

---

**RSI**

---



---

To the State Secretary for Social Affairs and Employment

---

Subject : Presentation of RSI report  
Your reference : ARBO/ATB/98/00914 and ARBO/ATB/98/39733  
Our reference : U-2558/PB/RA/571-K  
Enclosures : 1  
Date : 27 November 2000

Dear State Secretary,

In response to your request, worded in the letters referred to above, I hereby present you with an advisory report on RSI. It was compiled by a Health Council Committee that I appointed for this purpose and has been assessed by the Standing Committee on Medicine and the Standing Committee on Health and the Environment.

The current level of knowledge concerning the causes, prevention and treatment of the range of symptoms and disorders that the Committee considers to be RSI-related, exhibits important gaps in many areas. Accordingly, the Committee concludes that the scientific basis for concrete recommendations with respect to the prevention and treatment of RSI is limited. In its report, the Committee indicates which areas require further scientific research.

In view of the need to prevent RSI symptoms, various companies and organisations are introducing preventative measures. To ascertain the extent to which these measures are effective, it is vital that companies and organisations, in consultation with occupational health services, link the introduction of such measures to a systematic evaluative framework. With respect to the early detection and timely treatment of RSI symptoms, it is also important that the outcomes of treatments used in occupational health practice are monitored and evaluated.

Due to the considerable international interest in the RSI issue, the Health Council will shortly publish this report in English.

Today, I have also presented this report to the Minister of Health, Welfare and Sport.

Yours faithfully,  
(signed)  
Prof. JA Knottnerus

---

---

---

**RSI**

---

---

to:

the State Secretary for Social Affairs and Employment

the Minister of Health, Welfare and Sport

---

No. 2000/22E, The Hague, 27 November 2000

---

---

The Health Council of the Netherlands, established in 1902, is an independent scientific advisory body. Its remit is “to advise the government and Parliament on the current level of knowledge with respect to public health issues...” (Section 21, Health Act).

The Health Council receives most requests for advice from the Ministers of Health, Welfare & Sport, Housing, Spatial Planning & the Environment, Social Affairs & Employment, and Agriculture, Nature Preservation & Fisheries. The Council can publish advisory reports on its own initiative. It usually does this in order to ask attention for developments or trends that are thought to be relevant to government policy.

Most Health Council reports are prepared by multidisciplinary committees of Dutch or, sometimes, foreign experts, appointed in a personal capacity. The reports are available to the public.

---

Preferred citation:

Health Council of the Netherlands: RSI. The Hague: Health Council of the Netherlands, 2000; Publication No. 2000/22E.

---

all rights reserved

---

ISBN: 90-5549-366-X

---

---

# Contents

---

---

Executive summary 9

---

1 Introduction 13

1.1 The Ministerial Commission 13

1.2 The Committee 14

1.3 Layout of this advisory report 14

---

2 Definition of terms 15

2.1 Nomenclature 15

2.2 Symptoms and forms of RSI 16

2.3 Definition of RSI 17

---

3 Pathophysiological mechanisms 19

3.1 Overloading of muscle fibres, tendons and nerves 19

3.2 The role of the nervous system 22

3.3 Discussion 24

---

4 RSI in the Netherlands 25

4.1 Interpretation of the data 25

4.2 Prevalence research in the Netherlands based on complaints reported by respondents 27

4.3 Research abroad 32

4.4 Conclusion 32

---

---

5	Risk factors	35
5.1	Conceptual model	35
5.2	Methodological limitations	37
5.3	Physical (occupational) risk factors	38
5.4	Psychosocial (occupational) risk factors	40
5.5	Personal risk factors	41
5.6	Risk factors outside the workplace	42
5.7	Standardization of risk factors	42
5.8	Discussion	42

---

6	Prevention	45
6.1	Methodological problems	45
6.2	Research results	46
6.3	Key issues for research	49
6.4	Discussion	50

---

7	Treatment of patients with aspecific RSI complaints	53
7.1	The everyday situation	53
7.2	Current level of knowledge	54
7.3	Guidelines from professional organisations and current practice	59
7.4	Occupational reintegration	60
7.5	Discussion	61

---

	Literature	65
--	------------	----

---

	Annexes	73
A	The request for advice	75
B	The Committee	77

---

---

## Executive summary

---

RSI is a medical syndrome affecting the neck, upper back, shoulders, upper and lower arm, elbow, wrist or hand, or a combination of these areas. Its effects are restrictive or lead to participation problems. The syndrome is characterised by a disturbance in the balance between load and physical capacity, preceded by activities that involve, repeated movements or prolonged periods spent with one or more of the relevant body parts in a fixed position. RSI is always caused by a combination of factors. The definition of RSI adopted by the committee excludes pains and other conditions that are short-lived or acute. As a syndrome, RSI necessarily involves a complex of complaints. Although the descriptive accuracy of the syndrome's name has been widely questioned (RSI stands for Repetitive Strain Injury), it remains in use because it is so well known.

Various pathophysiological mechanisms can give rise to RSI problems. These mechanisms remain largely hypothetical. They include abnormalities affecting the muscles, nerves and tendons, separately or in combination. Disorders of the central nervous system may also lead to RSI.

The outcome of any attempt to estimate the prevalence of RSI depends greatly on the defined objective and methodology of the research. Insight into the syndrome's prevalence in the Netherlands comes entirely from self-reported data, i.e. data obtained from questionnaires. If no distinction is made on the basis of duration or seriousness, the prevalence of complaints proves to be between 20 and 40 per cent a year. One study distinguished between RSI complaints that did affect the sufferer's ability to perform day-to-day activities and those that did not. This approach is consistent with the

---

definition of RSI adopted by the committee. The prevalence of RSI problems interfering with day-to-day activities over the last year is 11 per cent for the neck/shoulder/upper back and 5 per cent for the elbow/wrist/hand. In the Netherlands, prevalence is greatest in the manufacturing industry, the hotel and catering trade, the building industry, transport, agriculture and 'other service industries'. People in certain professions are far more likely than average to suffer from RSI; these include tailors and dressmakers, construction workers, loaders/unloaders and packers, secretaries, typists and VDU users.

Risk factors associated with RSI include excessive use of force, working in awkward positions, working continuously in the same position (static strain) and repeated movements. Psychosocial occupational factors do not themselves lead to RSI problems, but can exacerbate physical factors. Insufficient opportunity for recovery, psychological strain (extreme pressure of work, high levels of stress, high working tempo, mentally demanding work) and inadequate social support (as provided through relations with colleagues, superiors and managers) are probably significant. Almost nothing is known about the extent to which personal factors (such as physical build and ability to handle stress) help to determine an individual's chances of developing RSI. Insight into the relative influence of the various risk factors and pathophysiology of RSI is important in relation to the formulation of preventive policies. Not enough is yet known about RSI causation to support the development of standards.

At present, scarcely any data is available on the effectiveness of particular preventive policies – even those that are in (widespread) use. Research is needed to determine the value of measures designed to improve posture, limit the use of force and reduce the duration of strain, such as the use of ergonomic workplace aids, the introduction of breaks and the variation of duties. If effective means were found of influencing psychosocial factors, such as work pressure and the atmosphere within the workplace, these could be expected to be useful in the prevention of RSI. Measures designed to increase workers' physical capacity might also have preventive value.

Integrated preventive strategies that address all risk factors are likely to be most effective. However, the development of such strategies depends on the availability of information regarding the significance of work-related psychosocial and personal risk factors.

Very little reliable research data is available regarding the treatment of RSI. Consequently, it is not possible to say which forms of therapy are effective. However, it is very important that people consulting their GP or company doctor for early symptoms of RSI receive consistent advice. In the early stages, particular emphasis should be placed on information and reassurance. Treatment should initially consist of relieving strain (by reducing exposure to the assumed risk factors), whilst also increasing the

---

body's ability to cope with strain. The latter is possible by encouraging physical exercise. Complete rest is, in the committee's view, inadvisable. Where a patient's complaints lead or threaten to lead to (occupational) participation problems, an integrated approach is called for, embracing work-related psychosocial and personal issues. Occupational reintegration can be promoted by, for example, providing alternative duties, improving the situation with regard to work-related psychosocial factors, maintaining contact with colleagues while on sick leave and allowing for a period of acclimatization on return.

Up until now, patients undergo many different forms of treatment, often without sufficient result. Apart from high costs this also results in much suffering, incomprehension and uncertainty. It is therefore particularly important that research soon provides more insights into the effectiveness of therapeutic treatments for RSI patients. Furthermore, a systematic framework for assessing the effectiveness of measures that are or will be implemented in practice is of equal importance.



# Introduction

---

## 1.1 The Ministerial Commission

On 18th June 1998 the President of the Health Council received a Ministerial Commission from the State Secretary for Social Affairs and Employment (SZW) on the subject of RSI (Annex A). This was followed later by a supplementary question, which was also raised on behalf of the Minister of Health, Welfare and Sport, regarding the potential treatment measures and occupational reintegration of people with RSI (Annex A).

The State Secretary for SZW voiced his concern that the number of people with RSI complaints could possibly rise due to the increase in repetitive work that has resulted chiefly from the growing use of VDUs and keyboards for more and more tasks, combined with increasing pressure of work. He wants to tighten up occupational health and safety policy as a matter of urgency in order to prevent these complaints. Furthermore, he wishes to consult with the social partners with a view to setting up results-oriented agreements in each of the sectors concerned. With this policy in mind, the State Secretary has put a number of questions to the Health Council (Annex A). These questions relate to the definition of terms, the occurrence of RSI, the identification and standardization of risk factors and the prevention and treatment of RSI.

---

---

## **1.2 The Committee**

The President of the Health Council has entrusted a committee which he has created specifically for this purpose (see Annex B) with the task of drawing up a response to the Ministerial Commission. The Committee has reviewed and assessed the scientific literature. Consideration has also been given to the gaps in current scientific knowledge. Experts and interested parties have been consulted in order to support the debate within the Committee (see Annex B).

---

## **1.3 Layout of this advisory report**

The advisory report begins by defining RSI (chapter 2). It then describes pathophysiological mechanisms that can give rise to RSI (chapter 3). An insight into these mechanisms is important when formulating opinions about risk factors for RSI, prevention and treatment of patients. The prevalence of RSI complaints is examined in chapter 4, which is followed by a chapter on the risk factors (chapter 5). Interventions designed to prevent RSI and recommendations for research are outlined in chapter 6. Chapter 7 provides an overview of the current level of knowledge with regard to the treatment of RSI patients.

## Definition of terms

---

In the scientific literature, RSI (*Repetitive Strain Injury*) is regarded as a collection of work-related complaints. The term is surrounded by many areas of uncertainty, as is demonstrated by the differences in nomenclature. In the USA, for example, reference is made to CTD (*Cumulative Trauma Disorders*), whereas in the UK the term *Work-Related Upper Limb Disorders* (WRULD) is used in addition to RSI. Another term that appears in the scientific literature is *Work-Related Upper Extremity Musculoskeletal Disorders* (WRUEMD). Other names are *cervicobrachial syndrome*, *occupational cervicobrachial disorder* (Japan, Sweden) and *occupational overuse syndrome* (Australia). It is, incidentally, unclear whether these terms are always construed in the same way.

---

### 2.1 Nomenclature

The designation 'Repetitive Strain Injury' has been the subject of widespread debate. The term is confusing and open to a variety of different interpretations. For example, the name suggests the presence of an injury, whereas in the majority of cases it is not possible to demonstrate any objectifiable abnormality which explains the complaints.

The term RSI is also widely known in the Netherlands and it is for this reason alone that the Committee is adopting this particular term. Although the term's descriptive accuracy is open to question, the Committee believes that this is the way to achieve maximum possible recognition of the problem, among risk groups, patients, the medical profession, researchers and policy-makers.

---

---

## 2.2 Symptoms and forms of RSI

RSI complaints can manifest themselves in many ways. The following are some of the symptoms affecting the neck, shoulders, arms, elbows, wrists, hands or fingers that have been reported in the literature (Bon98, Har98, Slu99, Yas97):

- pain
- stiffness
- tingling
- clumsiness
- loss of co-ordination
- loss of strength
- skin discolorations
- differences in temperature.

RSI complaints frequently appear simultaneously in more than one anatomical region. The complaints may also affect different anatomical structures within a given region, e.g.: nerves, tendons, muscles and the attachments and connections between different structures. The neck, upper back, shoulder, arm, elbow, wrist and hand are referred to collectively as the upper extremity. For a definition of the relevant regions, the Committee refers to Sluiter *et al.* (Slu00).

Based on the English term, it should, in theory, be possible for RSI to manifest itself in the knee or ankle, but thus far only problems affecting the upper extremity have been classified under RSI. This is also the basic premise underlying this advisory report.

Various readily diagnosable conditions can be classified under the heading of RSI. Examples are carpal tunnel syndrome, tennis elbow and tension neck syndrome — conditions which affect the nerves, tendons and muscles, respectively. The Committee classifies those RSI complaints that can be attributed to a specific, medically objectifiable disorder as ‘specific RSI’. RSI complaints for which there is no underlying medically objectifiable disorder are designated by the Committee as ‘aspecific RSI’. The Committee classifies both of these forms under the heading of RSI, because the causative factors are, in its opinion, the same.

Table 1 contains a summary of the objectifiable disorders which, according to the Committee, fall under the term RSI. Other classifications are also possible (Slu00). For all of these disorders, however, it is true to say that only a small proportion of the cases that occur can be designated as RSI. A case of carpal tunnel syndrome is not classified as RSI if it is associated with pregnancy or with thyroid hormone deficiency. White finger syndrome and hand-arm vibration syndrome do not, in the Committee’s opinion,

---

Table 1 Medically objectifiable disorders that can be classified under specific RSI.

diagnosis	anatomical region where complaints occur
carpal tunnel syndrome	wrist, hand
cubital tunnel syndrome	elbow, lower arm
Guyon's canal syndrome	hand
the Quervain's disease	lower arm, wrist, hand
epicondylitis lateralis/medialis cubiti	elbow, lower arm
rotator cuff syndrome	shoulder, upper arm
thoracic outlet syndrome	neck, upper arm
tension neck syndrome	neck, shoulder
tendinitis of the wrist/finger; flexors/extensors	wrist, hand

fall under the heading of RSI, since both conditions have only one cause, namely vibration. The Committee believes that RSI is always caused by a combination of factors.

Discussion of the diagnosis of RSI complaints falls outside the Committee's remit. A European guideline was recently published on this subject (Slu00). For the medically objectifiable disorders that are classified under specific RSI, the guideline includes descriptions of the clinical characteristics of the disorder concerned, the differential diagnoses and the experimental characteristics. According to this guideline, aspecific RSI is diagnosed by ruling out medically objectifiable disorders. In the future, diagnostic criteria will be produced by compiling structured information about these aspecific RSI complaints.

It is estimated that specific disorders are only responsible for 13 to 27% of all RSI complaints (Bar98, Mil88, Slu99, Vii83). The majority of the complaints cannot be traced back to one of the objectifiable disorders mentioned above. The vast majority of cases involve problems affecting the neck, shoulders or arms without there being any demonstrable pathological substrate or objective radiological, vascular, electrodiagnostic or other abnormality.

---

## 2.3 Definition of RSI

It is evident from the scientific data (see also chapter 5) that physical stress on the musculoskeletal system as a result of the application of force, posture, repeated movements and combinations of these factors, constitutes a risk factor for RSI (Ber94, NIO97, Slu00). We are constantly learning more about the role of psychosocial and personal factors (NIO97, Slu00, Win00). However, our knowledge about the relative

---

contributions that the different risk factors make to the emergence of RSI is still limited. Force, posture and repeated movements are characteristic features of the execution of tasks and other activities. The Committee believes that this must also be reflected in the definition of the term.

