Chapter 2.5: Effects of work on health: Physical demands and Ergonomics

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Objectives

Knowledge objectives:

- The students understands the difference between work-related and non-work related musculoskeletal complaints
- The student illustrates that musculoskeletal complaints are most often multifactorial in nature
- The student exemplifies the theoretical framework for work-related musculoskeletal complaints
- The student describes work in terms of physical demands, activities, posture/movement/applied forces and mechanical workload
- The student recalls physical risk factors for non-specific low back pain in terms of frequency, level and /or duration
- The student describes effective measures for counselling a worker with non-specific low back pain
- The student mentions examples of effective ergonomic measures for prevention of non-specific low back pain

Skills/attitudes related objectives:

- The student is attentive to ask for physical job demands preferably in terms of level, frequency and/or duration during a consultation session in patients with musculoskeletal complaints
- The student is able to assess the work-relatedness of non-specific low back pain in patients
- The student is able to find reliable sources of evidence about work-related physical risk factors and preventive measures for work-related musculoskeletal complaints

Concept Map

Framework

The theoretical framework for work-related musculoskeletal complaints is explained including examples based on the case of Jack the brick layer (**'Back to Jack'**). Next, for the high prevalent work-related musculoskeletal complaint, non-specific low back, the five questions regarding the assessment of a work-related musculoskeletal complaints are exemplified using the guideline that has been develop by SALTSA (Joint Programme for Working Life Research in Europe).

Advance organizer

Jack is a 47- year old brick layer (body height 193 cm, body weight 100 kg, BMI = 27). Each working day he gets up at five o'clock to ensure that he and his colleague are at the work site before traffic starts to jam. He enjoys his work. Today he has his four year voluntarily 'periodic health check up' as a brick layer. This is the first time in all these years he feels unsure about going to the 'company doctor'. Lately, his back is aching more often and he also feels 'slight tingling' above his knee that worry him. Also the recent discussions in the media to postpone the retirement age with 2 years worries him. His father also worked as a brick layer and could stop at the age of 57 due to receiving a work disability pension because of a 'bad back'. With the recent plans of the government, Jack still has to work for more than 20 years until he receives his workers' pension. Moreover, a 'bad back' nowadays is 'not enough' to receive a work disability benefit anymore.

He is not sure whether he should discuss his back problems with the company doctor. May be he has got the first signs of a herniation in his back and the doctor will tell him to stop working as a brick layer. Then he will become permanently disabled. May be it is better to skip the voluntary 'periodic health check up'. It is a busy day after all.

Car lights strike through the living room. Jack has to hurry. His colleague has just parked his car in front of his door to pick him up. A new working day lays ahead, another 1100 bricks to lay and one more day less of the total of 6933 days until his pension at the age of 67…

….

How was your day? Jack's wife asked. He laughed and said: ok. To his surprise the company doctor was present at the work site and appeared to be a reasonable guy. During a coffee break, Jack met the doctor in his temporary office and after chatting about their mutual hobby of cycling, Jack asked whether his back problems could be related to the bended posture while riding his race bike. The doctor asked him questions about how often he rode his bike and how his bike was set up. Moreover, he asked Jack about the amount of work he performed, his actual working methods and whether he liked his work. The physical examination revealed that it was unlikely that Jack's back complaints were due to a specific back disorder. The doctor called it 'non-specific low back pain' and reassured him that more than 90% of all back problems have no clear cause and that the prognosis is favorable: for most people the complaints will disappear in the upcoming 6-8 weeks. He assured Jack that staying active was the best thing to do and he should definitely keep riding his bike. A training, as suggested by his wife, in 'better lifting techniques' was *not* a good idea. The doctor told him that a recent review of similar studies stated that - contrary to the doctors' own expectations – training in manual material handling had no clear effect on preventing low-back pain and reducing back-related disability. Of course, losing some weight is beneficial for reducing the load on his low back while lifting and carrying. While visiting the work site, the doctor asked Jack why he did not use mechanical height adjustable scaffolds for the bricks and mortar. In contrast to riding a bike, bending less deep while picking up bricks and mortar saves energy and diminishes the risk of work-related low back pain, said the doctor. Jack laughed and said ‘I do it on purpose: this is my personal training plan to reduce some weight and keep in shape’. But then again, tomorrow he was going to discuss the possibility of these adjustable scaffolds with the site engineer.

