

See discussions, stats, and author profiles for this publication at:  
<https://www.researchgate.net/publication/304193817>

# Course, prognosis and management of nonspecific musculoskeletal disorders

Thesis · July 2016

---

READS

30

1 author:



[Harald Miedema](#)

Hogeschool Rotterdam

112 PUBLICATIONS 2,620 CITATIONS

SEE PROFILE



Course, prognosis and  
management of nonspecific  
musculoskeletal disorders

Harald S. Miedema



# Course, Prognosis and Management of Nonspecific Musculoskeletal Disorders

Harald S. Miedema

The research described in this PhD thesis was supported by Erasmus university Medical Center Rotterdam, Rotterdam university of Applied Sciences, ZonMw – Netherlands Organization for Health Research and Development and the Dutch Ministry of Health, Welfare and Sport.

The recent studies in this thesis (chapter 1, 3, 6, 7, 8 and 9) were performed at the Research Center Innovations in Care of Rotterdam university of Applied Sciences and the Department of General Practice of Erasmus university Medical Center Rotterdam, in close collaboration with the Department of Public Health of Erasmus university Medical Center Rotterdam. The studies in chapter 4 and 5 were performed at the Knowledge Center for Workrelated Musculoskeletal Disorders of Erasmus university Medical Center Rotterdam. The study in chapter 2 was performed at the Institute Prevention and Health Leiden of the Netherlands Organization for Applied Scientific Research TNO.

Financial support for the publication of this PhD thesis was provided by Rotterdam university of Applied Sciences.

Miedema, H.S.

Course, prognosis and management of nonspecific musculoskeletal disorders

PhD thesis Erasmus university Medical Center Rotterdam

Articles are reprinted with permission of the respective journals

© H.S. Miedema, 2016.

ISBN: 978-94-6169-888-9

Publisher: Rotterdam university of Applied Sciences

Printed by Optima Grafische Communicatie, Rotterdam, The Netherlands

Cover image and title pages © The Trustees of the British Museum



UNIVERSITY OF  
APPLIED SCIENCES

**Research Centre  
Innovations in Care**

# **Course, Prognosis and Management of Nonspecific Musculoskeletal Disorders**

**Beloop, Prognose en Management van Aspecifieke Aandoeningen van  
het Houdings- en Bewegingsstelsel**

## **Proefschrift**

ter verkrijging van de graad van doctor aan de  
Erasmus Universiteit Rotterdam  
op gezag van de rector magnificus

Prof.dr. H.A.P. Pols

en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op  
woensdag 6 juli 2016 om 11.30 uur

door

Harald Sijbren Miedema  
geboren te Groningen

**Erasmus University Rotterdam**



## **PROMOTIECOMMISSIE**

Promotoren: Prof.dr. B.W. Koes  
Prof.dr.ir. A. Burdorf

Leescommissie: Prof.dr. J.M.W. Hazes  
Prof.dr. J.R. Anema  
Prof.dr. R.W.J.G. Ostelo

*Voor mijn vader, Siebren Miedema († 24-8-2003)*



## CONTENTS

Chapter 1	General introduction	9
Chapter 2	Chronicity of back problems during working life. <i>Spine 1998;23:2021-8.</i>	27
Chapter 3	Incidence of low back pain related occupational diseases. <i>Eur J Pain 2014;18(6):873-82.</i>	45
Chapter 4	Multidisciplinary consensus on terminology and classification of complaints of arm, neck and/or shoulder. <i>Occup Environm Med 2007;64(5):313-9.</i>	67
Chapter 5	Comment on: Boocock MG et al. A framework for the classification and diagnosis of workrelated upper extremity conditions: systematic review. <i>Semin Arthritis Rheum 2009;38(5):407-8.</i>	87
Chapter 6	Guideline 'Nonspecific complaints of arm, neck and shoulder'. <i>Ned Tijdschr Geneesk. 2013;157:A6249.</i>	93
Chapter 7	Overview of ICF categories addressed within outcome measures applied in prognostic and intervention studies for nonspecific complaints of arm, neck and shoulder. <i>(Submitted).</i>	107
Chapter 8	Disability trajectories in patients with complaints of arm, neck and shoulder (CANS) in primary care: a prospective cohort study. <i>Phys Ther 2016;x (Epub ahead of print Dec 5, 2015).</i>	131
Chapter 9	General discussion	165
	Summary	197
	Samenvatting	209
	Dankwoord	221
	About the author	229
	List of publications	235
	PhD Portfolio	249



# CHAPTER 1

General introduction





## GENERAL INTRODUCTION

### BACKGROUND

#### Prevalence of musculoskeletal pain and disability

Musculoskeletal disorders (MSDs) are extremely common in both the developed and developing world and are usually associated with pain and loss of function.<sup>1-3</sup> Globally, all MSDs combined account for 21.3% of the total years lived with disability (YLDs), just second to mental and behavioral problems (23.2%).<sup>3</sup> In the developed world MSDs are the most frequent cause of long-term pain and physical disability, affecting hundreds of millions of people around the world.<sup>1,4</sup> Low back pain (LBP) is the number one cause of years lived with disabilities in both developed and developing countries. In high income countries neck pain comes second, in other developed countries third (after major depressive disorders).<sup>5</sup>

MSDs may have either an acute or a gradual onset and their outcomes may vary from complete restoration of health to a chronic progressive course. This course is not always predictable, although certain patterns predominate. MSDs may cause psychological distress and dysfunction, but also psychological factors and coping style may influence the course of these disorders. Besides causing pain and decreased functional capacity, MSDs have a substantial influence on work capacity and quality of life. Altogether, they inflict an enormous financial burden on society through both direct health expenditure related to treating the sequelae of the disorders, and indirect costs due to loss of productivity and social security benefits.<sup>1-4</sup>

MSDs are a diverse group of disorders with regard to pathophysiology, but they are linked anatomically and by their association with pain and impaired physical function.<sup>4</sup> Some MSDs are of acute onset and short duration, but many are recurrent or lifelong disorders. They encompass a large spectrum of specific disorders with elaborate pathophysiology, including: a) inflammatory diseases such as rheumatoid arthritis, gout or ankylosing spondylitis; b) degenerative disorders, such as osteoarthritis, disc herniation or osteoporosis; and c) disorders related to injury, such as sport injuries or consequences of falls and minor or major trauma. Together, these specific disorders account for less than half of all MSDs. The majority of MSDs fall into the category of so-called nonspecific disorders, that can be defined as disorders with no known underlying pathophysiology or diagnosis and the absence of evidence that a specific structure is linked to the pain or other symptoms. Often these nonspecific disorders are related to overload, deconditioning or workrelated overexertion.

MSDs are universally prevalent among all age and gender groups and across all socio-demographic strata of society.<sup>4</sup> The point prevalence of musculoskeletal pain in the adult population of Europe and the U.S. is approximately 30%, but estimates vary from 13% to 47%, depending on the methods of the epidemiological studies and differences in the studied populations.<sup>4,6</sup> The prevalence of many MSDs increases markedly with age, and many are related to lifestyle factors such as obesity and lack of physical activity.<sup>4</sup>

In the Netherlands, the overall self-reported point prevalence of musculoskeletal pain in the adult population is about 44%, with a top three of: 1) LBP (27%); 2) shoulder pain (21%); and 3) neck pain (21%).<sup>7</sup> Shoulder pain and neck pain often occur simultaneously, with or without additional pain in the arm or hand. Also combinations of LBP and neck or shoulder pain occur frequently. This thesis will focus on the two most prevalent subgroups of MSDs, LBP and pain or other complaints of the neck and upper extremity.

### **Prevalence of low back pain and associated disease burden**

LBP can be defined as pain lasting longer than one day and localized between the 12th rib and the inferior gluteal folds, with or without leg pain.<sup>8,9</sup> Most cases are nonspecific disorders, but in about 10% of cases a specific cause can be identified, such as herniated disc disease, spondylolisthesis, spinal stenosis, spondylarthritis, infectious disorders, neoplasms or metastases, osteoporosis, congenital disorders or trauma.<sup>8,10</sup> Low back pain (LBP) is one of the most common health problems in Western industrialized countries.<sup>8,9,11-14</sup> The lifetime prevalence is estimated to be as high as 70-85%.<sup>11</sup> Globally, LBP causes more disability than any other condition.<sup>9</sup> In Western European countries it also causes the highest burden of disease. Even in a recent study of the global burden of LBP, leading investigators in this field stated that further research is urgently needed to better understand the predictors and clinical course of LBP across different settings, and the ways in which LBP can be prevented and better managed.<sup>9</sup>

A recent review of prevalence studies and national health surveys about the global burden of LBP, estimated the age-standardized point prevalence in the total population (including children) in 2010 to be 9.4% (95% CI 9.0 to 9.8).<sup>9</sup> It was higher in men (mean: 10.1%; 95% CI 9.4 to 10.7) compared to women (mean: 8.7%; 95% CI 8.2 to 9.3). The prevalence rose with age and peaked at 80 years. The point prevalence was highest in Western Europe, with a mean of 15.0% (95% CI 14.1 to 16.0).

LBP poses a huge economic burden to society, mainly in terms of indirect costs associated with the large number of work days lost and workdisability pensions, and to a lesser extent by direct healthcare costs. In the Netherlands, the total costs of workdisability pensions due to LBP in 2002 and 2007 were estimated at € 1,561 million and € 1,361 million, of sickleave days at € 2,267 million and € 1,699 million and of healthcare at

€ 453 million and € 474 million.<sup>15</sup> Due to new legislation related to the management of sickleave and return to work, that was implemented in the Netherlands in 2002, the proportion of employees on sickleave decreased considerably. Analysis of data on sickleave in 2009 showed, that 14% of all sickleave days were related to LBP.<sup>16</sup> This corresponds with approximately € 1,820 million for salaries paid to employees on sickleave. Due to other new legislation for workdisability claims, that was implemented in the Netherlands in 2006, the number of new workdisability pensions due to LBP has dropped considerably.<sup>16</sup> An estimate of the total costs for work disability pensions in 2009 is € 1,188 million.<sup>16-18</sup> So, the total of indirect costs due to LBP in 2009 amount to about 3 billion euros. When Dutch inflation figures of the Statistics Netherlands for 2008 and 2009 are taken into account (3.7%), the healthcare costs in 2009 can be estimated at € 492 million. The sum of total direct and indirect costs would then be approximately € 3.500 million.

### **Prevalence of neck and upper extremity complaints and associated disease burden**

The MSDs that rank second and third as cause of musculoskeletal disability and pain are neck disorders and shoulder disorders.<sup>5,7,19</sup> They often occur together and also in combination with pain or other symptoms in the upper extremity. No clear internationally accepted definition for the group of musculoskeletal neck and upper-extremity complaints exists. A variety of umbrella terms have been proposed over the last three decades, with a large variation in different countries. These terms include 'repetitive strain injuries (RSI)', 'upper-extremity cumulative trauma disorders', 'cervicobrachial disorders' and 'musculoskeletal disorders of neck and upper-limb'. Many different classification systems have been introduced, often confined to workers and including the specification 'workrelated' or 'occupational'.<sup>20</sup> According to the World Health Organization (WHO), workrelated diseases are defined as multifactorial when the work environment and the performance of work contribute significantly, but as one of a number of factors, to the causation of disease (WHO 1985). However, many disorders that meet this definition can also occur in non-workers. The classification systems differed in the disorders they included, in the labels used to identify them and in the characteristics used to describe them. Until now, none of the proposed classification systems have resulted in a complete overview of all specific musculoskeletal neck and upper-extremity disorders.

Within the category of musculoskeletal neck and upper-extremity complaints, the proportion of specific disorders is much higher than in the category of LBP. However, many specific disorders are related to overexertion of particular tendons, insertions, bursae or joints (e.g. tendinopathy in shoulder, elbow or forearm, epicondylitis, bursitis, joint pain) or compression of particular nerves.<sup>21</sup> Because of the anatomical situation, such types

of pathophysiology are easier to recognize in the upper extremity than in the spine and surrounding tissues. In Dutch primary care patients who consulted their general practitioner (GP) for a new episode of musculoskeletal neck and upper extremity complaints, the overall proportion that received a specific diagnosis appeared to be almost 60%.<sup>22</sup> As shown in table 1, for some pain locations the proportion of specific diagnoses was very low (see neck), whereas for other pain locations the this proportion was much higher (see elbow).<sup>22,23</sup>

**Table 1** Specific diagnoses in a primary care cohort of patients with new musculoskeletal neck and upper-extremity complaints

Localization of complaints (multiple sites possible)	Proportion of cohort (n=679)	Proportion of patients with specific diagnosis	Specific diagnosis of GP included this category
Neck (n=211)	31.1%	2.4%	Cervical herniated disc / radicular syndrome
Upper back (n=53)	7.8%	-	-
Shoulder (n=374)	55.1%	61.2%	Subacromial impingement syndrome Rotator cuff syndrome Tendinopathies of shoulder muscles Subacromial bursitis Frozen shoulder
Elbow (n=147)	21.6%	68.0%	Lateral and medial epicondylitis Bursitis of elbow Osteoarthritis of elbow Cubital tunnel syndrome
Hand and wrist (n=133)	19.6%	29.3% <sup>1</sup>	Osteoarthritis of hand or wrist Carpal tunnel syndrome Guyon's tunnel syndrome Ganglion in wrist Free body in wrist Trigger finger Raynaud's phenomenon and peripheral neuropathy (Hand-arm-vibration syndrome)
Upper arm (n=53)	12.7%	3.8% <sup>2</sup>	Biceps tendinopathy
Forearm (n=41)	6.0%	65.8% <sup>3</sup>	Tendinopathy of flexor/extensor forearm muscles Quervain's syndrome Radial tunnel syndrome
Total (n=679)	100%	59.2%	

<sup>1</sup> Carpal tunnel syndrome and Guyon tunnel syndrome included in this category

<sup>2</sup> Biceps tendinopathy included in this category

<sup>3</sup> Quervain's disease and Radial tunnel syndrome included in this category

Neck and upper extremity complaints represent an important health issue, with a high point prevalence in general working age populations ranging from 12% in the U.S. to 33% in the Netherlands and 44-52% in the U.K.<sup>24-27</sup> In a study in an open Dutch

population, the prevalence of chronic neck and upper extremity complaints unrelated to trauma or systemic diseases was 19%.<sup>25</sup> The 12-month incidence among a primary care population aged 18-65 years was 9.7%;<sup>28</sup> about 77% of these patients experienced complaints in upper back, neck and/or shoulder, 25% in elbow and/or arm, and 19% in wrist and/or hand.

Neck and upper extremity complaints are responsible for a substantial economic burden to society. Comparable to LBP, the costs are mainly due to indirect costs associated with the large number of work days lost and workdisability pensions, and less so to direct healthcare costs. In the Netherlands, the total costs of workdisability pensions in 2004 due to 'repetitive strain injuries' were estimated at € 354 million, of sickleave days at € 1,436 million and of healthcare at € 178 million.<sup>29</sup> In this study, the proportion of indirect costs due to musculoskeletal conditions, that was related to repetitive strain injuries was estimated at 19%. The total costs of workdisability pensions due to neck and upper extremity complaints in 2009 can be estimated at € 418 million, taking into account the reduction due to the new legislation in 2004.<sup>16-18</sup> In the Dutch population, about 19% of people with chronic neck and upper extremity complaints reported disease-related sick leave, of which 39% with a duration >4 weeks.<sup>25</sup> Analysis of data on sickleave in 2009 showed, that 11% of all sickleave days were related to complaints of arm, shoulder and neck.<sup>16</sup> This corresponds with approximately € 1,430 million for salaries paid to employees on sickleave. So, the total of indirect costs due to neck and upper extremity complaints in 2009 amount to about € 1,848 million euros. When Dutch yearly inflation figures of the Statistics Netherlands for 2005-2009 are taken into account (8.1%), the healthcare costs in 2009 can be estimated at € 192 million. The sum of total direct and indirect costs would then be approximately € 2.040 million.

### **Course and prognosis of nonspecific musculoskeletal disorders**

There is still much debate about the course of nonspecific musculoskeletal disorders and the main prognostic indicators for unfavorable outcomes. Most research in this area has been performed with regard to nonspecific LBP. However, in a recent review it is stated that although it is generally assumed that about 90% of acute LBP-patients recover within six weeks, some well-conducted cohort studies show less optimistic proportions of short term recovery, ranging from 39% to 76%.<sup>30</sup> This variation can be explained to some extent by differences in cohorts and definitions used to define the onset or conclusion of an LBP-episode, including the way in which a study deals with the episodic nature of the complaints. This imposes a challenge for the analysis of recovery at long-term follow-up. LBP-episodes are traditionally regarded as separate events, but this point of view is recently being challenged in favor of seeing LBP as a long-term or lifelong condition, with different stages of the disorder and different patterns of pain

intensity or disability throughout life.<sup>31</sup> A number of prognostic factors for LBP may be specific for particular stages or patterns of the disorder or for specific outcomes. Only little is known about these long-term pain patterns or predictors over the life course. Further research on this topic could improve the understanding of the development and fluctuations in LBP, and therefore influence treatment approaches.

A review regarding the course of neck pain reported, that between half and three quarters of people who experience neck pain at some initial point will report neck pain 1 to 5 years later.<sup>32</sup> A Dutch study revealed that one year after GP-consultation for a new episode of nonspecific neck pain of short duration (< 6 weeks), 24% of patients did not report full recovery or much improvement and 47% still experienced neck pain.<sup>33</sup> Another Dutch study reported that the proportion of patients with poor outcome (<30% improvement) 12 months after GP-consultation for a new episode was 49% in case of neck pain, 43% in shoulder pain, 41% in elbow pain and 47% in hand/wrist pain.<sup>34</sup>

Data from representative patient cohorts with accurate description of the clinical course regarding different outcomes are necessary to learn more about the prognosis, of both LBP as well as neck and upper extremity complaints. Early identification of patients more likely to develop persistent disabling symptoms could help guide decisions regarding medical management and research regarding the effectiveness of treatment programs or strategies. For many possible prognostic indicators, especially regarding the psychosocial domain, consistent evidence is still lacking, despite the large number of cohort studies that have been performed.<sup>31,32,35-40</sup>

### **Management of nonspecific musculoskeletal disorders**

While no cures exist for the majority of musculoskeletal conditions, there has been an expansion of medical and surgical therapies that have the potential to reduce pain and suffering and the years of life lived with disability<sup>4</sup>. This especially relates to many specific disorders. Exercise therapy has proven to be beneficial for the majority of both specific and nonspecific disorders.<sup>41-43</sup>

To minimize the progression of a MSD to a chronic condition, appropriate medical care and treatment in acute and subacute stages should be provided and particular attention should be paid to the psychosocial and occupational factors.<sup>44</sup> Furthermore, enabling self-management and stimulating individuals to take responsibility for their own health and healthcare is stated as being desirable in the management of MSDs.<sup>44</sup> This could be part of the way in which psychological factors are addressed. However, the optimal management strategy of psychological and workrelated factors that are related to MSDs is still unclear.

Regarding psychological factors, the so-called 'yellow flags' have been identified almost two decades ago.<sup>45</sup> Originally this term was used to describe psychosocial prognostic factors for the development of chronic disability following the onset of musculoskeletal LBP.<sup>44,46</sup> The identification of yellow flags through early screening was expected to prompt for further detailed assessment and early intervention.<sup>44</sup> In recent conceptualizations of yellow flags, it has been suggested that their range of applicability should be confined primarily to psychological risk factors.<sup>46</sup> Psychological risk factors for poor prognosis can be identified clinically and addressed within interventions, but questions remain in relation to issues such as timing, necessary skills, content of treatments, and context. In addition, there is still a need to elucidate mechanisms of change and better integrate this understanding into the broader context of secondary prevention of chronic pain and disability.<sup>46</sup>

There is a rich and consistent pattern of evidence that supports a relationship between the workplace and the occurrence of MSDs of the low back, neck and upper extremities.<sup>47,48</sup> These disorders occur widely in workers, especially in jobs that are characterized by high physical demands, frequent or heavy lifting or manual materials handling, static or awkward work postures, high repetitive load and vibration of the whole body or the upper extremities.<sup>48</sup> In the large majority of cases of workrelated LBP a nonspecific diagnosis is applicable.<sup>49</sup> In most cases of workrelated neck and upper extremity complaints, the diagnosis is either nonspecific or includes a specific disorder related to overexertion of particular tendons, insertions or bursae (e.g. tendinopathy in shoulder, elbow or forearm, epicondylitis, bursitis) or compression of particular nerves.<sup>21</sup> In order to ensure adequate and safe working conditions, it is important to know which workrelated factors are most important in the occurrence of MSDs and how to assess the workrelatedness of a MSD in an individual worker. When this is possible, occupational physicians might be able to select those cases where intervention in the work environment is indicated.

## **MAIN OBJECTIVES OF THIS THESIS AND THE CONTRIBUTING STUDIES**

### **Contents of this thesis**

In this thesis several studies are brought together that contain information about the course, prognosis and management of the two most prevalent subgroups of MSDs, low-back-pain (LBP) and neck and upper extremity complaints. The first section of the thesis focuses on LBP and the second section on neck and upper extremity complaints. Together, these studies contribute to the insight into the possibilities to identify subgroups of patients through the assessment of non-biomedical criteria, especially within the category of nonspecific complaints. These subgroups might profit from a different

approach in support or treatment. In the final chapter of this thesis the findings are discussed in a broader context.

### **Main objectives of the studies regarding low back pain**

Considering the high prevalence and burden of LBP and the large proportion of LBP patients with nonspecific complaints, it is very important to obtain more insight in the course and prognosis of LBP. In this thesis two chapters are dedicated to LBP. The main aims of this section of the thesis are:

- To describe the course of patients with LBP over time and prognostic indicators for chronicity;
- To determine the consequences of LBP in terms of occupational diseases;

The first aim is addressed in a large cohort study among subjects with LBP in primary care with seven year follow-up. The relevance for this thesis is the fact that in a large cohort of people with an initial episode of LBP the proportion of patients with chronic or frequently recurring complaints could be studied. Furthermore, the work participation could be studied over time, as well as a number of demographical, disease-related and workrelated prognostic indicators for chronicity.

