another study, Nielson et al. found a correlation between workplace bullying and mental health. The latter is linked, though not strongly, to risk perception and the relation is weakly moderated by self-esteem [9].

Sleep problems may adversely affect workers' vigilance and alertness [10] while giving rise to health conditions and increased occupational accidents [11]. Instances of health impacts related to deteriorated sleep quality are muscle pain, migraine and gastrointestinal problems. [12]. Bernal et al. investigated the relation between different psychosocial risks and body areas affected by MSDs via literature review and meta-analysis [13]. The study shows that high psychosocial demands-low job control is connected to prevalent and incident low back pain, prevalent shoulder pain, prevalent knee pain and prevalent pain at any anatomical site. Effort-reward imbalance is linked to prevalent MSDs at any anatomical site while low social support is linked to incident back pain [13].

Impacts of psychological factors on physiological functions and their contributions to the development of MSDs have been hypothesized. Psychological factors are associated with muscle tension and increased spinal loading, and are connected to increased body awareness causing reporting of MSDs or association of MSDs with work factors [14]. Psychological factors are also deemed to be responsible for the experience of chronic pain after the initial muscle damage that caused the original acute pain has healed [15]. Association of psychological demands to physical demands may lead to misinterpretation of psychological factors as the causes of MSDs even though they are actually only confounders [15]. This review intends to scrutinize the various psychosocial models contributing to MSDs development and critically examine the popular instruments for measuring psychosocial risks, in order to provide new insight into how psychosocial risks interact with the physiological dimension leading to musculoskeletal disorders. It also systematically presents the strengths and constraints of the popular psychosocial instruments.

## 2. PSYCHOSOCIAL MODELS FOR MSDs DEVELOPMENT

The inter-relation between psychological aspect and the physiological or biomechanical aspect of MSDs development is presented in Bongers' model wherein these risk factors shed light into the organizational dimensions of an occupation, i.e. the management, production methods as well as the forms of contribution/ remuneration between individuals and organizations [16,17]. Stress results when employers perceive their expectations of the organizational dimensions are not met and this threatens their well-being, causing conflict or a "threatening discord" [18]. This model, therefore, treats work posing the risks of MSDs such as repetitive and fast-paced tasks as not necessarily problematic if individuals can adjust the intensity of their work or spread, hence reduce the risks via team work [19].

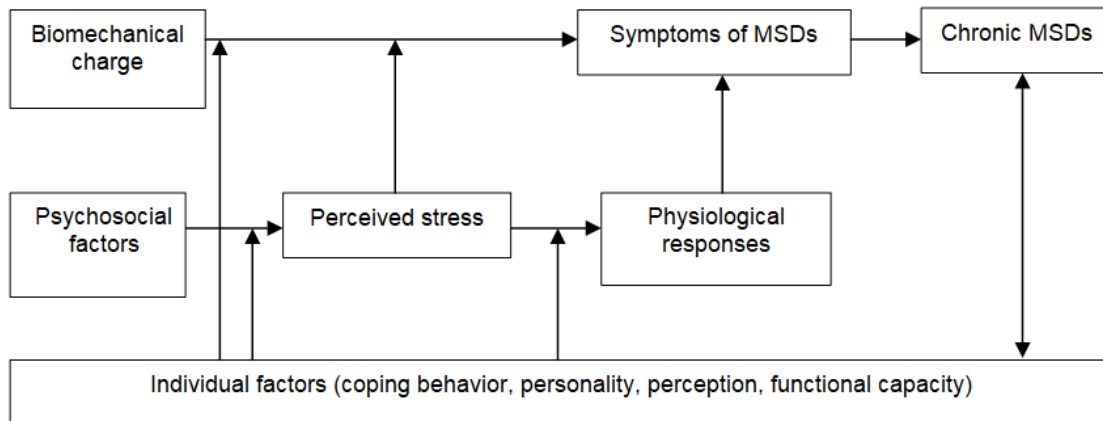
Bongers et al. postulated two ways psychosocial factors affect the development of MSDs [17]. The first suggests increasing biomechanical load causes faster movements and uncomfortable posture in individuals. While capabilities and perceived stress differ between individuals, the increased load leads to differing level of MSDs and disabilities (Fig. 1). The second suggests that workers associated the psychosocial factors as potential threats which prompt solutions. This causes stress, hence physiological responses of the nerve, the endocrine system and the immune system (Fig. 1) [17]. These responses take a toll on muscles and tendons by causing for instance, increase in muscular tonus, decrease in microcirculation in muscles and tendons and inflammation of the tendons [20].