Questions:

- How can low back complaints, and other musculoskeletal complaints, be attributed to work?

This question will be dealt with in chapter 1, Physical risk factors

- How can we establish the work-relatedness of a low back pain?

This question will be dealt with in chapter 2.1, Action Plan

- What do we know about effective interventions for return to work and prevention?

This question will be dealt with in chapter 2.2, Action Plan

1. Physical demands

1.1. ‘Heavy manual work’ and work-related musculoskeletal complaints

Manually lifting patients weighing more than 100 kg, performing surgery standing with a bended trunk during more than 8 hours, pushing and pulling more than 513 mini-containers per day, picking up and laying down more than 1100 bricks a day, picking up more than 299 parcels per day, handling more than 440 trolleys a day, moving more than 621 flower containers per day, carrying more than 15.000 kg of scaffolding material a day… In many professions, workers have to manually move many objects a day. Nurses, surgeons, waste collectors, warehouse workers, brick layers, truck drivers and scaffolders are just some of these professions. Despite mechanization and automation, there is still a lot of manual work that has to be performed, or as it is called manual material handling (MMH). These workers are often referred to as so-called ‘blue collar workers’.

There is a vast amount of literature that shows that physically demanding work increases the risk of musculoskeletal disorders in these workers for all body regions: upper extremity, low back and lower extremities. Table 1 shows examples of prevalent work-related MSDs, like shoulder complaints, lateral epicondylitis, symptomatic lumbar herniation and osteoarthritis of the knee and work-related and non-work related risk factors.

Table 1 Examples of prevalent work-related musculoskeletal disorders and work-related risk factors based on scientific literature

Musculoskeletal disorders	Examples of work-related risk factors
Upper extremity	
Shoulder complaints	• Working above shoulder height for more than 2 hours a day • Repetitive arm movements more than 2 times per minute during 4 hours a day • Hand-arm vibration • Duration of employment Van der Windt (2000), Sluiter et al. (2001)
Epicondylitis lateralis	• Handling tools > 1 kg • Handling loads >20 kg at least 10 times/day • Repetitive arme movements >2 h/day Sluiter et al. (2001), Van Rijn et al. (2009a)
Carpal Tunnel Syndrome	• Hand force requirement > 4 kg for more than 2 hours a day • Repetitive hand/wrist/finger movements more than 2 times per minute during 4 hours a day • Hand-arm vibration Sluiter et al. (2001), Van Rijn et al. (2009b)
Back	
Non specific low back pain	• Handle objects > 15 kg during > 10% of working day

	• Bending and/or twisting of the trunk > 40º for > ½ hour per working dayand force requirement > 4 kg for more than 2 hours a day • Whole body vibration levels >1 m/s^2 per working day for ≥ 5 years? Lötters et al. (2003)
Lumbar radiculopathy (lumbar disc herniation)	• Cumulative occupational lumbar load • Time urgency Seidler et al. (2009), Zhang et al. (2009)
Lower extremities	
Knee osteoarthritis	• Heavy physical workload Bierma-Zeinstra et al. (2007)
Hip osteoarthritis	• Heavy physical workload Bierma-Zeinstra et al. (2007)

Despite worldwide attention, MSDs remain a substantial concern at work. Slow progress is not for want of trying. For instance, prevention was a theme of The Bone and Joint Decade (2000-2010) of the World Health Organization and in 2007 the European Agency for Safety and Health at Work organized the "Lighten the Load" campaign to prevent work-related MSDs. Despite these initiatives, physical risks at work remain as persistent as ever according to the fifth European Working Conditions Survey. Therefore, it is of no surprise that MSDs account for high proportions of sickness absence from work: over 40 million workers in Europe are affected by MSDs attributable to their work. To be able to prevent work-related MSDs, we first have to understand how work can attribute to the onset and/or worsening of these complaints. Especially the multifactorial nature of MSDs make this understanding complex. This means that not only work but for instance also personal risk factors like a high Body Mass Index or sport related risk factors might contribute to the onset or worsening of musculoskeletal complaints.