Based on the considerations outlined above, the Committee has therefore arrived at the following definition of RSI:

*RSI is a multifactorial complaints syndrome affecting the neck, upper back, shoulder, upper and lower arm, elbow, wrist or hand, or a combination of these areas, which leads either to impairment or to participation problems. The syndrome is characterized by a disturbance in the balance between load and physical capacity, preceded by activities that involve repeated movements or prolonged periods spent with one or more of the relevant body parts in a fixed position as one of the presumed etiological factors.*

In essence, this definition is consistent with the revised version of the International Classification of Impairments, Disabilities, and Handicaps (ICI99). Here an ‘impairment’ is defined as the difficulties which an individual experiences in carrying out activities, while the term ‘participation problems’ refers to problems with social interaction.

In this definition, the Committee has consciously avoided establishing any link with work, since RSI can also arise as a result of activities performed outside work. The use of the terms ‘impairments’ or ‘participation problems’ in the definition implies that the designation RSI excludes pains and other conditions that are short-lived or acute. The term ‘complaints syndrome’ indicates that RSI necessarily involves a complex of complaints. The definition adopted by the Committee encompasses RSI complaints involving varying degrees of seriousness and duration. The Committee feels that it is not possible to provide a precise classification of these based on the current level of knowledge. It believes that the widespread practice of breaking the condition down into three phases (I, II and III) has not been clearly established and that there is no empirically validated correlation between the different phases and the prognosis of the RSI complaints. This means that any differentiation between the different phases is necessarily arbitrary. The Committee does acknowledge, however, that RSI complaints exhibit different degrees of severity.

The Committee notes that the term RSI (*Repetitive Strain Injury*) is inconsistent with its definition. Other factors apart from repeated movements (e.g. static strain) can contribute to the development of RSI. It has nevertheless decided to retain the name RSI for the reasons outlined in section 2.1.

## Pathophysiological mechanisms

---

Specific RSI embraces disorders affecting the muscles, nerves and tendons. In the case of aspecific RSI complaints, it is unclear in which structures (or combination of structures) abnormalities occur. Due to the involvement of several structures one cannot speak of 'the causal mechanism' of RSI. It is, however, quite conceivable that one or more common mechanisms may play a role in the development of the different symptoms. No single mechanism has been scientifically determined to date, although various hypotheses have been formulated. These hypotheses are to some extent complementary. Insight into pathophysiological mechanisms forms an important basis for the formulation of opinions about risk factors for RSI, for prevention and for the treatment of patients with RSI. In this chapter the Committee provides an overview of these mechanisms.

---

### **3.1 Overloading of muscle fibres, tendons and nerves**

---

#### *3.1.1 Muscle fibres*

During the time that a muscle is active, a cascade of mechanical and physiological processes occurs within it. Mechanical reactions include both elastic and plastic deformation of connective tissue and an increase in the pressure within the muscle. Physiological reactions include disturbance and subsequent readjustment of electrochemical and metabolic equilibria. These reactions can result in damage to the muscle tissue and thus may possibly contribute to the development of RSI.

---

During muscle activity, muscle fibres are recruited in order of the size of the particular motor unit to which they belong, in accordance with the so-called *size principle* (Hen65). This principle implies that small units with what are known as type-I fibres will remain activated continuously when prolonged tasks are performed. According to the so-called ‘Cinderella hypothesis’, this also determines the development of RSI (Häg91). Just like Cinderella, the small motor units are active over prolonged periods. Although the overall intensity of the load acting on the muscle is low, for the units involved it is high. Recent experiments do, in fact, demonstrate that certain units remain active continuously and, moreover, at a relatively high intensity (For99; Kad99; Wes97). Individuals who are able to interrupt briefly the activity of a muscle during a task, and thus also interrupt the activity of type-I fibres (Wes97), have a lower risk of RSI (Vei90; Vei93). This finding supports the Cinderella hypothesis.

One example of a disturbance of the equilibrium in and around the muscle, which is possibly directly related to RSI, is the accumulation of calcium in the muscle cells as a result of prolonged muscle activity (Wes92). The elevated concentration of calcium could indirectly result in damage to the cell wall and interfere with cell functions (Arm93, Edw88). This mechanism would also explain the abnormalities that have been discovered in the muscle cells (within the mitochondria) of patients with pain complaints in the trapezius muscle (Lar90, Lin91, Lin92).

Overloading of type-I muscle fibres, for which the probable underlying mechanism is accumulation of calcium, can result in damage to these fibres. This damage appears to be associated with pain complaints. This process could possibly be initiated by prolonged and uninterrupted muscle activity, along with poorly controlled agonist/antagonist interaction (co-contraction). Task- and workplace-related characteristics, organizational factors and possibly also personal factors determine whether some muscles are to be active (possibly continuously), for how long and at what level. The need for precision and the stress of the task in question will lead to a further increase in muscle activity (Gem98, Gom87, Lau98, Spo98, Wae91, Wae96).

---

### 3.1.2 *Tendons*

It is presumed that inflammations of the tendon and tendon sheath are caused by mechanical or thermal stress. Both forms of stress are determined by the force that the muscle in question exerts on the tendon. Four presumed pathophysiological mechanisms can be distinguished: exceeding a certain degree of extension (relative elongation) of the tendon; friction between tendon and tendon sheath; damage resulting from fatigue; and, finally, a mechanically induced local increase in temperature.

In 1967 Abrahams demonstrated that tendon tissue is damaged if it is elongated by more than 3 per cent (Abr67). He argued that this limit is not exceeded in connection

---

with physiological loads. However, subsequent research findings demonstrate that prolonged or repeated stress gives rise to a gradual increase in elongation and can ultimately result in damage (Ell78, Gol81, Gol87, Hub88). In animal experiments, damage to the tendon tissue has been discovered following frequent high-force loading (Bac90), but not in connection with frequent low-force loading (Smu95). The latter observation is inconsistent with the finding that RSI is also widespread in occupations which frequently only involve low-force activities.

Friction between tendon and surrounding tissue occurs where the tendon branches off, and thus generally in the region of joints in connection with non-neutral joint positions (Arm78). Some researchers blame damage to tendons and tendon sheaths on this friction (Moo91, Row87). Accordingly, Archambault *et al.* have shown in experimental animals that it was possible to damage the outermost layer of the tendon by means of low-force cyclical loading (Arc97). The amount of frictional energy produced depends on the number of loading cycles and the magnitude of the force exerted on the tendon. Finally, the friction is also to a great extent determined by the angle that is formed by the tendon (and thus the position of the underlying joint) (Gol81).

It is suspected that every time force is exerted upon a tendon, it sustains some degree of micro-damage, from which it will, under normal conditions, recover (Sch97). If there is insufficient opportunity for recovery, clinical symptoms could develop.

Due to the viscous and elastic properties of tendon tissue, heat is produced during a loading cycle. A rise in the temperature of a tendon *in vitro* above 42 °C results in damage to some types of fibroblasts (Ara89). It is therefore likely that a rise in the temperature within the tendon will result in tendon-tissue damage and necrosis. In animal experiments, such injurious temperatures have been attained in the tendon following repeated loading (Wil94). The rise in temperature is dependent on the force acting on the tendon and on the number and the frequency of the loading cycles.

Moore *et al.* have conducted a comparative study of the risk factors for tendon problems that have been identified in epidemiological studies (Moo91). Force, posture and repetition were revealed to be the central risk factors. It is evident from the above that each of the potential pathophysiological mechanisms that have been mentioned is associated with at least two of these three central risk factors.

---

### 3.1.3 Nerves

Disturbances in the function of peripheral nerves can also be caused by mechanical overloading. A comprehensive review of the literature is provided by Viikari-Juntura and Silverstein (Vii99). Both the pressure in the surrounding tissue and direct loading can, over time, impair nerve conduction. Elongation of the nerve is also cited as a cause of conduction disturbances, as is exposure to vibration.

---

The blood supply to the nerve is dependent on the hydrostatic pressure in the surrounding tissue. Various animal experiments have revealed that at a pressure of between 30 and 80 pascals the local circulation is reduced to such an extent that the survival of the nerve is threatened (Har79, Lun83, Ryd81). In experimental research with healthy volunteers, compression of a nerve at 40 pascals for four hours was found to result in reduced nerve conduction and reduced sensory perception (Gel83). It appears that the pressure in the carpal tunnel can reach such levels whenever force is applied with the fingers. The increase in pressure is principally dependent on the force that is applied and to a lesser extent on the position of the wrist (Rem97).

Direct compression of the nerve by surrounding structures has been demonstrated in the neck and the wrist. This form of compression can also lead to a reduction in local circulation and nerve conduction (Dah87; Ryd81). Nerves are surrounded by muscles and tendons, and hence the pressure on the nerve is dependent on the force that is applied. Furthermore, the position of the neck, shoulder and wrist determines the size of the area in which compression can occur. This area determines the degree of the damage that is caused by compression.

Friction between the nerve and the surrounding tissue can result in elongation of the nerve (Bay97). In experimental animals, elongation by approximately six per cent was found to lead to a change in the nerve conduction (Wal92).

The three hypothetical mechanisms whereby nerves are overloaded point to the same potential risk factors. These are, in particular, force (applied with the fingers), non-neutral joint positions or extreme movements and the duration and frequency of the load. These are consistent with risk factors for carpal tunnel syndrome as demonstrated in epidemiological research (Vii99) and aspecific forms of RSI (Sil86).

---

## 3.2 The role of the nervous system

Johansson and Sojka formulated a hypothesis regarding the development and persistence of pain in muscles. This also provides an explanation for the tendency of RSI to 'jump across' to other muscles (Joh91). The hypothesis is based on an interaction between muscle and nervous system which elicits a response both in the stressed muscles and in surrounding muscles. It is presumed that pain signals from the muscle lead to a change in the control of the muscles. This results in increased activity on the part of the muscle, giving rise to positive feedback (prolonged muscle activity does not only reinforce itself, but also the activity in surrounding muscles). This mechanism would explain why the muscle becomes overloaded and why local complaints spread to neighbouring muscles. It might be reinforced or even initiated by stress as a result of increased activation of the sympathetic nervous system interfering with this mechanism (Pas85, Pas96). Apart from the increased tonic muscle activity,

---

this mechanism could also explain the clumsiness displayed by patients with RSI, but this phenomenon is probably also associated with the central nervous system. Monkeys that performed a repetitive movement with one hand over a prolonged period developed a reticence as far as the use of the hand performing the repetitive movement was concerned, along with increased clumsiness and reduced performance. In these animals changes were also demonstrated in the cerebral cortex, which were suggestive of reduced differentiation of the sensory information from the hand and the arm (Byl96).

Another possible mechanism is focal dystonia or co-contraction. Muscles that do not necessarily need to be contracted for the purposes of a particular movement and are, in fact, intended for an opposite movement are then continuously contracted. The blood flow to the muscle is thus impaired, which can result in damage. The role played by this mechanism is demonstrated by the outcomes of a number of studies (Coh88, Hug85, Win91).

The forms of tissue overload discussed in section 3.1 can give rise to nociception (perception of harmful influences, generally in the form of pain). It is important to note, however, that tissue damage is not a prerequisite for nociception. Nociceptors (pain sensors) in muscle tissue can also be excited by substances released during prolonged muscle activity (Men93). Sensitization is the result of repeated excitation of nociceptors and is characterised by spontaneous activity and an increased response to stimulation of the nociceptors and those nerves in the spinal cord that are involved in the perception of pain. Some researchers argue that RSI sufferers have developed heightened pain perception as a result of sensitization (Lit95, Urs97). Cohen *et al.* also arrive at a similar hypothesis: RSI involves a disturbance of nociception in the spinal cord, induced by the continuous action of stimuli from nociceptors in relevant anatomical areas in the arms and the neck (Coh92). Research has confirmed that people with RSI have a reduced pain threshold and reduced tolerance of pain (Coh95). Frost and Stricoff (Fro97) believe that sensitization in RSI patients would arise in interaction with symptoms that occur in the muscle tissue as a result of overloading.

---

### 3.3 Discussion

The mechanisms discussed above are hypothetical, even though the results of experimental and epidemiological research support some of the hypotheses. Supplementary research will be needed to confirm the direct relationship between these mechanisms and the development of RSI complaints.

The Committee believes that RSI complaints, in common with many other disorders, develop because the balance between load and physical capacity is gradually disturbed. It feels that no single universal mechanism can be identified, but considers it likely that over time a cascade of changes in nerves, muscles or tendons gives rise to RSI

---

complaints. This cascade may be activated in one or more structures and the sequences of the changes in the different structures is not fixed. If this process is not brought to a halt in due course, a vicious circle will arise. The Committee is aware that this line of reasoning is not unique to RSI, but it does probably contrast with popular conceptions. Further research is also indicated in order to support this line of reasoning.

## **RSI in the Netherlands**

---

When evaluating a particular health problem, it is relevant to have an understanding of the seriousness and duration of the complaints, the extent of impairments and their implications for absence due to illness. There is still no effective system in the Netherlands for registering people with RSI complaints. Estimates of the prevalence of this condition is therefore based on research results. Efforts to interpret those results therefore run up against various problems.

---

### **4.1 Interpretation of the data**

Definitions of RSI in the scientific literature are usually neither precise nor unequivocal. In some publications the term refers to one or more disorders with specific medical diagnoses, such as carpal tunnel syndrome or tennis elbow. Elsewhere, prominence is given to complaint-based diagnosis (using RSI as an umbrella term) or emphasis is placed on the group of disorders without any specific diagnosis. It is usually unclear which fundamental criteria have been applied. Consequently it is often difficult to draw comparisons between the results of different investigations of the extent of the RSI problem. Due to the absence of an unequivocal definition in the literature, the Committee has formulated its own definition, the intention being to pave the way for a more conclusive definition of the term RSI (see section 2.3).

In epidemiological research, use is often made of questionnaires or (telephone) interviews. Other methods of gathering information are record-keeping and (supplementary) history-taking by a physician. The complaints reported by patients are

---

also dependent upon such factors as an individual's pain threshold, the interpretation of the way questions are phrased, familiarity with the complaints and the period to which the questions refer. In the case of history-taking, for example, the physician's perception and knowledge of RSI can play a role, especially in the absence of strict criteria. In the case of record-keeping, proper interpretation of the data demands completeness, clarity, the identification of the complaints and the correlation of these complaints with risk factors (occupational and non-occupational). If prevalence figures are based on the recording of absence from work, the seriousness of the complaints is clearly determinative: mild complaints which do not lead to absence will therefore be disregarded. Furthermore, the nature of the working conditions has a bearing on the length of the absence. Where working conditions are poor (for example, work that is associated with extreme joint positions), even individuals with mild complaints will absent themselves from work. If, however, it is possible to modify the work or else temporarily switch to alternative work (e.g. in an office environment) absenteeism will probably be lower.

RSI complaints usually develop gradually and there may be different episodes of varying duration. This problem should be overcome by including a specific date in the questions and asking explicitly about particular episodes. The fact that various options can be selected here also has a bearing on the results. In the published Dutch study (see section 4.2) participants were frequently questioned about complaints during the past 12 months. This is also referred to as period prevalence. It implies that the result obtained refers both to new cases (incidence) and to known, (relatively) long-standing cases or relapses (prevalence). This term therefore contrasts with the widely used term 'point prevalence', which refers to the number of cases at a particular moment. Henceforth in this advisory report, the term prevalence will be understood to mean period prevalence.