Research into the psychological factors of MSDs is compounded by a lack of standard definition in psychosocial constructs where a particular construct such as work-related stress is defined and measured differently in different studies. Bongers' work lacks clear definition of the psychological factors contributing to stress and their interplay with individual factors [16,17]. Karasek's and Siegrist's works provide insight into defining the psychological factors [21,22]. Karasek and Theorell proposed that psychological demand, decisional latitude and social support factors often work in tandem to produce tension and occupational stress [21]. Siegrist et al. focused on distributive justice in an organization and identified that high efforts and low rewards account partly to psychosocial risks [22].

The efforts can either be extrinsic and intrinsic. Extrinsic efforts correspond to Karasek's psychological demand and are related to the qualitative and quantitative work demands, concentration level needed, change and emergency management, etc. [23]. They generate rewards in terms of monetary satisfaction, esteem and potential control gained on other's job via promotion and job security. The intrinsic efforts portray attitudes and motivations that exude from excessive commitment to work [22]. Nonetheless, this concept of disequilibrium between efforts and rewards leading to stress, consequently physiological deterioration is not as widely used in Karasek's model in the study of MSDs [23].

Sauter and Swanson proposed an ecological model of MSDs which relates psychological strain directly to work organization [24]. This model is based on the notion that environmental factors cause strain which affects physical health. In this case, it results in MSDs. This is akin to Lazarus' (1991) transactional stress model which solicits the impact of environment on health via strain. Both models highlight that the experience of strain is personal and contextual [25]. Both models also present person-environment interaction wherein environmental stressors can be aggravated via interaction between MSDs and environment. Under strain, effect of stressors on MSDs is mediated as muscle tension increases. These models, however, are not entirely psychosocial-based.

Eatough et al. proposed a stress-based model that distinguishes two elements of the stress process i.e. stressors and strain [26]. Stressors are situational stimuli which arouse responses from the receptors. The responses are either adaptive, causing increased motivation or maladaptive [27]. Strain is a maladaptive response to environmental stressors and poses psychosocial implications for instance anxiety, tension and an overwhelming sensation due to job demand in addition to physiological ones such as hormonal or cardiovascular responses [28]. This model focuses on psychosocial strain caused by three main psychosocial stressors, i.e. work role stressors, job control and social characteristics [26]. Work roles means responsibilities and authorities related to a particularly position and role conflict is a stressor associated with incompatible expectations of work role by different members of an organization [26,29]. Job control represents



**Fig. 1. Model of the relations of influence between the biomechanical, psychosocial and individual risk factors and their impacts on the development of MSD [17]**

the level of autonomy an employee assumes in task performance and decision-making [26]. Social characteristics are linked to interpersonal interactions such as quality of supervision, leadership styles, organizational politics and interpersonal conflict. Leadership style, in particular, is tied to safety climate and MSDs [30,31].

Safety-specific leadership prioritizes safety performance and injury prevention. Inadequate safety-specific leadership represents a psychosocial work stressor. Nielsen et al. showed laissez-faire leadership causes higher level of psychological distress [7]. A possible explanation is laissez-faire leadership results in role conflict and role ambiguity, hence role stress and psychological distress [32]. This indicates laissez-faire leadership as counterproductive and destructive. According to Nielsen et al., bullying is another significant predictor of psychological distress in addition to laissez-faire leadership [9].