In order to prevent MSDs at work, ergonomics tries to improve the production system and/or the work demands (figure 1). The definition of ergonomics according to the International Ergonomics Society is: 'Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize human well being and overall system performance.' (http://www.iea.cc/01_what/What%20is%20Ergonomics.html). Examples of good practices to prevent work-related musculoskeletal complaints from more than 10 European countries are available at http://osha.europa.eu/en/publications/reports/TE7606536ENC.

As said, not only physical demands in work but also in private life and sport can contribute to the onset or worsening of MSDs. In addition to physical demands, some psychosocial demands contribute to the onset and maintenance of these complaints like time pressure or job dissatisfaction. For the sake of clarity, in this chapter we will focus on physical demands. Individual factors, ranging from aspects of physical capacity, such as maximum strength, to aspects of personality, such as commitment to work, work style and coping skills are also of influence. Differences between people in physical capacity or personality are large: therefore one worker might be more susceptible to develop MSDs than another person while doing the same kind of work. In addition, often no clear dose-response relationship exists between a physical demand and a specific or non-specific MSD. Therefore, it is not easy to establish a causal relationship between physical job demands and MSDs. However, the model presented in the chapter 'Action plan' supports professionals in their judgment. But first, the work-related musculoskeletal disorders will be explained using a general model.

1.2. Exposure to physical job demands

Each job consists of physical demands: generally speaking these are the tasks a worker performs using his hands and/or feet. Examples of job demands are performing surgery, building a brick wall or studying medicine. To perform these job demands activities are performed like sitting, standing, walking, lifting and carrying, pushing and pulling, and reaching and grasping. These activities can only be performed by moving the body and applying force. In epidemiology, being subjected to a possible risk factor is called exposure. Exposure is characterized by frequency (how often?), duration (how long?) and level (how intense?). These characteristics are used to determine whether or not for instance physical job demands really contribute to an increased risk for MSDs (see for instance table 1, work-related risk factors for lateral epicondylitis versus osteoarthritis of the knee). For instance, lifting objects weighing more than 10 kg ('level') during more than 10% of the working day ('duration') is a risk factor, and increases the risk of non-specific low back pain. This model is also illustrated in the ***Back to Jack*** case description for physical job demands, activities, posture/movement/applied forces, mechanical work load, and musculoskeletal complaints and ergonomic interventions and physical capacity.