The results of research conducted in different countries with regard to a particular sector may differ markedly owing to the fact that the content of the work is not comparable. An occupational title or name in one country may imply a different level of exposure than it does in another and the content of a particular job can even vary between companies within the same country. This too hinders comparisons between the outcomes of research into the occurrence of RSI. Cultural influences (in relation to the perception of pain, for example) can likewise be determinative for the results that are reported.

Interpretation of the scientific literature is thus complicated by problems involving the definition of terms, the research methodology and the context in which the research was performed. When discussing the different studies, the Committee will indicate the

---

specific aspects of definition and methodology and what implications they have with regard to the estimates.

---

## 4.2 Prevalence research in the Netherlands based on complaints reported by respondents

In much of the research, the questions asked about the occurrence of RSI complaints are not entirely consistent with the definition of RSI that is given by the Committee in chapter 2. The Committee gives further consideration to the interpretation of the results (also in relation to this definition) in section 4.2.3.

---

### 4.2.1 Prevalence in the working population

The CBS study using data from the Periodic Survey of Living Conditions (POLS) refers *inter alia* to reported upper extremity complaints (Ott98). The response in the part of the study that focused on health and working conditions was 56.4%, or around 11,000 participants. From this group, employed people were selected (according to the CBS definition: 15 years of age and over, with a minimum of 12 hours of paid work per week). The 4,653 respondents thus obtained were questioned in personal interviews about the occurrence of work-related pain complaints of the back, neck, shoulders, hands or arms over the past year. Because back complaints are not classified under RSI, people with chronic back complaints were not counted when determining the prevalence of RSI. Based on this study, the prevalence of RSI is estimated to be 19%.

The results were published recently of a study conducted by TNO Work and Employment within the framework of a European Commission programme (Bla99). The aim of that study was to review the prevalence of RSI complaints and the correlation with risk factors and to identify high-risk sectors and occupations. The participants were requested to complete and return a questionnaire which was distributed via the company. The question regarding the prevalence of RSI consisted of two parts:

- Have you experienced pain or complaints in the neck, shoulders, elbow, wrist or hand over the past 12 months?
- If so, do you believe these to be related to your work?

The prevalence was found to be 30.5%. The surveyed group (N = 10,813) cannot be regarded as a representative sample of the working population in the Netherlands. Small companies were relatively over-represented. The response was fairly low (35%), and it is therefore not possible to rule out selection bias.

A third study was conducted recently in the Netherlands by De Zwart *et al.* (Zwa97). Workers were asked if they regularly experienced pain or stiffness in the

---

neck, shoulder, elbow, wrist, hand or upper or lower arm. The sample consisted of 44,486 active workers engaged in a broad range of occupations in eastern Gelderland, who had completed a questionnaire about occupational complaints in the period from 1983-1992 (response 75-80%). There was found to be a large variation, depending on the type of work, age and gender. Physically demanding work produces the highest percentage prevalence rates. Prevalence also increases with age. To allow a comparison to be made with the CBS and TNO studies, the investigators were asked for the total percentage of complaints for the different anatomical regions. The percentage prevalence was 24.2% and thus lies in the same range as the results from the studies mentioned previously.

Very recently, the National Institute of Public Health and the Environment (RIVM) reported results from research into the prevalence of musculoskeletal complaints and disorders in 3,665 individuals taken from the general population (Pic00). The response rate in this study was 47%. Two anatomical regions were identified which are of relevance to RSI, namely the neck/shoulder/upper back and the elbow/wrist/hand. The prevalence of pain complaints in the general population aged 25 years and over during the previous 12 months was 44.5% for the neck/shoulder/upper back and 23.2% for the elbow/wrist/hand. For the working population (more than 12 hours of paid work per week) these figures were 42.8% and 19.6%, respectively. The more specific prevalence figures in the general population were 31.4% for the neck, 30.3% for the shoulder, 18.8% for the upper back, 11.2% for the elbow and 17.5% for the wrist/hand.

These findings are not entirely comparable with the prevalence figures mentioned above, since the study looked at separate anatomical regions which in the other studies have either been examined collectively or were disregarded (the upper back). Furthermore, participants were not asked about the relationship between the complaints and their work. In the RIVM publication, a comparison has been made between the results of the TNO study without the conditional relationship between the complaints and work and the RIVM study for complaints in the separate anatomical regions. The percentages in these two studies were then closely comparable.

Table 2 summarizes the key characteristics and the identified prevalence rates from the four studies mentioned.

---

#### 4.2.2 *Prevalence in particular sectors and occupations*

The prevalence rates identified for the different sectors in the above TNO and CBS studies are given in Table 3. It is evident from the table that the numerical disparity — already touched upon in section 4.2.1 — between the CBS prevalence on the one hand and that identified by the TNO (an average of 19 and 30.5 per cent, respectively) applies in each of the sectors that were studied. At the same time, the pattern of

---

Table 2 Research characteristics and identified RSI prevalence.

reference, organisation	study design and population, year	research definition of RSI	N	response (%)	prevalence (%)
Ott98 (CBS)	interview and questionnaire, sample survey of working population in NL, individual, 1997	self-reported work-related pain complaints in neck, shoulders, hands or arms during the past 12 months	4,653	46	19
Bla99 (TNO)	questionnaire, sample survey of working population in NL, via companies, 1995-1996	self-reported work-related complaints in neck, shoulders, elbow, hands or wrists, during the past 12 months	10,81	35	30.5
Zwa97 (Coronel Institute)	questionnaire, via company health services, 1982-1993	self-reported complaints in neck, shoulders, elbow, hands, wrists, lower or upper arm (regular complaints)	44,49	75-80	24.2
Pic00 (RIVM)	questionnaire, sample survey of municipal administration, 1998-1999	self-reported neck/shoulder/upper back complaints, during the previous 12 months; self-reported complaints in elbow/wrist/hand, during the past 12 months	3,665	47	42.8 <sup>a</sup> 19.6 <sup>a</sup>

<sup>a</sup> Prevalence in the working population (>12 hours work per week)

Table 3 Prevalence in the different sectors, according to CBS and TNO study (Sources: Ott98 and Bla99, respectively).

sector	prevalence (%)	
	CBS <sup>a</sup>	TNO <sup>a</sup>
agriculture	32	not investigated
other service industries	26 (1)	29 (5)
transport	24 (2)	32 (4)
construction	23 (3)	38 (2)
hotel and catering	22 (4)	40 (1)
manufacturing	20 (5)	33 (3)
business services	19 (6)	26 (10)
commerce	18 (7)	28 (7)
health care	17 (8)	29 (6)
financial institutions	15 (9)	28 (8)
civil service	14 (10)	27 (9)
education	11 (11)	23 (11)

<sup>a</sup> The figures in parenthesis indicate the ranking of prevalence according to size

numerical disparity between the sectors in the two studies is approximately the same, as is evident from the accompanying rankings. It can be concluded that there is a substantial variation in prevalence between the different sectors. Within transport, the building industry, the hotel and catering trade, manufacturing industry and 'other service industries', the prevalence rates are unmistakably higher than in the commercial sector, health care, financial institutions, the civil service and education. The business services sector occupies an intermediate position, while in agriculture, prevalence is also on the high side.

Prevalence figures per occupational group are only available for the TNO study. The highest prevalences in the TNO study are reported by tailors and dressmakers (47%), construction workers (43%), loaders/unloaders and packers (42%) and secretaries and typists (38%).

The Dutch Health and Safety Inspectorate has conducted a study among 'VDU users', i.e. individuals who in the course of their work sit in front of a VDU for more than 2 hours per day (Mas98). The workers in question were principally in the civil service. 47% of the participants 'sometimes' experienced complaints in the neck, shoulders, arms, fingers or wrists, and 9% experienced such complaints 'frequently'. Of these people, 82% attribute the complaints to the VDU work. The percentage of 'frequent complaints' rose with the number of hours of VDU work per day. In this study, consideration was also given (albeit cursorily) to the seriousness of the complaints. In 44% of the VDU users with complaints, the problems also persisted in the evenings and at weekends, while in 8% the complaints were so severe that they had resulted in absence from work.

A follow-up to this study, conducted among VDU users within financial institutions and architectural firms, revealed that 40% experienced the complaints in question (Mas99). This is considerably lower than the above-mentioned rate of 56%. The experimental population and the questions asked differed from the previous study. A different response category was added, namely 'no (no complaints)' was replaced with 'no, almost never (any complaints)'. The percentage of VDU users who frequently experienced complaints was also lower, however (5% as opposed to 9%).

---

#### 4.2.3 *Discussion*

At first sight, the Dutch studies involving the total working population reveal considerable differences in the identified prevalence figures. These differences are for the most part attributable to differences in study design and the questions asked. The different studies have a number of methodological limitations (low response, selective

---

sample, age distribution of respondents), and consequently it is unclear what influence they have had on the identified prevalences.

Based on the TNO, CBS and De Zwart studies, it is not possible to differentiate between the respondents on the basis of the seriousness and duration of RSI complaints. The sample populations include both individuals who have experienced once-only pain complaints and those who have been absent from work on account of the complaints. Extremely severe RSI complaints are probably under-represented in these studies, since a proportion of the patients concerned are excluded from employment for prolonged periods. The outcomes of the RIVM study confirm the fact that complaints may be associated with participation in the work process: among people who had been declared unfit for work, the prevalence of musculoskeletal complaints was more than double the level identified among other individuals. The RIVM sample survey also provides information about the seriousness of the complaints, about the consequences for both normal day-to-day activities and work and about consumption of care.

The definition of RSI complaints in the study in question is clearly somewhat less specific than the definition preferred by the Committee, in which the specification of 'a medical syndrome which leads either to impairment or participation problems' is a central element. The Committee believes that the proviso made in the RIVM study regarding 'musculoskeletal complaints which hinder the execution of day-to-day activities' most closely approximates its own definition. Assuming that once-only complaints (reported by approximately 8% of the total number of individuals with complaints) do not hinder the execution of day-to-day activities at all, or only marginally, the percentage prevalence of neck/shoulder/upper back complaints that satisfy the above proviso is approximately 11% and that of elbow/wrist/hand complaints is around 5%. It must be emphasized that these percentages are based on respondents' answers with regard to the occurrence of pain complaints in the course of the previous year. As stated earlier, it is not possible to gather from this data how great the overlap is between prevalence and incidence.

The prevalence study reveals a higher prevalence among women compared with men (Bla99, Ott98, Pic00, Zwa97). It is not yet clear whether there is an underlying biological explanation for this or whether women do work that involves a greater risk of RSI complaints.

Based on data from the National Institute for Social Insurance (LISV), between 2,500 and 3,000 new RSI patients are estimated to have started receiving disability benefit under the Disability Insurance Act (WAO) in 1998 (as calculated by the Ministry of Social Affairs on the basis of data recorded by the LISV). This is approximately three per cent of the total inflow. In 1999 between 3,500 and 4,000 patients with RSI complaints started receiving benefit, corresponding to four per cent of

---

the total WAO inflow. It does not necessarily follow that there has been an increase in the number of cases. The increase may, for example, also have been caused by the fact that awareness of RSI has increased or that it is more frequently identified as the reason for incapacity for work.

1st November 1999 saw the enactment of the new Working Conditions Act (*'Arbowet'*), whereby reporting of suspected occupational diseases to the NCvB (Netherlands Centre for Occupational Diseases) by occupational health services becomes mandatory. The recording by the NCvB of occupational diseases, which up until that point had been reported on a voluntary basis, will in the future provide a fuller and better insight into absence due to illness and the seriousness and type of RSI (specific disorders, aspecific RSI complaints).

---

### **4.3 Research abroad**

For various reasons (as stated in section 4.1), the Committee is not considering research conducted abroad into the extent of the RSI issue. Results from foreign research might well be helpful in identifying occupations with a high prevalence, although the same limitations will apply here too. A review of foreign studies into the relationship between work and various complaints and disorders that are classified under RSI highlights a number of occupations where prevalence is extremely high (Hag95). It needs to be noted in this connection that the research in question was not primarily aimed at determining prevalence, but — as was stated — at the possible work-relatedness of the disorder or complaint. The experimental populations have possibly been selected on the basis of high prevalence. Nevertheless, the high-risk occupations that were cited earlier feature prominently (see section 4.2): according to the review in question, there is a high prevalence of disorders and complaints which the Committee designates as RSI among workers in meat-processing industries, packers, assembly-line workers, production workers, welders, sheet-metal workers, scissors makers, check-out operators, typists, data inputters, office workers and members of orchestras. More recent research, besides confirming high prevalences in some of the occupations mentioned, has also discovered a high prevalence among ultrasonographers and in fish-processing companies (Ohl94, Smi97).

---

### **4.4 Conclusion**

In the Netherlands the period prevalence of work-related complaints of the neck, shoulder, arms or hands, as reported by respondents during the year preceding the study, in all probability stands at between 20% and 40% of the working population. This definition of RSI complaints is, however, considerably less specific than the Committee

---

would wish. The percentage prevalence rates that conform most closely to its own definition are estimated to be 11% for complaints of the neck/shoulder/upper back and approximately 5% for complaints of the elbow/wrist/hand.

In the Netherlands, a number of sectors can be identified which exhibit an increased prevalence: manufacturing industry, the hotel and catering trade, the building industry, transport, agriculture and 'other service industries'. People in certain professions are far more likely than average to suffer from RSI. They include tailors and dressmakers, construction workers, loaders/unloaders and packers, secretaries, typists and VDU users. Research conducted abroad has also demonstrated the higher prevalence in these occupations.



## **Risk factors**

---

Various publications have appeared in recent years about risk factors for RSI complaints. The most significant, and probably the best known, is a report by the US National Institute for Occupational Health and Safety (NIOSH), entitled *Musculoskeletal Disorders and Workplace Factors* (NIO97). In this report, the NIOSH presents a review of the epidemiological evidence for work-related disorders of the neck, upper extremity and the low back, with reference to data up until approximately 1995.

Very recently the Coronel Institute for Occupational and Environmental Health (University of Amsterdam Medical Centre, AMC) reported on guidelines for the diagnosis and identification of the work-relatedness of disorders of the upper extremity (Slu00). These guidelines, which were drawn up at European level, were based on evidence from research or, in the absence of such evidence, on consensus among experts. For each anatomical region of the upper extremity, the risk factors have been determined on the basis of literature data up until 1999 (including the NIOSH report).

---

### **5.1 Conceptual model**

Risk factors can be grouped into three different categories. First of all there are the physical risk factors, such as force, posture and repetition of movement. Then there are psychosocial (work-related) risk factors. Examples of the latter are atmosphere within the workplace, pressure of work and support from colleagues. A third category of risk factors includes personal factors, such as the ability to handle stress and physical build.

---

When discussing the question of which factors have a bearing on the development of RSI, it is beneficial to use a model which embraces these factors and how they are inter-related. Various models of this kind appear in the literature (Arm93, Bon93). The most recent model was devised by the US National Research Council (NRC99). The Committee believes that this model offers a good starting point for the formulation of opinions with regard to risk factors for the development of RSI (Figure 1).

To the left of Figure 1, categories of risk factors are presented which, apart from the fact that they may interact with one another, may also have a bearing on the physiological mechanisms that underlie the development of RSI. Examples of such risk factors are: task requirements in the workplace (e.g. the application of force, static strain and repetitive work), organisation of work (e.g. variety, enforced speed) and social context (e.g. atmosphere within the workplace).

