

## Conference Paper

# Risk Factors for Musculoskeletal Symptoms of Construction Workers: A Systematic Literature Review

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## Abstract

Construction jobs are known among occupations with high risk of musculoskeletal disorders. An effective intervention should be then developed to minimize the risk of the disorders. Previous studies have reported a number of risk factors including extreme temperature, awkward posture, repetition, vibration, static loading, contact stress, and force. However, the results seem inconclusive, due to lack of evidence reported. The purpose of this research is to review the literature systematically that reported evidence of risk factors for musculoskeletal symptoms in construction jobs. The following search engine were utilized: Pubmed, Web of Science, Science Direct, and Taylor and Francis Online. A total of 1204 abstracts were screened. The results indicated that 15 studies met the selection criteria and were therefore considered for review. Significant risk factors with strong evidence ( $p < 0.001$  or  $OR > 3$ ) in developing musculoskeletal symptoms for construction jobs included age, race, years of experience, occupational stress, working hours/day, high physical workload, awkward posture, psychological demands and mental workload, physical strength, fast work pace, manual handling, working against force or vibration, effort, working in hot/cold/humid conditions, organizational, performance, social, performance, and perceived risk. This study will enhance the awareness for the construction industry in developing risk factors that occur in the field. In terms of research method, we found most of the researches were performed cross-sectionally, using subjective measurement [self-reported] in collecting the data. Therefore, longitudinal study and mixed method between subjective and objective may use to measure the risk factors and musculoskeletal symptoms in future research.

**Keywords:** risk factors, musculoskeletal symptoms, construction jobs

## 1. Introduction

“Work-related musculoskeletal disorders [WMSDs] are injury of the muscles, tendons, ligaments, nerves, joints, cartilage, bones, or blood vessels in the arms, legs, head,

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neck, or back that is caused or aggravated by work tasks such as lifting, pushing, and pulling” [1]. Furthermore, other research explains that musculoskeletal disorders include sprains, strains, tears, soreness, pain, carpal tunnel syndrome, hernias, and connective tissue injuries of the structures [2]. There were 79,890 cases of musculoskeletal disorders in construction work in the United States between 2013 and 2015 [3], and 990 cases were of back disorders from 100,000 construction workers in the United Kingdom between 2013 and 2015 [4].

Intervention in preventing MSDs is still developed to be more effective and efficient. The current survey findings, however, indicate that most of the construction contractors did not have a (trade) site-specific ergonomics intervention [5]. Each occupation/trade requires the construction worker to employ trade-specific hand tools and working body positions that may contribute to different types and sources of work-related ergonomic [musculoskeletal] risks.

Musculoskeletal symptoms are pain, ache, or discomfort of different localization experienced sometimes, often, or very often for 12 continuous months [6]. By knowing factors predictive of shoulder pain development in construction workers, the employers can measure to protect the workers and may secondarily decrease medical expenses and maintain productivity [7]. The evaluation of these risk factors may be carried out through biomechanical, physiological, and physical analysis [8].

This systematic literature review aims to investigate evidence found in the last 10 years (2008–2017) of a number of risk factors for musculoskeletal symptoms in construction work. The previous study in investigating risk factors of musculoskeletal symptoms in construction jobs was in 2011 [9]. We identified and reported possible associations between exposure to risk factors to the development of musculoskeletal symptoms in construction work.

## 2. Methods

### 2.1. Literature search and data management

We searched four electronic databases (Science Direct, PubMed, Web of Science, and Taylor and Francis Online) from January 2008 to December 2017 in order to identify studies evaluating risk factors for musculoskeletal symptoms in construction jobs.

We searched literature including some keywords in every search engine. The keywords were risk factors, musculoskeletal symptoms/disorders, and construction workers/jobs. We based our procedure on guidelines in systematic literature review published by the University of Edinburgh [10]. All the titles identified were merged with Microsoft Excel software.

## 2.2. Inclusion and exclusion criteria

In this review, the musculoskeletal disorders due to slips, fall, or similar accidents were not included [2]. To be eligible, the article had to:

- be directly related to risk factors of musculoskeletal symptoms in construction jobs;
- be less than 10 years old (2008–2017);
- Be cross-sectional or longitudinal studies; and
- reported the statistically significant association between risk factors and musculoskeletal symptoms [2].