The second aim is addressed in a dynamic prospective cohort study with a follow-up of 3 years, that was conducted in addition to the Dutch Occupational Disease Registry of the Netherlands Centre for Occupational Diseases (NCOD). Data were collected by occupational physicians that consented to register all diagnosed occupational diseases (ODs) that occurred in their employee population, that was defined by size and economic sectors. A specific analysis within this study bears upon an instrument that was developed to assess the workrelatedness of nonspecific LBP.<sup>50-52</sup> This instrument provides a practical method for the determination of the contribution of various workrelated factors to the occurrence of nonspecific LBP in an individual worker. Based upon this instrument, the NCOD published a registration guideline for nonspecific LBP as OD at the beginning of 2005.<sup>53</sup> Since then Dutch OPs have had access to an evidence based instrument for notification of ODs due to nonspecific LBP. In the study in this thesis the trends in the number of notifications of LBP as OD since the introduction of this instrument at the beginning of 2005 could be analyzed, and incidence rates of notified ODs in the Netherlands that were attributed to LBP could be estimated.

### **Main objectives of the studies regarding neck and upper extremity complaints**

Considering the high prevalence and burden of complaints of the neck and upper extremities and the problems regarding the definition and classification for this group of complaints, including the large patient group with nonspecific complaints, it is very

important to obtain more insight in the course, prognosis and management of neck and upper extremity complaints. In this thesis four chapters are dedicated to neck and upper extremity complaints.

The main aims of this section of the thesis are:

- To develop a classification system for neck and upper extremity complaints;
- To develop a multidisciplinary guideline for diagnosis and treatment of nonspecific neck and upper extremity complaints;
- To evaluate the prominent patient reported outcome measures in studies of neck and upper extremity complaints, within the framework of the International Classification of Functioning, Disability and Health (ICF);
- To describe the course of disabilities in patients with neck and upper extremity complaints over time and prognostic indicators for less favorable outcomes;

The first aim is addressed by a Delphi study, aiming to achieve consensus among medical, paramedical and occupational health care professionals about a definition and classification system for this category of complaints and about the specific disorders that can be diagnosed by health care professionals. The relevance for this thesis is, that a clear definition and classification system for neck and upper extremity conditions is important to support the diagnostic process and allows research data to be compared.

Regarding the second aim, a multidisciplinary working group was installed containing representatives of the nine most relevant professional organizations, one patient organization and experts from four universities. In addition, a group of advisors, including representatives of four other professional organizations and one other patient organization, commented on specific parts of the draft guideline. The objective of this project was to develop an evidence based guideline with recommendations for diagnostic and therapeutic interventions and work participation, as well as clinical pathways, that could be subscribed by all participating professional and patient organizations.

The third aim is addressed by using the same selection of scientific literature that was used to corroborate the recommendations of the guideline for diagnosis and treatment of nonspecific neck and upper extremity complaints. After linking the patient reported outcome measures that were applied in the studies of this literature selection, an overview is provided of relevant outcomes regarding functions, activities and participation among patients with neck and upper extremity complaints and their association with the International Classification of Functioning, Disability and Health (ICF).

The final aim is addressed in a large cohort study of patients consulting their GP with a new episode of neck and upper extremity complaints, in which the course of disabilities over 2 years and demographical, clinical, physical and psychosocial prognostic indicators for less favorable outcomes are studied. The results of this analysis can help to identify patients at risk for worse outcomes at an early disease stage. This patient group might profit from a different approach in support or treatment.

## REFERENCES

1. WHO Scientific Group on the Burden of Musculoskeletal Conditions at the Start of the New Millennium. The burden of musculoskeletal conditions at the start of the new millennium. Geneva: World Health Organization; 2003. Report No.: 919. Available from: [http://whqlibdoc.who.int/trs/WHO\\_TRS\\_919.pdf](http://whqlibdoc.who.int/trs/WHO_TRS_919.pdf)
2. Brooks PM. The burden of musculoskeletal disease - a global perspective. *Clin Rheumatol.* 2006; 25(6):778–81.
3. March L, Smith EUR, Hoy DG, Cross MJ, Sanchez-Riera L, Blyth F, Buchbinder R, Vos T, Woolf AD. Burden of disability due to musculoskeletal (MSK) disorders. *Best Pract Res Clin Rheumatol.* 2014; 28(3):353–66.
4. Woolf AD, Vos T, March L. How to measure the impact of musculoskeletal conditions. *Best Pract Res Clin Rheumatol.* 2010;24(6):723–32.
5. Global Burden of Disease Study 2013 Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries. *Lancet.* 2015;386(9995):743–800.
6. Cimmino MA, Ferrone C, Cutolo M. Epidemiology of chronic musculoskeletal pain. *Best Pract Res Clin Rheumatol.* 2011;25(2):173–83.
7. Picavet HSJ, Schouten JSAG. Musculoskeletal pain in the Netherlands: prevalences, consequences and risk groups, the DMC(3)-study. *Pain.* 2003;102(1-2):167–78.
8. Krismer M, van Tulder M. Strategies for prevention and management of musculoskeletal conditions. Low back pain (non-specific). *Best Pract Res Clin Rheumatol.* 2007;21(1):77–91.
9. Hoy D, March L, Brooks P, Blyth F, Woolf A, Bain C, Williams G, Smith E, Vos T, Barendregt J, Murray C, Burstein R, Buchbinder R. The global burden of low back pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis.* 2014;73(6):968–74.
10. Miedema HS. Reuma-Onderzoek Meerdere Echelons (ROME): basisrapport. Leiden: TNO-Netherlands Organization for Applied Scientific Research; 1994. Report No.: 93.099.
11. Andersson GB. Epidemiological features of chronic low-back pain. *Lancet.* 1999;354(9178):581–5.
12. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, Woolf A, Vos T, Buchbinder R. A systematic review of the global prevalence of low back pain. *Arthritis Rheum.* 2012;64(6):2028–37.
13. Hoy D, Brooks P, Blyth F, Buchbinder R. The Epidemiology of low back pain. *Best Pract Res Clin Rheumatol.* 2010;24(6):769–81.
14. Van Tulder M, Koes B, Bombardier C. Low back pain. *Best Pract Res Clin Rheumatol.* 2002;16(5): 761–75.
15. Lambeek LC, van Tulder MW, Swinkels ICS, Koppes LLJ, Anema JR, van Mechelen W. The trend in total cost of back pain in The Netherlands in the period 2002 to 2007. *Spine.* 2011;36(13):1050–8.
16. Versantvoort M, Van Echtelt P. Belemmerd aan het werk Trendrapportage ziekteverzuim, arbeidsongeschiktheid en arbeidsdeelname personen met gezondheidsbeperkingen. Den Haag: Sociaal en Cultureel Planbureau; 2012. Report No.: 2012-17. Available from: [www.scp.nl/dsresour ce?objectid=32694&type=org](http://www.scp.nl/dsresour ce?objectid=32694&type=org)
17. Uitvoeringsinstelling Werknemersverzekeringen. Kwantitatieve informatie 2009. Amsterdam: Uitvoeringsinstelling Werknemersverzekeringen; 2010. Available from: [http://www.uwv.nl/overuww/Images/Kwantitatieve\\_informatie\\_2009.pdf](http://www.uwv.nl/overuww/Images/Kwantitatieve_informatie_2009.pdf)

18. Hakkaart-Van Roijen L, Tan SS, Bouwmans CAM. Handleiding voor kostenonderzoek; Methoden en standaard kostprijzen voor economische evaluaties in de gezondheidszorg; Geactualiseerde versie 2010. Diemen: College voor Zorgverzekeringen; 2011. Available from: <http://www.zorginstituutnederland.nl/binaries/content/documents/zinl-www/documenten/publicaties/overige-publicaties/1007-handleiding-voor-kostenonderzoek/1007-handleiding-voor-kostenonderzoek/Handleiding+voor+kostenonderzoek.pdf>
19. Picavet H, Van Gils HWV, Schouten, JSAG. Klachten van het bewegingsapparaat in de Nederlandse bevolking, prevalenties, consequenties en risicogroepen. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu; 2000. Report No.: 266807002. Available from: <http://www.rivm.nl/bibliotheek/rapporten/266807002.pdf>
20. Van Eerd D, Beaton D, Cole D, Lucas J, Hogg-Johnson S, Bombardier C. Classification systems for upper-limb musculoskeletal disorders in workers: a review of the literature. *J Clin Epidemiol.* 2003;56(10):925–36.
21. Sluiter JK, Rest KM, Frings-Dresen MH. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. *Scand J Work Environ Health.* 2001;27(Suppl 1): 1–102.
22. Feleus A, Bierma-Zeinstra SMA, Miedema HS, Verhagen AP, Nauta AP, Burdorf A, Verhaar JAN, Koes BW. Prognostic indicators for non-recovery of non-traumatic complaints at arm, neck and shoulder in general practice--6 months follow-up. *Rheumatology.* 2007;46(1):169–76.
23. Feleus A, van Dalen T, Bierma-Zeinstra SMA, Bernsen RMD, Verhaar JAN, Koes BW, Miedema HS. Kinesiophobia in patients with non-traumatic arm, neck and shoulder complaints: a prospective cohort study in general practice. *BMC Musculoskelet Disord.* 2007;8(1):117.
24. Morse TF, Dillon C, Warren N, Levenstein C, Warren A. The economic and social consequences of work-related musculoskeletal disorders: the Connecticut Upper-Extremity Surveillance Project (CUSP). *Int J Occup Environ Health.* 1998;4(4):209–16.
25. Huisstede BMA, Wijnhoven HA, Bierma-Zeinstra SM, Koes BW, Verhaar JA, Picavet S. Prevalence and characteristics of complaints of the arm, neck, and/or shoulder (CANS) in the open population. *Clin J Pain.* 2008;24(3):253–9.
26. Walker-Bone K, Palmer KT, Reading I, Coggon D, Cooper C. Prevalence and impact of musculoskeletal disorders of the upper limb in the general population. *Arthritis Rheum.* 2004;51(4):642–51.
27. Urwin M, Symmons D, Allison T, Brammah T, Busby H, Roxby M, Simmons A, Williams G. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis.* 1998;57(11):649–55.
28. Feleus A, Bierma-Zeinstra SMA, Miedema HS, Bernsen RMD, Verhaar JAN, Koes BW. Incidence of non-traumatic complaints of arm, neck and shoulder in general practice. *Man Ther.* 2008;13(5): 426–33.
29. Blatter B, Houtman I, Bossche S van den, Kraan K, Heuvel S van den. Gezondheidsschade en kosten als gevolg van RSI en psychosociale arbeidsbelasting in Nederland. Hoofddorp: TNO Kwaliteit van Leven; 2005. Available from: [http://www.monitorarbeid.tno.nl/dynamics//modules/SPUB0102/view.php?pub\\_id=100141&att\\_id=4911](http://www.monitorarbeid.tno.nl/dynamics//modules/SPUB0102/view.php?pub_id=100141&att_id=4911)
30. Da Cunha Menezes Costa L, Maher CG, Hancock MJ, McAuley JH, Herbert RD, Costa LOP. The prognosis of acute and persistent low-back pain: a meta-analysis. *Can Med Assoc J.* 2012;184(11): E613–24.
31. Dunn KM, Hestbaek L, Cassidy JD. Low back pain across the life course. *Best Pract Res Clin Rheumatol.* 2013;27(5):591-600.

32. Carroll LJ, Hogg-Johnson S, van der Velde G, Haldeman S, Holm LW, Carragee EJ, Hurwitz EL, Cote P, Nordin M, Peloso PM, Guzman J, Cassidy JD. Course and prognostic factors for neck pain in the general population: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine*. 2008;33(4 Suppl):S75-82.
33. Vos CJ, Verhagen AP, Passchier J, Koes BW. Clinical course and prognostic factors in acute neck pain: an inception cohort study in general practice. *Pain Med*. 2008;9(5):572-80.
34. Henschke N, Ostelo RWJG, Terwee CB, van der Windt DAWM. Identifying generic predictors of outcome in patients presenting to primary care with nonspinal musculoskeletal pain. *Arthritis Care Res*. 2012;64(8):1217-24.
35. Chou R, Shekelle P. Will this patient develop persistent disabling low back pain? *JAMA*. 2010;303(13):1295-302.
36. Hayden JA, Dunn KM, van der Windt DA, Shaw WS. What is the prognosis of back pain? *Best Pract Res Clin Rheumatol*. 2010;24(2):167-79.
37. Grotle M, Foster NE, Dunn KM, Croft P. Are prognostic indicators for poor outcome different for acute and chronic low back pain consulters in primary care? *Pain*. 2010;151(3):790-7.
38. Van der Windt DAWM, Kuijpers T, Jellema P, Van der Heijden GJMG, Bouter LM. Do psychological factors predict outcome in both low-back pain and shoulder pain? *Ann Rheum Dis*. 2007;66(3):313-9.
39. Kuijpers T, Van der Windt DAWM, Van der Heijden GJMG, Bouter LM. Systematic review of prognostic cohort studies on shoulder disorders. *Pain*. 2004;109(3):420-31.
40. Bruls VEJ, Bastiaenen CHG, De Bie RA. Prognostic factors of complaints of arm, neck, and/or shoulder: a systematic review of prospective cohort studies. *Pain*. 2015;156(5):765-88.
41. Rodrigues EV, Gomes ARS, Tanhoffer AIP, Leite N. Effects of exercise on pain of musculoskeletal disorders: a systematic review. *Acta Ortop Bras*. 2014;22(6):334-8.
42. Barker AL, Talevski J, Morello RT, Brand CA, Rahmann AE, Urquhart DM. Effectiveness of aquatic exercise for musculoskeletal conditions: a meta-analysis. *Arch Phys Med Rehabil*. 2014;95(9):1776-86.
43. O'Connor SR, Tully MA, Ryan B, Bleakley CM, Baxter GD, Bradley JM, McDonough SM. Walking exercise for chronic musculoskeletal pain: systematic review and meta-analysis. *Arch Phys Med Rehabil*. 2015;96(4):724-734.e3.
44. Walsh NE, Brooks P, Hazes JM, Walsh RM, Dreinhofer K, Woolf AD, Akesson K, Lidgren L. Standards of care for acute and chronic musculoskeletal pain: the Bone and Joint Decade (2000-2010). *Arch Phys Med Rehabil*. 2008;89(9):1830-45.
45. Kendall NAS, Linton SJ, Main CJ. Guide to assessing psychosocial yellow flags in acute low back pain: risk factors for long term disability and work loss. Wellington: Accident Compensation Corporation and the New Zealand Guidelines Group; 1997. Available from: [http://www.acc.co.nz/PRD\\_EXT\\_CSMP/groups/external\\_communications/documents/guide/prd\\_ctrb112930.pdf](http://www.acc.co.nz/PRD_EXT_CSMP/groups/external_communications/documents/guide/prd_ctrb112930.pdf)
46. Nicholas MK, Linton SJ, Watson PJ, Main CJ. Early identification and management of psychological risk factors ("yellow flags") in patients with low back pain: a reappraisal. *Phys Ther*. 2011;91(5):737-53.
47. National Research Council and the Institute of Medicine. Musculoskeletal Disorders and the Workplace; low back and upper extremities. Washington: National Academy Press; 2001. Available from: [http://www.nap.edu/openbook.php?record\\_id=10032&page=R1](http://www.nap.edu/openbook.php?record_id=10032&page=R1)

48. Bernard BP, Putz-Anderson VP-A, Burt SE, Cole LL, Fairfield-Estill C, Fine LJ, Grant C, Gjessing C, Jenkins L, Hurrell Jr JJ, Nelson N, Pfirman D, Roberts R, Stetson D, Haring-Sweeney M, Tanaka S. Musculoskeletal disorders and workplace factors; a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. Cincinnati: National Institute for Occupational Safety and Health; 1997. Available from: <http://www.cdc.gov/niosh/docs/97-141/pdfs/97-141.pdf>
49. Koes BW, van Tulder M, Lin C-WC, Macedo LG, McAuley J, Maher C. An updated overview of clinical guidelines for the management of non-specific low back pain in primary care. *Eur Spine J.* 2010; 19(12):2075–94.
50. Lötters F, Burdorf A, Kuiper J, Miedema H. Model for the work-relatedness of low-back pain. *Scand J Work Environ Health.* 2003;29(6):431–40.
51. Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijjer PPFM, Spreeuwers D, Lötters F, Miedema HS. Criteria for determining the workrelatedness of nonspecific low-back pain. Amsterdam: Coronel Institute of Occupational Health, AMC; 2004. Available from: <http://www.occupationaldiseases.nl/content/criteria-nonspecific-low-back-pain-published>
52. Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijjer PPFM, Spreeuwers D, Lötters F, Miedema HS. Assessing the work-relatedness of nonspecific low-back pain. *Scand J Work Environ Health.* 2005 Jun;31(3):237–43.
53. Nederlands Centrum voor Beroepsziekten. Registratierichtlijn D004 Aspecifieke lage rugklachten. Nederlands Centrum voor Beroepsziekten, Coronel Instituut AMC Amsterdam; 2005. Available from: [www.beroepsziekten.nl/datafiles/D004.pdf](http://www.beroepsziekten.nl/datafiles/D004.pdf)





# CHAPTER 2

## Chronicity of Back Problems During Working Life

Harald S. Miedema, Astrid M.J. Chorus, Cees W.J. Wevers,  
Sjef van der Linden

Spine 1998;23(18):2021-2028.



## ABSTRACT

**Study Design:** A follow-up study of a cohort of 444 patients aged 16 to 59 years who consulted with their general practitioners (GPs) in 1987-1988 for an incident episode of back pain.

**Objectives:** To determine the proportion of patients with back pain in whom chronic back problems develop after a follow-up of 7 years, to compare health outcomes and labor force participation of patients with and without chronic back problems and to identify determinants of chronicity.

**Summary of Background Data:** The incidence and prevalence of back pain are very high. A large proportion of the costs related to medical consumption, absence from work, and disability are probably caused by chronic back problems. It is unknown what proportion of back problems become chronic, especially after a long follow-up period, and which factors can predict chronicity.

**Methods:** Data on the course of the symptoms and medical consumption from the period between 1987-1988 and 1991 were gathered retrospectively. Data on several health outcomes, including labor force participation, and data on some work characteristics were collected prospectively in 1991. A more extensive data set on health outcomes including logical status and working situation was collected in 1994.

**Results:** Chronic back problems developed in 28% of the patients. These patients reported more pain, higher levels of medical resource consumption, worse health outcomes, and lower labor force participation. Episodes of back pain before 1987-1988, severe pain in 1991, and disability score in 1991 were positively associated with chronicity in 1994, as well as difficulties with job performance in 1991, and frequent stooping in the subgroup of patients who held a paying job in the follow-up period.

**Conclusions:** Even after a follow-up of 7 years, the proportion of people with chronic back problems was high. The consequences for quality of life, labor force participation, and consumption of medical resources are clear. Further research is necessary to examine determinants and ways to prevent chronicity.

**Key words:** chronic back pain; chronicity; follow-up study; labor force participation; quality of life

## INTRODUCTION

Low back pain is one of the most common health problems in Western industrialized countries.<sup>15,42</sup> In more than 90% of cases, no specific cause of back pain can be found.<sup>1,13</sup> In The Netherlands, the annual incidence of consultation for back pain with a general practitioner (GP) is approximately 5%-7%.<sup>29,32,33,50</sup> The prevalence of back pain in the adult general population in The Netherlands is approximately 26%,<sup>20</sup> the prevalence of back pain in the past year approximately 49%.<sup>38</sup> Back problems are responsible for much of the consumption of medical resources.<sup>32,33</sup> In a period of 4 years after consultation with a GP for an incident episode of back pain, 46% of the patients were referred to a physiotherapist and 16% to a medical specialist (first referral mostly to orthopedic surgeons [54%] and neurologists [44%]). Approximately 15% of the patients who consulted a medical specialist underwent back surgery.

In The Netherlands, back problems are the most frequent cause of sick leave and work disability.<sup>4,18</sup> For 1991 the direct medical costs of back pain in The Netherlands have been estimated at \$367.6 million and the indirect costs for the entire labor force at \$4.6 billion (\$3.1 billion for absenteeism and \$1.5 billion on account of disability).<sup>48</sup> Most of the medical and indirect costs of back pain are incurred by patients with chronic symptoms. In most studies in which the issue of chronicity was examined, investigators looked only at relatively short periods.

The current study was performed to estimate the proportion of patients with chronic back problems after a follow-up of 7 years. Health outcomes and labor force participation (LFP) were compared between patients with chronic back pain and those with non-chronic back pain.

## MATERIALS AND METHODS

In 1991, the so-called ROME study was conducted as a retrospective follow-up of a sample of patients seeking medical attention in general practice to musculoskeletal disorders (MSDs).<sup>32</sup> The source population was derived from a representative national survey of symptoms and disorders in general practices, conducted by The Netherlands Institute of Primary Care.<sup>14</sup> In this survey, 161 GPs in 103 practices, serving 335,000 patients, registered all contacts with patients, including the initial morbidity, for 3 months in 1987 or in the beginning of 1988. The morbidity data were coded according to the International Classification of Primary Care.<sup>28</sup>

Contacts for the same symptom or illness were indicated as belonging to the same episode of care. An episode of care was defined as the phase of an illness during which a patient asked for medical attention. During the 3-month registration period, the first

contact for a certain illness (index consultation) could be the first contact in an episode of care or a follow-up contact in an episode of care that started before the registration period. If it was the first contact of a new episode, the illness could be entirely new (first contact ever) or recurring after a period without any symptoms. These episodes are called incident episodes. Further details of the survey are published elsewhere.<sup>14</sup>

In the ROME study, a regional selection of all 67 GPs working in 39 practices in four provinces of The Netherlands (Gelderland, Utrecht, Zuid-Holland, and Noord-Brabant) were invited to participate in a study of MSDs at the level of general and specialist practice.<sup>32</sup> Forty-four GPs (66%) from 26 practices (66%) and serving a total population of 97,587 patients responded positively. Regardless of age, all patients attending these practices who had an incident episode of any type of MSD, including back pain, were selected.

In the registration period in 1987 or 1988 the participating GPs registered 4761 incident episodes of MSDs; 35% of these were localized in the back. Three years later, in 1991, 3890 patients (83.2%) were traced and invited to participate in the ROME study. The response rate was 80% (3125 patients, 35% of whom had back problems). Patients were monitored retrospectively for 4 years from the start of the registration period in 1987 or 1988.