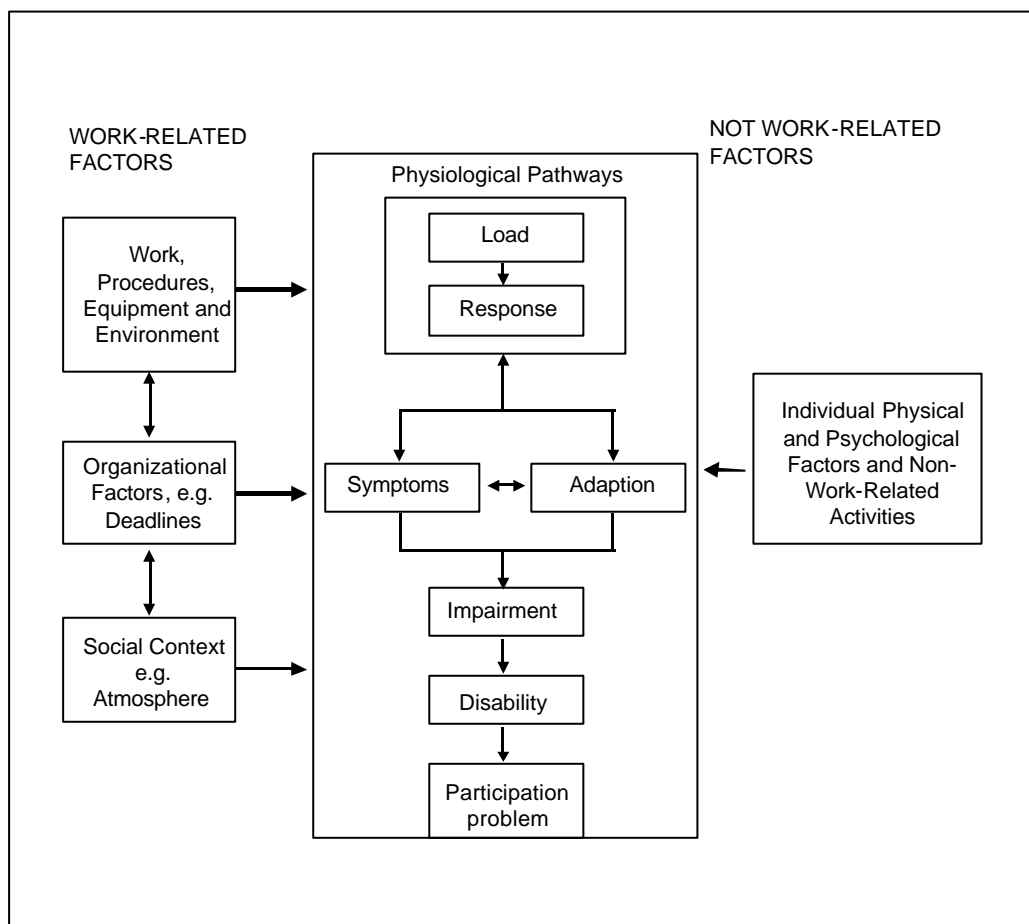


Figure 1 National Research Council RSI model (Source: NRC99, edited).

These factors define the stress. The central section represents possible physiological and behavioural mechanisms that are blamed for the development of RSI and associated complaints. Starting from the top, the column presents a continuum of essentially normal adaptive responses to external stress (top) via the development of more enduring complaints and symptoms if there are insufficient opportunities to adapt due to the duration and intensity of the stress (centre) to the development of a disorder which can ultimately result in an impairment or a participation problem. As explained in chapter 3, we still have a great deal to learn about the precise nature of the (psycho)physiological processes involved. It is also significant that factors such as individual physical capacity, opportunities for adaptation, individual perception of impairments and activities during leisure time (see right-hand column) can have an impact on the processes in the middle column.

---

## 5.2 Methodological limitations

Research into risk factors for RSI is associated with a number of methodological limitations. The NIOSH report contains a critical discussion of the frequently unclear outcomes of the studies (NIO97). The results of more recent studies are also not easy to interpret. There are various reasons for this:

### Cross-sectional design of research

Due to the fact that the risk factors and the outcome measure (for example, existence/absence of RSI complaints) are both being surveyed within an experimental population at the same time, no judgement can be made about a possible cause-effect relationship. Nevertheless, some of the factors under consideration may be both a cause and an effect of RSI. For example: is job satisfaction limited by the RSI complaints or has a lack of job satisfaction contributed to the development of the complaints?

In cross-sectional research, selection bias has played a role (and possibly a major one). Those with the most complaints are excluded from the study because they are either at home sick or else they have, in the mean time, changed their job (the so-called 'healthy worker effect'). This usually results in the importance of the risk factors being underestimated. A further problem in this type of study is the fact that in the case of self-reported exposure, people with complaints may possibly attach greater importance to the exposure than healthy individuals would. This results in an overestimation of the effect of a risk factor.

## Problems in measuring exposure

Exposure to physical risk factors (in terms of intensity, frequency and duration) cannot be established with sufficient precision via a questionnaire. In addition to a questionnaire-based study, it is therefore often advisable to conduct a workplace analysis of those factors. Psychosocial risk factors can to a certain extent be quantified on the basis of questionnaires. Other methods (for example a personal interview) are frequently more difficult to execute (costs, effect on participation). Consequently, quantification of risk factors of this type is almost exclusively carried out on the basis of questionnaires.

## Measurement and definition problems concerning the outcome measure

The outcome measure (e.g. RSI complaints, certain specific diagnoses, seriousness of the disorder) is also associated with definition and measurement problems. A broad-based definition of RSI complaints (e.g. 'RSI complaints during the past year') can result in too much 'noise', making it impossible to identify a relationship with a given risk factor. Furthermore, the diagnosis of certain abnormalities is based on diagnostic tests with moderate sensitivity or specificity. This too can lead to a distortion of the results or make it impossible to demonstrate the true effect. Differences in the method used in determining the outcome measure (e.g. via an interview or via a case history) can also influence the results.

---

### **5.3 Physical (occupational) risk factors**

---

#### **5.3.1 NIOSH**

The NIOSH results are summarized in Table 4. For the risk factors 'repetition', 'force' and 'posture' (whether separately or in combination), there is strong (or extremely strong) evidence of a relationship with complaints of the neck, shoulder, elbow, hand and wrist. In the case of the 'posture' risk factor, positions in which little or no variation occurs (static strain) are also extremely important, in addition to awkward positions (twisted joints, working beyond one's physical limits). Exposure to vibrations primarily appears to be a risk factor for complaints of the hand/wrist and then specifically for carpal tunnel syndrome and for hand-arm vibration complaints. Owing to the Committee's RSI definition, which is based on the predicate that the disorder is determined by more than one factor, hand-arm vibration syndrome is not classified under RSI. The NIOSH results also show that vibration is the only risk factor for hand-arm vibration syndrome.

---

Table 4 Evidence for correlation between physical work-related factors and musculoskeletal disorders (Source: NIO97).

	repetition	force	posture	vibration	combination
neck and neck/shoulder	++	++	+++	+/0	
shoulder	++	+/0	++	+/0	
elbow	+/0	++	+/0		+++
hand/wrist					
- carpal tunnel syndrome	++	++	+/0	++	+++
- tendinitis	++	++	++		+++
- hand-arm vibration syndrome				+++	

+++ strong evidence  
 ++ sufficient evidence  
 +/0 insufficient evidence

### 5.3.2 Coronal Institute for Occupational and Environmental Health

Table 5 contains a summary of the findings on the risk factors for each anatomical region (Slu00). Here too, repetition, force and posture feature prominently as risk factors. They are, however, more closely defined as regards duration, frequency and intensity than is the case in the NIOSH report. 'Posture', for example, is defined as 'position in relation to frequency or duration' and 'repetition' as 'repetitive movement in relation to duration'.

Table 5 Physical risk factors for RSI (Source: Slu00).

	posture related to frequency or duration	force related to frequency or duration	repetition of movement related to duration	vibrating hand tool	combination of physical factors	low temperature
neck	x		x			
shoulder and upper arm	x		x		x	
elbow and lower arm	x	x	x	x	x	
wrist and hand	x	x	x	x	x	x

x: correlation between the risk factor and the occurrence of complaints

---

## 5.4 Psychosocial (occupational) risk factors

According to the Committee, psychosocial (occupational) factors are not to be regarded as risk factors which in themselves (i.e. in the absence of physical risk factors) lead to RSI complaints. In combination with physical factors, the psychosocial risk factors may well increase the risk of the occurrence of RSI. This is confirmed by research.

---

### 5.4.1 NIOSH

As far as work and work environment are concerned, the NIOSH understands the following factors to be psychosocial risk factors: the content of the work, the organisation structure, personal relations at work, time-related aspects of the work and financial, economic and social aspects (NIO97). These may also be termed work organisation-related factors. According to the report, there is evidence to suggest a positive correlation between certain psychosocial factors (increase in workload, monotonous work, little social support) and the occurrence of upper extremity disorders. Lack of personal control over one's work and dissatisfaction with the work were evidently also correlated with musculoskeletal disorders, but the connection was less clear.

There proved to be stronger evidence for neck/shoulder disorders than for hand/wrist disorders. The NIOSH sought a possible explanation for this in the research field. In the Scandinavian countries a great deal of research has been conducted specifically into neck/shoulder disorders, in which it has been customary to adopt elaborate scales for psychosocial risk factors. In research into the wrist/hand-disorders a less elaborate form of risk analysis has generally been employed as far as psychosocial factors were concerned. This research mostly took place in North America. Furthermore, the Scandinavian investigations generally took place in an office environment, where the physical stress is lower, whereas the role played by psychosocial factors in the development of musculoskeletal disorders is possibly greater (Wes96). It is also possible that adverse psychosocial factors might have a greater effect on the neck/shoulder, in the form of muscle tension and strain, than on the hand/wrist. The Committee notes in this connection that the dynamic strain is indeed lower in an office setting than it is, for example, in an industrial work environment, but that in an office the static strain, in the form of continuous muscle tension, may well be extremely high.

---

#### 5.4.2 *Coronel Institute for Occupational and Environmental Health*

In the report from the European Saltsa project, three categories of psychosocial factors are identified, namely 'insufficient opportunity for recovery', 'a high level of psychological strain' and 'low social support' (Slu00). 'Insufficient opportunity for recovery' has been defined as: less than ten minutes' break during each hour of highly repetitive work. Psychologically stressful work factors include work stress, work rate, work pressure and work that is very mentally demanding. Social support at work refers to the relationship with colleagues, superiors and the management. All three of these factors are related to all of the anatomical regions in which RSI complaints can occur.

---

#### 5.4.3 *Other research*

In the Dutch CBS study (Ott98), once a correction had been made for the other risk factors there was no longer any obvious link between the psychosocial factors 'degree of control', 'work pressure' and 'atmosphere within the workplace' and the occurrence of RSI complaints. The study conducted by TNO Work and Employment among more than 10,000 workers revealed a slight, but probably statistically significant, connection (odds ratios between 1.28 and 1.85) for the investigated psychosocial factors 'high quantitative demands', 'little variation of duties', 'little social support' and 'low job satisfaction'. There was no statistically significant correlation between the factor 'little autonomy' and RSI complaints (OR 1.05). Analysis of these risk factors for the separate regions (neck, shoulders, elbow and hand/wrist) did not reveal a markedly different picture (Bla99).

Prospective research into risk factors for neck complaints demonstrated that high pressure of work ('high task requirements') and little support from colleagues were associated with a significantly increased risk of neck complaints (Bon00). The other psychosocial factors that were investigated ('highly conflicting task requirements', 'little scope for use of skills', 'little autonomy', 'low job security') did not result in a statistically significant increase in the risks for neck complaints.

---

### 5.5 **Personal risk factors**

By personal risk factors the Committee means such factors as ability to handle stress, the setting of limits, physical build and general condition. There is evidence to suggest that, as is the case with low-back complaints, such factors can to some extent predispose to RSI, or else, in combination with other risk factors, lead to a higher risk of developing the disorder (Tyr94, Win91). It has also been demonstrated that

---

perfectionism is a characteristic that is more commonly found in RSI patients than in the general population (Dzw99, Eij00). This finding has, however, also been made in connection with other disorders and is not, therefore, specific to RSI.

Differences in such personality-related characteristics mean that not everybody is equally 'RSI-sensitive'. Here too, we encounter the problem that with cross-sectional research methods it is not possible to discern whether changes in these factors are a (secondary) cause or simply an effect of RSI complaints. As has already been noted in chapter 4, research has shown that women have a higher risk of RSI complaints (Ott98, Pic00, Zwa97). The background to this phenomenon is still unclear.

---

## **5.6 Risk factors outside the workplace**

Risk factors outside the workplace are not often investigated, but may well contribute to the development of RSI (see, for example, Nor97). They do not, by definition, need to be intrinsically any different to the risk factors at work. During leisure time too, activities take place which, for example, involve the use of force or the performance of repetitive movements. Such factors must, in fact, be brought into the evaluation in the same way as work-related factors. The Committee believes that we currently still know too little about the influence of non-occupational risk factors to be able to take them into consideration.

---

## **5.7 Standardization of risk factors**

Standardization of risk factors is designed to set maximum limits (either quantitative or qualitative) for worker exposure. However, standardization makes greater demands on our understanding of the risk factors than does merely tracing them. For example, in order to standardize the risk factor 'posture' it is necessary to know which positions need to be avoided (and to what extent). In the European guideline that was formulated by the Coronel Institute, threshold values were stipulated, which were principally based on consensus among experts (Slu00). The Committee feels, however, that due to a lack of sufficiently detailed scientific data it is not possible to establish a quantitative standard for any given risk factor. Qualitative recommendations can be made, however (see also chapter 6).

---

## **5.8 Discussion**

It has been adequately demonstrated that physical risk factors — in the form of repetition, posture and force — have a bearing on the development of RSI complaints. For possible psychosocial occupational factors this link is much less obvious, although

---

according to the Committee they do play a role in combination with physical risk factors. Examples are 'insufficient opportunity for recovery', a 'high level of psychological strain' (work pressure, work stress, work rate and work that is very mentally demanding) and 'low social support' (relations with colleagues, superiors and management). Personal factors could also be very important, but there is a lack of reliable research results in this area.

Additional research is needed in order to demonstrate the role that psychosocial and personal risk factors play in the development of RSI complaints. Once this has been clarified, we shall have to look into the relative contribution made by the different sorts of risk factors. In order to answer that question, future research would need to take all of the different sorts of risk factors into consideration, along with those factors outside of the workplace which could influence the development of RSI complaints. In this research, one would preferably need to monitor a high-risk group of individuals without any complaints over a period of time, i.e. a cause-effect relationship needs to be investigated. In order to establish standards for risk factors, greater insight is needed into the duration, frequency and intensity of those risk factors.



## Prevention

---

Little methodologically sound research has been conducted with regard to the prevention of RSI complaints. The Committee is therefore also taking into consideration publications of research that is less methodologically sound.

---

### 6.1 Methodological problems

The outcome measure for research into the prevention of RSI complaints would ideally be health-related, e.g. the occurrence of (pain) complaints identified using a validated measuring instrument. Because as a rule complaints develop gradually, researchers have frequently opted for an intermediate outcome measure, e.g. subjective assessment of fatigue affecting a particular group of muscles. This has the disadvantage that the relationship between this intermediate outcome measure and RSI complaints is often not immediately apparent. A second methodological problem is the fact that in many cases the research does not include a control group. Thus it is not possible to establish with any degree of certainty the extent to which the result obtained is the result of an intervention or of other factors. A third difficulty is the fact that insufficient research results are available to allow clear conclusions to be drawn about the effect of preventive measures. Finally, there is often no distinction made between specific RSI disorders and aspecific complaints.