Cohort and case-control studies are more appropriate for evaluating cause-and-effect than cross-sectional studies [2]. However, the literature on this review is mostly cross-sectional.

## 2.3. Screening process

At first, the authors chose papers from search engines by using keywords. After that do the selection of duplicated paper. The abstract paper is identified in conformity with the research question to be answered. After that retrieved full texts for all potential papers.

## 2.4. Evaluation process

The criteria used to evaluate a potential causal relationship are the level of significance and consistency between the studies [2]. To fulfil the criterion of 'strength of association' of relative risks or odds ratio defining the association between exposure and outcome had to present a ratio of at least '1.0'. Furthermore, significant values [ $p$ -value] were also used to classify the risk factors. Risk factors were considered 'consistent' if more than one study reported their association with the outcome of

interest. Risk factors identified from the studies were classified as strong evidence, reasonable evidence, or insufficient evidence [2].

- i. Strong evidence risk factors—having Odd Ratios (OR) more than 3 or  $p$ -value less than 0.001 ( $p < 0.001$ )
- ii. Reasonable risk factors—having OR between 1 and 3 or  $p$ -value less than 0.05 ( $p < 0.05$ )
- iii. Insufficient evidence risk factors—having OR less than 1 or  $p$ -value more than 0.05 ( $p > 0.05$ )

### 3. Results

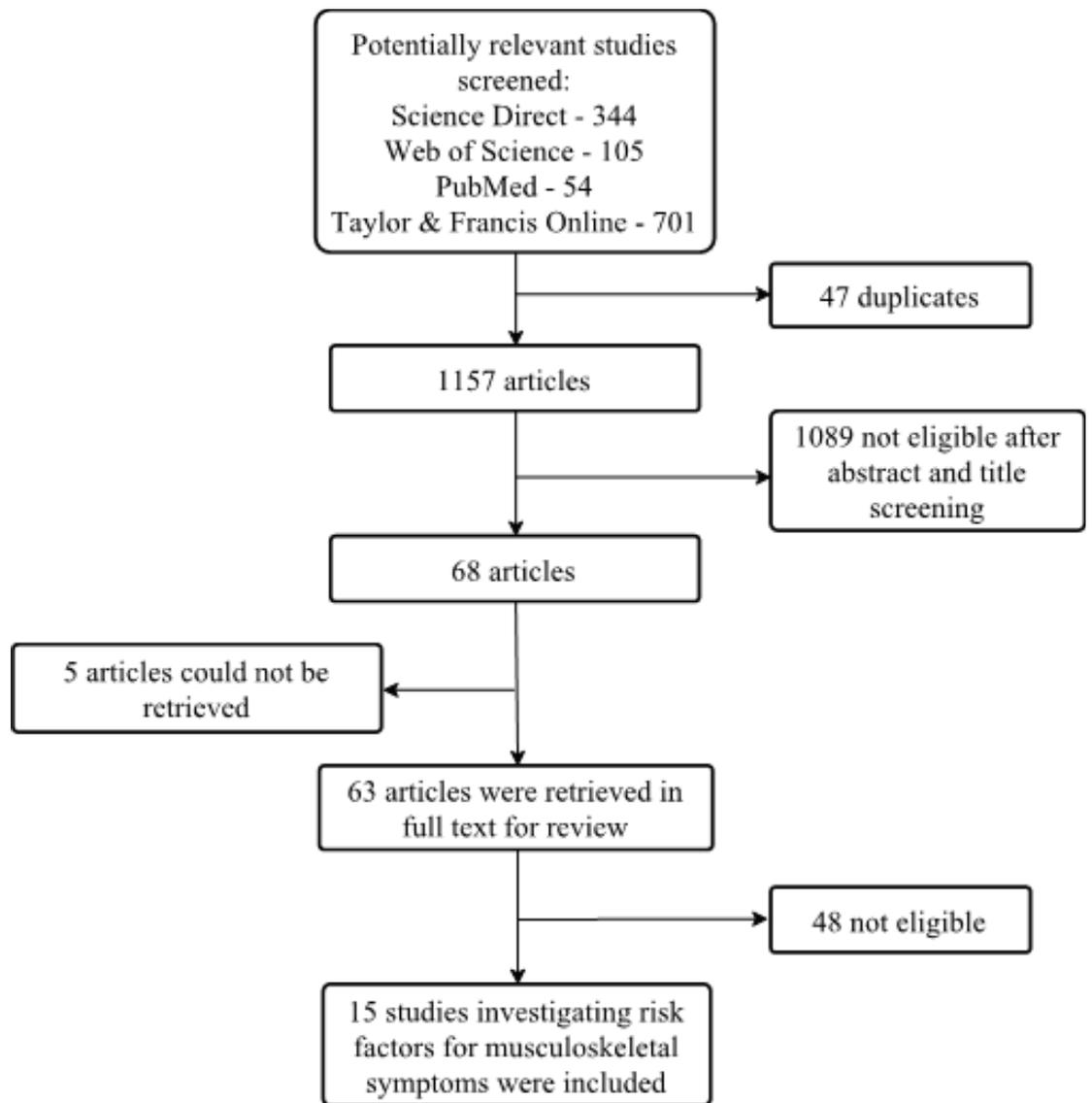
#### 3.1. Literature search and evaluation