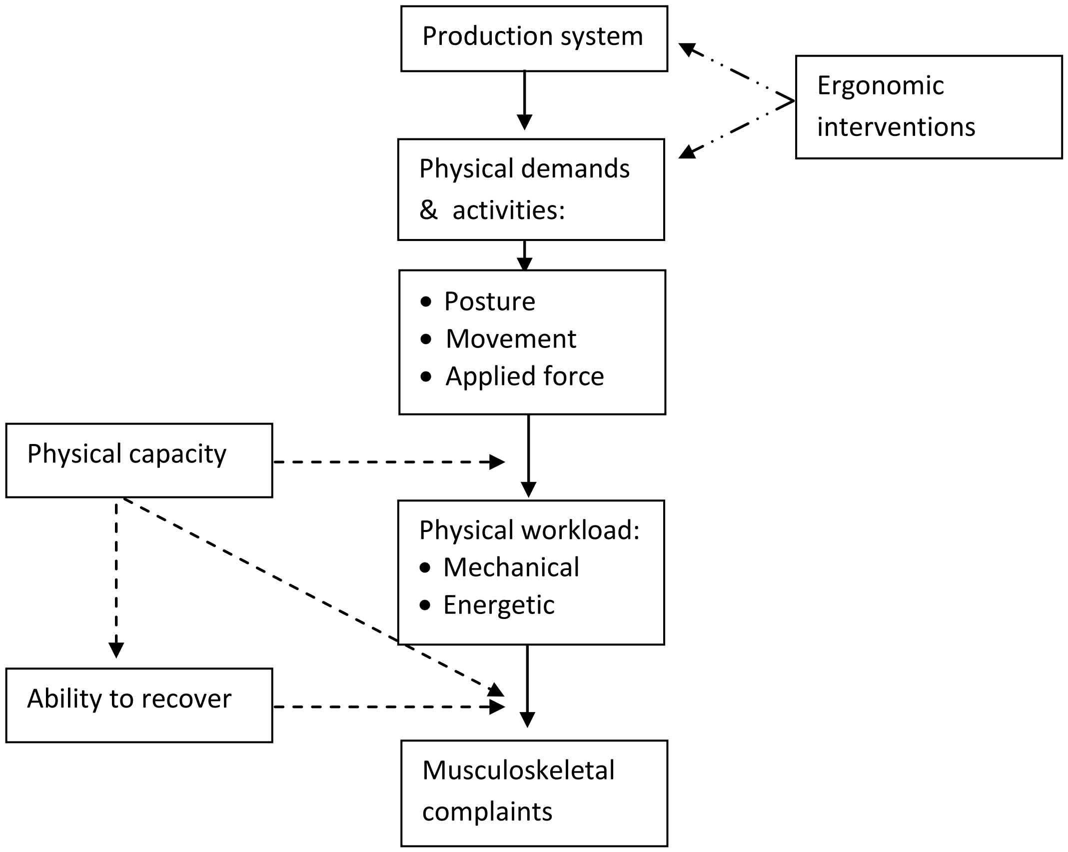

Figure 1. A simple cause-effect model for work-related musculoskeletal complaints. The effect modifying role of physical capacity and ability to recover as well as the main point of an ergonomic intervention are also depicted (Kuijer 2002), http://dare.uva.nl/document/62415, page 20.

Back to Jack

The average one-handed bricklayer spends 20% of the working time on bricks weighing 5–10 kg (Figure 2). Bricklayers handle about 87 to 262 bricks per hour. The handling of bricks weighing less than 5 kg or more than 10 kg is seen in 4% and 7% of the working time, respectively. For most of their working time (57–77%), bricklayers are standing upright. A bricklayer spends 55% of the working time in a in a moderately aggravating posture. Kneeling or squatting is seen during at most 4% of the working time (Boschman et al. 2010).

Figure 2. Brick layers at work

1.3. Movement, Posture, and Exerted Hand Force

To perform the physical jobs demands, a worker has to work in a certain body posture, has to move and to apply forces with in most cases his hand and/or feet to perform the physical job demands. Of course, the movements, postures and forces can also be described in terms of exposure. For instance, a risk factor for non specific low back pain is 'bending ('movement') more than 40 degrees ('level') during more than 30 minutes ('duration') a working day (Lötters et al. 2003).

Back to Jack

While bricklaying, bending occurs during 10–53% of the working time mainly due to the picking up of bricks and mortar at ground or knee level. Up to 84% of the bricks and 96% of the mortar are picked up below knee. During a working day, an average bricklayer makes 912 trunk flexions with more than

20 degrees trunk flexion and 842 flexions with more than 60 degrees trunk flexion: approximately 105–130 times per hour. The conventional bricklayer works during 30% (129 min) of the working time with the arms more than 60 degrees elevated. For nearly 70% (5 hr) of the working time the arms are 30 degrees elevated. During bricklaying contractions of long duration (>3 s) are unusual. The forearm muscles are involved in moderate (3–15% maximal voluntary contraction, MVC) and high intensity (>31%MVC) contractions of short duration (0–3 s during 40% of the working time) (Boschman et al. 2010).

1.4. Mechanical load

To move and to work in a certain body posture and apply forces results in loading of muscles and joints. This loading can be expressed in mechanical terms by applying the laws of physics in terms of *forces* (Newton, abbreviated by N) and *Moments (Newton meters, abbreviated by Nm)* at a certain joint (Figure 3).

Back to Jack

The load on the low back resulting from the handling of bricks and blocks is studied in laboratories, using for instance the peak compression force on the discus L5/S1 as an outcome measure for the load on the lower back during brick or block laying. Compression forces up to nearly 6000 N (= about the weight of four station cars on your back!) were calculated. Working with bricks and blocks of less than 5 kg resulted in maximal peak compressive forces of approximately 3500 N. Compression forces exceeding 3400 N are seen as risk factor for low back complaints based on the NIOSH (National Institute of Safety and Health, United States of America) lifting equation (Waters et al. 1993).