Data were collected by means of a mailed self-administered questionnaire and examination of available medical files (general practice or, if applicable, specialist practice) for data on contacts, diagnostic and therapeutic interventions, and referrals. The questionnaire contained general questions about age, gender, and education; the course and outcome of the MSD; contacts with health care professionals during the follow-up period; and the consequences of the MSD for LFP.

In the current study, patients were included who had indicated in 1991 that they were willing to participate in a follow-up study and who were aged 16-59 years at the time of the index consultation in 1987-1988.<sup>11</sup> In total, 1823 patients were eligible for the study. This was 58% of the cohort that had participated in 1991; 41% of these patients had back problems.

### **Data Collection**

The selected cohort was followed up for 3 years from the first data collection in 1991. Therefore, the total follow-up period was 7 years (3-4 years retrospectively and 3 years prospectively). Written informed consent was obtained from all participants. Efforts were made to collect information about the reasons for nonparticipation among those who declined to participate.

The data were collected by means of a self-administered questionnaire mailed to the patients. The questionnaire contained questions about the course and outcome of the

MSD, medical resource consumption in the period between 1991 and 1994, work situation, and occupational history.

### **Course and Outcome of the Musculoskeletal Disorder**

To assess the course of the MSDs, respondents were asked whether the symptoms were still present at the time of completing the questionnaire and about the frequency of episodes in the past 3 years (no episodes, only one episode of short duration, a few episodes, many episodes, symptoms present continuously). In addition, respondents were asked about the severity of the pain caused by the MSD, and whether the severity of the symptoms had changed in the past 3 years (i.e., whether the situation had improved, remained similar, or had worsened). Medical resource consumption was assessed by asking respondents whether they had consulted a general practitioner, a medical specialist, or a physiotherapist in the past 3 years. Several standardized survey instruments for quality of life were used to assess outcome of the MSD. A validated version of the Dutch Health Assessment Questionnaire (HAQ) containing 20 items was used to assess the ability to perform activities of daily living.<sup>3</sup> In 1991, a translated version of the modified HAQ (m-HAQ) had been used, to which two questions about use of a bicycle and public transport had been added.<sup>39,40</sup> These questions were also asked in the 1994 questionnaire. Information on perceived general health was obtained with the use of the RAND-36,<sup>5,52,53</sup> fatigue was assessed by the Multidimensional Fatigue Inventory (MFI),<sup>46</sup> and psychological health with the 12-item version of the General Health Questionnaire (GHQ-12).<sup>16,19</sup> Respondents were asked about their current work status (currently having a paying job, having left the labor force, and never having had a paying job).

### **Statistical Analysis**

In this study, the data concerning back problems were analyzed separately. First, a non-response analysis was carried out to examine possible selection bias. Responding and nonresponding subjects were compared on the basis of data collected in 1991 on the patients' characteristics and their back problems.

To study the correlation between chronicity of back symptoms and various outcomes after 7 years, a variable for chronicity was constructed. In 1991 and again in 1994, respondents were asked about the presence or absence of their back problems and the frequency in the previous years - that is, the frequency between 1987-1988 and 1991 relative to the frequency between 1991 and 1994. Possible responses were: back symptoms continuously present, frequent periods with back symptoms, occasional back symptoms, and one episode of back symptoms with none occurring thereafter. The category of chronic back disorders consisted of respondents who indicated in 1991 and again in 1994 that back symptoms were present at the time of completion of the

questionnaire and that the symptoms had been present frequently or continuously in the period between 1987-1988 and 1991 and had continued with the same frequency between 1991 and 1994. The category of non-chronic back disorders consisted of respondents who did not qualify for the chronic category.

To study determinants of chronicity of back problems, the variable for chronicity in 1994 was used as the dependent variable, and several characteristics of back problems and work requirements in 1991 were used as independent variables in a multivariate, unconditional logistic regression analysis. Determinants were sought in the total group and in the subgroup that held a paying job between 1987-1988 and 1994 (Subgroup 1) and in the subgroup that met three criteria: a paying job in the follow-up period, frequent or continuous symptoms between 1987-1988 and 1991, and symptoms in 1991 (Subgroup 2). Disease characteristics and work tasks were determined by use of a self-administered questionnaire in 1991 and were predictive of the outcome in 1994. Subgroup 1 was created because variables relating to the working situation were only determined in patients with a paying job during follow-up. Subgroup 2 was created to seek determinants in a subset that had severe symptoms in 1991.

The cutoff point for disability in the study is 0.5, meaning that there were at least some difficulties in 5 out of the 10 items of the applied version of the m-HAQ, or many difficulties in 3 items, or inability to perform an activity in 2 items (or combinations). All statistical analyses were performed using the statistical package SPSS-X version 4.1 (SSPS, Chicago, IL).<sup>47</sup>

## **RESULTS**

### **Non-response**

Of the 745 eligible patients with back problems, 444 (59.6%) participated in this study. The non-responding subjects refused to participate, did not return a completed questionnaire, or were lost to follow-up (moved or died). Table 1 shows some characteristics of responding and non-responding subjects. More of those responding were middle-aged, had higher education, and had a paying job in 1987-1988 than those not responding.

### **Chronicity of Back Problems**

After 7 years, 28% of the patients with symptoms could be defined as having a chronic back disorder. In results of the ROME study, the yearly incidence of GP consultation for new (38%) or recurring (62%) back problems was 70 per 1000 people in the practice populations. In the age group of 20 to 64 years, the incidence was 97 per 1000 people. With these

**Table 1.** Characteristics of Respondents and Non-respondents Considering the Situation in 1991

Situation in 1991	Respondents (n = 444)	Nonrespondents (n = 301)
Sex (male)	59.2	54.5
Age in 1987/1988†		
16-19 yr	2.3	5.0
20-29 yr	14.0	18.6
30-39 yr	37.9	30.9
40-49 yr	29.3	24.9
50-59 yr	16.5	20.6
Level of education*		
Primary	51.1	62.3
Secondary	39.5	28.2
Vocational colleges/university	9.4	8.9
No data	1.4	3.0
Having a paid job between 1987/1988 and 1991†	74.3	65.4
Having a paid job in 1991 at completion	67.5	55.5
Having complaints in 1991	71.3	65.4
Frequency of complaints 1987/1988-1991		
Constantly	19.5	22.4
Frequently	24.8	20.0
Sometimes	44.4	43.1
Only once	11.3	14.6
Pain intensity 1987/1988-1991		
Severe	23.8	25.2
Moderate	56.9	51.3
Mild	18.6	22.5
No pain	0.7	1.0
No data	0.7	1.0
Hindrance due to complaints in 1991		
Severe	0.2	1.0
Moderate	22.9	22.7
Mild	44.0	37.8
No	32.9	38.5
No data	0.7	0.7
State of Complaints in 1991 vs. 1987/1988		
Worsened	14.0	12.6
Similar	47.0	42.9
Improved	39.1	44.5
Modified HAQ score		
0.0 - 0.4	89.8	85.7
≥ 0.5	10.2	14.3
No data	4.7	7.3

\*  $P < 0.01$  comparing respondents with nonrespondents†  $P < 0.05$  comparing respondents with nonrespondents

figures, a yearly incidence of 27 per 1000 people of back symptoms that became chronic in the population of working age can be estimated. Table 2 shows some characteristics of patients with chronic versus non-chronic back problems, LFP, and consumption of medical resources. Differences in gender, age, education, and LFP were not significant. People with chronic problems experienced more frequent moderate to severe pain and indicated higher levels of medical attention needed for their back symptoms.

**Table 2.** Characteristics of Patients With an Incident Episode of Back Problems in 1987/1988

Characteristic	Nonchronic Complains (n = 317)	Chronic complaints (n = 124)	Statistical Difference (p)
Gender (male)	57.4	64.5	NS
Age in 1987/1988			NS
16-29 yr	18.3	11.3	
30-39 yr	37.9	37.1	
40-49 yr	28.1	33.1	
50-59 yr	15.8	18.5	
Level of education			NS
Primary	49.4	56.2	
Secondary	39.8	38.0	
Vocational colleges, university	10.8	5.8	
Pain intensity			< 0.0001
Moderate/severe	49.2	75.0	
Labor force participation			NS
Working in 1994	68.4	59.0	
Stopped working after 1987/1988	12.0	20.5	
Stopped working before 1987/1988	15.5	17.2	
Never been working	4.1	3.3	
Contact with a GP	49.8	81.5	< 0.0001
Contact with a physiotherapist	39.1	62.1	< 0.0001
Contact with a medical specialist	17.0	46.8	< 0.0001

NS = non significant

### Outcome of Chronic Versus Non-chronic Back Problems

In Table 3, perceived general health according to the RAND-36 questionnaire in relation to chronicity is shown. For comparison, reference data for the RAND scores from a study of the general population of 18 to 64 years of age are also indicated.<sup>53</sup> The scores of the people with non-chronic symptoms are almost comparable to those of the general population. The patients with chronic back problems have significantly worse scores for physical functioning, social functioning, role impairments caused by physical problems, pain, and general health.

**Table 3.** Mean Scores\* and 95% CI for the Dimensions of the RAND-36 of Patients With Chronic and Non-chronic Back Problems and Reference Scores From the General Population 18-65 Years of Age<sup>†</sup>

Characteristic	Chronic problem (n = 124)	Nonchronic problem (n = 317)	General population (n = 871)
Physical functioning	59.4 (55.3-63.5)	82.3 (80.1-84.5)	85.2
Social functioning	70.6 (66.2-75.0)	81.4 (79.1-83.7)	87.7
Role impairment physical	74.4 (71.0-77.8)	82.8 (80.7-84.9)	81.4
Role impairment social	78.0 (74.1-81.9)	81.9 (79.4-84.4)	84.7
Mental health	69.0 (65.1-72.9)	71.8 (69.8-73.8)	76.8
Vitality	57.5 (53.7-61.3)	63.2 (61.3-65.1)	68.0
Painlessness	51.4 (48.3-54.4)	73.2 (70.7-75.7)	82.4
General health	56.8 (53.0-60.6)	70.0 (68.0-72.0)	73.3
Changes in health	42.9 (39.5-46.3)	50.3 (48.2-53.4)	53.3

\* A lower score indicates a poorer health

CI = confidence interval

<sup>†</sup> From reference 53

The RAND subscale on mental health did not show a significant difference between patients with chronic symptoms and those with non-chronic symptoms. This is consistent with the absence of difference between the chronic and non-chronic groups in the proportion of patients with more than one ( $\geq 2$ : 39.7% vs. 38.6%) or more than two ( $\geq 3$ : 28.9% in both groups) positively scored questions on the GHQ-12. Reference figures for the GHQ from the Dutch general population and GP population are 25-29% compared with 49% for more than one positively scored question, and 15-21% compared with 40% for more than two positively scored questions.<sup>16</sup>

The MFI dimensions, general and physical fatigue, and reduced vitality, produced significantly worse scores in those with chronic symptoms than in those with non-chronic symptoms (data not shown). Scores for mental fatigue and reduced motivation were not significantly different (data not shown). Reference data from the general or GP population are not available.

In the questionnaire of 1991, some possible determinants of chronicity in 1994 were present. The odds ratios (ORs) for developing chronic back problems in 1994 in the presence or absence of certain characteristics in 1991 were calculated using multivariate logistic regression. Table 4 shows the ORs for some characteristics in the total group with back problems and for Subgroups 1 and 2 (see Methods). Age, gender, and education were not associated with a higher risk of development of chronic back problems, nor was having a paying job at the time of follow-up or in 1991. Having had one or more episodes of (consultations for) back pain before the index consultation in 1987-1988,

**Table 4.** Adjusted Odds Ratio (OR) and 95% Confidence Intervals (95% CI) for Determinants of Chronic Back Problems

Determinant	Number	Total group (n = 444)	Number	Subgroup 1 (n = 333)	Number	Subgroup 2 (n = 126)
Gender:						
Men	248	1 (referent level)	230	1 (referent level)	93	1 (referent level)
Woman	166	0.55 (0.30-1.00)	103	0.65 (0.29-1.45)	33	0.52 (0.16-1.73)
Age (yr):						
16-29	68	1 (referent level)	65	1 (referent level)	22	1 (referent level)
30-39	160	1.39 (0.63-1.12)	137	1.74 (0.65-4.62)	53	3.48 (0.69-17.61)
40-49	122	0.92 (0.40-2.13)	99	0.93 (0.32-2.70)	41	1.86 (0.34-10.04)
50-59	64	1.06 (0.39-2.87)	32	1.84 (0.45-7.59)	16	15.15 (1.09-210.54)*
Education:						
Primary	211	1.47 (0.54-4.02)	164	0.82 (0.24-2.84)	76	0.26 (0.04-2.11)
Secondary	162	1.75 (0.63-4.89)	130		47	1.31 (0.20-8.82)
Vocational colleges, university	41	1 (referent level)	39	1 (referent level)	9	1 (referent level)
Having a paid job in follow-up period	333	1.21 (0.56-2.63)	all		all	
Recurrent complaints in 1987/1988	125	8.24 (4.68-25.53)*	94	10.38 (4.89-22.02)*	69	7.31 (2.10-20.74)*
Pain in 1991:						
Absent/mild	81	1 (referent level)	68	1 (referent level)	19	1 (referent level)
Moderate/severe	333	3.95 (1.80-8.70)*	265	3.74 (1.45-9.65)	113	1.92 (0.48-7.75)
m-HAQ-score in 1991:						
<0.5	375	1 (referent level)	308	1 (referent level)	108	
≥ 0.5	39	11.93 (4.85-29.33)	25	30.95 (5.70-70.90)*	24	14.94 (1.37-162.36)*
Characteristics of work:						
Physically demanding			120	1.00 (0.35-2.89)	51	0.41 (0.06-2.59)
Psychologically demanding			130	1.41 (0.58-3.47)	49	0.92 (0.19-4.38)
Frequent time pressure			133	0.52 (0.23-1.20)	45	0.42 (0.10-1.80)
Frequent standing/walking			182	0.38 (0.16-0.90)*	73	0.36 (0.08-1.66)
Frequent sitting			113	0.61 (0.26-1.46)	40	0.75 (0.19-2.88)
Frequent stooping			133	5.91 (2.04-17.18)*	61	16.14 (2.34-111.51)*
Frequent lifting/carrying heavy weights			123	0.60 (0.20-1.80)	51	1.61 (0.30-8.71)
Frequent kneeling/squatting			100	0.70 (0.26-1.85)	41	0.41 (0.08-2.21)
Frequent work in same posture			114	1.48 (0.70-3.16)	47	1.92 (0.60-6.11)
Having difficulty with work performance in 1991			93	5.46 (2.60-11.46)*	60	7.31 (2.19-24.41)*
Thinking in 1991 work is cause of complaints			197	1.69 (0.75-3.83)	87	3.32 (0.98-11.16)

\* Statistically significant

Subgroup 1 = persons who held a paid job between 1987/1988 and 1994

Subgroup 2 = persons with a paid job in follow-up period, frequent or continuous complaints between 1987/1988 and 1991 and complaints present in 1991

having moderate to severe pain (compared with no or mild pain), and disability in 1991 ( $m\text{-HAQ} \geq 0.5$ ) were strong determinants. In Subgroup 1, models that included these variables showed a significantly higher risk of development of chronic back problems in those having difficulties with performance of the job and in those reporting stooping required on the job. This effect was similar or more pronounced in Subgroup 2.

### **Labor Force Participation in Relation to Chronicity of Back Problems**

The LFP of patients with back problems was 70% in 1987-1988, 63% in 1991, and 66% in 1994. Changes in LFP can be caused by early retirement, work disability, stopping work for other reasons, and beginning work or reintegration. Fifteen percent of the people with non-chronic back problems with a paying job in the follow-up period stopped working after 1987, compared with almost 26% of the patients with a chronic disorder. As a result, the LFP in 1994 was much lower among patients with chronic pain. The unadjusted OR for stopping work among patients with chronic symptoms compared with those with non-chronic symptoms was 2 (95% confidence interval [CI] 1.1-3.5). When controlling for the well-known determinants of unemployment - age, gender, and education - the adjusted OR was 1.8 (95% CI 0.9-3.5)

## **DISCUSSION**

This article is a report of the results in a subgroup of patients with back pain in a larger cohort of patients with MSDs in general practice, who were originally included in the ROME study.<sup>11,32</sup> The ROME study was conducted in four provinces in the middle and southern parts of The Netherlands. The total incidence of MSDs in this region was approximately 10% higher than the incidence in The Netherlands as a whole.<sup>50</sup> Participants in the ROME study were slightly older and more highly educated than the population mean.<sup>32</sup>

The response rate for patients with low back problems in the current study was 59.6%. The possibility that patients with chronic symptoms were more likely to respond than others could have biased the sample to include more patients with chronic back problems, which could lead to overestimation in the results. The (not significant) difference of 5-6% between respondents and non-respondents regarding still having symptoms in 1991 and improvement of symptoms in 1991 compared with 1987-1988 pointed in this direction. All other indicators for severity were comparable between the groups.

Labor force participation of respondents in 1991 was significantly higher (12%) than that of non-respondents. This was probably because in the invitation letter, an interest

in work was mentioned, apart from the focus on health status in general. If it is assumed that LFP is associated with a better health status, then this could have led to inclusion of healthier people in the group of respondents. The results of LFP in 1994 show that stopping work occurred more frequently among patients with chronic pain. In conclusion, given the purpose of the current study, selection bias is not thought to have distorted the results to a great extent, especially because most of the results refer to differences between the chronic and non-chronic groups. The questions about chronicity in this study were not validated, but results in other studies have shown that self-reports on specific musculoskeletal conditions are reasonably accurate.<sup>23</sup> Therefore, the results of the current study can be expected to indicate the chronicity of low back problems and its consequences for health status and LFP.

After the follow-up of 7 years, a considerable proportion (28%) of the respondents who had a new episode of symptoms in 1987-1988 could be considered to have chronic low back problems, according to the study definition. It should be remembered that this figure refers to a cohort of patients that had consulted with their GP and not to all patients with back pain in the population. Only approximately 1 in 5 people with back pain consult a GP.<sup>20</sup> People who consult their GPs for back pain have a less favorable prognosis in duration of symptoms and chance of having recurrent symptoms than people who do not.<sup>30,37,43</sup> Other follow-up studies concerning back pain patients had shorter follow-up periods. Results in most of them showed a high proportion of chronic problems,<sup>10,27,38,43</sup> with one exception.<sup>12</sup> Carey et al. reported from results of a large prospective cohort study of 1555 people that after a follow-up of 6 months, only 5% had not reported functional recovery.<sup>8</sup> However, 31% of the patients had not completely recovered, indicating that low-grade pain or disability may persist much longer. This may also have contributed to the high proportion of patients with chronic symptoms in the current study. However, there were marked differences in physical functioning between those with chronic and those with non-chronic symptoms (Table 3). In a Dutch study after a follow-up period of 1 year, only 10% of the patients still experienced low back pain.<sup>24</sup> However, 75% of the patients who recovered before the end of the follow-up period had one or more relapses. Van Tulder et al. concluded after a follow-up study of patients with chronic back pain with a mean duration of more than 4 years at baseline, that once low back pain has persisted for longer than 3 months, recovery is unlikely, especially in severe cases.<sup>49</sup> During 1 year of follow-up, 10% of those with chronic symptoms reported having back pain continuously, 47% at some time in all 4-month intervals, 22.5% in two 4-month intervals, and only 14.5% in one 4-month interval. In the current results, persistence of symptoms dropped from 40% of the patients in 1991 to 28% in 1994.

There were marked differences between patients who have chronic back pain and those who do not in consumption of medical resources, general and physical fatigue, general health, physical and social functioning, and pain. All these factors indicate that chronic low back disorders represent a serious health problem, not only for society in sick leave and work disability, but also for the patients involved, who indicate a clearly decreased quality of life. The psychological outcomes, as measured in this study, were not significantly different between those with chronic and those with non-chronic symptoms. This is remarkable, because results in several studies have indicated psychological factors as determinants of chronicity in people with back pain of relatively short duration and in those in which symptoms are more chronic.<sup>2,6,17,22,26</sup> An explanation could be that the instruments used in the current study lacked sensitivity for psychological factors that contribute to chronicity of back problems. Because the data presented here were part of a larger study of MSDs, no instruments specific for back problems were used. In addition, it has been suggested that psychological factors are mainly associated with disabilities that are associated with back pain.<sup>45</sup>

In patients who held a paying job during the follow-up period, the LFP in 1994 was much lower among those with chronic symptoms. Even when controlling for the well-known determinants of unemployment age, gender, and education, the OR of 1.8 for stopping work in those with chronic symptoms compared with those with non-chronic symptoms was almost significant. Labor force participation of patients with back problems in 1991 (63% among respondents and non-respondents) was comparable to the LFP in the general Dutch population of the same age in 1991 (64%), but had decreased in comparison with LFP of patient with back pain in 1987-1988 (68%).<sup>35,41</sup> In 1987-1988, LFP was somewhat higher than that of the general population (57% in 1987). This was probably because among patients with back problems, the proportion of men was higher and the mean age was somewhat lower. In addition, the baseline cohort of the ROME study was selected on the basis of consultation with the GP because of the MSD, and the rate of consultation could be higher among people with a paying job, because of the necessity of quick reduction of the symptoms, enable them to continue work. Indeed, when the LFP in 1987-1988 of all people of the ROME study aged 18-59 is considered, LFP is somewhat higher than in the general Dutch population of working age.<sup>41</sup>

In the current study, only some of the determinants of chronicity of back problems were measured in 1991. Workrelated and psychological variables were studied in more detail in the questionnaire of 1994. Recurrent symptoms at the index consultation, moderate or severe pain and especially a higher level of disability in 1991, were clearly associated with chronicity 3 years later, as could be expected. Results in other studies also indicated these variables as predictors of worse outcome.<sup>10,12,17,27,42,44,49</sup> This means that patients

with recurrent symptoms, with much pain, or with disability should be given special attention to prevent chronicity.