The literature search result generated 1204 papers. Title screening and abstracts generated 68 potential papers. Of the 15 studies that were included, 11 had a cross-sectional study, 1 had a prospective cohort study, 2 had a longitudinal study, and 1 had a case-control study [7, 11–23, 24]. Figure 1 shows the search and selection process of the paper.

#### 3.2. Risk factors for musculoskeletal symptoms and their evidence by body part

The authors included 6 studies on non-specified musculoskeletal symptoms, 3 studies on ankles/feet musculoskeletal symptoms, 4 studies on shoulder musculoskeletal symptoms, 1 study on back musculoskeletal symptoms, 5 studies on low back musculoskeletal symptoms, 4 studies on neck musculoskeletal symptoms, 2 studies on elbow musculoskeletal symptoms, 2 studies on hand/wrists musculoskeletal symptoms, 2 studies on fingers musculoskeletal symptoms, 3 studies on upper back musculoskeletal symptoms, 2 studies on hips/thigh musculoskeletal symptoms, and 2 studies on knee/legs musculoskeletal symptoms. Risk factors are classified by the affected body, the type of risk factor, and the level of evidence that indicates its relationship to musculoskeletal symptoms [2].

Table 1 shows a summary of several studies, including types of complaints, risk factors, and evidence levels. Risk factors that have been identified from these studies are the years of experience, the duration of a break during work, age, marital status,



**Figure 1:** Stages of systematic literature review of studies investigating risk factors for musculoskeletal symptoms in construction jobs.

educational status, Body Mass Index (BMI), smoking, type of work, working duration, previous pain, working in hot / cold / humid conditions, shorter stature, bending and twisting the back, physical health, mental health, obesity, high physical workload, organizational, technological, environmental, economic, social, mental task contents, performance, individual growth, physical task contents, perceived risk, and dissatisfaction. The next sections present our findings for each body part.

### 3.3. Non-specified musculoskeletal symptoms

Strong evidence risk factors identified for non-specified musculoskeletal symptoms in construction jobs are age, race, the years of experience, occupational stress, working hours/day, high physical workload, awkward posture, psychological demands, mental workload, physical strength, working against force, working against vibration, manual handling, and fast work pace [11–15]. Reasonable evidence risk factors identified for non-specified musculoskeletal symptoms in construction jobs are weight, Body Mass Index (BMI), obesity, educational status, the year of experience, the duration of a break during work, the use of protective equipment, cold environment, manual handling, work repetitiveness, psychosocial demands, job dissatisfaction, and physical unfitness [11–13, 16, 17]. Insufficient evidence risk factors identified for non-specified musculoskeletal symptoms in construction jobs are age, BMI, educational status, marital status, type of work, and working hours/day [11, 12, 15].

### 3.4. Ankles/feet

Reasonable evidence risk factors identified for ankles/feet symptoms in construction jobs are working duration, effort, and dissatisfaction [18–20].

### 3.5. Shoulder

Strong evidence risk factors identified for shoulder symptoms in construction jobs are working in hot, cold, or humid conditions, organizational, and performance [7, 19, 20]. Reasonable evidence risk factors identified for shoulder symptoms in construction jobs are previous neck pain, shorter stature/height, awkwardly bending, economic, social, and mental task contents [7, 19, 20]. Insufficient evidence risk factors identified for shoulder symptoms in construction jobs are technological and environmental [19, 20].