---

---

## 6.2 Research results

---

### 6.2.1 *Review publications*

Ergonomic measures designed to prevent RSI are widely publicized, but there is scant scientific data to support the efficacy of these measures. This is confirmed in a review article about ergonomic intervention research (Wes97). The authors draw a distinction between three types of ergonomic intervention: interventions aimed at mechanical exposure, interventions aimed at the production system and the culture of the organisation, and interventions aimed at changes in relation to the worker. Examples of each of these types are: adapting work-stations to suit individual workers, expansion of tasks, team-building and training aimed at increasing physical capacity. None of the studies that were considered satisfied the criteria for methodologically sound research. Nevertheless, several conclusions are formulated in the review article which the Committee summarizes as follows.

Interventions aimed at mechanical exposure are probably best suited to work situations in which exposure is high. The evidence for interventions aimed at re-designing the production system with a view to promoting health is minimal. Interventions aimed at the culture of an organisation, and thus at psychosocial risk factors, reveal all manner of results. Changing the exposure may well frequently prove effective, but the effects are usually inadequate in terms of reducing the risk of complaints developing. Interventions aimed at changes in which the worker is actively involved (medical supervision of workers with an elevated risk, physical training or training aimed at working technique, or combinations of the two) frequently resulted in fewer complaints. By way of contrast, passive measures (e.g. information and relaxation therapy) do not prove so successful.

The lack of scientific evidence also comes to the fore in the conclusions reached in two other reviews. The first, dating from 1998, is the work of a US committee representing computer manufacturers and ergonomic consultants (The Office Ergonomics Research Committee; OERC) (Bet98). It includes a report on the connection between various ergonomic measures in relation to office work and the prevention of musculoskeletal disorders. The general conclusion is that there is little scientific knowledge about the precise causes of these disorders and the value of widely used interventions. The report also contains the warning that findings from research in which only one factor was optimized, and also 'once-only' results, must not be regarded as definitive. The OERC points out that all of the elements that can have a bearing on the development of RSI complaints must be identified. These elements include working practices, how tasks are

---

completed, equipment and workplace ergonomics, individual, organizational and psychosocial factors.

The US National Research Council has also reviewed publications about intervention research with regard to the prevention of RSI complaints (NRC99). Based on strict criteria (control group, consideration of confounding factors, relevant measures, randomized research and 'blind' evaluation), only 43 of the 720 publications that were originally tracked down were subjected to closer scrutiny. Even these 43 publications failed to satisfy all of the criteria. Furthermore, in some of them 'low-back complaints' were adopted as the outcome measure. The NRC concludes that alternative equipment designed to improve hand and wrist positions in order to reduce the force acting on the palm and fingers can reduce the risk of upper extremity disorders. Another conclusion in the NRC report is that ergonomic interventions involving equipment and work-stations have a beneficial effect on the prevention of musculoskeletal complaints, RSI and accidents in healthy workers.

---

### 6.2.2 *Specific research*

Information and training programmes designed to prevent RSI complaints showed positive results, but either had an indirect outcome measure (level of knowledge, high-risk hand movements) or else an extremely short follow-up (one week) (Dor90, Riz97). Based on scientific research, however, the OERC concludes that no significant effects can be discerned from prevention or reduction of stress by means of exercise programmes (Bet98).

Research into workplace aids in the form of 'ergonomic' keyboards or arm and wrist supports has yielded varying results. Modified keyboards generally result in a less stressful joint position, reduced pain sensation and a reduction in the amount of force required, but no connection has been demonstrated between the use of these keyboards and the occurrence of RSI complaints (Rem99, Tit99, Zec00). The use of arm supports in VDU work with a keyboard resulted in less shoulder- and neck-muscle activity than working without such aids (Kor97). This is confirmed in Swedish research, but using a mouse in conjunction with an arm support resulted in a greater strain on the lower arm than working without an arm support (Fer97). Wrist supports, on the other hand, led to a greater strain than working without aids (Kor97). The OERC also established that support of the arms produced less fatigue (Bet98). Research into different sorts of input devices (computer mice, keyboard) also reveals varying results. In some of the users, the complaints are transferred to other locations, but a reduction in the complaints was also observed (Fer97). The OERC believes that the manner in which input devices are used is more important than the type of device (Bet98).

Strain on the trapezius muscle and neck pain were reduced when the office workplace was modified by creating more space to support the lower arms on the desk and making the height of the working surface easily adjustable (Aar98). These adjustments had virtually no effect on shoulder pain and pain in the lower arm. This study incorporated pre- and post-intervention measurement and a control group. After adapting the workplace, an eye test was also performed which, if necessary, led to the subject being measured for spectacles especially designed for VDU work. Following this intervention, shoulder pain was less intense. No effect was observed on the other outcome measures (pain in neck and lower arm).

Longitudinal research (after correction for the other factors) showed that improvement of the working environment led to a reduction in hand and arm complaints. Fewer neck, shoulder and back symptoms were observed in connection with a reduction in housekeeping tasks and the use of a comfortable chair (Nel98).

Various investigations have been conducted into the taking of breaks as a means of preventing RSI. In a review article based largely on US research results, Thé *et al.* concluded that the introduction of additional breaks in VDU work led to higher productivity or fewer pain complaints (Thé99). According to the OERC report discussed in section 6.2.1, taking one break per hour during VDU work is associated with an increase in performance (Bet98). According to research carried out in a manufacturing company by TNO Work and Employment, four short breaks of 10 minutes' duration plus a 30-minute lunch break had a beneficial effect on the pain complaints, fatigue, pinching strength in the hands and physical dexterity (Thé99). The total break time in one day was in this case increased by 10 minutes. There was also evidence to suggest that some form of activity during breaks (i.e. exercises) has a more beneficial effect than passive breaks.

The occurrence of RSI complaints before and after the expansion of tasks has been investigated in one study. No conclusive result emerged, but other factors may have interfered with the research, such as changes in psychosocial climate or inability to perform new tasks (Chr99).

Atmosphere within the workplace, work pressure, degree of control and the variation of duties are factors which may possibly influence the development of RSI complaints. In a number of companies TNO Work and Employment has investigated the effect of more varied tasks and a lower work rate or greater scope for organizing one's own work (Dou00). The outcome measures were the perceived physical stress, the resultant quality and the productivity. The workers who carried out more varied tasks did not judge the physical stress to be any lower, given a consistent level of quality and consistent or increased productivity. However, the ability to organize one's own work had a beneficial effect on the assessment of the physical stress and (to an even greater extent) on the opinions that were voiced with regard to quality and productivity.

---

---

### 6.2.3 Conclusion

It is evident from the above that there is little evidence to support the effectiveness of preventive measures for RSI complaints. Most of the research is methodologically inadequate. In much of the research there is either no control group, or an indirect outcome measure has been used or else the outcome measure has not been clearly defined. In some cases the findings are contradictory. Some potential preventive measures aimed at psychosocial and personal risk factors have still only received minimal research, for example the effect of (re)organizing one's work and learning to handle work stress.

The Committee perceives a need for more methodologically sound research into the effectiveness of preventive measures for RSI complaints. A greater insight into the pathophysiological mechanisms underlying RSI might pave the way for epidemiological intervention research. In that research, the intervention would need to be randomly allocated (preferably individually) and a control group would be required. In practice, randomization of an intervention at individual level is in some cases not feasible, e.g. when re-organizing a production line or when introducing a new organisation structure. In such cases, randomization should preferably be carried out at company or departmental level. If it is not possible to randomly allocate the intervention, observational research (*with* a control group) can be an option under certain circumstances. The Committee emphasizes that the inclusion of a control group is far preferable, since this substantially increases the value of the results. A further proviso is that a health-related quantitative outcome measure should be adopted. In the case of an intermediate outcome measure, the relationship between that measure and the occurrence of RSI complaints must have been demonstrated in other research. The follow-up period must be long enough to determine whether the intervention is also workable in the longer term. The Committee recommends that the effectiveness of a particular preventive measure should also be evaluated one year after its introduction.

---

## 6.3 Key issues for research

The basis for intervention research designed to prevent RSI complaints lies in an understanding of the risk factors and pathophysiology of RSI complaints. The mechanisms that may be responsible for the development of RSI complaints remain for the most part hypothetical and therefore still offer no pointers with regard to prevention.

Since at this point in time there are only a number of physical risk factors that are known to contribute to the development of RSI complaints, it is obvious that interventions will initially focus on investigating risk factors of this type. Examples of

---

these are ergonomic aids aimed at reducing the amount of force required and improving the posture. Measures aimed at reducing the duration of the strain (e.g. taking breaks and variation of duties) could also prove effective.

The Committee notes that ergonomic aids also require supplementary measures, such as individual information and training in the optimal use of the device in question. This would need to form an integral part of the research into the effectiveness of the intervention.

It is likely (but not yet certain) that psychosocial occupational factors play a role in the development of RSI complaints. The Committee considers that it is not easy to take action in relation to risk factors of this type. If methods were to become available which could effectively combat such problems as work pressure, dealing with superiors and the atmosphere within the workplace, these would, according to the Committee, be important tools in reducing RSI complaints. The Committee expects the impact of such methods to be particularly significant in combination with measures aimed at reducing physical load.

It is about personal risk factors for RSI complaints that the least is known. Nevertheless, the Committee anticipates that efforts to increase physical capacity by improving physical condition and improving muscle function will have a preventive effect. Possible measures are the promotion of physical exercise in general and company fitness. It is important that muscles other than those used during work activities should be exercised, or else that the 'work muscles' should be used in a different way. Additional research is needed in order to support the Committee's ideas in this regard.

---

## **6.4 Discussion**

As was stated earlier, the Committee regards the current level of knowledge as insufficient to enable it to recommend a definitive package of preventive measures. This therefore also means that the preventive measures that have already been adopted lack a scientific basis, it believes. The Committee urges that the introduction of preventive measures should be effected in a manner which allows for subsequent evaluation. After a given intervention has been introduced, it must be possible to determine how effective it has been.

In general terms, however, the Committee does feel able to make certain recommendations. Alongside the reduction of physical load, it believes that increasing physical capacity may possibly prove effective in preventing RSI complaints. The preventive measures that have been adopted to date have primarily been aimed at

---

reducing physical load. The same applies, for example, to a campaign undertaken by the Ministry of Social Affairs and Employment (taking breaks, varying work activities, well-designed office workplaces).

The Committee expects that it will in future primarily be a combined approach, consisting of preventive measures aimed both at the physical and the psychosocial and personal risk factors, that will prove effective in preventing RSI complaints. An understanding of the pathophysiology of RSI complaints and the relative importance of different risk factors forms an important basis for preventive measures.



## **Treatment of patients with aspecific RSI complaints**

---

For specific RSI diagnoses (such as tennis elbow), there is a reasonable degree of consensus with regard to treatment. For aspecific RSI complaints, the situation is far less consistent. It has been found in the Netherlands that patients with RSI complaints are treated within various disciplines, both by medical specialists and by paramedical practitioners (Slu99). In this chapter the Committee is therefore focusing on the treatment of patients with aspecific RSI complaints, and as far as the specific disorders (see also section 2.2) are concerned it refers to current clinical practice. It notes, however, that as far as the treatment of patients with specific disorders classified under the heading of RSI is concerned, it is also important to give consideration to working conditions and to the way in which the patient deals with work and with stress in general (see section 7.5). That consideration will, it anticipates, have a beneficial impact on the result of the treatment.

---

### **7.1 The everyday situation**

In 1988 an inventory study was published regarding the treatment of 229 patients with RSI complaints (Mil88). The effectiveness of the different treatments was not discussed, aside from the fact that, according to the patients, the treatment had been of little help, or else no help at all. The treatments administered were: rest (in 100% of the cases), ergonomic measures, medication (100% of the cases), physiotherapy (94% of the cases), psychological treatment (common, percentage not given), wrist splints (16% throughout the day) and 69% alternative therapy (acupuncture, medication, tai chi,

---

warm compresses, etc). In a study by Pransky *et al.* 112 patients with RSI were monitored over a period of 16 months (Pra99). During this period they underwent treatment via the regular circuit (no trial procedure). None of the treatments (medication, injections, surgery, rehabilitation therapy, psychological counselling) were related to any of the outcome measures in the study (work participation, self-reported functional status and a change in the complaints). At the end of the follow-up period the majority of the patients did report a reduction in the pain intensity and in their fear of pain or else an improvement in their quality of life and functional status. The investigators called for better selection of patients for procedures that are expensive and invasive, such as surgery (Pra99).

Research among 807 members of the Dutch RSI Association shows that countless different treatments are administered, including: physiotherapy, manual therapy, postural therapy, painkillers, rest, regular light exercise and other therapies (Slu99). Patient opinions about the effect of the treatments were, in general, unfavourable. 83% of the patients had at some time received physiotherapy. Only 18% of them felt they had derived much benefit from it, while 25% stated that they had not experienced any positive effect. 62% of the patients had undergone postural therapy (Cesar or Mensendieck), of whom 24% experienced a beneficial effect, while 8% said they had felt no benefit. Rest and regular light exercise had been recommended to 97% and 90% of the patients, respectively, and were also found by a high percentage of patients to be beneficial (63% and 50%, respectively). The percentage of patients who had derived no benefit from rest was low (5%), compared with the 36% who had not found regular light exercise to be useful. 50% of the patients received pain medication: 28% of them had not noticed any beneficial effect, whereas 5% had.

---

## **7.2 Current level of knowledge**

---

### **7.2.1 Physiotherapy**

In a randomized study, active physiotherapy in the form of training of neck and shoulder muscles was compared with passive physiotherapy (massage, heat therapy and stretching) in workers with pain complaints in the neck region (Lev93). Directly after active physiotherapy there was a reduction in the pain complaints. Muscle strength, grip strength and the endurance of the muscles also increased following active physiotherapy, while headaches occurred less frequently. However, passive physiotherapy also had some favourable effects, so that neither form emerged as being more positive than the other.

The Committee is otherwise unaware of any results from intervention research that specifically focuses on physiotherapy. Physiotherapy was, however, frequently one of the elements in a multidisciplinary treatment programme (see section 7.2.3).

---

### 7.2.2 *Exercise therapy (Mensendieck, Cesar)*

There is no evidence to be found in the literature to support the effectiveness of this form of therapy for RSI complaints. The Netherlands Paramedical Institute is currently formulating a guideline for the treatment of patients with RSI complaints by means of Mensendieck exercise therapy (see section 7.3).

---

### 7.2.3 *Multidisciplinary treatment*

Feuerstein *et al.* investigated the effect of a multidisciplinary approach in 19 patients with chronic RSI complaints who had been unable to work for a period in excess of three months. The treatment consisted of a daily programme lasting between four and six weeks and consisting of various aspects: warming up, building up physical condition, work conditioning/simulation, coping with work-related pain and stress, and ergonomic counselling. After an average follow-up period of 18 months, 74% of the patients were back at work. In the control group (15 patients), who received standard care, the proportion was 40%. The standard care consisted of one or more of the following forms of treatment: treatment by a GP, physiotherapy, chiropractic, hand-function training, (rehabilitation counselling or pain control (Feu93).

In a Swedish study, multidisciplinary treatment of 53 patients with neck and shoulder complaints was no more effective than traditional treatment in 40 patients (Ekb94). On average, the sick leave after treatment was higher in the group of workers who had undergone the multidisciplinary treatment. This was possibly partly due to the fact that no more than 50% of them were able to work in addition to participating in the multidisciplinary programme. There was a correlation between a change in working conditions and a reduction in sick leave, regardless of the type of treatment. The groups were not allocated on a randomized basis, but the two groups were largely comparable.