In the current study, 'having difficulties in performing the job' in 1991 and the work requirement of 'frequent stooping' in 1991 showed a positive association with chronicity in 1994. Because this concerns self-reported variables, these data must be interpreted with caution. Patients' reports about physical work demands were found to be in moderate to substantial (but not total) agreement with the observations of a physical therapist.<sup>31</sup> In the current study, the frequency of stooping and the amount of forward bending were not quantified, which makes this variable a rather rough indicator. In a recent review of biomechanical and psychosocial influences on occurrence and chronicity of back problems in workers, Burton concluded that there is no convincing evidence that continuation of previous work is detrimental to prolonged disability or recurrence of symptoms.<sup>7</sup> Psychosocial factors, especially fear avoidance behavior because of inadequate strategies for coping with pain, are probably more important than physical work demands.<sup>7,31</sup> In the current results, a self-report in 1991 of 'blaming work' was almost significantly related to chronicity in workers who had had frequent or continuous symptoms in the previous 4 years. This finding may point to psychosocial factors, such as fear avoidance behavior. It is not clear whether alteration of physical work demands can contribute to the prevention of chronicity in addition to interventions that involve psychosocial advice and promote activity.<sup>7</sup> In another recent review, Hadler concluded that biomechanical factors are only rarely related to regional back injury.<sup>21</sup> Helping people to cope with their back problem is therefore the most obvious intervention. For workers, this could mean providing an accommodating workplace, because for all people with backache, biomechanical demands are challenging.<sup>21</sup>

Many predictors of chronicity have been suggested in the literature, including psychologic factors such as depression, anxiety, hypochondriasis, hysteria, and fear avoidance;<sup>6,9,15,17,26,34</sup> social factors such as divorce rates, alcoholism, and disability compensation;<sup>2,15,25,34,51</sup> and workrelated factors.<sup>9,25,36</sup> Most investigators conclude that the evidence for determinants of chronicity is still poor. Good prospective studies of the course and chronicity of back problems, including physical, psychological, and social factors, should be given high priority, considering the high incidence and prevalence of back pain and the high proportion of chronic symptoms.

## REFERENCES

1. Abenhaim L, Rossignol M, Gobeille D, Bonvalot Y, Fines P, Scott S. The prognostic consequences in the making of the initial medical diagnosis of work-related back injuries. *Spine*. 1995;20:791-5.
2. Akerlind I, Hornquist JO, Bjurulf P. Psychological factors in the long-term prognosis of chronic low back pain patients. *J Clin Psychol*. 1992;48:596-605.
3. Bijlsma JWJ, Oude Heuvel CHB, Zaalberg A. Development and validation of the Dutch questionnaire capacities of daily life (VDF) for patients with rheumatoid arthritis. *J Rehabil Sci*. 1990;3:71-4.
4. Bongers PM, Westhoff MH, Miedema HS, Bloemhoff A, Davidse W, Van der Grinten MP, Urlings IJM. *Preventie van klachten en aandoeningen van het bewegingsapparaat*. Leiden: TNO Prevention and Health; 1996. Report nr. 96.047.
5. Brook RJ, Ware JE, Davies-Avery A, Stewart AL, Donald CA, Rogers WH, Williams KN, Johnston SA. Overview of adult health status measures fielded in RAND's Health insurance study. *Med Care*. 1979;15:724-35.
6. Burton AK, Tillotson KM, Main CJ, Hollis S. Psychosocial predictors of outcome in acute and sub-chronic low back trouble. *Spine*. 1995;20:722-8.
7. Burton AK. Back injury. Biomechanical and psychosocial influences. *Spine*. 1997;22:2575-80.
8. Carey TS, Garrett J, Jackman A, McLaughlin C, Fryer J, Smucker DR, and the North Carolina back pain project. The outcomes and costs of care for acute low back pain among patients seen by primary care practitioners, chiropractors and orthopedic surgeons. *N Engl J Med*. 1995;333:913-7.
9. Cats Baril WL, Frymoyer JW. Identifying patients at risk of becoming disabled because of low-back pain. The Vermont Rehabilitation Engineering Center predictive model. *Spine*. 1991;16:605-7.
10. Chavannes AW, Eijk JTM, Faas A, Lodder A, de Melker RA. Prognostiek van lage rugpijn. Een secundaire analyse. *Huisarts Wet*. 1997;40:151-4.
11. Chorus AMJ, Miedema HS, Andries F, Hildebrandt VH, Wevers CWJ, Van der Linden S. Chronicity of musculoskeletal disorders: A 7-year follow-up study. Submitted.
12. Coste J, Delecoeuillerie G, Cohen de Lara A, Le Parc JM, Paolaggi JB. Clinical course and prognostic factors in acute low back pain: An inception cohort study in primary care practice. *BMJ*. 1994;308: 577-580.
13. Deyo RA, Tsui-Wu Y. Functional disability due to back pain. A population based study indicating importance of socioeconomic factors. *Arthritis Rheum*. 1987;30:1247-53.
14. Foets M, Van der Velden J. *Een nationale studie naar ziekten en verrichtingen in de huisartspraktijk: Basis-rapport: Methoden van onderzoek*. Utrecht, The Netherlands: Dutch Institute for Primary Health Care; 1990.
15. Frymoyer JW. Back pain and sciatica. *N Engl J Med*. 1988;318:291-300.
16. Furer JW, König-Zahn C, Tax B. *Het meten van de gezondheidstoestand 3: Psychische gezondheid*. Assen: Van Gorcum; 1995.
17. Gatchel RJ, Polatin PB, Kinney RK. Predicting outcome of chronic back pain using clinical predictors of psychopathology: A prospective analysis. *Health Psychol* 1995;14:415-20.
18. *Gemeenschappelijke Medische Dienst. Jaarverslag 1991*. Amsterdam: GMD; 1992.
19. Goldberg DP, Williams P. *A user's guide to the General Health Questionnaire*. Windsor: NFER-Nelson; 1988.
20. Haanen HCM. *Een epidemiologisch onderzoek naar lage rugpijn*. Rotterdam: Erasmus University; 1984.
21. Hadler NM. Back pain in the workplace. What you lift or how you lift matters far less than whether you lift or when. *Spine* 1997;22:935-40.

22. Hasenbring M, Marienfeld G, Kuhlendahl D, Soyka D. Risk factors of chronicity in lumbar disc patients. A prospective investigation of biologic, psychologic, and social predictors of therapy outcome. *Spine* 1994;19:2759-65.
23. Heliövaara M, Aromaa A, Klaukka T, Knekt P, Joukamaa M, Impivaara O. Reliability and validity on interview data on chronic diseases: The mini Finland Health Survey. *J Clin Epidemiol* 1993;46: 181-91.
24. Van den Hoogen HJ, Koes BW, Deville W, Van Eijk JT, Bouter LM. The prognosis of low back pain in general practice. *Spine* 1997;22:1515-21.
25. Infante Rivard C, Lortie M. Prognostic factors for return to work after a first compensated episode of back pain. *Occup Environ Med* 1996;53:488-94.
26. Klenerman L, Slade PD, Stanley IM, Pennie B, Reilly JP, Atchison LE, Troup JD, Rose MJ. The prediction of chronicity in patients with an acute attack of low back pain in a general practice setting. *Spine* 1995;20:478-84.
27. Von Korff M, Deyo RA, Cherkin D, Barlow W. Back pain in primary care. Outcomes at 1 year. *Spine* 1993;18:855-62.
28. Lamberts H, Wood M, eds. International classification of primary care. New York: Oxford University Press; 1987.
29. Lamberts H. In het huis van de huisarts. Verslag van het Transitieproject. Lelystad: Meditekst; 1991.
30. Lanier DC, Stockton P. Clinical predictors of outcome of acute episodes of low back pain. *J Fam Pract* 1988;27:483-9.
31. Lindström I, Öhlund C, Nachemson A. Validity of patient reporting and predictive value of industrial physical work demands. *Spine* 1994;19:888-93.
32. Miedema HS. Reuma-onderzoek meerdere echelons (ROME study): basisrapport. Leiden: TNO Prevention and Health; 1994.
33. Miedema HS, Van der Linden S. Incidence of back pain in general practice and resulting health care events. In: Auquier L, Paolaggi JB. *Atelier de travail sur l'épidémiologie et le traitement des lombalgies*. Paris: BLD Communication; 1994:8-10.
34. Nachemson AL. Newest knowledge of low back pain. A critical look. *Clin Orthop* 1992;279:8-20.
35. Netherlands Central Bureau of Statistics (CBS). *Vademecum of health statistics in the Netherlands 1995*. The Hague: SDU Publishers; 1995.
36. Oleinick A, Gluck JV, Guire K. Factors affecting first return to work following a compensable occupational back injury. *Am J Ind Med* 1996;30:540-55.
37. Philips HC, Grant L. The evolution of chronic back pain problems. A longitudinal study. *Behav Res Ther* 1991;29:435-41.
38. Picavet HSJ, Schouten JSAG, Smit HA. Prevalenties en consequenties van lage rugklachten in het MORGEN-project 1993-1995. Bilthoven: RIVM; 1996.
39. Pincus T, Callahan LF, Brooks RH, Fuchs HA, Olsen NJ, Kaye JJ. Self-report questionnaire scores in rheumatoid arthritis compared with traditional physical, radiographic and laboratory measures. *Ann Intern Med* 1989;110:259-66.
40. Pincus T, Summey JA, Soraci SA Jr, Wallston KA, Hummon NP. Assessment of patient satisfaction in activities of daily living using a modified Stanford health assessment questionnaire. *Arthritis Rheum* 1983;26:1346-53.
41. Van Poppel MNM, Miedema HS, Boshuizen HC, et al. Labor force participation and working conditions of patients with musculoskeletal disorders. Submitted.

42. Raspe HH. Back pain. In: Silman AJ, Hochberg MC, eds. *Epidemiology of the rheumatic diseases*. Oxford/New York/Tokyo: Oxford University Press; 1993:360-74.
43. Roland MO, Morrell DC, Morris RW. Can general practitioners predict the outcome of episodes of back pain? *BMJ* 1983;286:523-5.
44. Roland M, Morris R. A study of the natural history of back pain, I: Development of a reliable and sensitive measure of disability in low-back pain. *Spine* 1983;8:141-4.
45. Simmonds MJ, Kumar S, Lechelt E. Psychosocial factors in disabling low back pain: Causes or consequences. *Disability Rehabil* 1996;18:161-8.
46. Smets EM, Garssen B, de Haes JC. The Multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. *J Psychosomatic Res* 1995;39:315-25.
47. SPSS. Reference guide. Chicago: SPSS Inc.; 1990.
48. Van Tulder MW, Koes BW, Bouter LM. A cost of illness study of back pain in The Netherlands. *Pain* 1995;62:233-240.
49. Van Tulder MW, Koes BW, Bouter LM. Management of chronic non-specific low back pain in primary care: A prospective study. In: Van Tulder MW, Koes BW, Bouter LM, eds. *Low Back Pain in Primary Care. Effectiveness of Diagnostic and Therapeutic Interventions*. Amsterdam: Institute for Research in Extramural Medicine; 1996:33-44.
50. Van der Velden J, Bakker DH de, Claessens AAMC. Een nationale studie naar ziekten en verrichtingen in de huisartspraktijk: Basis-rapport: Morbiditeit in de huisartspraktijk. Utrecht: Dutch Institute for Primary Health Care; 1990.
51. Weiser S, Cedraschi C. Psychosocial issues in the prevention of chronic low back pain: A literature review. *Baillieres Clin Rheumatol* 1992;6:657-84.
52. Van der Zee KI, Sanderman R, Heyink J. A comparison of two multidimensional measures of health status: The Nottingham Health Profile and the RAND 36-item health survey 1.0. *Qual Life Res* 1996;5:165-74.
53. Van der Zee KI, Sanderman R. Het meten van de gezondheidstoestand met de RAND-36. Een handleiding. Groningen: Noordelijk Centrum voor Gezondheidsvraagstukken; 1992.



# CHAPTER 3

## Incidence of low back pain related occupational diseases in the Netherlands

Harald S. Miedema, Henk F. van der Molen, P. Paul F.M. Kuijjer,  
Bart W. Koes, Alex Burdorf.

European Journal of Pain 2014 Jul;18(6):873-82.



## ABSTRACT

**Background:** Until recently no evidence based criteria were available to determine the workrelatedness of low back pain (LBP) in an individual worker. Incidence figures for LBP that can be qualified as occupational disease (OD) are scarce. We studied the trend in the number of OD-notifications due to LBP in the Netherlands and estimate incidence rates of LBP-related OD-notifications.

**Methods:** We developed an instrument for the assessment of workrelatedness of non-specific LBP (NLBP) in 2004, accompanied by an OD-registration-guideline. We analyzed the trend in LBP-related OD-notifications in the register of the Netherlands Centre for Occupational Diseases (NCOD) from 2004-2011. We estimated incidence rates for LBP-related OD-notifications with data from a prospective cohort study, performed by NCOD in 2009-2011.

**Results:** After implementation of the instrument and guideline, we noticed a huge increase in numbers of OD-LBP-related notifications, from 0.7% of all notified ODs in 2004, via 8.6% in 2005 and 13.6% in 2008, to 9.1% in 2011. We estimated the incidence rate of ODs due to LBP at 24.1 per 100,000 worker years (19.2 for NLBP), with a large difference between men and women (31.3 and 3.2 respectively).

**Conclusions:** The instrument for the assessment of workrelatedness of NLBP played an important role in the recognition of LBP-related ODs. It provides a basis for a more uniform and objective evaluation of the role of workrelated risk factors in the occurrence of NLBP. This knowledge can be used to initiate or direct preventive actions towards subgroups with higher incidence rates.

### What's already known about this topic:

- Until recently no evidence based criteria were available to determine the workrelatedness of low back pain (LBP)
- Incidence figures for LBP that can be qualified as occupational disease are scarce

### What does this study add:

- Trend in notifications of LBP-related occupational disease in the Netherlands after implementation of the instrument for the assessment of workrelatedness of nonspecific LBP
- Estimates of the incidence rates of LBP-related occupational disease in the Netherlands

## INTRODUCTION

Worldwide, 37% of adult cases of low back pain (LBP) can be attributed to their occupation, with an estimated annual loss of 818,000 disability-adjusted life years worldwide.<sup>33</sup> However, until recently no evidence based criteria were available to determine the workrelatedness of LBP in an individual. In order to ensure safe working conditions, accurate assessment of the workrelatedness of NLBP in the individual worker is important to enable the occupational physicians (OPs) to select those cases where workrelated intervention is indicated.

Comprehensive literature overviews concerning workrelated risk factors for NLBP have been published.<sup>2,5,6,16,17,24,25,30</sup> Most reviews conclude that there is substantial evidence for a relationship between workrelated risk factors and NLBP, but some others do not. This has been subject to debate, because the conclusions of these reviews are often dependant upon inclusion criteria for original studies, evaluation criteria of both methodological quality of included studies and statistical results and interpretation thereof, and even terminology used in formulating results and conclusions.<sup>1,22,23,32,37-39</sup> In most reviews a qualitative synthesis of the results of original studies was conducted and no meta-analysis could be performed. Often the workrelated risk factor is dichotomized, thus exposure-response relationships cannot be established. In addition, reported associations are often not adjusted for presence of other workrelated risk factors. In most work situations multiple risk factors are present simultaneously and dose-response relationships seem obvious.

Based upon epidemiological and experimental studies, several national and international occupational health guidelines have been developed.<sup>4,9,15,28,36,41,43,44</sup> These often include acceptable exposure limits for physical demands at work. However, they cannot be used to determine the relative contribution of various workrelated risk factors for NLBP in an individual. At the end of 2004, we published a practical instrument for the assessment of workrelatedness of NLBP in Dutch,<sup>19</sup> as well as in English.<sup>20</sup> Based upon this instrument, the Netherlands Centre for Occupational Diseases (NCOD) developed a registration guideline for NLBP as occupational disorder (OD) at the beginning of 2005.<sup>31</sup> Since then Dutch OPs have had access to an evidence based instrument for notification of ODs due to NLBP. Dutch OPs are obliged by law to notify any recognized OD. This notification is independent from compensation for sickness absence or work disability due to this OD, which in the Netherlands is the same for all disorders (occupational and non-occupational). However, in case of longstanding disabilities or permanent work disability an employee may claim damages because of loss of income due to an OD.

The purpose of the study described here is to:

- 1) study trends in the number of notifications of LBP as OD in the period 2004-2011
- 2) estimate incidence rates of notified ODs due to LBP in the Netherlands

## **METHODS**

### **Development of the instrument for the assessment of work-relatedness of NLBP**

The instrument for the assessment of workrelatedness of NLBP incorporates 3 risk factors that showed consistent and strong associations and were judged by a national and an international expert panel to be suitable in the assessment of workrelatedness of LBP.<sup>19-21,25</sup> These were manual material handling (MMH), frequently bending and twisting of the trunk (FBTT) and whole body vibration (WBV). In a meta-analytic model pooled odds ratios were calculated for each risk factor, adjusted for other risk factors. These pooled odds ratios were used in a clinical decision model to construct a score-table from which the probability of workrelatedness can be read off for a given exposure (Supporting information Fig. S1, upper part). This probability corresponds to the attributable fraction (AF) among exposed subjects in epidemiological studies, i.e. in the proportion of cases of NLBP in a given group, exposed to a specific combination of risk factors that is attributed to this exposure. The AF is a mean proportion for the exposed group as a whole, but in the probability model this mean AF is assigned as the AF at individual level, and is interpreted as the probability of workrelatedness for an individual worker. In order to calculate this probability, the pooled odds ratio for each risk factor was transformed to a score. The probability that the individual's NLBP is due to workrelated risk factors can vary between 0% and 66% (Supporting information Fig. S1, lower part), and decreases with age as a result of the fact that the a priori probability of NLBP increases with age. Thus, the basic outcome of the instrument for the assessment of workrelatedness of NLBP is the probability that the NLBP of an affected worker is caused by the incorporated workrelated risk factors.

According to Dutch law, an OD is 'a disease or complaint mainly due to risk factors occurring at work or in a work environment'.<sup>27</sup> So, interpreting 'mainly' as more than 50%, national and international experts were in favor of notification of NLBP as OD when the probability of workrelatedness exceeds 50%.<sup>21</sup> If the probability is less than or equal to 50%, this does not necessarily mean that the NLBP is not an OD. It may be that the exposure to one particular risk factor substantially exceeds the exposure limits in the decision model. In that case it is conceivable that the NLBP is mainly caused by exposure to this single workrelated factor, even though the calculated total probability of workrelatedness does not exceed 50%. Therefore, substantial higher exposure levels to the separate risk factors than defined in the decision model should also be taken into account for the

decision whether or not a case of NLBP is regarded as OD. Based on existing guidelines, two criteria for notification of NLBP as OD were added for the cases of NLBP in which the probability of workrelatedness is equal to or less than 50%:

- 1) with regard to Whole Body Vibration a daily exposure exceeding 1.15 m/s<sup>2</sup> in intensity during an eight-hour reference period;<sup>13</sup>
- 2) with regard to the risk factor 'lifting', as part of MMH, a NIOSH lifting Index above 2.<sup>26,45,46</sup>

In the instrument for assessment of the workrelatedness of NLBP, a three step procedure is presented:

- 1) Case definition (Supporting information Table S1): In view of the primary aim of the instrument to assist in the determination of the degree to which working conditions cause NLBP in a worker presenting with this complaint, the instrument starts with the first time the worker is presenting with NLBP. A strict case definition should be used in order to determine whether the diagnosis NLBP is applicable. Exclusion criteria are specific causes of NLBP. The so-called 'red flags' can be used to check if there are signs or symptoms that could indicate specific causes of LBP.<sup>36,42,43</sup>
- 2) Inventory of risk factors ( Supporting information Fig. S1, upper part): The exposure to the relevant risk factors in the working environment must be assessed, preferably by collection of reliable, quantitative exposure data.<sup>21</sup> Besides information from the case history, it is advised to use data from worksite studies and/or risk inventories and evaluations, possibly supplemented by exposure data compiled for the branch of industry in question or the results of scientific studies of exposure in the relevant professional group. The score sheet (supporting information fig. S1) can be used as a checklist, in order to enable a systematic evaluation of the relevant risk factors that can be present in a specific working environment. If a risk factor exceeds the cut-off point for moderate or high exposure, the score for that level of exposure must be noted in the box on the right side. After evaluation of all the risk factors in the model and notation of the score per individual risk factor, a total score can be obtained by adding up the scores for the individual risk factors.
- 3) Determination of the probability of workrelatedness (Supporting information Fig. S1, lower part): A conversion table can be used, which translates the exposure score into the estimated probability of workrelatedness of NLBP. It enables a simple way to read off the probability that corresponds with the total score that was found of all risk factors in the model. As indicated before, the relationship between the exposure to risk factors at work and the probability of workrelatedness depends on the age of the worker concerned.

Supporting information Table S2 summarizes the proposed interpretation of the probability of workrelatedness of the NLBP and the consequences for the case management plan and the decision whether the NLBP should be regarded as an OD.