The stress model builds upon the transactional stress-based model. Eatough et al. demonstrated that high levels of psychosocial work stressors comprising low safety leadership, low job control and high role conflict are related to increased strain, hence MSDs of wrist/hand, shoulders and lower back [26]. The stressor-strain theories discussed above encompass the job characteristics model [33], the job-demand control model [23] and affective events theory [34]. Job characteristics model relates the characteristics of job to five work-related outcomes, i.e. motivation, satisfaction, performance, absenteeism and turnover, via the

moderating effects of three psychological states, namely experienced meaningfulness, experienced responsibility and knowledge of results [35]. The job characteristics consist of five domains, i.e. skill variety, task identity, task significance, autonomy and feedback. The model sets the foundation for job design and enrichment in an organization [35]. The affective events theory, however, explains the relationship between emotions and job performance as well as job satisfaction. The theory advocates that job satisfaction of employees is affected by positive-inducing and negative-inducing emotional incidents at work [36].

Attempts are made to associate different psychosocial risk factors with different anatomical areas affected by MSDs. Higher psychological work demands increase likelihood of MSDs in general [37]. A lack of social support is frequently linked to MSDs of the back, the neck and less frequently to MSDs of the upper limb. Assuming control over one's work reduces the development of MSDs, particularly of the neck, the shoulder and the back areas though no such connection has been established with MSDs of the elbow and hand. Use of skills and monotony of work pose risks in the framework of dorsopathies [37].

Lanfranchi and Duveau proposed a theoretical model concerning clinical ergonomics of activity and gesture in the study of MSDs (Fig. 2) [38]. The model builds upon Karasek's and Siegrist's psychosocial models of occupational health. It focuses on the cognitive and psychological respects, especially work demands, maneuver

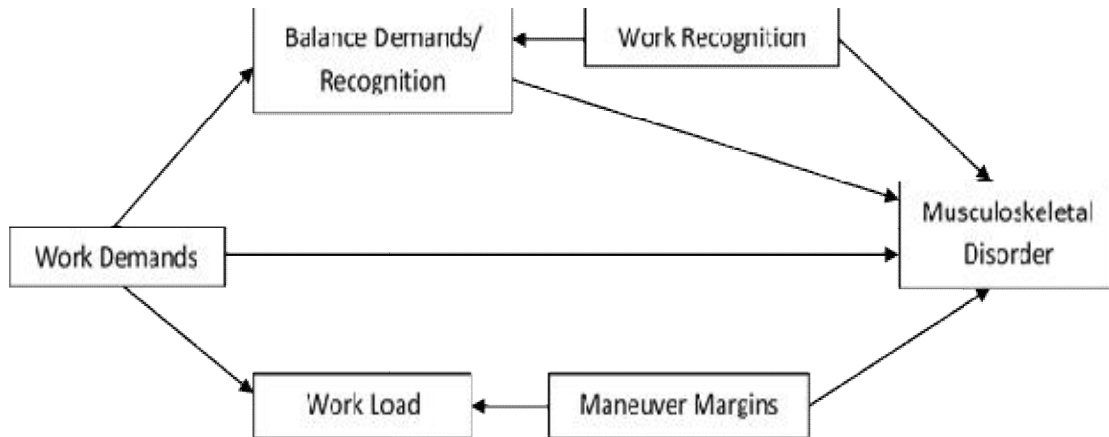
margins and work recognition. In clinical analysis of activity, a method of “double” is used which requires crossed self-confrontation of work instruction. In self-confrontation, workers review visual records of their own activities. In crossed self-confrontation, one worker reviews visual records of another worker’s work activities [38].

Work demands are linked to the physical and psychological demands of a task which are usually within the limit of the workers [39]. Maneuver margins refer to the accessible internal and external resources that increase the self-control of an individual over work activity. Examples of variables related to maneuver margins are decision-making latitude and degree of procedural autonomy [38]. Work recognition depends on the feedbacks of peer on the work performed and also to certain extents, on material rewards, and potential career advancement. The model does not single out social support as it is considered a subset of maneuver margins and work recognition. According to the model, workers who perceive high work demand, have insufficient maneuver margins and lack work recognition are at risk of greater musculoskeletal pain (Fig. 2) [38].