Mayer *et al.* looked into the extent to which the multidisciplinary approach that is successful in low-back complaints is also effective in patients with chronic musculoskeletal complaints of the upper extremity (May99). The programme, which is aimed at functional improvement and alleviation of pain, included physical training aimed at increasing the mobility, strength and endurance of specific muscles and psychological counselling (both in groups and individually). After a year, 78% of the 163 patients were still at work, while 29% had engaged a new therapist and 5% had undergone surgery.

The results were comparable with the outcomes in patients with low-back complaints who had been selected via prospective randomized research.

In a study in which 24 RSI patients were treated as part of a multidisciplinary rehabilitation programme, 7 of the 12 participants who were no longer in employment returned to work (Bar98). The treatment consisted of medication, physiotherapy (including ergonomic training) and workplace simulation. In addition, the workplace was assessed and modified, and psychological counselling took place (pain management) and 'Electromyographic (EMG) biofeedback' (measurement of muscle tension with the aid of an electronic signal; see also section 7.2.5).

Multidisciplinary treatment of patients with chronic neck and shoulder pain (with differences consisting only in the type of psychological counselling) was investigated in a randomized study (Jen95). The treatment included providing information about anatomy, stress, diet, pain behaviour, pain medication, health behaviour and coping with illness, learning relaxation techniques, mobilization and exercises. The psychological counselling consisted of 'coaching' (5 hours) or cognitive behavioural therapy (16 hours). Both groups of patients showed improvements with regard to psychological outcome measures and absence from work, both after 6 and 12 months. This study only permits an assessment of the effectiveness of the psychological counselling, since the remaining treatment was the same for both groups. There was, broadly speaking, no difference between the outcomes of the two treatments. From the cost point of view, it was concluded that 'coaching' came out on top.

---

#### 7.2.4 *Chiropractic*

In a study into the chiropractic treatment of patients with RSI, 38 patients were randomly allocated either to spinal manipulation therapy (SMT) or to a combination of this therapy and massage. After five weeks, all patients reported some improvement, but this was greater in the patient group receiving combination therapy (Leb87). Based on this study, however, it is not possible to determine the effectiveness of chiropractic, since no comparison has been made with an untreated group. Whilst it is likely that the massage had some effect in the short term, the effect may also have been due to the combination of both therapies.

---

#### 7.2.5 *EMG biofeedback*

From a randomized study of 48 patients following treatment with 'EMG biofeedback', relaxation techniques and a combination of the two procedures, it emerged that each of the three treatments had a beneficial short-term effect on the pain that was experienced and the psychopathology (anxiety, depression) compared with a control group (Spe95b).

---

The effect of relaxation techniques as the sole therapy was greatest. Although the level of pain that was being experienced after six months was still lower, only one patient was completely free from pain complaints.

---

### 7.2.6 *Improvement in general condition*

Research reveals that a weekly programme of sporting activities had a beneficial effect on the occurrence of musculoskeletal complaints and on physical capacity (Ska96). This effect has primarily been observed in those patients who did not take regular exercise outside of this exercise programme and in people over 40 years of age. The improvement of physical condition frequently forms part of multidisciplinary treatment programmes (see 7.2.3).

---

### 7.2.7 *Behavioural therapy (chronic pain or other complaints)*

Pain is usually broken down into four components: the detection of tissue damage by sensitive receptors (nociception), the perception of these signals within the nervous system (pain perception), negative reactions to pain, anxiety or stress when an individual's physical or psychological integrity is threatened (experience of pain) and pain behaviour. Anatomical, physiological and psychological factors can also determine each of these components. Pain control can, in principle, act on each component. The experience of pain may continue once the nociception has disappeared. In this phase it may be useful to exert a positive influence on the way the patient copes with pain and on pain behaviour by means of psychological counselling (Loe99, Pol96).

In a randomized study in which a comparison was made between RSI patients who received either individual cognitive therapy or group therapy, there was no difference in the experience of pain and in measures of depression and anxiety after two years (Spe91). Both groups displayed an improvement in the outcome measures, but in the majority of cases the pain complaints were still just as pronounced. The patients had thus probably learned how to manage pain better, but the pain had not disappeared as a result. After six months, the controls (waiting list) had less favourable outcomes, but they were not monitored over a two-year period.

Randomized research into the effectiveness of cognitive behavioural therapy (16 sessions) for medically unexplained physical complaints showed a significant improvement in recuperation, less intense symptoms and better sleep quality after six months compared with controls who received standard medical care (Spe95a). There was also a beneficial effect on the frequency of the symptoms, restrictions on social activities and leisure activities, and disease behaviour. These differences were still manifest after one year.

---

---

### 7.2.8 *Alternative medicine*

The Committee is aware that some patients with RSI complaints have recourse to acupuncture, tai chi, the Feldenkreis technique, the Alexander technique, the Ayur Vedic approach and laser therapy. There is absolutely no scientific documentation to support the effectiveness of these techniques.

In research whereby 30 RSI patients were randomly allocated either to hypnotherapy (six sessions, once a week) or to the control group (waiting list), the blood flow to the hands in the treated group improved and the pain in the hands diminished (Moo96). These differences were both statistically significant.

---

### 7.2.9 *Early versus late treatment*

Linton *et al.* discovered in randomized research that early intervention in patients who initially presented with musculoskeletal pain resulted in fewer days of absence from work and an eight-fold reduction in the risk of chronic pain (Lin93). These patients were compared with a group that received the standard care. Due to GP waiting times for complaints of this type, such care can only begin after two to three weeks. In Sweden the standard treatment generally consists of resting for two to three weeks, possibly accompanied by not working, pain control in severe cases and the advice that in the event of pain, activities must be halted. Musculoskeletal pain was defined as pain in the neck and back (for example), without these complaints having resulted in absence from work during the previous three months. The intervention consisted of an examination by a GP and instructions from a physiotherapist to promote everyday activities and to remain 'healthily' active. The intervention and control groups differed both with regard to the timing and the content of the intervention. This hinders the interpretation of the results. It should be noted that this early intervention was not effective in patients who had previously already experienced an episode of musculoskeletal pain. Furthermore, RSI complaints were in this study not regarded as being in any way different from back complaints.

---

### 7.2.10 *Conclusion*

The Committee concludes that there is insufficient data to allow for definitive and detailed recommendations regarding the treatment of patients with aspecific RSI complaints. Although a number of studies were randomized, either the follow-up was too short, the number of subjects was very small, or else the outcome measure was not entirely relevant (e.g. grip strength). Furthermore, the findings were virtually always

---

‘once-only’. The results of multidisciplinary treatment would appear to be very promising, however. A few of the studies performed in this area exhibited reasonable methodological quality (Feu93, May99). A disadvantage of a multidisciplinary approach is the fact that it is virtually impossible to quantify the separate contributions made by the different components. In principle, the entire effect could be due to just one of the treatments.

There is a need for well designed, randomized research into the effectiveness of different treatments (or combinations of treatments). The Committee calls for research into a combined approach, comprising physical, psychosocial and personal factors, for patients who face the threat of participation problems (see section 7.5). It is important that a control group should be involved in the research, who will preferably not be offered any treatment. Since this is often problematic, alternative solutions are waiting-list controls or controls who receive the ‘standard’ care. There is also a need for research in which different forms of treatment are compared. Here too, a control group is desirable.

Apart from a good control group, outcome measures must be selected which can be determined with a validated measuring instrument (Bea97). The duration of the effect of the treatment also needs to be considered with reference to pre-defined outcome measures. It is also very important that the experimental group should have been well defined with regard to the characteristics of the patients and their RSI complaints.

---

### **7.3 Guidelines from professional organisations and current practice**

The Committee has asked the professional organisations representing those care givers who might be expected to come into contact with RSI patients whether they have developed (or are developing) guidelines or a set of standards for the treatment of patients with RSI complaints. If the response was in the negative, they were questioned about current practice in relation to these patients. The following professional organisations have been approached in this connection: the Royal Netherlands Society of Physiotherapy (KNGF), the Dutch Occupational Therapy Society (NVE), the Dutch Society for Mensendieck Exercise Therapy (NVOM), the Cesar Kinesiology Society, the Dutch Association of Chiropractors (NCA), the Dutch Society of General Medical Practitioners (NHG), the Dutch Rheumatology Society (NVR), the Dutch Orthopaedic Society (NOV), the Dutch Society of Rehabilitation and Physical Medicine Practitioners (VRA), the Dutch Association for Medical Services in Industry (NVAB) and the Dutch Neurology Society (NVN).

It transpires that there is only one professional organisation (the Dutch Society for Mensendieck Exercise Therapy) that is currently developing an RSI guideline. This

---

guideline gives a description of the empirical experience-based treatment practices applied by Mensendieck therapists with patients with RSI complaints, since no supporting scientific data is available. For some of the professional organisations RSI is certainly a key issue. The therapeutic advice that was given had little or no scientific basis. This is consistent with the current level of knowledge with regard to the treatment of RSI (see section 7.2.10).

---

## 7.4 Occupational reintegration

A review article by Krause *et al.* investigated the connection between modified work and return to work, based on 29 studies (Kra98). The most significant finding is that modified work (fewer hours, less stressful duties, on a therapeutic basis), facilitated the return to work of temporarily and permanently disabled workers. Return to work was approximately twice as common when workers had access to some form of modified work. Furthermore, the number of days of sick leave was halved as a result of the implementation of modified work schedules. Much of the material that was studied did not involve RSI patients. A further review article revealed that little is known about the effect of ergonomically modified work in connection with resumption of work following musculoskeletal complaints (Bee00). What little data is available does, however, suggest that it could be effective. Here too, the methodological quality of the research leaves something to be desired. It has been concluded from organizational measures in the form of modified working hours that it is reasonably safe to assume that this is effective in connection with the resumption of work (Bee00).

Swedish research results reveal a correlation between the duration of sick leave following treatment and the degree of physical and mental strain involved in the work (Ekb96). Individuals who took longer sick leave reported poorer quality of life and no alleviation of pain. Lengthy sick leave was found to be more closely correlated to conditions at work than to personal factors. These results underline the importance of improving the working conditions with a view to a return to work. Other research has also demonstrated that improving tasks and working methods has a beneficial effect on the outcome of rehabilitation programmes (Har96).

There is evidence to suggest that reintegration incorporating a period of acclimatization designed to consider the basis on which a return to work will take place has a beneficial effect on work participation (Sch95). This period can be used to determine what changes might potentially be made to the work, what breaks are required and what the situation is with regard to support from colleagues and superiors. If it transpires that reintegration does not adversely affect the complaints, then the number of hours worked can be increased in consultation with the company doctor.

---

---

## 7.5 Discussion

Not enough is known about the natural course and prognosis of RSI, principally due to the methodological shortcomings in the published research (Col96). It is important that we gain such an understanding if we are to devise preventive measures and scientifically supported standard treatment procedures. Although there is insufficient scientific data on which to base recommendations concerning the treatment of patients with aspecific RSI complaints, the Committee will here outline its ideas regarding the treatment of this group of patients.

The Committee attaches great importance to a number of basic principles. To some extent, these principles are the same as those applying to the treatment of patients with low-back complaints and chronic aspecific pain complaints (see also GR99). Because of the widespread publicity surrounding RSI, the Committee anticipates that an ever increasing proportion of patients will present with incipient complaints. It also believes that severer forms of RSI can be prevented if prompt treatment is available. A prerequisite for this is early recognition.

The Committee draws a distinction between three stages in the treatment of patients with RSI complaints. Incipient complaints are characterised by the symptoms set out in chapter 2, without there being any question of participation problems. In a second stage, participation problems are a central concern. Finally there is a stage in which chronic pain complaints predominate. Future research will need to ascertain whether there is any scientific basis for this classification and the proposed therapeutic approach.

As a first step, primary care givers (GPs, company doctors) should be aware of the existence and the presentation of RSI complaints and they should all follow the same treatment procedure. With incipient complaints, adequate patient education is extremely important in addition to the diagnosis. As regards the diagnosis itself, the Committee recommends that the European guideline should be followed (Slu00). The main consideration as regards patient education is that the patient must have a clear idea of what he can expect from the physician. Patient education must consist of information about reducing the strain by taking regular rest. It also needs to be made clear that RSI can resolve, but that this is sometimes a lengthy process. We know from research into chronic pain complaints of the back that the elimination of anxiety and uncertainty has a beneficial effect on the severity of the pain complaints (GR99, Mai92). Reduction of the strain can be achieved by examining known risk factors, such as lack of variety or poor work position. Then it is necessary to identify those factors that can be changed by the worker and by the employer. Then efforts must be made to reduce the exposure to the

---

presumed risk factors and thus the strain by (for example) modifying the working process or through the use of other aids. What is important here is that the patient is counselled by a company doctor and that there is consultation with the employer. Besides reducing the strain, it is important to increase physical capacity. This can be achieved by taking more exercise in everyday life, doing specific exercises and taking part in sport. The Committee believes that the practice of advising absolute rest must be discontinued, since absolute rest gives rise to a (further) reduction in physical capacity. It anticipates that this approach will lead to a reduction in incipient RSI complaints in a large group of patients.

If the complaints threaten to lead to problems with work participation, the Committee feels that a more active form of therapy needs to be adopted. At this stage, it must be made clear to the patient that we still have a great deal to learn about the treatment of RSI. Treatment will therefore also preferably need to take place in an investigational context. During this phase it is also important to establish the extent to which anxiety and uncertainty are determining the patient's behaviour. A patient who is anxious or uncertain may develop pain-avoidance behaviour (fear of movement), possibly resulting in the persistence of the complaints. Here the supervising physician must intervene: he will need to dispel uncertainties, so that patients feel that they can move as normally as possible. One way to achieve this is not to normalize the pattern of movement in response to the pain but according to a pre-arranged timetable, the aim being to increase the load gradually (GR99). This is also sometimes referred to as a *graded activity* approach (For76). This approach requires the care giver to have good powers of assessment. In the opinion of the Committee, this is a promising approach, but it needs to be offered to patients under the supervision of physiotherapists in an investigational context, in order to be able to determine its effectiveness. The same applies to the provision of advice with regard to both posture and the workplace.

In view of the suspicion that personal risk factors play a not inconsiderable role, these factors also need to be considered. Noteworthy examples are: ability to handle stress, coping with the setting of targets and limits, problem-solving, cognitive restructuring, redirecting attention, communication skills and assertiveness training.

Over time, the RSI-associated pain complaints can become chronic. Chronic pain complaints do not, in the Committee's opinion, necessarily form part of the natural course of RSI, but they can arise as a consequence of it. Factors other than the original factor will then perpetuate the pain. It is likely that stress and environmental and emotional factors compound the original tissue damage and contribute to the intensity and persistence of the pain. Treating a patient with chronic pain in a manner that is merely aimed at temporary alleviation does not address the underlying pathological process (Loe99). If it is not possible to eliminate the source of the pain, certain forms of

psychological therapy should be contemplated, such as cognitive and behavioural therapy aimed at modifying the effect of pain on an individual's life.

According to the Committee, the prospects of successful occupational reintegration are improved if, besides modifying his duties (via improvements in working methods or the workplace and by introducing variety into the duties) a worker maintains contact with work during his absence. Limiting the duration of sick leave and introducing a period of acclimatization also have a beneficial effect on the return to work (Sch95, Wei99). In addition, it goes without saying that it is advisable to look into whether there is any scope for improvement as regards the psychosocial occupational factors (such as the atmosphere within the workplace and support from colleagues and managers).