Risk factor	Score	Probability of work-relatedness (%)		
		Age < 35 years	Age 35 – 45 years	Age > 45 years
<b>Total exposure score</b>				
0		0	0	0
1		7	7	6
2		14	13	12
3		20	18	17
4		26	23	22
5		31	28	26
6		35	32	30
7		39	35	33
8		43	39	36
9		46	42	39
10		49	44	42
11		52	47	44
12		55	49	46
13		57	51	48
14		59	53	50
15		61	54	51
16		62	56	53
17		64	57	54
18		65	58	55
19		66	60	56
<b>A Manual materials handling</b>				
Lifting, holding or moving object by hand without the help of mechanical aids				
A1 Does worker handle objects > 15 kg during > 10% of working day? No, go to A2 / Yes, score 7 and go to B	→			
A2 Does worker handle objects = 5kg > 2x per minute for total of > 2 hours per working day, or objects > 25kg > 1x per day? No, score 0 and go to B / Yes, score 4 and go to B	→			
<b>B Bending or twisting of trunk</b>				
Bending trunk forwards or sideways and/or twisting trunk (NB: The times given refer to the total time during which worker works in this position during a working day)				
B1 Does worker work with trunk bent and/or twisted > 40° for > ½ hour per working day? No, go to B2 / Yes, score 7 and go to C	→			
B2 Does worker work with trunk bent and/or twisted > 20° for > 2 hours per working day? No, score 0 and go to C / Yes, score 5 and go to C	→			
<b>C Whole-body vibration</b>				
The vibration levels given below are time-weighted averages over an 8-hour period; if the actual exposure time per working day is shorter, the time-weighted average can be calculated with the aid of the formula $a8 = aexp \cdot \sqrt{Te/8}$ (Where a8 = time-weighted average over 8 hours, aexp = vibration level (measured or estimated), Te = daily exposure time)				
C1 Has worker been exposed to average vibration levels > 1 m/s <sup>2</sup> per working day for > 5 years? No, go to C2 / Yes, score 5 and calculate total score	→			
C2 Is worker exposed to average vibration levels > 0.5 m/s <sup>2</sup> per working day? No, score 0 and calculate total score / Yes, score 3 and calculate total score	→			
<b>Total score (0-19)</b>	→			

Supporting information Fig. S1. Model and score-sheet for the assessment of the workrelatedness of NLBP

**Supporting information table S1.** Case definition of nonspecific low back pain (NLBP)

<b>Case definition</b>	Pain in the lower back region lasting at least 24 hours without any demonstrable physical cause
<b>Red flags</b> If one or more of the signs listed are observed, further investigation should be carried out to exclude specific causes such as:	<ul style="list-style-type: none"> <li>• First signs NLBP appearing under 20 or over 55 years</li> <li>• Constantly present progressive back pain</li> <li>• Recent back trauma</li> <li>• History of malignancy</li> <li>• Prolonged use of corticosteroids</li> <li>• Use of hard drugs, use of immunosuppressive drugs</li> <li>• History of HIV or AIDS</li> <li>• General malaise, fever, elevated BSE</li> <li>• Unexplained weight loss</li> <li>• Past history of unexplained peripheral arthritis, iridocyclitis or inflammatory bowel disease</li> <li>• Pain worse at night and better when exercising</li> <li>• Morning stiffness</li> <li>• Neurological dysfunction (motor dysfunction, sensory abnormalities and/or miction disturbances)</li> <li>• Lumbar kyphosis or past history of lumbar lordosis</li> <li>• Palpable slip of processi spinosi of L4-L5</li> </ul>
<ul style="list-style-type: none"> <li>- radicular syndrome due to a herniated disc</li> <li>- osteoporotic vertebral fracture</li> <li>- vertebral fracture after trauma</li> <li>- spinal stenosis</li> <li>- infectious spondylitis or discitis</li> <li>- spondylitis ankylopoetica (M. Bechterew)</li> <li>- severe forms of spondylolisthesis</li> <li>- malignancy</li> </ul>	

**Supporting information Table S2.** Interpretation of the probability of workrelatedness of nonspecific low back pain (NLBP)

<b>PROBABILITY OF WORKRELATEDNESS</b>	
$\leq 50\%$	$> 50\%$
<b>INTERPRETATION</b> The NLBP may be due to risk factors at work.	<b>INTERPRETATION</b> The NLBP is largely due to risk factors at work.
<b>CASE MANAGEMENT PLAN</b> Intervention depends on exposure to the individual risk factors; if a risk factor is present, it is worthwhile considering lowering the exposure.	<b>CASE MANAGEMENT PLAN</b> Intervention is needed to lower the exposure to the workrelated risk factors covered by the inventory.
<b>OCCUPATIONAL DISEASE?</b> <u>YES, if:</u> - Whole-body vibration level $> 1.15 \text{ m/s}^2$ average over 8-hour working day - NIOSH Lifting Index $> 2$	<b>OCCUPATIONAL DISEASE?</b> <b>YES</b>

**Notification of ODs due to NLBP in the Netherlands**

In the Netherlands, occupational physicians (OPs) are obliged by law to notify cases of ODs to the register of the NCOD. The notification of a particular OD follows the registration guideline of the NCOD for that diagnosis. No personal information except sex and age are provided. OD-notifications are performed by individual OPs through a secured

internet notification form of the NCOD or through a secured electronic database of an Occupational Health Service which connects directly to the NCOD. At the beginning of 2005 the NCOD developed a registration guideline for the notification of ODs due to NLBP.<sup>31</sup> Before 2005 already some OD-notifications due to NLBP-related diagnoses took place, based upon criteria for excess of WBV or calculation of a NIOSH lifting index of 2 and more.<sup>13,45</sup> As stated before, these two criteria were incorporated in the instrument for the assessment of the workrelatedness of NLBP. The guideline consisted of the complete instrument and the registration procedure. In the period 2004-2011 we studied the number of notifications of NLBP as OD in the NCOD register. Based upon the Dutch Classification for Occupational Health Care and Social Affairs (CAS-code), which is an extraction from ICD-10 for application by OPs and insurance physicians, the register distinguishes 14 diagnoses of the lower back.<sup>29</sup> For this analysis we included in the diagnostic subcategory NLBP the following 7 diagnoses: acute, subacute and chronic NLBP, spondylosis or osteoarthritis of the spine, lumbago with ischialgia or ischialgia alone and other disc disorders (than herniated discs). We included in the diagnostic subcategory specific low-back pain (SLBP) the following 7 diagnoses: herniated lumbar disc, radiculopathy, spinal stenosis, spondylolysis, other deforming disorders of back or neck, other spondylogenic disorders of back or neck and other disorders of the spine. In the NCOD register each worker diagnosed with an OD is anonymously reported and the following information is recorded in a database: disease or pathology with clinical diagnosis, demographic characteristics (age, gender), exposure (information on physical, chemical, biomechanical and psychosocial factors), occupation, economic sector and consequences for work ability. The economic sector is assigned based on the 21 main economic sectors described in the Statistical Classification of Economic Activities in the European Community.<sup>14</sup>

### **Prospective cohort-study**

In addition to the register, the NCOD set up a 5-year dynamic prospective cohort-study for the period 2009-2013. All Dutch registered OPs with known email addresses (n=1,773) were asked by the NCOD to participate. The aim of this study was: 1) to give a more accurate number of (reported) ODs for large worker groups by addressing under-reporting of ODs by OPs possibly due to lack of knowledge or motivation by special training and attention; and 2) to estimate incidence figures of ODs enabled by the knowledge of the size and characteristics of the workers' population at risk.<sup>40</sup> The registration procedure was the same as in the regular NCOD-register and therefore complied to the legislation with regard to notification of OD's. The study did not meet the criteria of the Dutch 'Act medical-scientific research with human participants' and therefore no separate approval of a Medical Ethics Committee was needed.

The inclusion criteria for participation of OPs were: 1) covering a population of employees; 2) reporting the economic sectors and size of their employee population; and 3) willingness to register all diagnosed ODs. In this study we had access to the data from the period 2009-2011.

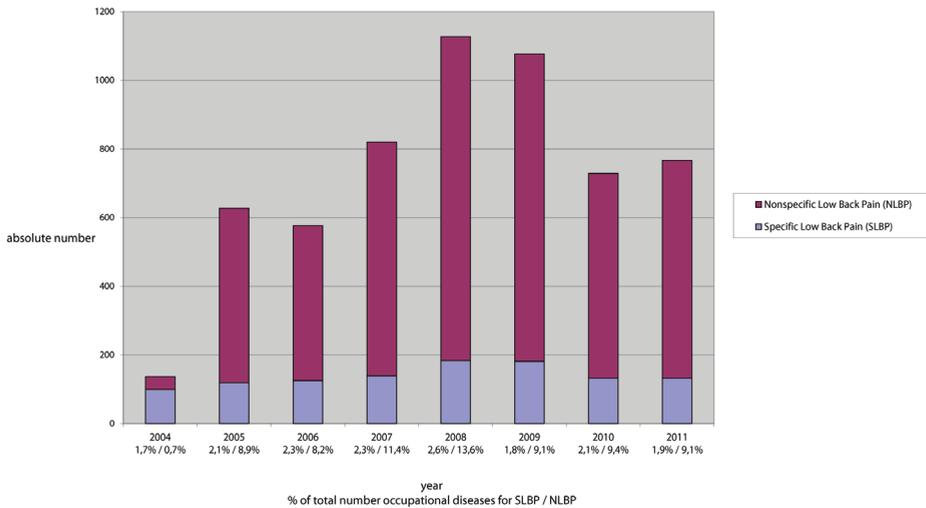
## Analysis

Data from the regular NCOD register are shown as absolute numbers of the diagnostic categories SLBP and NLBP and proportion of SLBP and NLBP in relation to the total number of registered ODs. From the data of the prospective cohort-study we calculated incidence figures and 95% confidence limits (95% CL) taking the number of notifications of NLBP as OD per 100,000 worker-years in 2009, 2010 and 2011, for the total of low back disorders, as well as the subcategories SLBP and NLBP. The unit of worker-years was corrected for changes in the participation of OPs each 6-months period. OPs ending their participation before July 1 were considered to have no participation, and those ending between July 1 and December 31 were considered to have participated only during the first half of the calendar year. New participants between January 1 and July 1 were considered participants only during the last half of the calendar year. When the lower end of the 95% CL was negative, we noted zero, because a negative incidence is not possible. We also calculated the annual incidence rate of NLBP with 95% CL for each economic sector. In the cohort-study, only the total number of workers and subdivision in economic sector were available, however no demographic data nor details about occupation. Based upon data of Statistics Netherlands for the total working population (>12 hours per week) in the Netherlands in 2009, 2010 and 2011, we calculated for each year the proportions of the subpopulations according to sex and to the age categories (<20; 21-30; 31-40; 41-50; 51-60; and >60 years) and estimated for each demographic subcategory the yearly incidence rates with 95% CL for NLBP. Finally, for the total of LBP (NLBP+SLBP) and for each subcategory of NLBP we calculated the incidence rate per 100,000 worker years (total of 2009-2011).

## RESULTS

### NCOD register of ODs

In Figure 1 the number of notifications of ODs with SLBP or NLBP in the NCOD register of 2004-2011 is presented. At the end of 2004 the registration guideline for NLBP was introduced. In the bottom of the graph the proportion of the total of notifications of SLBP and NLBP respectively in relation to the total of registered ODs in that year is indicated.



**Figure 1.** Number of notified occupational diseases due to Low Back Pain in the register of the NCOD

From 2004 to 2005 there was a clear rise of notifications of NLBP as OD, followed by a further increase until 2008. This was also reflected in the relative contribution of ODs due to NLBP, which rose from 0.7% (2004), via 8.9% (2005) to 13.6% (2008). The number of notifications due to SLBP increased to a much lesser extent and the proportion of SLBP remained rather constant over the whole period. Contrary to SLBP the rise in the number of notifications of NLBP as OD cannot be explained by the rise in the notifications of all ODs, because the relative number of notifications for all ODs compared to 2007 was 105% in 2008 and 148% in 2009, whereas the proportion of ODs due to NLBP was 13.6% in 2008 and dropped to 9.1% in 2009.

### Incidence rate of ODs due to LBP

In 2009 the prospective cohort-study started, covering 21 economic sectors and a total of 514,590 workers in 2009, 537,085 in 2010 and 487,081 in 2011. In only 17 sectors ODs due to LBP were notified. The coverage of the economic sectors varied from 476 worker-years for the mining and quarrying sector in 2011 to 120,841 worker-years for the health sector in 2010 and 2011. In 2009 189 OPs started and 5 ended their participation in the cohort-study. In 2010 186 OPs started and 16 ended their participation and in 2011 these numbers were 174 and 6. So the mean number of participating OPs was 179, this is about 9.1% of all active OPs ( $n=1,968$  in 2010) in the Netherlands.<sup>34</sup> The participating OPs were representative for all registered OPs in the Netherlands: 63% were male, mean age was 51 years (sd 6.1) and mean duration of registration with the NCOD was 8 years (sd 1.8), compared to respectively 66%, 50 years (sd 7.1) and 7 years (sd 2.5) in the total group. Within the study period 14.2% of all OD-notifications due to LBP (NLBP

13.9%, SLBP 15.5%) originated from the cohort-study. In 2009 81% (153/189) of the OPs reported at least one OD, with a mean of 12 (1782/153) ODs per year (range 1-81). In 2010 and 2011 these figures were 68% (127/186) and 68% (118/174) respectively and a mean of 11 (1398/127; range 1-80) and 12 (1472/118; range 1-82) ODs per year respectively. Using the total number of employees (i.e. excluding independent workers) as reported by Statistics Netherlands as denominator the mean yearly incidence rate in the period 2005-2011 for all notified ODs was 86.6 (range 71.9 (2006) –124.7 (2009)), based upon the NCOD register. The mean yearly incidence rate for LBP (NLBP) in this period was 10.5 (8.6) per 100,000 employees (range 7.6 (5.9) in 2006 to 14.1 (11.8) in 2008; mean 2009-2011 10.9 (9.0)).

The prospective cohort-study was set up to determine incidence rates for ODs in the Netherlands more accurately (Table 1). In the period 2009-2011 the mean incidence rate of notified ODs due to LBP was 24.1 per 100,000 worker years. For NLBP the incidence rate was 19.2 per 100,000 worker years, with 84.5% of the diagnoses in the categories of acute, subacute or chronic NLBP. The number of acute and subacute NLBP that is reported as OD was relatively high (68.4% of cases with NLBP). In the period 2009-2011 the mean ratio between incidence rate of ODs due to NLBP in the prospective cohort-study and the rate as a result of the national registration was 2.1. The mean incidence of OD notifications due to SLBP was 4.9 per 100,000 worker years. The large majority of these cases were registered with a diagnosis of herniated lumbar disc or lumbar radiculopathy (88.0%).

About 91% of all notifications of NLBP as OD occurred in men. The incidence rate per 100,000 worker years of OD notification due to NLBP for men and women was 31.3 and 3.2 respectively. The proportion of cases of OD due to NLBP that fell in the age categories 31-40 years, 41-50 years and 51-60 years was 25%, 34% and 20% respectively. The incidence rates for these age categories were relatively high, 20.1, 23.3 and 26.9 per 100,000 worker years respectively.

The incidence figures for NLBP as OD in the different economic sectors varied considerably over the years 2009-2011 (Table 2). Only 6 economic sectors had sufficient cumulative numbers over the 3 years of either ODs or subpopulation to yield an incidence rate that differed significantly from zero. Of these, the sectors 'Construction', 'Transport and storage' and 'Agriculture, forestry and fishing' had incidence rates that were higher than average, although the latter had a rather small population and 1, 3 and 0 cases of NLBP in 2009, 2010 and 2011. The sectors 'Health care' and 'Government and defence' also had sufficient subpopulation numbers and a relatively low incidence rate, whereas 'Manufacturing industries' also had a substantial subpopulation and an incidence rate slightly lower than average.

**Table 1.** Incidence rate / 100,000 worker years (with 95% confidence limits) of occupational disease notifications due to nonspecific and specific low back pain (NLBP / SLBP) in prospective cohort study

	Year of notification 2009			Year of notification 2010			Year of notification 2011			Mean 2009-2011				
	Nr. ODs	population	CI	95% CL	Nr. ODs	population	CI	95% CL	Nr. ODs	population	CI	95% CL	CI	95% CL
Total LBP	135	514,590	26	22-31	112	537,085	21	17-25	124	487,081	25	21-30	24	22-27
NLBP	109	514,590	21	17-25	93	537,085	17	14-21	94	487,081	19	15-23	19	17-21
SLBP	26	514,590	5	2-8	19	537,085	4	2-5	30	487,081	6	4-8	5	4-6
For NLBP:														
Men	92	289,200	32	25-38	87	299,693	29	23-35	90	269,843	33	26-40	31	28-35
Women	12	225,390	5	2-8	6	237,392	3	1-5	4	217,238	2	0-4	3	2-5
<20 years	1	14,923	7	0-20	1	13,964	7	0-21	4	12,664	32	1-63	14	3-26
21-30 years	7	96,743	7	2-13	9	99,361	9	3-15	2	90,110	2	0-5	6	3-9
31-40 years	27	128,133	21	13-29	22	129,975	17	10-24	26	114,464	23	14-31	20	16-25
41-50 years	36	144,085	25	17-33	34	151,458	22	15-30	31	137,357	23	15-31	23	19-28
51-60 years	37	109,093	34	23-45	24	117,085	21	12-29	29	108,132	27	17-37	27	21-32
>60 years	1	21,613	5	0-14	3	25,243	12	0-25	2	24,354	8	0-20	8	2-15

N = number of workers in cohort-study; CI = cumulative incidence; 95% CL = 95% confidence limits

**Table 2.** Incidence rate / 100,000 worker years (with 95% confidence limits) of occupational disease notifications due to nonspecific low back pain (NLBP) in various economic sectors<sup>a</sup> in prospective cohort study

	Year of notification 2009			Year of notification 2010			Year of notification 2011			Mean 2009-2011	
	Nr. ODs	population	CI 95%CL	Nr. ODs	population	CI 95%CL	Nr. ODs	population	CI 95%CL	CI	95%CL
Construction	26	27,585	94 58-130	39	26,628	146 100-192	51	23,248	219 159-280	150	123-177
Transport and storage	38	34,555	110 75-145	35	39,378	89 59-118	29	31,242	93 59-127	97	78-116
Agriculture, forestry and fishing	1	3,797	26 0-78	3	4,068	74 0-157	0	6,385		28	1-56
Manufacturing industries	16	74,049	22 11-32	8	76,403	10 3-18	8	62,237	13 4-22	15	10-20
Government and defence	3	31,119	10 0-21	2	33,850	6 0-14	2	39,404	5 0-12	7	2-12
Health care	7	119,330	6 2-10	0	120,841		0	120,841		2	1-3
Mining and quarrying	1	563	178 0-526	0	566		0	476		62	0-184
Electricity, gas and water supply	1	3,206	31 0-92	1	5,681	18 0-52	0	3,001		17	0-40
Water and waste processing	2	3,245	62 0-147	0	4,128		0	4,782		16	0-39
Scientific and free occupations	0	11,109		1	11,724	9 0-25	2	6,893	29 0-69	10	0-22
Information and communication	3	16,040	19 0-40	0	14,145		0	11,978		7	0-15
Hotels and restaurants	1	13,023	8 0-23	0	13,391		1	8,446	12 0-35	6	0-14
Real estate	1	6,007	17 0-49	0	6,234		0	4,505		6	0-18
Administration	3	20,891	14 0-31	0	20,976		0	18,073		5	0-11
Wholesale and retail	4	62,789	6 0-13	0	60,612		1	51,009	2 0-6	3	0-5
Education	1	39,081	3 0-8	1	43,727	2 0-7	0	44,793		2	0-4
Financial services and insurances	0	20,483		1	22,101	5 0-13	0	18,394		2	0-5

N = number of workers in cohort-study; CI = cumulative incidence; 95% CL = 95% confidence limits;

<sup>a</sup> When in a particular economic sector no cases of OD due to NLBP were notified (Nr. ODs = 0), the cells CI and 95% CL are left empty

## DISCUSSION

With the development and implementation of the instrument for assessment of work-relatedness of NLBP, accompanied by an OD-registration guideline for NLBP, we were able to facilitate the registration of ODs due to NLBP. In a cohort-study we could estimate the sex- and age-specific incidence rates.

In an international context the obscurity about notification of ODs due to NLBP has led to extensive under-registration. In many statistics considering ODs, back disorders are not a separate entity.<sup>18</sup> Hence, data about the incidence rate of ODs due to NLBP are scarce. Prior to this study only from the Occupational Physicians Reporting Activity (OPRA) in the UK, 1996-2001, an incidence rate for OD of the lumbar spine of 48.4 and 44.6 per 100,000 for male and female workers respectively was reported, compared to 31.3 and 3.2 in our study.<sup>10</sup> However, there were no clear registration criteria for notification of NLBP as OD. Later, OPs that participated in an OPRA-survey indicated that history of onset, recurrence or worsening of symptoms in relation to workplace changes, symptoms consistent with occupational exposure and similar symptoms in co-workers performing similar job tasks were considerations to register a case as OD.<sup>11</sup> In the OPRA-study 50% of the LBP consisted of 'mechanical back pain', 38% of ill-defined back pain and 12% of back pain resulting from disc problems. Thus, 12% of ODs due to LBP were attributed to specific disorders, compared to 20% in our study.

The overall incidence rate for ODs due to LBP in the OPRA-register is about twice the rate in our study. However in the Netherlands 90% of OD-notifications due to NLBP occurred in men, compared to 53% in the UK. So among men the incidence rate in the UK was 50% higher and among women 14 times. In the Netherlands there is a general trend towards lower incidence rates among women, because in the NCOD-register of 2009-2011 84% of all OD-cases were male and of OD-cases due to NLBP 96%. In a report of the NCOD the reason for the low number of female cases is attributed to the relatively high number of notifications in the economic sector 'Construction', in which only few female workers are present.<sup>41</sup> Indeed, 39% of notifications of ODs due to NLBP occurred in this sector, as part of 70% of all OD-notifications. However, this cannot be the only explanation, since in the cohort-study also other sectors with sufficient population size had low incidence rates among women. Perhaps OPs in the Netherlands are more reluctant to recognize ODs among female workers. This explanation might be supported by the fact that the incidence rate in 'Health care', in which the majority of employees is female, was low, contrary to ample evidence in this sector with regard to workrelated risk factors for NLBP.<sup>8</sup> However, incidence rates for subgroups should be interpreted with caution because of small numbers and large variations over time.

Because information about age distribution or occupations was not available, we cannot say anything about higher or lower risk among age groups or occupational groups within the economic sectors. We can assume that within some economic sectors, such as 'Construction' or 'Health care', physical work load will be higher in many occupations, but of course in these sectors there are also occupations with less physical demands.

Among male workers, the higher incidence rate of ODs due to NLBP in the OPRA-register might partly be explained by selection of cases due to application of the instrument for the assessment of workrelatedness of NLBP, because the incidence rate for all ODs is about the same in both studies (342 and 346 per 100,000 worker-years in UK and Netherlands respectively).<sup>12,40</sup>

The peak in OD-notifications due to NLBP in 2008 may be explained by a maximum effect of the implementation efforts. The peak of OD-notifications in 2009 can be explained by: 1) the start of the cohort-study; and 2) a considerable raise in notifications in the sector 'Construction' due to an administrative extension in the sector-specific preventive screening-procedure, accountable for the recognition of 93% of ODs, instead of notification with OP-consultation, mostly because of prolonged sickness-absence.<sup>41</sup>

The slight raise in OD-notifications due to SLBP might be caused by increased general attention for OD-notification due to LBP. The further raise in 2008/2009 coincided with the peaks for NLBP.

At the end of the study-period a remarkable trend was noticeable, when both total and NLBP-related numbers of OD-notifications decreased by one-third compared to 2009. In this period the proportion of OD-notifications due to NLBP originating from the cohort-study increased from 12.2% to 15.6%-14.8%. This trend is possibly due to a decrease of (reporting) OPs or changes in economic sectors (e.g. less activities in 'Construction').