The “Brussels model” postulates that physical workload causes accumulation of metabolites in muscles, leading to the release of inflammatory substances which impair accuracy of information transmitted by muscle spindles. This results in disturbance of neuromuscular control. In the context of MSDs, “Brussels model” predicts that sustained cycle of postural deviations, hence

stronger co-contraction of agonistic and antagonistic muscles around the joints leads to higher sensitivity to painful stimuli and consequently chronic musculoskeletal pain [40].

Neuromotor noise model hypothesizes that prolonged movement time as a result of increased task demands or external stressors during repetitive motor tasks causes increased level of muscular co-contraction [41]. Lately, a study shows that satisfactory end-point accuracy in goal-directed arm movements can be efficiently maintained by modulating the degree of co-contraction of antagonistic muscles [41]. The neuromotor noise theory of limb displacement asserts Newtonian physics, i.e. net driving force of all muscles acting upon the limb’s mass as determinants of speed and extent of limb displacement [42]. Resistance in relation to the mass of the total limb system, level of co-contraction and environmental friction gives rise to stiffness of the system. The theory assumes that muscle-force production is a stochastic process where increasing force level leads to increasing neuromotor noise. It is shown that increasing movement speed raises end-point variability due to larger muscle forces required, in parallel to Fitt’s Law [42]. Movement speed within human capability in motor tasks indicates signal-to-noise ratios (SNR) of the neuromotor signals responsible for motion. Low speeds are connected to low SNRs and SNRs are affected by summed effect of natural frequencies of the biophysical processes as well as cognitive processes involved in motion planning [43].



**Fig. 2. Model of existing relations between musculoskeletal disorders and the factors of maneuver margins, work demands and work recognition [38]**

**Table 1. Comparison of psychosocial questionnaires [22,46,47,48]**

Psychosocial factors	COPSOQIII	Dass21	HSE management standards indicator tool	QPSNordic	General health questionnaire	Job content questionnaire	NIOSH generic job stress questionnaire
Psychological demand	√	x	√	√	x	√	√
• Work demands	√	x	√	√	x	√	√
Decisional latitude		x	x	√	x	√	√
• Job control	√	x	√	√	x	√	√
• Maneuver margins	√	x	x	x	x	x	√ (Resource control)
Social characteristics	√	x	√	√	x	√	√
• Social support	√	x	√	√	x	√	√
• Interpersonal interactions	√	x	√	√	x	√	√
• Leadership style	√	x	√	√	x	√	x
Distributive Justice	√	x	x	√	x	x	-
• Efforts and rewards	√	x	x	√	x	x	x
• Job security	√	x	x	√	x	√	√
• Work recognition	√	x	x	x	x	x	x
Role conflict/ clarity	√	x	√	√	x	√	√
Remark	Include personal and organizational factors; less physical factor	For assessment of psychological well-being			For assessment of psychological well-being	Less survey items on effort and rewards, leadership style and role conflict.	Only one question on maneuver margins

### 3. INSTRUMENTS FOR MEASUREMENT OF PSYCHOLOGICAL CONSTRUCT

Measurement of psychological constructs relies on subjective instruments such as self-reporting whose reliability and validity can be questionable, unlike measurements of physical stressors such as spinal compression from lifting which are well defined [44]. Dissatisfaction and stress for instance are not easy to understand as they are “composite” factors and rely on personal reflections in data collection [45]. An array of subjective instruments is available for measurement of psychosocial risk factors. Tabanelli et al. identified 33 instruments for this purpose, 26 are questionnaires and 7 are observational instruments. Instances of the instruments are the Copenhagen Psychological Questionnaire, the Effort-Reward Imbalance, the General Nordic Questionnaire, HSE Indicator Tool and Job Characteristics Index, to name a few [46]. The questionnaires differ in their objectives and measures. Some questionnaires assess multiple psychosocial factors while others assess specific attributes.