Figure 3. A laboratory study measuring the biomechanical load on the low back based on data about the weight of the object and the body posture and movements.

1.5 Musculoskeletal complaints

These forces and moments might ‘tear and wear’ joints and muscles and thereby result in MSDs.

Back to Jack

In the Netherlands, brick layers have a high prevalence of low back complaints: the 12 month prevalence for regular and sustained low back complaints is 45% (van der Molen et al. 2004) (table 2). The prevalence among the general working population in the Netherlands is about 33%.

Table 2. The 12 month prevalence of musculoskeletal complaints among brick layers in the Netherlands

	No, never (%)	Yes, once (%)	Yes, regular (%)	Yes, sustained (%)
Neck	56	25	13	6
Shoulders	43	31	18	8
Lower back	21	34	35	10
Upper back	61	21	13	5
Elbows	63	18	12	7
Wrists/hands	61	22	11	6
Hips/thighs	68	17	11	4
Knees	46	28	17	9
Ankles/feet	72	16	8	4

2. Action plan

2.1. Assessment of the work-relatedness of non-specific low-back pain

Non-specific low-back pain occurs widely in workers, especially in physically demanding jobs like in health care and in the construction work. In order to ensure adequate working conditions for such workers, it is important to know what work-related factors play a role in the occurrence of such complaints. A number of work-related factors have been found to be clearly associated with non-specific low back pain: lifting, bending and twisting of the trunk and whole body vibration. However, in practice it is difficult to determine to what extent these factors play a role in the occurrence of these complaints in individual workers. Therefore, specific criteria have been developed to provide a reliable basis for uniform determination of the role of work-related risk factors in the occurrence of non-specific low-back pain.
The criteria are based on a systematic review including meta-analyses and a workshop for experts from eight European countries: United Kingdom, Italy, France, Sweden, Greece, Finland, Norway, The Netherlands, and the USA. As a result a 3-step plan was developed to provide a simple means of calculating the probability of work-relatedness (‘attributable fraction’) of non-specific low-back pain on the basis of data on exposure to established risk factors in the work situation. The full document can be retrieved at: http://www.occupationaldiseases.nl/content/criteria-nonspecific-low-back-pain-published.

NB: In the present assessment, the steps are in line with the 5 step model as is presented in the other chapters. For instance, the personal risk factors are included in the present step 3 as the factor ‘age’ and in the a priori chance of getting low back pain and the risk factors in the present step 2 are based on the scientific literature.

Step 1. Diagnosis of non-specific low back pain

Case definition of ‘non-specific low-back pain’
Pain in the lower back region lasting at least 24 hours without any demonstrable physical cause.

Red flags
If one or more of the signs listed below are observed, further investigation should be carried out to exclude specific causes such as radicular syndrome due to a slipped disc at segment L4-L5 or L5-S1, or less common complaints such as malignancy, osteoporotic vertebral fracture, stenosis, spondylitis ankylopoetica (Bechterew’s disease) and severe forms of spondylolisthesis:
> First signs of back pain appearing in workers less than 20 or more than 55 years old;
> Constant progressive back pain;
> Trauma;
> History of malignancy;
> Prolonged use of corticosteroids;
> Drugs use, immunosuppression, HIV;
> (Regular) general malaise;
> Unexplained weight loss;
> Neurological dysfunction (motor dysfunction, sensory abnormalities and/or miction disturbances);

> Lumbar kyphosis and/or past history of lumbar lordosis;
> Infectious complaints

Back to Jack

History taking and physical examination, including Lasègue, did not reveal any signs of a specific low back disorder or other illnesses as a cause for Jack's low back pain. Therefore, the doctor concluded this was a case of non-specific low back pain.