It is assumed that in the NCOD-register there is under-reporting by OPs due to various reasons, such as lack of time, feeling insecure when to recognize an OD, or worries about possible debates with employers or employees or legal consequences. One goal of the cohort-study was to counterbalance this under-reporting.<sup>35,40</sup> The ratio of OD-notifications due to NLBP in the cohort-study and the NCOD-register was 2.1. In 2009 the incidence rate in the cohort-study for all ODs was 346 per 100,000 workers.<sup>40</sup> This is a factor 2.8 higher. So, the extra attention and training for participating OPs contributed to a doubling of the incidence rate for ODs due to NLBP. This raise may be less than expected, since a preceding pilot-study showed a sevenfold raise for all ODs in a sentinel group compared to other OPs.<sup>35</sup> However, in this pilot-study participating OPs already had similar numbers of OD-notifications in two years preceding this study. In conclusion, since 2005 in the Netherlands the OD-notification due to NLBP as part of the obligations

of OPs is already high and higher than notification of other ODs. This might be a result of the clarity that is provided for OD-notification due to NLBP through the development and attention given to the instrument for the assessment of workrelatedness of NLBP accompanied by the NCOD-guideline.

Before 2005 already some OD-notifications due to NLBP-related diagnoses took place (n=38 in 2004). Before 2005 criteria for excess of WBV were well known, since many Dutch research-projects contributed to this knowledge.<sup>13,25</sup> Also many OPs were familiar with the NIOSH lifting index.<sup>45</sup> So it can be assumed that the instrument for the assessment of workrelatedness of NLBP was accountable for the annual surplus of 500-600 OD-cases. MMH and WBV are also accounted for in the instrument, but especially the addition of FBTT and the possibility of combining physical loads due to MMH, FBTT or WBV, including dose-response relationships by application of lower threshold scores, might enable OPs to recognize more OD-cases due to NLBP.

In the development phase of the instrument for the assessment of workrelatedness of NLBP there has been ample discussion at what cut-off point NLBP can be defined as OD.<sup>21</sup> Due to the relatively high a priori probability of NLBP, a probability of for example 40% indicates an AF of 60% for other, mostly not workrelated factors. However, the AF for the three workrelated factors of 40% could still indicate an important contribution of the working conditions. Recognition of an OD takes place when the disease occurs among exposed workers with a frequency above average and a causal relationship with exposure in specific working environment has been determined.<sup>18</sup> Theoretically, when in a body of workers the mean AF exceeds 50%, the prevalence of NLBP will be higher than in a subgroup of the general population that is comparable for all other risk factors except those incorporated in the instrument. In that case the NLBP can be considered as mainly caused by occupational risk factors. Translating this group level to the individual, it seemed rational to choose 50% as cut-off point for recognition as OD.

Another example of this reasoning has been applied in Germany in the recognition of primary lung cancer as OD related to exposure to asbestos.<sup>3</sup> In contrast, when the AF is below 50%, workrelated factors still might have contributed considerably to a case of NLBP. The participants of the international workshop suggested that at an individual level the presence of aggravating factors, such as previous episodes of NLBP or job dissatisfaction, may be sufficient reason to propose workplace interventions, even at an AF below 50%.<sup>21</sup> So, from a prevention point of view, also identification of cases with AFs below 50% are of interest. In addition, with respect to occupational health surveillance, an AF below 50% can also provide sufficient reason for preventive interventions in the presence of aggravating factors or high exposure levels.

## Conclusions

In the Netherlands, an incidence rate of ODs due to LBP of 24.1 per 100,000 workers could be determined, with 90% of cases occurring among male workers. The instrument for the assessment of workrelatedness of NLBP played an important role in the recognition of ODs due to NLBP. It provides a promising basis for a more uniform and reliable evaluation of the role of workrelated risk factors in the occurrence of NLBP.

With this the instrument and the subsequent registration guideline it has become possible to make an estimate of the number of cases of NLBP that apply to the definition of OD and to monitor this figure over time and in different subgroups. This knowledge can be used to initiate or direct preventive actions towards subgroups with higher incidence rates of LBP.

## FUNDING SOURCES

Development of the instrument for the assessment of workrelatedness of nonspecific low back pain was funded by the Netherlands Organization for Health Research and Development (ZONMw). The international meeting was financially supported by the Swedish Joint Program for Working Life Research in a European Perspective (SALTSA). The Netherlands Center for Occupational Diseases is supported by the Dutch Ministry of Employment and Social Affairs. This research at the Center of Expertise Innovations in Care of the Rotterdam university of applied sciences is funded by the Dutch Ministry of Education, Culture and Science.

## ACKNOWLEDGEMENTS

Freek Lötters and Judith Kuiper performed much work in the development of the decision model and instrument for the assessment of workrelatedness of nonspecific low back pain and the preceding review of the literature.

## REFERENCES

1. Andersen JH, Haahr JP, Frost P. Details on the association between heavy lifting and low back pain. *Spine J*. 2011;11(7):690-1.
2. Bakker EW, Verhagen AP, Van Trijffel E, Lucas C, Koes BW. Spinal mechanical load as a risk factor for low back pain: a systematic review of prospective cohort studies. *Spine*. 2009;34(8):E281-93.
3. Baur X, Schneider J, Weitowitz HJ. Diagnostik Und Begutachtung Asbestbedingter Berufskrankheiten Kurzdarstellung Der Neuen S2k- Leitlinie Mit Kommentierung Und Fallbeispielen. Diagnosing and Expertizing Asbestos-Induced Occupational Diseases: New Directive with Commentaries and Case Reports. *Dtsch Med Wochenschr*. 2011;136:2319–2324.
4. Bolm-Audorff U, Brandenburg S, Brüning T, Dupuis H, Ellegast R, Elsner G, Franz K, Grasshoff H, Grosser V, Hanisch L, Hartmann B, Hartung E, Hering KG, Heuchert G, Jäger M, Krämer J, Kranig A, Ludolph E, Luttmann A, Nienhaus A, Pieper W, Pöhl K-D, Remé T, Riede D, Rompe G, Schäfer K, Schilling S, Schmitt E, Schröter F, Seidler A, Spallek M, Weber M. Medizinische Beurteilungskriterien zu bandscheibenbedingten Berufskrankheiten der Lendenwirbelsäule (I / II). Konsensempfehlungen zur Zusammenhangsbegutachtung der auf Anregung des HVBG eingerichteten interdisziplinären Arbeitsgruppe. *Trauma und Berufskrankheit*. 2005;7(3):711-52 / 2005;7(4):320-332.
5. Bombardier C, Kerr MS, Shannon HS, Frank JW. A guide to interpreting epidemiologic studies on the etiology of back pain. *Spine*. 1994;19:2047S-2056S.
6. Burdorf A, Sorock G (1997). Positive and negative evidence of risk factors for back disorders. *Scand J Work Environ Health*. 1997;23:243-56.
7. Burdorf A, Van der Beek A. In musculoskeletal epidemiology are we asking the unanswerable in questionnaires on physical load? *Scand J Work Environ Health*. 1999;25:81-3.
8. Burdorf A, Jansen J. Predicting the long-term course of low back pain and its consequences for sickness absence and associated work disability. *Occup Environ Med*. 2006;63:522-529.
9. Carter JT, Birrell LN. Occupational health guidelines for the management of low-back pain at work - principal recommendations. London: Faculty of Occupational Medicine; 2000.
10. Chen Y, McDonald JC, Cherry NM. Incidence and suspected cause of work-related musculoskeletal disorders, United Kingdom, 1996–2001. *Occup Med*. 2006;56:406–413.
11. Chen Y, Agius R, McNamee R, Turner S, Taylor S, Fulluck L, Lines S, Roberts C, Hussey L. Physicians' beliefs in the assessment of work attribution when reporting musculoskeletal disorders. *Occup Med*. 2005;55:298–307.
12. Cherry NM, McDonald JC. The incidence of work-related disease reported by occupational physicians, 1996-2001. *Occup Med*. 2002;52(7):407-11.
13. Directive 2002/44/EC of the European Parliament and of the Council. The minimum health and safety requirements regarding exposure of workers to the risks arising from physical agents (vibration). Sixteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC. *Official Journal of the European Communities L 177*. 2002:13-19.
14. Eurostat. NACE rev. 2. Statistical classification of economic activities in the European Community. Luxembourg: Office for Official Publications of the European Communities; 2008. Available from: [http://epp.eurostat.ec.europa.eu/cache/ITY\\_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF](http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF).
15. Fallentin N, Viikari-Juntura E, Waersted M, Kilbom Å. Evaluation of physical workload standards and guidelines from a Nordic perspective. *Scand J Work Environ Health*. 2001;27(Suppl 2):1-52.
16. Hoogendoorn WE, Van Poppel MNM, Bongers PM, Koes BW, Bouter LM. Physical load during work and leisure time as risk factors for back pain. *Scand J Work Environ Health*. 1999;25:387-403.

17. Hoogendoorn WE, Van Poppel MN, Bongers PM, Koes BW, Bouter LM. Systematic review of psychosocial factors at work and private life as risk factors for back pain. *Spine*. 2000;25:2114-25.
18. International Labour Office (ILO). List of occupational diseases (revised 2010). Identification and recognition of occupational diseases: Criteria for incorporating diseases in the ILO list of occupational diseases. Geneva: International Labour Office, Occupational Safety and Health Series; 2010. Report No. 74.
19. Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijjer PPFM, Spreeuwers D, Lötters F, Miedema HS. Rugklachten door werk: instrument voor het bepalen van de arbeidsgerelateerdheid van specifieke lage rugklachten. Rotterdam: Kenniscentrum AKB Erasmus university Medical Center (Erasmus MC); 2004. Available from: <http://www.beroepsziekten.nl/datafiles/instrumentarbeidsgerelateerdheidlrk.pdf>.
20. Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijjer PPFM, Spreeuwers D, Lötters F, Miedema HS. Criteria for determining the work-relatedness of nonspecific low-back pain. Amsterdam: Coronel Institute of Occupational Health Academic Medical Center (AMC); 2004; Available from: <http://www.occupationaldiseases.nl/content/criteria-nonspecific-low-back-pain-published>.
21. Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijjer PPFM, Spreeuwers D, Lötters F, Miedema HS. Assessing the work-relatedness of non-specific low-back pain. *Scand J Work Environ Health*. 2005; 31:237-43.
22. Kuijjer PPFM, Frings-Dresen MHW, Gouttebauge V, Van Dieën JH, Van der Beek AJ, Burdorf A. Low back pain: we cannot afford ignoring work. *Spine J*. 2011;11:164-168.
23. Kuijjer PPFM, Takala EP, Burdorf A, Gouttebauge V, Van Dieën JH, Van der Beek AJ, Frings-Dresen MHW. Low back pain: doesn't work matter at all? *Occup Med*. 2012;62:152-154.
24. Kwon BK, Roffey DM, Bishop PB, Dagenais S, Wai EK. Systematic review: occupational physical activity and low back pain. *Occup Med*. 2011;61:541-548.
25. Lötters F, Burdorf A, Kuiper J, Miedema H. Model for the work-relatedness of low-back pain. *Scand J Work Environ Health*. 2003;29:431-40.
26. Marras WS, Fine LJ, Ferguson SA, Waters TR. The effectiveness of commonly used lifting assessment methods to identify industrial jobs associated with elevated risk of low-back disorders. *Ergonomics*. 1999;42:229-45.
27. Ministry of Employment and Social Affairs. Arbeidsomstandighedenregeling (BWBR0008587; WBJA/W2/97/0086) artikel 1.11 lid 1. (The Hague, Ministerie Sociale Zaken en Werkgelegenheid (SZW); 2012. Available from: [http://wetten.overheid.nl/BWBR0008587/Hoofdstuk1/Paragraaf14/Artikel1111/geldigheidsdatum\\_18-12-2012](http://wetten.overheid.nl/BWBR0008587/Hoofdstuk1/Paragraaf14/Artikel1111/geldigheidsdatum_18-12-2012)).
28. National Institute for Health and Clinical Excellence. NICE Clinical Guideline 88: Low Back Pain: Early Management of Persistent NonSpecific Low Back Pain. London: NICE; 2009.
29. National Institute for Employee Benefit Schemes LISV. CAS: Classificaties voor Arbo en SV: Classificatie van klachten, ziekten en oorzaken voor bedrijfs- en verzekeringsartsen. Amsterdam: Landelijk Instituut Sociale Verzekeringen LISV; 1997. Available from: [http://www.arbokennisnet.nl/images/dynamic/Dossiers/Arbobeleid/Overzicht\\_CAS\\_codes.pdf](http://www.arbokennisnet.nl/images/dynamic/Dossiers/Arbobeleid/Overzicht_CAS_codes.pdf)).
30. National Research Council and the Institute of Medicine. Musculoskeletal disorders and the workplace: low back and upper extremities. Panel on musculoskeletal disorders and the workplace (chair Barondess, J.A.). Commission on Behavioural and Social Sciences and Education. Washington DC: National Academy Press; 2001.
31. Netherlands Centre for Occupational Diseases. Registratierichtlijn D004 Specifieke lage rugklachten. Amsterdam: Nederlands Centrum voor Beroepsziekten Academic Medical Center (AMC); 2005. Available from: <http://www.beroepsziekten.nl/datafiles/D004.pdf>.

32. Olsen O. Re: Bakker EW et al. Spinal mechanical load as a risk factor for low back pain: a systematic review of prospective cohort studies. *Spine*. 2010;35:E576–7.
33. Punnett L, Prüss-Utün A, Nelson DI, Fingerhut MA, Leigh J, Tak S, Philips S. Estimating the global burden of low back pain attributable to combined occupational exposures. *Am J Ind Med*. 2005;48(6):459-69.
34. Schepman SM, Van der Velden L, Hingstman L. Capaciteitsraming voor bedrijfsartsen 2012-2022/2028. Utrecht: NIVEL; 2011. Available from: <http://www.nivel.nl/sites/default/files/bestanden/Rapport-capaciteitsraming-bedrijfsartsen%202.pdf>.
35. Spreeuwens D, De Boer AGEM, Verbeek JHAM, De Wilde NS, Braam I, Willemsse Y, Pal TM, Van Dijk FJH. Sentinel surveillance of occupational diseases: a quality improvement project. *Am J Ind Med*. 2008;51:834–42.
36. Staal JB, Hlobil H, Van Tulder MW, Waddell G, Burton AK, Koes BW, Van Mechelen W. Occupational health guidelines for the management of low back pain: an international comparison. *Occup Environ Med*. 2003;60:618–626.
37. Takala EP, Andersen JH, Burdorf A, Fallentin N, Hartvigsen J, Leclerc A, Veiersted KB. Re: Bakker EW et al. Spinal mechanical load as a risk factor for low back pain: a systematic review of prospective cohort studies. *Spine*. 2010;35:E1010–13.
38. Takala EP. Lack of statistically significant association does not exclude causality. *Spine J*. 2010;10:944–6.
39. Talmage J. So why does my back hurt doc? *Spine J*. 2010;10:73–5.
40. Van der Molen HF, Kuijter PPFM, Smits PBA, Schop A, Moeijes F, Spreeuwens D, Frings-Dresen MHW. Annual incidence of occupational diseases in economic sectors in The Netherlands. *Occup Environ Med*. 2012;69:519-521.
41. Van der Molen H, Smits P, Kuijter P, De Groene G, Bakker J, Pal T, Sorgdrager B, Lenderink A, Stinis H, Maas J, Van Valen E, Brand T. Beroepsziekten in cijfers 2012. Amsterdam: Nederlands Centrum voor Beroepsziekten Academic Medical Center (AMC); 2012. Available from: <http://www.beroepsziekten.nl/datafiles/beroepsziekten-in-cijfers/ncvb-BIC-2012.pdf>.
42. Verbeek JHAM, Anema JR, Everaert CPJ, Foppen GM, Heijmans M, Hlobil H, Maijjer JMA, Melis MTM, Meulenbeld C, Nieuwland R, Oberndorff A. Richtlijn: Handelen van de bedrijfsarts bij werknemers met rugklachten. Utrecht: Kwaliteitsbureau NVAB; 2006. Available from: <http://nvab.artsennet.nl/Nieuws/Rugklachten-2.htm>.
43. Waddell G, Burton K. Occupational health guidelines for the management of low-back pain at work - evidence review. London: Faculty of Occupational Medicine; 2000.
44. Washington State Department of Labor and Industries. Ergonomics. Olympia (WA): Washington State Department of Labor and Industries; 1994.
45. Waters TR, Baron SL, Piacitelli LA, Anderson VP, Skov T, Haring-Sweeney M, Wall DK, Fine LJ. Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics*. 1993; 36:749-76.
46. Waters TR, Baron SL, Piacitelli LA, Anderson VP, Skov T, Haring-Sweeney M, Wall DK, Fine LJ. Evaluation of the revised NIOSH lifting equation. A cross-sectional epidemiologic study. *Spine*. 1999;24: 386-95.





# CHAPTER 4

## Multidisciplinary consensus on the terminology and classification of complaints of the arm, neck and/or shoulder

Bionka M.A. Huisstede, Harald S. Miedema, Arianne P. Verhagen,  
Bart W. Koes, Jan A.N. Verhaar.

*Occupational and Environmental Medicine* 2007;64:313–319



## ABSTRACT

**Background:** There is no universally accepted way of labelling or defining upper-extremity musculoskeletal disorders. A variety of names are used and many different classification systems have been introduced.

**Objective:** To agree on an 'unambiguous language' concerning the terminology and classification that can be used by all relevant medical and paramedical disciplines in the Netherlands.

**Methods:** A Delphi consensus strategy was initiated. The outcomes of a multidisciplinary conference were used as a starting point. In total, 47 experts in the field of upper-extremity musculoskeletal disorders were delegated by 11 medical and paramedical professional associations to form the expert panel for the Delphi consensus strategy. Each Delphi round consisted of a questionnaire, an analysis and a feedback report.

**Results:** After three Delphi rounds, consensus was achieved. The experts reported the consensus in a model. This so-called CANS model describes the terms, definition and classification of complaints of arm, neck and/or shoulder (CANS) and helps professionals to classify patients unambiguously. CANS is defined as 'musculoskeletal complaints of arm, neck and/or shoulder not caused by acute trauma or by any systemic disease'. The experts classified 23 disorders as specific CANS, because they were judged as diagnosable disorders. All other complaints were called nonspecific CANS. In addition, the experts defined 'alert symptoms' on the top of the model.

**Conclusions:** The use of the CANS model can increase accurate and meaningful communication among healthcare workers, and may also have a positive influence on the quality of scientific research, by enabling comparison of data of different studies.

**Abbreviations:** CANS, complaints of arm, neck and/or shoulder; RSI, repetitive strain injury; UECTD, upper-extremity cumulative trauma disorder

## INTRODUCTION

Multidisciplinary consensus on terminology and classification of upper-extremity musculoskeletal disorders is a first requirement for accurate and meaningful communication among clinicians. Universal classification of these conditions of the upper limb and neck is necessary to assess prognosis and options for treatment,<sup>1,2</sup> to study the natural course of the conditions, and to compare research findings across geographic regions and time periods within different (working) populations.

In a systematic appraisal of worldwide prevalence rates,<sup>3</sup> substantial differences in the reported prevalence rates of upper-extremity disorders were found. Point prevalence estimates ranged from 1.6–53% and the 12-month prevalence estimates ranged from 2.3–41%. It was concluded that one of the main reasons for the differences found in this latter study is the absence of a universally accepted taxonomy for upper-extremity musculoskeletal disorders.

A variety of terms for upper-extremity musculoskeletal disorders are used in different countries all over the world, including repetitive strain injury (RSI), upper-extremity cumulative trauma disorder (UECTD) and workrelated upper-limb disorder (WRULD). Many different classification systems have been introduced. Van Eerd et al<sup>4</sup> found 27 different classification systems for the working population. The systems differed in the disorders they included, in the labels used to identify the disorders and in the criteria used to describe the disorders.

Two sets of consensus criteria for upper-extremity disorders were recently proposed in the UK<sup>5</sup> and in Europe.<sup>6</sup> Both Harrington et al<sup>5</sup> and Sluiter et al<sup>6</sup> gave criteria for a limited number of upper-extremity disorders only. Despite their efforts, implementation of these criteria would have been easier if the experts, chosen by the researchers in both studies, would have been key persons chosen by representatives of the persons who have to work with the criteria in practice. Until now, none of the proposed classification systems have resulted in a complete overview in which (in principal) all musculoskeletal upper-extremity disorders are evaluated and discussed for inclusion. Moreover, they did not produce a workable classification tool that can be used in daily practice in an easy way (i.e., no special training and/or no substantial time needed to perform) by both researchers and health professionals. Therefore, we concluded that there is a need for a classification system on musculoskeletal upper-extremity disorders that (1) could be generally accepted and used by all disciplines, (2) can support the diagnosis and classification of (in principal) all upper-extremity conditions and (3) is reported as a practical tool. Our first aim is to achieve consensus in the Netherlands, with a further intention to use the results of this study to eventually achieve international consensus.

The decisions made regarding classification were based on the international literature. To make implementation of the results of the project more feasible, we invited 11 medical and paramedical associations to assign delegates to participate in this consensus project.

---

**Participating disciplines (on behalf of the professional associations)**

---

general practitioners  
physical and rehabilitation medicine specialists  
occupational physicians  
orthopaedic surgeons  
rheumatologists  
neurologists  
physical therapists  
exercise therapists Cesar  
exercise therapists Mensendieck  
occupational therapists  
psychologists

---

An unambiguous classification system that is accepted by all professionals involved may increase multidisciplinary cooperation and have a positive influence on the performance of studies and also allow data to be compared. This paper presents the results of the Delphi consensus strategy used to achieve consensus and the resulting model.

## **METHODS**

### **The staff team**

The staff team initiated and executed the Delphi consensus strategy. All three staff team members have an epidemiological as well as a clinical background. The epidemiologist/physician, the occupational health physician/psychologist and the health scientist/physiotherapist were responsible for the construction of the questionnaires, the analysis of the responses and the formulation of feedback. The staff team first initiated an invitational conference; the outcomes of this conference were used for the design of the first questionnaire of the Delphi consensus strategy.