---

The Hague, 27 November 2000,  
on behalf of the Committee

(signed)

Dr PMM Beemsterboer  
Secretary

Professor MHW Frings-Dresen  
Chair



---

## Literature

---

- Aar98 Aaras A, Horgen G, Bjorset H-H, *et al.* Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomic interventions. *Appl Ergonomics* 1998; 29: 335-54.
- Abr67 Abrahams M. Mechanical behaviour of tendon in vitro: a preliminary report. *Med Biol Engin.* 1967; 5: 433-43.
- Ara89 Arancia G, Trovalusci C, Mriutti G, *et al.* Ultrastructural changes induced by hyperthermia in Chinese hamster V79 fibroblasts. *Int J Hypertherm.* 1989; 5: 341-50.
- Arc97 Archambault JM, Herzog W, Hart D. The effect of load history in an experimental model of tendon repetitive motion disorders. Marconi Research Conference. San Francisco, 1997.
- Arm78 Armstrong TJ, Chaffin DB. An investigation of the relationship between displacements of the finger and wrist joints and the extrinsic finger flexor tendons. *J Biomechanics* 1978; 11: 119-28.
- Arm93 Armstrong TJ, Buckle P, Fine LJ, *et al.* A conceptual model for work-related neck and upper-limb disorders. *Scand J Work Environ Health* 1993; 19: 73-84.
- Bac90 Backman C, Boquist L, Fridén J, *et al.* Chronic Achilles tendon paratenonitis: an experimental model in the rabbit. *J Orthop Res* 1990; 8: 541-7.
- Bar98 Barthel HR, Miller LS, Deardorff WW, *et al.* Presentation and response of patients with extremity repetitive use syndrome to a multidisciplinary rehabilitation program: a retrospective review of 24 cases. *J Hand Ther* 1998; 11: 191-9.
- Bay97 Bay BK, Sharkey NA, Szabo RM. Displacement and strain of the median nerve at the wrist. *J Hand Surg* 1997; 22: 621-7.
- Bea97 Beaton DE, Hogg-Johnson S, Bombardier C. Evaluating changes in health status: reliability and responsiveness of five generic health status measures in workers with musculoskeletal disorders. *J Clin Epidemiol* 1997; 50: 79-93.
-

- Bee00 van der Beek AJ, Frings-Dresen MHW, Elders LALM. Effectiviteit van werkaanpassingen bij werkhervatting na klachten aan het bewegingsapparaat. *Tijdschr Bedrijfs Verzekeringsgeneesk* 2000; 5: 137-43.
- Ber94 Bernard B, Sauter S, Fine L, *et al.* Job task and psychosocial risk factors for work-related musculoskeletal disorders among newspaper employees. *Scand J Work Environ Health* 1994; 20: 417-26.
- Bet98 Bettendorf RF. Upper extremity musculoskeletal disorders in the office workplace, findings of the office ergonomics research committee . Yarmouth Port 1998.
- Bla99 Blatter BM, Bongers PM. Work related neck and upper limb symptoms (RSI): high risk occupations and risk factors in the Dutch working population. Hoofddorp: TNO Work and Employment, 1999, (report 4070117r9800293).
- Bon93 Bongers PM, de Winter CR Kompier *et al.* Psychosocial factors at work and musculoskeletal disease. *Scand J Work Environ Health* 1993; 19: 297-312.
- Bon98 Bongers P, Hoogendoorn L, Ridder de M. Repetitive strain injuries. Deel 1. Klachten en risicofactoren. *Tijdschr Bedrijfs Verzekeringsgeneesk* 1998; 8: 227-33.
- Bon00 Bongers P, Ariens G, van de Heuvel S, *et al.* Risicofactoren voor nekklachten, resultaten van een longitudinaal onderzoek. Den Haag: Elsevier, 2000.
- Byl96 Byl NN, Merzenich MM, Jenkins WM. A primate genesis model of focal dystonia and repetitive strain injury: I Learning-induced differentiation of the representation of the hand in the primary somatosensory cortex in adult monkeys. *Am Acad Neurol* 1996; 47: 508-20.
- Chr99 Christmansson M, Friden J, Sollerman C. Task design, psycho-social climate and upper extremity pain disorders-effects of an organisational redesign on manual repetitive assembly jobs. *Appl Ergonomics* 1999; 30: 463-72.
- Coh88 Cohen LG, Hallett M. Hand cramps: clinical features and electromyographic patterns in a focal dystonia. *Neurology* 1988; 38: 1005-12.
- Coh92 Cohen ML, Arroyo JF, Champion GD, *et al.* In search of the pathogenesis of refractory cervicobrachial pain syndrome. *Med J Aust* 1992; 156: 432-6.
- Coh95 Cohen ML, Sheater-Reid RB, Arroyo JF, *et al.* Evidence for abnormal nociception in fibromyalgia and repetitive strain injury. *J Musculoskeletal pain* 1995; 3: 49-57.
- Col96 Cole DC, Hudak PL. Prognosis of nonspecific work-related musculoskeletal disorders of the neck and upper extremity. *Am J Ind Med* 1996; 29: 657-68.
- Dah87 Dahlin LB, Norborg C, Lundbrg G. Morphologic changes in nerve cell bodies induced by experimental graded compression. *Exp Neurol* 1987; 95: 611-21.
- Dor90 Dortch HL, Trombly CA. The effects of education on hand use with industrial workers in repetitive jobs. *Am J Occup Ther* 1990; 44:777-82.
- Dou00 Douwes M, Blatter BM, Thé KH, *et al.* RSI-preventie in de praktijk. Zeist: Uitgeverij Kerckebosch, 2000.
- Dzw99 Dzwierzynski WW, Brad BK, Rush MD, *et al.* Psychometric assessment of patients with chronic upper extremity pain attributed to workplace exposure. *J Hand Surg* 1999; 24 A: 46-52.
- Edw88 Edwards RHT. Hypotheses of peripheral and central mechanisms underlying occupational muscle pain and injury. *European Journal of Applied Physiology* 1988; 57, 275-81.
-

- Ekb94 Ekberg K, Björkqvist B, Malm P, *et al.* Controlled two year follow up of rehabilitation for disorders in the neck and shoulders. *Occup Environ Med* 1994; 51:833-8.
- Ekb96 Ekberg K, Wildhagen I. Long-term sickness absence due to musculoskeletal disorders: the necessary intervention of work conditions. *Scand J Rehab Med* 1996; 28: 39-47.
- Ell78 Ellis DG. Creep failure of rat tendon. *J Biomech Engin* 1978; 100: 229-34.
- Eij99 van Eijsden-Besseling MDF, Medische diagnose. In: Huppes G, Schreibers KBJ, red. *Handboek RSI – risico's, oplossingen, behandeling*. Den Haag: SDU, 1999.
- Eij00 van Eijsden-Besseling MDF, Peeters FPML, Hoekstra R, Reijnen JAW. Structure of personality as additional risk factor for the development of RSI (repetitive strain injury). Abstract. 3rd Mediterranean Congress of Physical Medicine and Rehabilitation, 2000.
- Fer97 Fernström E, Ericson MO. Computer mouse or trackpoint-effects on muscular load and operator experience. *Appl Ergonomics* 1997; 28: 347-54.
- Feu93 Feuerstein M, Callan Harris S, Hickey P, *et al.* Multidisciplinary rehabilitation of chronic work-related upper extremity disorders. *JOM* 1993; 35: 396-403.
- For76 Fordyce WE. *Behavioral methods for chronic pain and illness*. ST Louis: CV Mosby Company, 1976.
- For99 Forsman M, Kadefors R, Zhang Q, *et al.* Motor-unit recruitment in the trapezius muscle during arm movements and in VDU precision work. *Int J Ind Ergonomics* 1999; 24: 619-30.
- Fro97 Frost L, Stricoff R. Repetitive strain injury: A new definition and treatment strategy based on the client-centered practice. *Work* 1997; 8: 45-53.
- Gel83 Gelberman RH, Szabo RM, Williams RV, *et al.* Tissue pressure threshold for peripheral nerve viability. *Clinical Orthopaedics* 1983; 285-91.
- Gem98 van Gemmert AWA, van Galen GP. Auditory Stress Effects On Preparation and Execution of Graphical Aiming - a Test of the Neuromotor Noise Concept. *Acta Psychologica* 1998; 98: 81-101.
- Gol81 Goldstein SA *Biomechanical aspects of cumulative trauma to tendons and tendon sheaths*. University of Michigan, 1981.
- Gol87 Goldstein SA, Armstrong TJ, Chaffin DB, *et al.* Analysis of cumulative strain in tendons and tendon sheaths. *J Biomechanics* 1987; 20: 1-6.
- Gom87 Gomer FE, Silverstein LD, Berg WK, *et al.* Changes in electromyographic activity associated with occupational stress and poor performance in the workplace. *Hum Factors* 1987; 29:131-43.
- GR99 Gezondheidsraad. *Diagnostiek en behandeling van het lumbosacraal radiculair syndroom*. Den Haag: Gezondheidsraad, 1999; publicatie nr 1999/18.
- Häg91 Hägg GM. Lack of relation between maximal force capacity and muscle disorders caused by low level static loads. A new explanation model. In: Queinnee Y, Daniellou F, red. *IEA*. Paris: Taylor & Francis, 1991: 9-11.
- Hag95 Hagberg M, Silverstein B, Wells M, *et al.* *Work related musculoskeletal disorders (wmsds)*: In: Kuorinka I, Forcier L, red. *for prevention*. London: Taylor & Francis, 1995.
- Har79 Hargens AR, Romine JS, Sipe JC, *et al.* Peripheral nerve-conduction block by high muscle-compartment pressure. *J Bone Joint Surg* 1979; 61: 192-200.
-

- Har96 Harkapaa K, Jarvikoski A, Hakal L, *et al.* Outcome of rehabilitation programmes for employees with lowered working capacity. *Disabil Rehabil* 1996; 18: 143-8.
- Har98 Harrington JM, Carter JT, Birrell L, *et al* syndromes. *Occup Environ Med* 1998; 55: 264-71.
- Hen65 Henneman E, Somjen G, Carpenter DO. Excitability and inhibitability of motoneurons of different sizes. *J Neurophysiol* 1965; 28: 599-620.
- Hub88 Hubbard RP, Chun KJ. Mechanical responses of tendons to repeated extension and wait periods. *J Biomechan Engin* 1988; 110: 11-9.
- Hug85 Hughes M, McLellan DL. Increased co-activation of the upper limb muscles in writer's cramp, *J Neur Neurosurg Psych* 1985; 48: 782-7.
- ICI99 RIVM. ICIDH-2. Internationale classificatie van het menselijk functioneren. Nederlandse vertaling van het Beta-2 voorstel, volledige versie. Bilthoven: RIVM, 1999.
- Jen95 Jensen I, Nygren A, Gamberale F, *et al.* The role of the psychologist in multidisciplinary treatments for chronic neck and shoulder pain: a controlled cost-effectiveness study. *Scand J Rehab Med* 1995; 27: 19-26.
- Joh91 Johansson H, Sojka P. Pathophysiological mechanisms involved in genesis and spread of muscular tension in occupational muscle pain and in chronic musculoskeletal pain syndromes: a hypothesis. *Med Hypotheses* 1991; 35: 196-203.
- Kad99 Kadefors R, Forsman M, Zoega B, *et al.* Recruitment of low threshold motor-units in the trapezius muscle in different static arm positions. *Ergonomics* 1999; 42: 359-75.
- Kor97 de Korte E, van der Kraan I, Kuijer P, *et al.* Ondersteuning en steunen? Een onderzoek naar het effect van ondersteuning op de belasting van de bovenste extremiteit bij beeldschermwerk. *Tijdschr Ergonomie* 1997; 173-9.
- Kra98 Krause N, Dasinger LK, Neuhauser F. Modified work and return to work: a review of the literature. *J Occup Rehabil* 1998; 8: 113-39.
- Lar90 Larsson SE, Bodegard L, Henriksson KG, *et al.* Chronic trapezius myalgia. Morphology and blood flow studied in 17 patients. *Acta Orthop Scand* 1990; 61: 394-8.
- Lau98 Laursen B, Jensen BR, Sjøgaard G. Effect of speed and precision demands on human shoulder muscle electromyography during a repetitive task. *Eur J Appl Physiol* 1998; 78: 544-8.
- Leb87 Leboeuf C, Grant BR, Maginnes GS. Chiropractic treatment of repetitive strain injuries: A preliminary prospective outcome study of SMT versus SMT combined with massage. *J Aust Chiropract Assoc* 1987; 17: 11-4.
- Lev93 Levoska S, Keinänen-Kiukaanniemi S. Active or passive physiotherapy for occupational cervicobrachial disorders? A Comparison of two treatment methods with 1-year follow-up. *Arch Phys Med Rehabil* 1993; 74: 425-30.
- Lin91 Lindman R, Hagberg M, Änquist KA, *et al.* Changes in muscle morphology in chronic trapezius myalgia. *Scand J Work Environ Health* 1991; 17: 347-55.
- Lin92 Lindman R. Chronic trapezius myalgia - a morphological study. Umea: University of Umea, 1992.
- Lin93 Linton SJ, Hellsing AL, Andersson D. A controlled study of the effects of an early intervention on acute musculoskeletal pain problems. *Pain* 1993; 54: 353-9.
-

- Lit95 Littlejohn GO. Key issues in repetitive strain injury. *J Musc Pain* 1995; 3: 25-33.
- Loe99 Loeser JD, Melzack R. Pain: an overview. *Lancet* 1999; 353: 1607-9.
- Lun83 Lundborg G, Myers R, Powell H. Nerve compression injury and increased endoneural fluid pressure: a "miniature compartment syndrome". *J Neurol Neurosurg Psych* 1983; 46: 1119-24.
- Mai92 Main CJ, Wood PLR, Hollis S, *et al.* The distress and risk assessment method. A simple patient classification to identify distress and evaluate the risk of poor outcome. *Spine* 1992; 17: 42-52.
- Mas98 Massaar J. Repetitive Strain Injury (RSI) bij beeldschermwerkers: de muisarm ontzenuwd. Den Haag: VUGA, 1998.
- Mas99 Massaar J. Repetitive Strain Injury (RSI) bij beeldschermwerkers. Een onderzoek onder werknemers van financiële instellingen en architectenbureaus. Den Haag: VUGA, 1999.
- May99 Mayer TG, Gatchel RJ, Polatin PB, *et al.* Outcomes comparison of treatment for chronic disabling work-related upper-extremity disorders and spinal disorders. *JOEM* 1999; 41: 761-70.
- Men93 Mense S. Nociception from skeletal muscle in relation to clinical muscle pain. *Pain*.1993; 54: 241-89.
- Mil88 Miller MH, Topliss DJ. Chronic upper limb pain syndrome (repetitive strain injury) in the Australian Workforce: A systematic cross sectional rheumatological study of 229 patients. *J Rheumatol* 1988; 15: 1705-12.
- Moo91 Moore A, Wells R, Ranney D. Quantifying exposure in occupational manual tasks with cumulative trauma disorder potential. *Ergonomics* 1991; 34: 1433-53.
- Moo96 Moore LE, Wiesner SL. Hypnotically-induced vasodilatation in the treatment of repetitive strain injuries. *Amer J Clin Hypn* 1996; 39: 97-104.
- Nel98 Nelson NA, Silverstein BA. Workplace factors associated with a reduction in musculoskeletal symptoms in office workers. *Human Factors* 1998; 40: 337-50.
- NIO97 National Institute for Occupational Safety and Health. Musculoskeletal disorders and workplace factors. Cincinnati: U.S. Department of Health and Human Services, 1997; (report nr 97-141).
- Nor97 Nordstrom DL, Vierkant RA, Destefano F, *et al.* Risk factors for carpal tunnel syndrome in a general population. *Occup Environ Med* 1997; 54: 734-40.
- NRC99 National Research Council. Work-related musculoskeletal disorders, report, workshop summaries and workshop papers . Washington DC: National Academy Press, 1999.
- Ohl94 Ohlsson K, Hansson G-A, Balogh I, *et al.* Disorders of the neck and upper limbs in women in the fish processing industry. *Occup Environ Med* 1994; 51: 826-32.
- Ott98 Otten F, Bongers P, Houtman I. De kans op RSI in Nederland. Gegevens uit het permanent onderzoek leefsituatie, 1997. *Maandber Gezondheidsstat (CBS)* 1998; 11: 5-19.
- Pas85 Passatore M, Grassi C, Filippi GM. Sympathetically-induced development of tension in jaw muscles: the possible contraction of intrafusal muscle fibers. *Pflügers Archiv Eur Jo Physiol* 1985; 405: 297-304.
- Pas96 Passatore M, Deriu F, Grassi C, *et al.* A comparative study of changes operated by sympathetic nervous system activation on spindle afferent discharge and on tonic vibration reflex in rabbit jaw muscles. *J Autonomic Nervous System*. 1996; 57: 163-7.
-