Step 2. Assess exposure to work-related risk factors

Assess exposure to work-related risk factors

→ collect objective information about exposure to the following risk factors at work
→ answer the questions in the following table, and fill in the individual scores
→ determine the total score

	Risk factor	Score
A	**Manual materials handling** Lifting, holding or moving object by hand without the help of mechanical aids	
A1	Does worker handle objects > 15 kg during > 10% of working day? **No, go to A2 / Yes, score 7 and go to B** →	
A2	Does worker handle objects > 5kg > 2x per minute for total of > 2 hours per working day, or objects > 25kg >1x per day? **No, score 0 and go to B / Yes, score 4 and go to B** →	
B	**Bending or twisting of trunk** Bending trunk forwards or sideways and/or twisting trunk (NB. The times given refer to the total time during which worker works in this position during a working day)	
B1	Does worker work with trunk bent and/or twisted > 40º for > ½ hour per working day? **No, go to B2 / Yes, score 7 and go to C** →	
B2	Does worker work with trunk bent and/or twisted > 20º for > 2 hours per working day? **No, score 0 and go to C / Yes, score 5 and go to C** →	
C	**Whole-body vibration** The vibration levels given below are time-weighted averages over an 8-hour period; if the actual exposure time per working day is shorter, the time-weighted average can be calculated with the aid of the formula a8 = aexp*√Te/8 (where a8 = time-weighted average over 8 hours, aexp = vibration level (measured or estimated), Te = daily exposure time)	
C1	Has worker been exposed to average vibration levels >1 m/s² per working day for ≥ 5 years? **No, go to C2 / Yes, score 5 and calculate total score** →	
C2	Is worker exposed to average vibration levels > 0.5 m/s² per working day? **No, score 0 and calculate total score / Yes, score 3 and calculate total score** →	
	Total score (0-19) →	

Back to Jack

Jack has to lift bricks of up to 10 kg during a day. This is done for more than two hours a day. Moreover, Jack has to bend a lot: more than a 1000 times per day and often below knee height. Jack's answers are supported by the productivity per day and by the scientific literature on this topic (see the italic text in paragraph 1.1 and 1.2 of this chapter). Jack and his colleague drive a fiat Doblo. He drives to and from the workplace mainly over tarmac roads and the quality of the chairs and the suspension of the car is good. The total number of driving hours per day are in general 2 hours. For specific information on levels of vibration for this car (or other vehicles) you can use: http://www.ispesl.it/vibrationdatabase/documenti/leggiDett.asp?lang=en&quale=537

The data show that the level is lower than 0.5 m/s^2 for 2 hours a day (0.14 or 0.15 m/s^2). This makes a total of 4 points for lifting, 7 points for bending and twisting and 0 points for whole body vibration, sums up to 11 points.

Step 3. Probability of work-relatedness

Step 3 → Probability of work-relatedness

The relationship between the exposure to risk factors at work and the probability of work-relatedness depends on the age of the worker concerned. Read off the probability corresponding to the total exposure score calculated from the checklist on page 12 from the appropriate column in the table below.
The horizontal line in each column indicates the 50% work-relatedness probability limit.

	Age < 35 years	Age 35 – 45 years	Age > 45 years
Total exposure score	**Probability of work-relatedness (%)**		
0	0	0	0
1	7	7	6
2	14	13	12
3	20	18	17
4	26	23	22
5	31	28	26
6	35	32	30
7	39	35	33
8	43	39	36
9	46	42	39
10	49	44	42
11	52	47	44
12	55	49	46
13	57	51	48
14	59	53	50
15	61	54	51
16	62	56	53
17	64	57	54
18	65	58	55
19	66	60	56

Back to Jack

Jack is 47 years old. So 11 points make a probability of 44% for work-relatedness. So the low back pain is work-related but not the main cause. Of course, the doctor discusses prevention of low back pain with Jack.

2.3. Counseling the worker and prevention

There exists a lot of 'beliefs' regarding treatment and prevention of non-specific low back pain. One has to bear in mind that non-specific low back pain is called 'non-specific' because the pathophysiological mechanisme is still 'unkown'. This makes it complex to theoretically understand the effects of treatment and prevention. Despite that, there is consensus and evidence for the following actions in counseling and prevention.