### **Invitational conference**

A multidisciplinary invitational conference (December 2002) was the starting point of the project. A total of 19 representatives of 10 of the 11 different medical and paramedical professional associations concerned with treatment of patients with upper-extremity

disorders were present. Only one psychologist representing one national association was lacking. Structured group communication techniques were used at the conference to exchange ideas and expertise on the subject. The outcomes of the conference were used for further research to achieve the consensus.

### **Terminology**

In the Netherlands, the term 'RSI' is often used for symptoms of the arm or neck without a clear diagnosis. However, more than 90% of the participants of the conference were of the opinion that 'RSI' is an unclear and confusing name for these ailments. During the conference, the staff team offered the participants a list of 14 Dutch and English terms used for upper-extremity musculoskeletal disorders that are frequently used in scientific literature and medical textbooks. The participants selected seven terms from this list and added one other term to it. The resulting eight terms were proposed in the Delphi-I questionnaire.

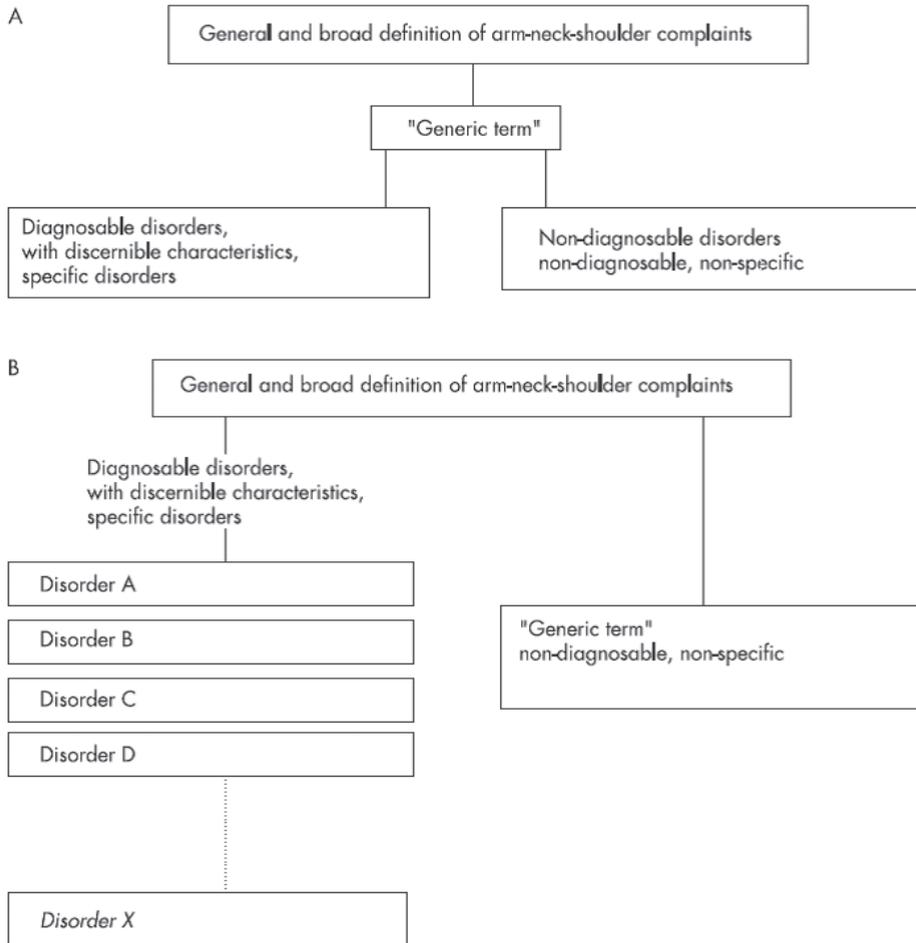
### **Definition**

During the invitational conference, it became clear that the participants gave priority to a general and broad definition of upper-extremity disorders rather than to a narrowly described definition. It should include 'complaints of pain', 'localised in the arm, neck and/or shoulder' and 'no trauma involved'. Possibly 'no systemic disease involved' could be included; 'related to the musculoskeletal system' could be added to indicate that only musculoskeletal disorders should be considered. The participants chose not to mention the suspected etiology of complaints in the definition.

### **Classification and model**

Complaints meeting the general definition should be divided into diagnosable and non-diagnosable disorders. A diagnosable disorder should be defined as one with discernible characteristics, which can be diagnosed in a reproducible way. The diagnosis can be made through case history, physical examination, imaging and laboratory testing. It is important to realise that when a disorder is diagnosable, it does not necessarily mean that treatment is available. During the conference, two models were initially discussed for the classification of patients (fig 1A,B). In model 1A the diagnosable and non-diagnosable disorders are two defined groups. Model 1B is largely similar to model 1A; however, the group 'diagnosable disorders' was subdivided into separate disorders, which have to be mentioned and approached individually. The staff team decided to present both models in the Delphi-I questionnaire.

## Classification of CANS



**Figure 1.** Two models for the classification of patients: model A and model B

### Delphi consensus strategy

Of all consensus techniques available, we chose the Delphi consensus strategy as our preferred method. In this method an expert panel is asked to answer questions concerning the subject. Then, through repeated feedback of the answers in several rounds involving all participants, the researchers try to develop consensus on opinions.<sup>7</sup> The advantage of this method is that it is a written, anonymous method<sup>8</sup> in which the opinions of the experts are combined whilst bias through institutional role, status or dominant personality is avoided.<sup>9</sup>

## **Selection of participants**

The boards of the 11 relevant medical and paramedical associations in the Netherlands were asked to delegate a maximum of six experts each in the field of upper-extremity disorders, who were willing to participate in the expert panel.

## **Procedure**

In the questionnaires of each Delphi round, we asked questions about term, definition and classification of complaints of the arm, neck and/or shoulder. We used structured questions with the answer formats 'agree/don't agree/don't know' or 'yes/no/don't know'. For classification of the different complaints, the possible answers were diagnosable/non-diagnosable/no opinion. We invited the expert panel to give an explanation for their choices. After each round a feedback report was made to inform the expert panel about the answers and argumentations of the other experts. On the basis of the answers and arguments of the experts, the staff team decided which questions would appear in the next questionnaire. Staff team decisions were presented and justified in the feedback report.

## **Delphi-I questionnaire**

The Delphi-I questionnaire was constructed using the outcomes of the invitational conference. The questionnaire of Delphi-I consisted of two parts. Part A contained questions concerning items for which 70% or more participants of the conference agreed on, and part B concentrated on the conflicting items.

Items that were only discussed in small groups and not plenary were also included in part B. Separately, one question was included about the cut-off point for consensus concerning the whole Delphi survey.

## **Delphi-II and Delphi III questionnaires**

The questionnaires of Delphi-II and Delphi-III were constructed using the results of Delphi-I and Delphi-II, respectively. The remarks of the expert panel were incorporated in the questionnaire of the next round. In this way, we collected and reported the opinions of the expert panel in each round in order to achieve consensus.

## **Analysis**

The analysis of the responses from the Delphi rounds was both qualitative and quantitative. Qualitatively, two staff members independently analysed the answers of the expert panel; they compared the results of their analysis. Quantitatively, we reported for each question on how many participants gave which answers. Also, percentages were given of the positive and negative answers.

## RESULTS

### Expert panel

From January till March 2003, the 11 medical and paramedical professional associations selected 47 experts to form the expert panel for the Delphi consensus strategy. Experts from all 11 disciplines participated in the survey as delegates for their respective professional associations. Three experts, all Mensendieck exercise therapists, ended their participation during the process. Two of them only returned the Delphi-I questionnaire, the third did not return any of the questionnaires.

Of the 46 experts, 44 (96%) returned the Delphi-I questionnaire; 40 (87%) and 43 (93%) returned the Delphi-II and Delphi-III questionnaires, respectively. The most common reason for non-response was 'lack of time'. The final results of the Delphi consensus strategy—that is, the consensus model— were presented in October 2004.

### Cut-off point for consensus

In the Delphi-I questionnaire a cut-off point of 70% agreement was accepted: Consensus was reached when >70% of the experts gave the same answer to a question.

### Term

In Delphi-I, it became clear that almost all experts (93%) gave priority to dispose of the term RSI. Although the term RSI has played an important role in recognising the extent of the problem, the term has led to negative associations concerning patients dealing with these problems. It was considered to be an umbrella term. Furthermore, the term was judged unclear and confusing: an injury is not always involved, and, besides 'repetitive strain', 'static burden' also may generate the complaints.

In the Delphi-I questionnaire the expert panel was asked to rank the eight terms on the list composed of the outcomes of the invitational conference and to place their preferred name on the top. In this round they could also bring up other (new) terms. The staff team decided that the five terms which scored 70% of the votes in Delphi-I, complemented with another term given by one of the experts, would be used for the Delphi-II questionnaire. This list involved three English and three Dutch terms.

In Delphi-II the expert-panel was asked to divide six points among both the English and the Dutch terms, separately. Elsewhere in Delphi-II, the experts were asked whether an English or a Dutch term should be used. In Delphi-II, consensus was reached about bringing into use an English term: CANS—complaints of arm, neck and/or shoulder.

### Definition

In Delphi-I, the experts agreed to bring into use a general and broad definition. During Delphi-I and Delphi-II, all of the items mentioned in the conference were adopted, with a

few minor changes. The expert panel decided to change 'complaints of pain' into 'complaints' because pain and also other sensations, such as tingling, can be involved. Traumas such as fractures and ruptures needed to be excluded from the definition. However, micro-traumas can be involved in CANS. Therefore, the word 'acute' was added to the element concerning the presence of traumata and became 'no acute trauma involved'. In conclusion, 'complaints', 'localised in the arm, neck and/or shoulder', 'no acute trauma involved', 'no systematic disease involved' and 'related to the musculoskeletal system' were included in the definition. In Delphi-III, consensus was achieved on the following definition of CANS: 'Musculoskeletal complaints of arm, neck and/or shoulder not caused by acute trauma or by any systemic disease'.

## Classification and model

### *Number of disorders classified*

The staff team constructed a list of 29 disorders of the upper-extremity based on textbooks and the scientific literature. The experts added eight other disorders during Delphi-I. In total, the expert panel discussed 37 diagnoses that met the definition of CANS and classified these as diagnosable or non-diagnosable. During this process, six disorders were excluded from this list for various reasons (table 1). Finally, 23 disorders were classified as diagnosable and four as non-diagnosable.

### *Diagnoses excluded from classification*

In Delphi-III, the experts decided to exclude the diagnosis 'tendonitis of the wrist/fore-arm' from the list; this term was considered too general and specific disorders, such as De Quervain's disease were already part of the list. The experts also decided to exclude the diagnoses 'lung tumour' and 'cardiac diseases'. Although these diseases can cause problems in the upper extremity, they are not related to the musculoskeletal system. Because the experts achieved consensus on excluding systemic diseases from CANS, they decided to delete rheumatic diseases from the list after Delphi-II. Although osteoarthritis is not a systemic disease, it was included within rheumatic diseases.

### *Shoulder complaints*

In Delphi-I, a well-known clinical problem concerning musculoskeletal disorders of the shoulder, such as tendonitis and bursitis, emerged; they are difficult to differentiate but can be identified as a group. Therefore, some of the experts pleaded for the introduction of a generic term for these disorders, so that they can be classified as diagnosable. This idea was presented and adopted in Delphi-II. In Delphi-III, consensus was achieved to use the term 'subacromial impingement syndrome' for the disorder that includes the rotator cuff syndrome, tendonitis of the m infraspinatus, m supraspinatus and m subscapularis, and bursitis in the shoulder area.

**Table 1.** Classification of complaints

	Specific	Nonspecific	Exclusion
<b>Neck region</b>			
Cervical disc hernia	x		
Radiating neck complaints		x	
Tension neck syndrome		x	
<b>Shoulder region</b>			
Frozen shoulder	x		
Instability of the shoulder	x		
Labral lesion of the glenoid	x		
Rotator cuff tears	x		
Bursitis of the shoulder	}		These disorders can be discerned only as a group. Consensus has been achieved about the term 'subacromial impingement syndrome' for these disorders and classification as specific
Rotator cuff syndrome			
Tendinitis of the m.infraspinatus			
Tendinitis of the m.subscapularis			
Tendinitis of the m.supraspinatus			
Suprascapular nerve compression	x		
<b>Elbow region</b>			
Bursitis of the elbow	x		
Instability of the elbow	x		
Lateral epicondylitis	x		
Medial epicondylitis	x		
Tendinitis of the biceps tendon	x		
<b>Forearm, wrist and hand region</b>			
Carpal tunnel syndrome	x		
Cubital tunnel syndrome	x		
De Quervain's disease	x		
Dupuytren disease	x		
Guyon canal syndrome	x		
Hand-arm vibration syndrome		x	No consensus about classification. Therefore, nonspecific CANS
Oarsman's wrist	x		
Radial tunnel syndrome	x		
Raynaud's phenomenon	x		
Tendinitis of the wrist/forearm			x Mention the specific tendon involved
Trigger finger	x		

**Table 1.** Classification of complaints (continued)

	Specific	Nonspecific	Exclusion
Not specifically one region			
Bechterew disease			x Rheumatic disease, added as 'alert symptom'
Complex regional pain syndrome	x		
Fibromyalgia			x Rheumatic disease, added as 'alert symptom'
Local arthritis (not RA) in a joint of upper extremity	x		
Lung tumor			x No musculoskeletal disorder, added as 'alert symptom'
Osteoarthritis			x Rheumatic disease, added as 'alert symptom'
Rheumatoid arthritis			x Rheumatic disease, added as 'alert symptom'
Thoracic outlet syndrome		x	No consensus about classification. Therefore, nonspecific CANS

*Non-diagnosable disorders*

In Delphi-II consensus was achieved on the classification of the 'tension neck syndrome' and 'radiating neck complaints' (or 'radiculopathy without a herniated disc') as non-diagnosable. In Delphi-III the experts decided that disorders for which no consensus about classification was achieved during the three Delphi rounds would be classified as non-diagnosable, until more information becomes available about the diagnostic criteria for the disorder. This was the case for the 'thoracic outlet syndrome' and the 'hand-arm vibration syndrome'.

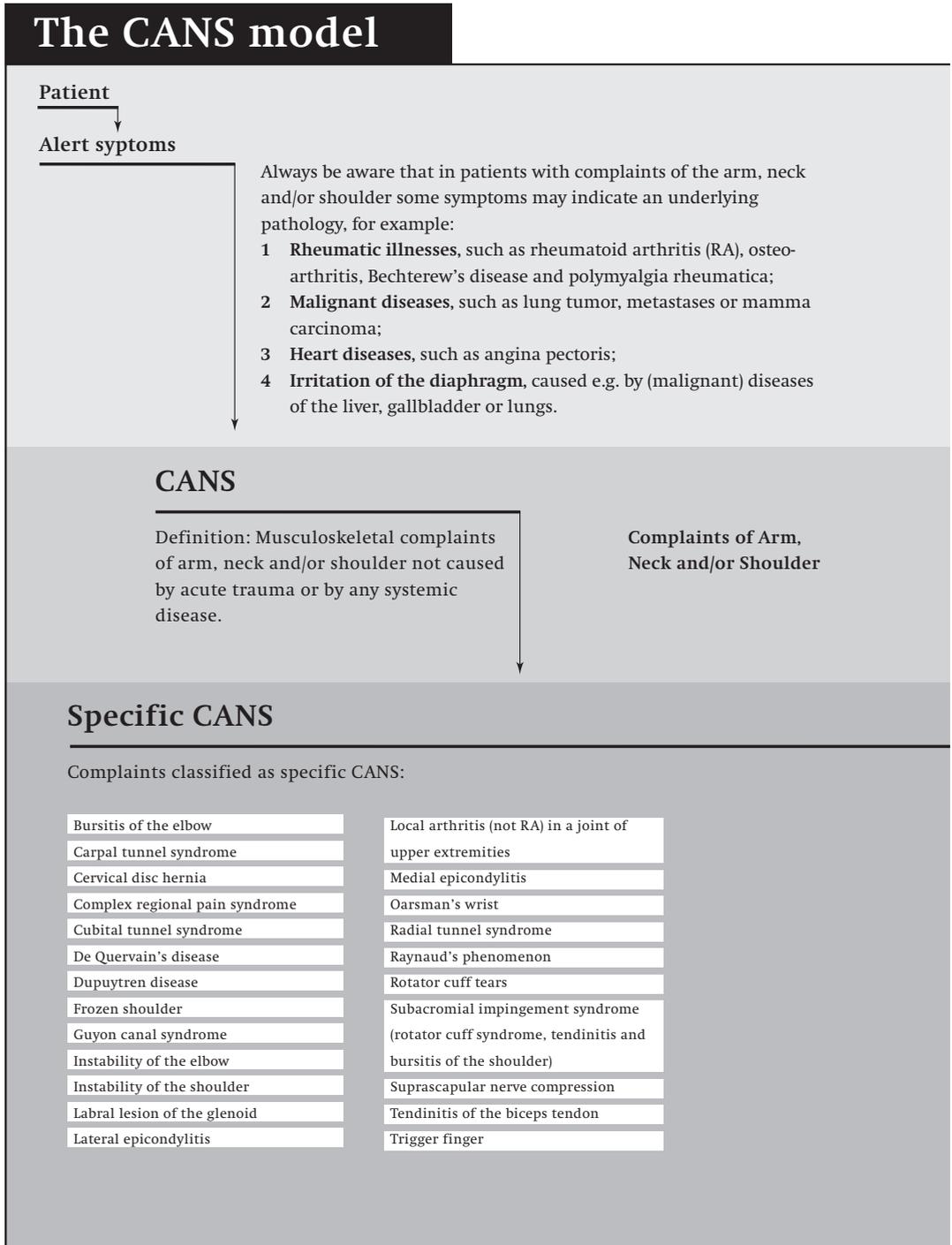
*Alert symptoms*

It is generally known that a physician has to be aware of so-called 'alert symptoms' while making a diagnosis. For example, symptoms may appear to be a result of complaints in the upper extremity, but are in fact caused by serious conditions such as angina pectoris. Diseases such as rheumatoid arthritis and osteoarthritis also need to be identified. To make sure that the symptoms of these disorders get the attention they need, the expert panel decided in Delphi-II to add 'alert symptoms' at the top of the final model.

**The CANS model and the flow chart**

In Delphi-I, consensus was achieved to use model 1B (fig 1B) for the classification of patients. In Delphi-III the experts achieved consensus to use the terms 'specific CANS' and 'nonspecific CANS' instead of 'diagnosable-CANS' and 'non-diagnosable CANS'. The whole model will be called the CANS model.

**Figure 2.** The CANS model and flowchart



## Flow chart

1

### Step 1. Are alert symptoms involved?

The complaints of the arm, neck and/or shoulder can be caused by the symptoms of an underlying (malignant) pathology.

When there is an alert symptom, then this has to be treated. If there is not, go to step 2.

2

### Step 2. Is there a possibility of an acute trauma or systemic disease?

If so, one does NOT call it CANS. Otherwise, it does concern CANS and go to step 3.

3

### Step 3. Is there a possibility of specific CANS?

You can find the 23 complaints designated as specific CANS in the model. These disorders will be mentioned by their specific name.

Treat these complaints as is usual for your profession.

4

### Step 4. Is there a possibility of non-specific CANS?

If the complaints cannot be diagnosed as one of the disorders mentioned in the list of specific CANS, one calls these complaints 'non-specific CANS'. Treat these complaints as is usual for your profession.

## Non-specific CANS

Complaints that are NOT one of the disorders classified as specific CANS.

A flow chart has been developed to help the doctor or paramedical therapist to classify the patient using the CANS model (fig 2). When complaints meet the definition of CANS, the clinician has to investigate whether or not one of the 23 disorders mentioned as specific CANS is present. If present, the diagnosis will be mentioned by its specific label, such as 'carpal tunnel syndrome' or 'lateral epicondylitis'. If not present, the complaints will be diagnosed as 'nonspecific CANS'.

## DISCUSSION

The aim of the Delphi consensus strategy was to decide on an 'unambiguous language' concerning the terminology and classification of complaints of the arm, neck and/or shoulder for all relevant medical and paramedical disciplines in the Netherlands involved in the treatment of patients with these complaints. After three Delphi rounds, multidisciplinary consensus was achieved and reported in the CANS model. As far as we know, this is the first time a multidisciplinary classification system on a national level has been developed in which all relevant medical and paramedical professions dealing with the treatment of patients with CANS were involved and in which (in principal) all musculoskeletal upper-extremity disorders were evaluated and discussed for inclusion.

Williams and Webb<sup>10</sup> observed weaknesses in the Delphi consensus strategies, including (1) limited descriptions of experts' characteristics, (2) imprecise definitions for consensus and (3) low response rates.

In a consensus procedure, there is a risk of bias in the selection of participants. In the present Delphi consensus strategy, 11 medical and paramedical associations selected the expert panel. In this way, the expert panel consisted of professionals with various medical and paramedical backgrounds, all seen as experts on upper-extremity disorders within their own discipline. In a decision-making group heterogeneity can lead to a better performance than homogeneity in terms of considering all relevant aspects of the topic.<sup>11</sup> Furthermore, it has been shown that doctors willing to participate in an expert panel are representative for their colleagues.<sup>12</sup>

To avoid an imprecise definition for consensus, the experts discussed the cut-off point for consensus and decided in Delphi-I that consensus would be defined as >70% agreement. To maintain rigour when using the Delphi method, a 70% minimum response rate should be achieved.<sup>13</sup> We were privileged with high response rates in all three Delphi rounds; an average of 92% (range 87–96%) of the participants returned the questionnaires.

The experts achieved consensus about excluding systemic diseases, such as rheumatic diseases, from CANS and decided to add them as 'alert symptoms' on the top of the

model. Although osteoarthritis is not a systemic disease, it was included within the group of rheumatic diseases. Local arthritis (not rheumatoid arthritis) in a joint of the upper extremity is classified as one of the 23 specific disorders. An inflammation of the AC joint is an example of such a local arthritis. In the Delphi consensus strategy, the experts did not discuss 'local osteoarthritis in a joint of the upper extremity'. A joint can degenerate as a result of overuse, such as osteoarthritis of the AC joint, or as a result of sports such as tennis or swimming. We cannot change the results of the consensus, but we see the absence of this specific disorder as a limitation of our model.