- Pic00 Picavet HSJ, van Gils HWV, Schouten JSAG. Klachten van het bewegingsapparaat in de Nederlandse bevolking. Prevalenties, consequenties en risicogroepen. Bilthoven: RIVM, 2000; (RIVM-rapport 266807 002).
- Pol96 Polatin PB, Mayer TG. Occupational disorders and the management of chronic pain. *Orthop Clin North Am* 1996; 27: 881-90.
- Pra99 Pransky G, Benjamin K, Himmelstein J, *et al.* Work-related upper-extremity disorders: prospective evaluation of clinical and functional outcomes. *JOEM* 1999; 41: 884-92.
- Rem97 Rempel D, Keir J, Smitz WP, *et al.* Effects of static fingertip loading on carpal tunnel pressure. *J Orthop Res* 1997; 15: 422-6.
- Rem99 Rempel D, P Tittiranonda, Burastura S, *et al.* Effect of keyboard keyswitch design on hand pain. *JOEM* 1999; 41: 111-9.
- Riz97 Rizzo TH, Pelletier KR, Serxner S, *et al.* Reducing risk factors for cumulative trauma disorders (CTD's): The impact of preventive ergonomic training on knowledge, intentions and practices related to computer use. *Am J Health Promotion* 1997; 11: 250-3.
- Row87 Rowe M. The diagnosis of tendon and tendon sheath injuries. *Seminars Occup Med* 1987; 2: 1-6.
- Ryd81 Rydevik B, Lundborg G, Bagge U. Effects of graded compression on intraneural blood flow: an in vivo study on rabbit tibial nerve. *J Hand Surgery* 1981; 6: 3-12.
- Sch95 Schmidt SH, Oort-Marburger D, Meijman T. Employment after rehabilitation for musculoskeletal impairments: the impact of vocational rehabilitation and working on a trial basis. *Arch Phys Med Rehabil* 1995; 76: 950-4.
- Sch97 Schechtman H, Bader HL. In vitro fatigue of human tendons. *J Biomechanics* 1997; 30: 829-36.
- Sil86 Silverstein BA, Fine LJ, Armstrong TJ. Hand-wrist disorders in industry. *Br J Ind Med* 1986; 43: 779-84.
- Ska96 Skargren E, Oberg B. Effects of exercise program on musculoskeletal symptoms and physical capacity among nursing staff. *Scand J Med Sci Sports* 1996; 6: 122-30.
- Slu99 Sluiter JK, Frings-Dresen MHW. RSI-patiënten gehoord: inventarisatie van werkfactoren, klachten en subjectieve meningen over behandeling en begeleiding. Amsterdam: Coronel Instituut voor Arbeid Milieu en Gezondheid. academisch Medisch Centrum/ Universiteit van Amsterdam, 1999.
- Slu00 Sluiter JK, Rest KM, Frings-Dresen MHW. Criteria document for evaluation of the work-relatedness of upper extremity musculoskeletal disorders. Amsterdam: Coronel Institute for Occupational and Environmental Health, Academic medical center, University of Amsterdam, 2000.
- Smi97 Smith AC, James GF, Gong-Yuan X, *et al.* Musculoskeletal pain in cardiac ultrasonographers: results of a random survey. *J Am Soc Echocardiogr* 1997; 10: 357-62.
- Smu95 Smutz WP, Bishop A, Niblock H, *et al.* Measurement of creep strain in flexor tendons during low-force, high-frequency activities such as computer keyboard use. *Clin Biomechanics* 1995; 10: 67.
- Spe91 Spence SH. Cognitive-behaviour therapy in the treatment of chronic occupational pain of the upper limbs: a 2 yr follow-up. *Behav Res Ther* 1991; 29: 503-9.
- Spe95a Speckens AEM, van Hemert, Spinhoven P, *et al.* Cognitive behavioural therapy for medically unexplained physical symptoms: a randomised controlled trial. *Br Med J* 1995; 311: 1328-32.
-

- Spe95b Spence SH, Sharpe L, Newton-John T, *et al.* Effect of EMG biofeedback compared to applied relaxation training with chronic upper extremity cumulative trauma disorders. *Pain* 1995; 63: 199-206.
- Spo98 Sporrong H, Palmerud G, Kadefors R, *et al.* The effect of light manual precision work on shoulder muscles—an EMG analysis. *J Electromyography Kinesiol* 1998; 8: 177-84.
- Sus91 Susser M. What is a cause and how do we know one?: a grammar for pragmatic epidemiology. *Am J Epidemiol* 1991; 133(7): 635-48.
- Thé99 Thé KH, Douwes M, Bongers PM. Kort en vaak pauzeren ter preventie van RSI. *TBV* 1999; 4: 116-21.
- Tit99 Tittiranonda P, Rempel D, Armstrong T, *et al.* Effect of four computer keyboards in computer users with upper extremity musculoskeletal disorders. *Am J Ind Med* 1999; 35: 647-61.
- Tyr94 Tyrer S. Repetitive strain injury. *J Psychosom Res* 1994; 38: 493-8.
- Urs97 Ursin H. Sensitization, somatization, and subjective health complaints. *Int J Behav Med* 1997; 4: 105-16.
- Vei90 Veiersted KB, Westgaard RH, Andersen P. Pattern of muscle activity during stereotyped work and its relation to muscle pain. *Int Arch Occup Health* 1990; 62: 31-41.
- Vei93 Veiersted KB, Westgaard RH, Andersen P. Electromyographic evaluation of muscular load pattern as a predictor of trapezius myalgia. *Scand J Work, Environ Health* 1993; 19: 284-90.
- Vii83 Viikari-Juntura E. Neck and upper limb disorders among slaughterhouse workers. An epidemiologic and clinical study. *Scand J Work Environ Health* 1983; 9: 283-90.
- Vii99 Viikari-Juntura E, Silverstein B. Role of physical load factors in carpal tunnel syndrome. *Scand J Work Environ Health* 1999; 25: 163-85.
- Wae91 Waersted M, Bjorklund, RA, Westgaard RH. Shoulder muscle tension induced by two VDU-based tasks of different complexity. *Ergonomics* 1991; 34: 137-50.
- Wae96 Waersted M, Eken T, Westgaard RH. Activity of single motor units in attention-demanding tasks: firing pattern in the human trapezius muscle. *Eur J Appl Physiol* 1996; 72: 323-9.
- Wal92 Wall E, Massie J, Kwan M, *et al.* Experimental stretch neuropathy. *J Bone Joint Surg* 1992; 74: 126-9.
- Wei99 van der Weide W. Quality of occupational rehabilitation for low-back pain. (Proefschrift). Amsterdam: Universiteit van Amsterdam, 1998.
- Wes92 Westerblad H, Allen DG. Changes of myoplasmic calcium concentration during fatigue in single mouse muscle fibers. *J Gen Physiol* 1991; 98: 615-35.
- Wes96 Westgaard RH, Jansen T, Jensen C. EMG of neck and shoulder muscles: the relationship between muscle activity and muscle pain in occupational settings. *Electromyography and Ergonomics*. London: Taylor & Francis, 1996.
- Wes97 Westgaard RH, Winkel J. Review article Ergonomic intervention research for improved musculoskeletal health: a critical review. *Int J Ergonomics* 1997; 20: 463-500.
- Wil94 Wilson AM, Goodship, AE Exercise-induced hyperthermia as possible mechanism for tendon degeneration. *J Biomechanics* 1994; 27: 899-905.
- Win91 Windgassen K, Ludolph A. Psychiatric aspects of writer's cramp. *Eur Arch Psychiatry Clin Neurosci* 1991; 241: 170-6.
- Win00 van der Windt AWM, Thomas E, Pope DP, *et al.* Occupational risk factors for shoulder pain: a systematic review. *Occup Environ Med* 2000; 57: 433-42.
-

- Yas97 Yassi A. Repetitive strain injury. *Lancet* 1997; 349: 943-7.
- Zec00 Zecevic A, Miller DI, Harburn K. An evaluation of the ergonomics of three computer keyboards. *Ergonomics* 2000; 43: 55-72.
- Zwa97 de Zwart BCH, Broersen JPJ, Frings-Dresen MHW, *et al.* Musculoskeletal complaints in the Netherlands in relation to age, gender and physically demanding work. *Int Arch Environ Health* 1997; 70: 352-60.

---

A The request for advice

---

B The Committee

---

---

## Annexes



---

## The request for advice

---

On 17 June the State Secretary for Social Affairs and Employment wrote a letter (ARBO/ATB/98/00914) to the President of the Health Council commissioning an advisory report on RSI.

In my letter of 21st April 1998 to the Lower House (ARBO/ATB/98/00989) I announced a Ministerial Commission to the Health Council concerning the scientific status quo and consensus with regard to the causal indicators of RSI and opportunities for effective intervention. This Commission is enclosed herewith.

Recently published studies have revealed that workers are increasingly being confronted during and after work with complaints and disorders of the fingers, wrists, arms, elbows and shoulders, which are being designated as Repetitive Strain Injuries (RSI). For many people declared unfit for work, these complaints, along with other musculoskeletal disorders, are providing grounds for receipt of disability benefit under the Occupational Disability Insurance Act (WAO). The number of people declared unfit for work due to RSI is estimated at between 300 and 600 workers per annum.

There are various reasons for the increase in the number of workers with RSI complaints. The principal reason in the increased number of repetitive tasks performed per worker as a result of ongoing mechanisation and automation of production systems over the past decade. There is also evidence to suggest a correlation between work pressure and RSI. Compared with the other EU member states, pressure of work in the Netherlands appears to be extremely high and, what is more, on the increase. In my opinion, the increase in the number of RSI complaints and their seriousness provides grounds for occupational health and safety policy as a matter of urgency in order to prevent these complaints.

---

In doing so I am making use of the criteria that are already enshrined in existing legislation with regard to physical load. In addition, I shall be holding discussions with the social partners with a view to reaching results-oriented agreements for each sector concerned. These agreements will refer to possible ways of reducing the number of RSI complaints in high-risk sectors. To accomplish this, it is essential that we have more detailed knowledge about RSI, especially with regard to the risk factors and potential preventive measures. It is against this background that the following questions have been formulated.

- Is it possible to arrive at a definition of RSI that is both unequivocal and based on scientific consensus? If so, what is that definition?
- What factors have been scientifically demonstrated to contribute to the development of RSI?
- In which occupations and economic sectors does RSI most commonly occur? Within these occupations and sectors, which risk factors make a significant contribution to the high incidence and prevalence of RSI?
- Can you specify measures which might help to prevent RSI effectively and efficiently?
- Is it possible to incorporate the factors specified under point 2 in set of standards in such a way that compliance with these standards will result in a significant reduction in RSI?

In answering these questions, I would request that you make use of research material from abroad in addition to results from Dutch research. Finally, I would ask that you specifically identify those areas in which there are still significant gaps in our knowledge.

The State Secretary for Social Affairs and Employment (SZW)

signed

FMG de Grave

In June 1998 the State Secretary for SZW, acting also on behalf of the Minister of Health, Welfare and Sports (VWS), asked the Health Council for supplementary advice with regard to RSI.

An important objective of the government's policy programme for this cabinet period — besides adopting preventive measures to limit the inflow into the national disability insurance (WAO) scheme — is to bring about a reduction in the number of people declared unfit for work by promoting lasting occupational reintegration. In this connection, I should like to put the following question to the Health Council:

- Which treatment methods have been scientifically demonstrated to contribute to an improvement in RSI-related complaints, in such a way as to prevent long-term sick leave and/or promote the occupational reintegration of RSI patients?

The State Secretary for Social Affairs and Employment

signed

JF Hoogervorst

---

---

## The Committee

- 
- Dr MHW Frings-Dresen, *Chair*  
Professor of Occupational Health; University Medical Centre (AMC), Amsterdam
  - Dr AMNG van Attekum  
company doctor; University of Maastricht
  - Dr PM Bongers  
epidemiologist; TNO Work and Employment, Hoofddorp
  - Dr JH van Dieën  
exercise scientist; Free University of Amsterdam
  - Dr GP van Galen  
Professor of Experimental Psychology; Catholic University of Nijmegen
  - Dr S van der Linden  
Professor of Rheumatology; University of Maastricht
  - Dr W van Mechelen  
Professor of Occupational Health Care; Free University of Amsterdam
  - C Muskee  
rehabilitation specialist; Beatrixoord Rehabilitation Centre, Haren
  - Dr RAB Oostendorp  
Scientific Director, Dutch Paramedical Institute, Amersfoort; Professor of  
Paramedical Care; St Radboud UMC, Nijmegen
  - J Ruitenbergh, *advisor*
  - Ministry of Social Affairs and Employment
-

- Dr JW Stenvers  
neurologist; Onze Lieve Vrouwe Gasthuis, Amsterdam
- Dr PMM Beemsterboer, *Secretary*  
Health Council of the Netherlands, The Hague

During the period from August-December 1999, Dr E van Rongen of the Health Council of the Netherlands, The Hague, served as acting secretary of the Committee

The Committee consulted the following experts:

- I Bense  
Mensendieck exercise therapist; Harderwijk
- J Driehuizen  
physiotherapist; Amsterdam
- M van Essen  
practitioner of orthopaedic and occupational medicine; Netherlands RSI Institute, Leusden
- MDF van Eijdsen  
rehabilitation specialist; University of Maastricht
- Dr GJ Lankhorst  
Professor of Rehabilitation Medicine; Free University of Amsterdam
- Dr JWS Vlaeyen  
psychologist; University of Maastricht

The following interested parties were consulted:

- M Davelaar; Dutch RSI Association, Delft
- CS Frenkel; VNO-NCW\*, The Hague
- JH Koning; VNO-NCW, The Hague
- X van Noort; Dutch RSI Association, Delft
- J Warning; League of Dutch Trade Union Federations (FNV), Utrecht
- E Zegers; Dutch RSI Association, Delft

Administrative support: R Aksel-Gauri

Design: J van Kan

---

\* Federation of Netherlands Industry-Netherlands Christian Employer's Association

---