2.3.1 Counseling the worker

The following advice is for workers presenting themselves with *(sub)acute low back pain (< three months)* based on http://www.backpaineurope.org/web/files/WG1_Guidelines.pdf:

- Give adequate information and reassure the patient
- Advise patients to stay active and continue normal daily activities including work if possible
- Prescribe medication, if necessary for pain relief; preferably to be taken at regular intervals; first choice paracetamol, second choice NSAIDs. Do not prescribe bed rest as a treatment

The following advice is for workers presenting themselves with *chronic low back pain (> three months)* based on http://www.backpaineurope.org/web/files/WG2_Guidelines.pdf:

- Cognitive behavioural therapy, supervised exercise therapy, brief educational interventions, and multidisciplinary (bio-psycho-social) treatment can each be recommended for non-specific chronic low back pain.

2.3.2 Prevention

- Physical exercise is recommended in the prevention of LBP, for prevention of recurrence of LBP (Level A) and for prevention of recurrence of sick leave due to LBP. There is insufficient evidence to recommend for or against any specific type or intensity of exercise.
- Temporary modified work and ergonomic workplace adaptations can be recommended to facilitate earlier return to work for workers sick listed due to LBP.
- There is some evidence that, to be successful, a physical ergonomics programme would need an organisational dimension and involvement of the workers; there is insufficient evidence to specify precisely the useful content of such interventions.
- Lumbar supports or back belts are not recommended.
- Shoe inserts/orthoses are not recommended. There is insufficient evidence to recommend for or against in-soles, soft shoes, soft flooring or antifatigue mats.
- Whilst multidimensional interventions at the workplace can be recommended, it is not possible to recommend which dimensions and in what balance.

For more information see: http://www.backpaineurope.org/web/files/WG3_Guidelines.pdf

- There is moderate quality evidence that MMH advice and training with or without assistive devices does not prevent back pain or back pain-related disability when compared to no intervention or alternative interventions. (Verbeek et al. 2011, http://summaries.cochrane.org/CD005958/advice-on-material-handling-techniques-and-using-assistive-devices-to-prevent-and-treat-back-pain-in-workers).

Back to Jack

On a short notice, Jack still has to lift bricks manually. However, the exposure to the other work-related risk factor for non-specific low back might be reduced. Arbouw – the Dutch health and safety organization in construction– informed Jack's company doctor that working with a scaffolding console to adjust the working height of the storage of materials resulted in a significant reduction of the frequency and duration of trunk flexion (> 60 degrees) by 79% and 52% respectively, compared with bricks set out on the ground floor (Van der Molen et al. 2004). Moreover, the frequent use of ergonomic measures was associated with a non-significant 15% (RR = 0.85; 95% confidence interval = 0.46-1.55) reduced risk of reporting regular or sustained low back complaints among construction workers after a 4.5-year period (Van der Molen et al. 2010). That is why the doctor asked Jack why he did not use mechanical height adjustable scaffolds for the bricks and mortar. Moreover, the fact that he did not advice a training in proper manual handling was based on the Cochrane review by Verbeek et al. (2011, http://summaries.cochrane.org/CD005958/advice-on-material-handling-techniques-and-using-assistive-devices-to-prevent-and-treat-back-pain-in-workers). More importantly, the doctor reassured Jack about the significance of his low back complaints and stimulated Jack to maintain an active lifestyle, both in his work and in his private life (see above, European guideline for prevention in low back pain (2004), http://www.backpaineurope.org/web/files/WG3_Guidelines.pdf). Finally, the doctors' remark about losing weight is not based on evidence for prevention of low back pain. Of course, it will result in a lower mechanical load on the back while picking up bricks. On the other hand, no 'harm is expected from losing weight' and it might support Jack to keep an active lifestyle.

Summary

This chapter shows that the onset or worsening of MSDs can be due to the work a patient performs. Therefore, a physician – regardless of his expertise – should always ask whether the patient finds his complaints work-related because this might have consequences for counseling, treatment, return-to-work and prevention. The chapter is illustrated by an in-depth description of the case of Jack: a brick layer suffering from low back pain.

Key words

Attributable risk
Bending and twisting
Cochrane reviews
Effectiveness of interventions
Ergonomics
Exposure (Duration, Frequency and Level)
Force (N)
Lifting and carrying
Manual material handling

Mechanical workload
Moment (Nm)
Musculoskeletal disorders
Non-specific low back pain
Occupational disease
Physical job demands
Risk factor
Whole body vibration
Work-related disease
Work-related fraction

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