TABLE 1: Risk factors for musculoskeletal symptoms in construction jobs.

Body part	Strong evidence	Reasonable evidence	Insufficient evidence	Refs
Risk factor				
Non-specified musculoskeletal symptoms				
Age	✓		✓	[11, 15]
Weight,		✓		[11]
Body Mass Index		✓	✓	[11, 12]
Obesity		✓		[13]
Educational status		✓	✓	[11, 12]
Marital status			✓	[12]
Race	✓			[11]
The years of experience	✓	✓		[11, 12]
Smoking			✓	[12]
The duration of break during work		✓		[12]
The use of protective equipment		✓		[12]
Occupational stress	✓			[15]
Type of work			✓	[12]
Working hours/day	✓		✓	[11, 12]
High physical workload	✓			[13]
Cold environment		✓		[16]
Awkward posture	✓			[11, 14]
Non-specified musculoskeletal symptoms				
Psychological demands and mental workload	✓			[11]
Physical strength	✓			[11]
Working against force or vibration	✓			[11]
Work repetitiveness		✓		[17]
Manual material handling	✓	✓		[11, 17]
Psychosocial demands		✓		[17]
Job dissatisfaction		✓		[17]
Physical unfitnes		✓		[17]
Fast work pace	✓			[11]
Ankles/feet				
Working duration		✓		[18]
Effort		✓		[19, 20]
Dissatisfaction		✓		[19, 20]
Shoulder				
Previous neck pain		✓		[7]

Body part	Strong evidence	Reasonable evidence	Insufficient evidence	Refs
<b>Risk factor</b>				
Working in hot, cold, or humid conditions	✓			[7]
<b>Shoulder</b>				
Shorter stature/height		✓		[7]
Awkwardly bending and twisting the back		✓		[7]
Organizational	✓			[19, 20]
Technological			✓	[19, 20]
Environmental			✓	[19, 20]
Economic		✓		[19, 20]
Social		✓		[19, 20]
Mental task contents		✓		[19, 20]
Performance	✓			[19, 20]
Physical health		✓		[21]
<b>Back</b>				
Physical health		✓		[21]
Mental health		✓		[21]
Negative expectations to management			✓	[22]
Cold environment	✓			[23]
Sitting			✓	[24]
<b>Upper back</b>				
Social	✓			[19, 20]
<b>Upper back</b>				
Mental task contents			✓	[19, 20]
Physical task contents		✓		[19, 20]
<b>Lower back</b>				
Mental task contents			✓	[19, 20]
Physical task contents		✓		[19, 20]
Effort		✓		[19, 20]
<b>Neck</b>				
Cold environment	✓			[23]
Organizational	✓			[19, 20]
Technological			✓	[19, 20]
Individual growth			✓	[19, 20]
Performance	✓			[19, 20]
Dissatisfaction			✓	[19, 20]
<b>Elbow</b>				
Organizational	✓			[19, 20]

Body part	Strong evidence	Reasonable evidence	Insufficient evidence	Refs
<b>Risk factor</b>				
Environment			✓	[19, 20]
Economic		✓		[19, 20]
Individual growth			✓	[19, 20]
Perceived risk	✓			[19, 20]
Performance	✓			[19, 20]
<b>Hand/wrist</b>				
Organizational			✓	[19, 20]
Technological		✓		[19, 20]
Individual growth			✓	[19, 20]
Physical task contents		✓		[19, 20]
Perceived risk		✓		[19, 20]
<b>Fingers</b>				
Organizational			✓	[19, 20]
Economic		✓		[19, 20]
Physical task contents		✓		[19, 20]
<b>Hips/thighs</b>				
Economic		✓		[19, 20]
Individual growth			✓	[19, 20]
Social	✓			[19, 20]
Mental task contents			✓	[19, 20]
Individual growth			✓	[19, 20]
Performance	✓			[19, 20]
Dissatisfaction			✓	[19, 20]
<b>Knee/lower legs</b>				
Mental task contents			✓	[19, 20]
Effort		✓		[19, 20]
Dissatisfaction		✓		[19, 20]

### 3.6. Back

Strong evidence risk factors identified for back symptoms in construction jobs is cold environment [23]. Reasonable evidence risk factors identified for back symptoms in construction jobs are physical health and mental health [21]. Insufficient evidence risk factors identified for back symptoms in construction jobs are negative expectations and sitting [22, 24].