The Copenhagen Psychosocial Questionnaire for example, evaluates psychosocial factors, stress, individual health/ well-being and personality factors, i.e. coping style, sense of coherence etc. It includes numerous psychosocial attributes such as cognitive demands, commitment, freedom, demands to hide emotions, emotional demands, influence, insecurity, satisfaction etc. [46]. Similar to the Copenhagen Psychosocial Questionnaire, the General Nordic Questionnaire assesses multiple psychosocial risk factors encompassing job demands/ control, role expectation, work predictability, social interaction, leadership, communication, organizational culture, work group, etc. However, it lacks the psychosocial dimensions of emotional and cognitive demands, the meaning of work, job insecurity, job satisfaction, stress and health which are covered in the former [46].

The Effort-Reward Imbalance Questionnaire, however, is specific for the evaluation of effort-reward relations as determinants of well-being. The questionnaire adopts 3 uni-dimensional scales and the survey items encompass aspects of effort, reward and over-commitment [22]. The Job Content Questionnaire also examines specific attributes of job stress development proposed by Karesk et al., i.e. decision latitude, psychological demands and social support [47].

The General Health Questionnaire (GHQ) is another instrument used in many studies to understand the distress faced by workers and the antecedents. Unlike questionnaires mentioned previously which assess psychosocial risk factors at the workplace, the GHQ assesses mental well-being and is used as a tool to screen individuals at risk of psychiatric disorders [48]. It probes the four common mental health domains, i.e. depression, anxiety, somatic symptoms and social withdrawal and these represent very specific areas of the psychosocial environment [48]. A comparison of various psychosocial questionnaires in relation to psychosocial factors identified in various psychosocial models for MSDs development is presented in Table 1.

The questionnaires and instruments for evaluation of psychosocial risk factors are often designed to be applicable across diverse workplaces, assuming that the risk factors are homogenous in the workplaces [49]. In reality, workers in different workplaces are faced with different challenges wherein some psychosocial risks may be more prevalent than others. Oil and gas operations, for instance, are associated with dangerous working conditions and globalized workforce having diverse attitudes, beliefs, values and behavior [5].

### 4. CONCLUSION AND RECOMMENDATIONS

The development of MSDs has been associated with psychosocial risk factors in addition to the biomechanical aspects, which are in turn affected by risk perception, safety climate and personality traits of employees. Various models relating psychosocial risks to MSDs have been proposed shedding light into the potential increase of biomechanical load and perception of potential threats upon exposure to psychosocial risks which result in stress. However, unlike the biomechanical dimension, psychosocial factors often lack clear definition and measuring these factors present many challenges. There are numerous stressors contributing to psychosocial risks comprising efforts and rewards imbalance, work role, job control, social characteristics and leadership style. Different psychosocial risk factors also seem to affect different anatomical areas. This review reveals the need for development of sector-specific instruments for evaluation of psychosocial risk factors as current instruments take on a largely undifferentiated approach in assessing the risk factors across diverse workplaces. It shows the interconnection

between the models of psychosocial risk factors and MSDs. These models can be integrated for a more well-rounded understanding of the constructs and correlations involved. This review is important in providing an overview of the models linking psychosocial factors and MSDs, highlighting the interrelation between the models, and pointing to future directions for perfecting the models and improving the psychosocial instruments.

It is obvious from the review that the psychosocial instruments differ in their purposes with some intended to examine the personal and organizational factors affecting psychological health and others identifying the mental and physiological symptoms to determine psychological health or the state of a psychological condition. The tools need to be used in tandem particularly when assessing psychological well-being and identifying the contributing factors are important, for instance in evaluating the severity of depression, anxiety, stress, etc. The instruments probing contributing factors to psychosocial health can look into facets related to collaboration and coordination, for instance between groups and departments, as promulgated by the relational coordination concept [50]. With the recent COVID-19 outbreak which has multiple psychosocial implications, for instance changes on job demand and social characteristics, it is important to refine the questionnaires to capture the impacts of the pandemic on the psychosocial domains and the development of MSDs [51,52]. Besides, as this review concerns MSDs, it recommends expansion of items in the instruments, particularly for somatic or physiological symptoms related to MSDs.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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