### 3.7. Upper back

Strong evidence risk factors identified for upper back symptoms in construction jobs is social [19, 20]. Reasonable evidence risk factors identified for upper back symptoms in construction jobs is physical task contents [19, 20]. Insufficient evidence risk factors identified for upper back symptoms in construction jobs is mental task contents [19, 20].

### 3.8. Lower back

Reasonable evidence risk factors identified for lower back symptoms in construction jobs are physical task contents and effort [19, 20]. Insufficient evidence risk factors identified for lower back symptoms in construction jobs is mental task contents [19, 20].

### 3.9. Neck

Strong evidence risk factors identified for neck symptoms in construction jobs are a cold environment, organizational, and performance [19, 20, 23]. Insufficient evidence risk factors identified for neck symptoms in construction jobs are technological, individual growth, and dissatisfaction [19, 20].

### 3.10. Elbow

Strong evidence risk factors identified for elbow symptoms in construction jobs are organizational, perceived risk, and performance [19, 20]. Reasonable evidence risk factors identified for elbow symptoms in construction jobs is economic [19, 20]. Insufficient evidence risk factors identified for elbow symptoms in construction jobs are the environment and individual growth [19, 20].

### 3.11. Hand/wrist

Reasonable evidence risk factors identified for musculoskeletal hand/wrist symptoms in construction jobs are technological, physical task contents, and perceived risk [19, 20]. Insufficient evidence risk factors identified for hand/wrist symptoms in construction jobs are organizational and individual growth [19, 20].

### 3.12. Fingers

Reasonable evidence risk factors identified for fingers symptoms in construction jobs are economic and physical task contents [19, 20]. Insufficient evidence risk factors identified for fingers symptoms in construction jobs is organizational [19, 20].

### 3.13. Hips/thighs

Strong evidence risk factors identified for hips/thighs symptoms in construction jobs are social and performance [19, 20]. Reasonable evidence risk factors identified for hips/thighs symptoms in construction jobs is economic [19, 20]. Insufficient evidence risk factors identified for hips/thighs symptoms in construction jobs are individual growth, mental task contents, and dissatisfaction [19, 20].

### 3.14. Knee/lower legs

Reasonable evidence risk factors identified for knee/lower legs symptoms in construction jobs are effort and dissatisfaction [19, 20]. Insufficient evidence risk factors identified for knee/lower legs symptoms in construction jobs is mental task [19, 20].

## 4. Discussion

Risk factors are defined as actions or conditions that increase the likelihood of injury to the musculoskeletal system [9]. This systematic literature review shows a causal relationship between risk factors such as individuals, psychosocial, and physical. Awkward postures, force, repetition, vibration, manual handling, bending and twisting, and extreme temperature are classified as Ergonomic Risk Factors (ERF)/biomechanical/physical risk factors [9, 25]. Age, gender, BMI, educational status, individual growth and smoking status are classified as individual factors [24, 25]. Mental task contents/psychological demands and dissatisfaction are classified as psychosocial factors [26]. Organizational, technological, environmental, social and economic have own classification same as their names. Although there are some risk factors that have insufficient evidence that does not mean it is not a risk. It requires further investigation in the future. Previous reviews [9] only focused on the definition of ERF in construction industry without any quantitative evidence. These reviews synthesize

the evidence of risk factors for musculoskeletal symptoms in construction jobs based on the quantitative result ( $p$ -value or OR).

Current reviews show majority research using self-reported assessment methods. Further research should combine with objective assessment methods that can compare or strengthen the result. These multifactorial risk factors that caused the necessity of multi-intervention strategies are required to prevent musculoskeletal disorders in construction jobs. Four assessment techniques can be used for measuring ERF of construction workers. Among them are self-reported, observation-based camera-based and direct measurements [27].

## 5. Conclusions

This systematic literature review shows some factors that influence the musculoskeletal symptoms in construction jobs. Individual, psychosocial and physical factors are the most significant related to shoulder, neck, ankles/feet, back, elbow, hand/wrist, fingers, hip/thighs, knee or non-specified musculoskeletal symptoms. This study will enhance the awareness of the risk factors that might occur in the construction industry. The implication from this research is developing multi-intervention strategies to prevent musculoskeletal disorders in construction jobs.

## Conflict of Interest

The authors declare that they have no conflict of interest in the research topic.

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