One of the oldest classification systems used is the ICD. The ICD is used in many countries for general epidemiological and many health-management purposes. It is used to classify diseases and other health problems recorded on many types of health and vital records, including death certificates and hospital records. Buchbinder et al<sup>14</sup> studied the ICD-9 for soft-tissue disorders of the neck and upper limb; they examined the overall accuracy of identifying soft-tissue disorders of these conditions and studied whether the codes themselves, on an individual basis, accurately reflected the underlying problems as documented in the medical records. They found poor agreement between the diagnostic labels recorded in the medical records and the ICD codes, suggesting that many of the terms are being used interchangeably.

To date, the 'RSI' report by the Health Council of the Netherlands<sup>15</sup> and the so-called SALTSA report 'Criteria document for evaluating the workrelatedness of upper-extremity musculoskeletal disorder'<sup>6</sup> were considered the state-of-the-art in the Netherlands. Many professional organisations and researchers used these reports as a starting point to develop their own terminology and classification system. This way, over and over again, new terms and classification systems have been generated; this problem occurs not only in the Netherlands but also in other countries. Use of the CANS model can help solve this problem, but we realise that different implementation projects and strategies will be needed before all professionals accept the model. We have already launched projects to implement the CANS model in daily practice. A national conference on upper-extremity musculoskeletal disorders was organised for researchers, clinicians and paramedical health professionals in which the CANS model was revealed. The results of our study were also presented at other congresses and meetings. The Dutch media were very interested in our work; they published on CANS and reported that consensus was achieved.

Nowadays, the CANS model is taught in the professional training and retraining of healthcare professionals. However, despite all our efforts to implement the CANS model, and the fact that the CANS model is already used in practice by many professionals, more time and more projects are needed before the model is fully accepted in the Netherlands.

The factor 'workrelatedness' is not mentioned in the CANS model. Ergonomic workloads such as repetitive and forceful motion, work organisational factors and psychosocial work factors have definitely been implied as a cause of CANS. Currently, many experts are of the opinion that a single common pathway that links exposure in the workplace resulting in CANS cannot be identified.<sup>16</sup> Workrelatedness is not a decision-making factor for including or excluding patients in the CANS model. The model does more justice to reality, as activities at work as well as activities in daily living, such as housekeeping, sports, hobbies and stress at home, can influence the complaints.

Although few data are available on the validity and repeatability of the diagnostic tests of upper-extremity disorders,<sup>5</sup> the expert panel of the Delphi consensus strategy achieved consensus to label 23 diagnoses as specific CANS. We did not develop consensus on the diagnostic criteria for these disorders because the aim of this project was to agree on an 'unambiguous language'. However, the results of this study are just a starting point for the use of consensus terminology.

The CANS model should be re-evaluated after testing it in clinical practice. Moreover, further development of consensus regarding the diagnostic criteria of all the specific disorders is needed; this will make the CANS model even more practical. Because the criteria specified for diagnoses of specific disorders vary among different classification systems,<sup>4</sup> we recommend (inter)national multidisciplinary cooperation to describe these criteria in which key persons—researchers and paramedical and medical professionals—cooperate.

## **Conclusion**

The participants in this Delphi survey achieved multidisciplinary consensus on the terminology and classification of complaints of the arm, neck and/or shoulder and reported their result in the CANS model. Adoption of this model can be the first step towards an unambiguous, multidisciplinary accepted classification system for these conditions. Studies on diagnostic criteria and validation studies for both the classification system and the diagnostic criteria are needed to further refine this work.

## ACKNOWLEDGEMENTS

We thank the following organisations and people for their participation.

Selection participants, Delphi consensus strategy: Dutch College of General Practitioners, Dutch Orthopaedic Society, Royal Dutch Society for Physical Therapy, The Netherlands Society of Occupational Medicine, The Netherlands Society of Physical and Rehabilitation Medicine, The Netherlands Society of Neurology, Dutch Society of Exercise therapists Cesar and Mensendieck, Dutch Society for Rheumatology, Dutch Association of Occupational Therapy and the Dutch Professional Association of Psychologists.

Expert-panel, Delphi consensus strategy: T Appels, P Assendelft, I Bakker, P Barendregt, D van der Beek, S Bierma-Zeinstra, R Brenner, C Broekkamp, J Coene, R Diercks, M van Dijk, W Draijer, J Godtschalk, J van Groenendaal, M van Heel, M Heemskerk, E Hendriks, P Houtman, M Jansen, I Janssen, B Kolnaar, S Koning, M de Krom, B Kruik, M van der List, W van der Meij, G Meijer, H Osamulia, J Patijn, V Pigmans, J Plasman, J Rasker, P Rietveld, A Romijnders, J Ruijgrok, R Te Slaa, J Starreveld, J Stenvers, J Tellekamp, A Verhoeven, C Visser, W Wertheim, D Wever, F de Wilde, W Willems. Their participation in this project does not necessarily mean that they fully agree with the final achieved consensus. The CANS model is the result of a 'communis opinio'.

## REFERENCES

1. Walker-Bone KE, Palmer KT, Reading I, et al. Criteria for assessing pain and nonarticular soft-tissue rheumatic disorders of the neck and upper limb. *Semin Arthritis Rheum* 2003;33:168–84.
2. Konijnenberg HS, de Wilde NS, Gerritsen AA, et al. Conservative treatment for repetitive strain injury. *Scand J Work Environ Health* 2001;27:299–310.
3. Huisstede BM, Bierma-Zeinstra SM, Koes BW, et al. Incidence and prevalence of upper-extremity musculoskeletal disorders. A systematic appraisal of the literature. *BMC Musculoskelet Disord* 2006;7:7.
4. Van Eerd D, Beaton D, Cole D, et al. Classification systems for upper-limb musculoskeletal disorders in workers: a review of the literature. *J Clin Epidemiol* 2003;56:925–36.
5. Harrington JM, Carter JT, Birrell L, et al. Surveillance case definitions for workrelated upper limb pain syndromes. *Occup Environ Med* 1998;55:264–71.
6. Sluiter JK, Rest KM, Frings-Dresen MH. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. *Scand J Work Environ Health* 2001;27(Suppl 1): 1–102.
7. Powell C. The Delphi technique: myths and realities. *J Adv Nurs* 2003;41:376–82.
8. Verhagen AP, de Vet HC, de Bie RA, et al. The Delphi list: a criteria list for quality assessment of randomized clinical trials for conducting systematic reviews developed by Delphi consensus. *J Clin Epidemiol* 1998;51:1235–41.
9. Murphy MK, Black NA, Lamping DL, et al. Consensus development methods, and their use in clinical guideline development. *Health Technol Assess* 1998;2:i–iv, 1–88.
10. Williams PL, Webb C. The Delphi technique: a methodological discussion. *J Adv Nurs* 1994;19: 180–6.
11. Black N, Murphy M, Lamping D, et al. Consensus development methods: a review of best practice in creating clinical guidelines. *J Health Serv Res Policy* 1999;4:236–48.
12. McKee M, Priest P, Ginzler M, et al. How representative are members of expert panels? *Qual Assur Health Care* 1991;3:89–94.
13. Walker AM SJ. The Delphi method: a useful tool for the allied health researcher. *Br J Ther Rehabil* 1996;3:677–81.
14. Buchbinder R, Goel V, Bombardier C. Lack of concordance between the ICD-9 classification of soft tissue disorders of the neck and upper limb and chart review diagnosis: one steel mill's experience. *Am J Ind Med* 1996;29:171–82.
15. Willems JH. RSI; een rapport van de Gezondheidsraad. [Repetitive strain injury (RSI); a report from the Health Council of the Netherlands.] *Ned Tijdschr Geneesk* 2002;146:1969–70.
16. Buckle PW, Devereux JJ. The nature of work-related neck and upper limb musculoskeletal disorders. *Appl Ergon* 2002;33:207–17.





# CHAPTER 5

## Comment on: A Framework for the Classification and Diagnosis of Work-Related Upper Extremity Conditions: Systematic Review\*

Harald S. Miedema, Bionka M. Huisstede.  
Seminars of Arthritis and Rheumatism 2009;38:407-8.

\* Seminars of Arthritis and Rheumatism 2009;38:296-311.





## LETTER TO THE EDITOR

We read with interest the recent systematic review by Boocock and coworkers regarding a framework for the classification and diagnosis of workrelated upper extremity conditions.<sup>1</sup> The authors made a considerable effort to review the current literature and identify national and international nomenclature used as umbrella terms to describe these conditions and comprehensively discussed the relevant medical terminology and associated clinical definitions appropriate to these terms.

We would like to comment on the model that was proposed in their article and on some other issues regarding the selection of diagnoses and classification criteria.

1. In October 2006 our e-publication reported (ahead of the printed version that was published in May 2007) the results of an extensive multidisciplinary consensus project among Dutch medical and paramedical professionals involved in the diagnosis and treatment of musculoskeletal complaints of the upper extremity.<sup>2</sup> We summarized the results of this consensus project in the so-called CANS model, a flowchart that helps to classify the patient with upper-extremity complaints. CANS is an abbreviation for Complaints of the Arm, Neck, and/or Shoulder and is defined as musculoskeletal complaints of arm, neck, and/or shoulder not caused by acute trauma or by any systemic disease. The purpose of our project was to classify, in principal, all upper-extremity conditions as specific or nonspecific. Finally, in the CANS model 23 disorders were classified as specific. We are very pleased to see that Boocock and coworkers adopted the CANS model and proposed a further division for the specific conditions into 5 categories: tendon-related, nerve-related, circulatory/vascular joint-related, and pain syndrome. However, the authors did not refer to our article when presenting their model, and in their review did not include the full list of specific diagnoses as mentioned in the CANS model. We do not object to their subdivision of specific conditions. However, we feel that the category 'bursa-related' is missing and that the category 'tendon-related' should be extended to 'muscle-tendon-related.' Moreover, we feel that the category 'pain syndrome' should be excluded, because this can also relate to specific conditions in other categories (e.g., lateral epicondylitis) or to nonspecific complaints. In clinical practice, a subdivision into anatomic sites could be more helpful because, when consulted by a patient with complaints at a certain site, the professional has to differentiate between a list of diagnoses that are relevant for that particular site. By a process of elimination, the professional can then conclude that the complaints are nonspecific.

2. In the title of their article, Boocock and coworkers mention the term 'workrelated,' but they only use this term to define which conditions are workrelated or not, in the opinion of their expert panel. However, many of the conditions they exclude can also be associated with workrelated risk factors, and all conditions they include can be caused

by factors not related to the workplace. Therefore, we chose not to mention the term 'workrelated' in the CANS model, so that it can be used for all upper-extremity musculoskeletal complaints, irrespective of their origin.

3. Huisstede has already summarized the diagnostic criteria of the 23 specific disorders of the CANS model<sup>3</sup> and added the available diagnostic criteria to these 23 disorders as described in the articles of Harrington, Sluiter, and Helliwell and their coworkers.<sup>4-6</sup> She observed a striking similarity between the criteria found by the consensus approach of Harrington and coworkers,<sup>4</sup> the literature/consensus approach of Sluiter and coworkers,<sup>5</sup> and the statistical approach of Helliwell and coworkers.<sup>6</sup>

Furthermore, it can be observed that all these authors restricted the diagnostic criteria to clinical assessment methods in which diagnostic imaging and invasive procedures were not considered. Boocock and coworkers followed this approach. We regret this because we feel that to determine some diagnoses in clinical practice, diagnostic imaging, laboratory testing, and/or invasive procedures are necessary in addition to case history and physical examination, and therefore, should be included in diagnostic criteria sets.

4. In their article Boocock and coworkers state that, in the Netherlands, the term repetitive strain injury (RSI) is still the leading term for the classification of upper-extremity conditions due to its wide recognition. This is incorrect. In fact, because there was lack of support for this term among many stakeholders, especially health care professionals, it was decided to start our multidisciplinary consensus project. The resulting CANS model was endorsed by the 10 professional associations whose delegates participated in our expert panel. The introduction of the CANS model means that we can dispense with the term RSI.

In conclusion, we agree with Boocock and coworkers that a clearly defined and workable classification tool can have substantial advantages in clinical practice as well as for research. With the presentation of the CANS model we already stated that the determination of diagnostic criteria would be a necessary subsequent step to enhance the usability of the model in practice. We endorse the effort of Boocock and coworkers to take the first step in this direction and thus initiate an international discussion regarding the CANS model. We stress that – even after reviewing the present scientific literature – a consensus procedure is necessary to compose a definite set of criteria for each specific diagnosis that is (or will be) included in the CANS model. We suggest using a Delphi consensus strategy, because this is anonymous and yields no bias through status or dominant personality. The experts participating in such a project should originate from all relevant medical and paramedical disciplines and include professionals that are seen as key persons within their discipline and/or professionals currently involved in clinical practice. We believe that this effort should be conducted internationally so that the results can be implemented in all the countries involved.

## REFERENCES

1. Boockock MG, Collier JM, McNair PJ, Simmonds M, Larmer PJ, Armstrong B. A framework for the classification and diagnosis of work-related upper extremity conditions: systematic review. *Semin Arthritis Rheum* 2009;38(4):296-311.
2. Huisstede BM, Miedema HS, Verhagen AP, Koes BW, Verhaar JA. Multidisciplinary consensus on the terminology and classification of complaints of the arm, neck and/or shoulder. *Occup Environ Med.* 2007;64(5):313-9.
3. Huisstede B. Complaints of the Arm, Neck and/or Shoulder. A new approach to its terminology and classification: the CANS model (Dissertation). Rotterdam: Erasmus university Medical Center (Erasmus MC); 2007.
4. Harrington JM, Carter JT, Birrell L, Gompertz D. Surveillance case definitions for work-related upper limb pain syndromes. *Occup Environ Med.* 1998;55(4):264-71.
5. Sluiter JK, Rest KM, Frings-Dresen MH. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. *Scand J Work Environ Health.* 2001;27(Suppl 1): 1-102.
6. Helliwell PS, Bennett RM, Littlejohn G, Muirden KD, Wigley RD. Towards epidemiological criteria for soft-tissue disorders of the arm. *Occup Med.* 2003;53(5):313-9.



# CHAPTER 6

## Guideline 'Nonspecific complaints of arm, neck and/or shoulders'

Harald S. Miedema, Anita Feleus.\*

Nederlands Tijdschrift voor Geneeskunde 2013;157:A6249  
(Dutch title: Richtlijn 'Aspecifieke klachten arm, nek en/of schouders')

\* On behalf of the multidisciplinary working group for the development of the Guideline 'Nonspecific complaints of arm, neck and/or shoulder'; the members are mentioned at the end of this article.



## KEY POINTS

- Complaints of arm, neck and/or shoulder (CANS) are an important health problem. In the Netherlands, in any previous year about 33% of all adults reported to have CANS and more than 25% had CANS at the moment of inquiry. In addition, more than 10% of days lost to sickness absence is attributed to CANS.
- End 2012, a multidisciplinary guideline was published with recommendations for the diagnosis, treatment, care, and (work) participation of patients with nonspecific CANS. The purpose of this guideline is to improve the process of care and the multidisciplinary cooperation required, as well as to improve the communication with patients.
- The project started with a revision of the existing CANS model (dating from 2004). During this update, the list of disorders was extended to cover 36 specific diagnostic categories. In addition, a clinical pathway was developed that focuses on optimal timing of diagnostics and treatment, and on the multidisciplinary cooperation.
- The improved diagnostic process means that patients with specific CANS receive faster and better targeted treatment. Also, better understanding of treatment results leads to the choice of more effective treatments for patients with nonspecific CANS, so that more patients receive the most beneficial form of treatment.

## INTRODUCTION

Complaints of arm, neck and/or shoulder (CANS) represent a major health problem. In the Netherlands, over one third of adults reported CANS in the previous year and more than a quarter had CANS at the moment of inquiry. In about 25% of these patients the main cause is an acute trauma or systemic disease. More than 10% of days lost to sickness absence is attributed to CANS.<sup>1</sup> The point prevalence of chronic symptoms, i.e. symptoms that persist for more than 3 months, is reported to be 19%. Of these patients, almost 60% reported healthcare use because of CANS in the previous year. In general practice, the incidence of episodes of CANS is estimated at 97 per 1000 registered patients per year.<sup>2</sup> In this group, 77% had complaints in the upper back-neck-shoulder region, 25% in the elbow-forearm region, and 19% in the wrist-hand region. In 42% of these patients the complaints occurred in a combination of these sites.

In the Netherlands, occupational health professionals and staff advisors often used to refer to these complaints as 'repetitive strain injury' (RSI).<sup>3</sup> However, this term led to confusion because it suggests an eliciting injury whereas, in most cases, no objectively determined disorder is present. The term also suggests that repetitive load is the causative factor of the injury. Although this may sometimes be true, many times it is not and often a combination of factors can be involved.

End 2004, eleven professional associations of healthcare professionals reached consensus on the terminology and classification of CANS. It was decided to use the term 'CANS' for musculoskeletal complaints of arm, neck and/or shoulder for which there is no underlying acute trauma or systemic disease. This neutral terminology made no statement about possible causes or mechanisms of action. The CANS model was developed based on this consensus. The goal of this model was to establish (whenever possible) a specific diagnosis as quickly as possible.

The CANS model allows to distinguish between 'specific CANS' – the 23 diagnostic categories in the model dating from 2004 – and 'nonspecific CANS'. In general practice, the ratio between specific and nonspecific CANS is estimated at about 3:2. Improved diagnostics may increase the proportion of patients diagnosed with specific CANS, which results in more patients receiving more focused treatment. Moreover, better insight into treatment results leads to the choice for effective treatments in patients with nonspecific CANS; this implies that more patients will receive the most promising form of treatment.

In 2010, the Royal Dutch Society for Physiotherapy (KNGF) published the first guideline for patients with nonspecific CANS. Also, at end 2008, the Royal Dutch Society for Physiotherapy initiated the development of a multidisciplinary guideline for CANS; this was finally authorized in 2012 by the participating professional organizations and is summarized in this article.<sup>4</sup> The rationale for the development of a multidisciplinary guideline was the need for a practical guide to distinguish between patients with specific and nonspecific CANS in order to initiate the best evidence-based treatments, and to optimize the timing of the intervention. In addition, there was a need for better and more timely multidisciplinary collaboration between the various healthcare professionals. Finally, from the patient's perspective, there was a need for better information, better coordination of care with and between the healthcare professionals, and more focused attention on work. The guideline was developed in accordance with the methodology of 'evidence-based guideline development' and is intended for all healthcare and occupational healthcare professionals involved with patients suffering from CANS.

## DIAGNOSTICS

Because nonspecific CANS is a diagnosis by exclusion, the working group for the development of the multidisciplinary guideline focused on the list of specific diagnostic categories. This led to consensus regarding the need for a review: 3 diagnostic groups were deleted and 16 diagnostic groups were added. This means that the updated CANS model has a total of 36 diagnostic categories (Table 1).

The guideline categorizes nonspecific CANS as '*workrelated or activity-related pain, stiffness, tingling and/or numbness, located at the neck, shoulders, upper back, arms and/or hands and persisting for more than 2 weeks*'. The complaints are not related to a systemic disease or trauma, and specific CANS are excluded as far as possible. Initially, there is a relationship between the symptoms and specific activities or work; however, later on the symptoms can persist without any such relationship. In addition, the complaints can disturb a patient's sleeping pattern. The symptoms generally begin at the dominant side of the body but can also manifest on the contralateral side, but then with a less severe form. A combination of specific and nonspecific CANS can also occur.

To determine whether the guideline applies to an individual patient, the healthcare professional must first determine whether there is sufficient compliance with the definition of nonspecific CANS. For this, a previous trauma and general or systemic disorders that can cause complaints in the arm, neck and shoulder area, need to be excluded as a possible cause.

**Table 1.** Overview of 36 specific diagnostic categories from the revised CANS model by specific pain region and in general (source: Guideline 'Nonspecific complaints of arm, neck and/or shoulder'<sup>4</sup>).**Specific Disorders of CANS-model**

If no specific disorder can be diagnosed, the disorder is classified as nonspecific

<p><b>General disorders</b></p> <ul style="list-style-type: none"> <li>• Congenital disorder in upper extremity *</li> <li>• Congenital malformation in upper extremity *</li> <li>• Local Monarticular Arthritis (non rheumatoid) in upper extremity joint</li> <li>• Local Monarticular Osteoarthritis (Artrosis) in upper extremity joint *</li> <li>• Tumor of bone in upper extremity *</li> <li>• Tumor of soft tissue in upper extremity *</li> </ul>	<p><b>Disorders of the Elbow region (incl. forearm)</b></p> <ul style="list-style-type: none"> <li>• Bursitis of elbow</li> <li>• Cubital Tunnel syndrome</li> <li>• Instability of elbow</li> <li>• Lateral epicondylitis</li> <li>• Medial epicondylitis</li> <li>• Osteochondritis of elbow *</li> <li>• Other compression syndromes of N. Medianus *</li> <li>• Other compression syndromes of N. Radialis *</li> <li>• Other compression syndromes of N Ulnaris *</li> <li>• Radial tunnel syndrome</li> </ul>
<p><b>Disorders of the Neck region</b></p> <ul style="list-style-type: none"> <li>• Cervical Disc Hernia</li> <li>• Cervical Facetjoint Pain * #</li> </ul>	<p><b>Disorders of the Hand-wrist region</b></p> <ul style="list-style-type: none"> <li>• Avascular Osteonecrosis of hand *</li> <li>• Carpal Tunnel syndrome</li> <li>• De Quervain's tendinopathy</li> <li>• Dupuytren's disease</li> <li>• Guyon canal disease</li> <li>• Hand-Arm-Vibration Syndrome *</li> <li>• Instability of the wrist *</li> <li>• Local Osteoarthritis in hand-joints *</li> <li>• Other tendinopathies of finger/wrist-extensors *</li> <li>• Other tendinopathies of finger/wrist-flexors *</li> <li>• Trigger finger</li> </ul>
<p><b>Disorders of the Shoulder region (incl. upper arm)</b></p> <ul style="list-style-type: none"> <li>• Biceps tendinopathy</li> <li>• Frozen shoulder</li> <li>• Instability of shoulder</li> <li>• Labral lesion of glenoid</li> <li>• Neuralgic Amyotrophy *</li> <li>• Rotator cuff tear</li> <li>• Subacromial impingement syndrome †</li> <li>• Suprascapular nerve compression</li> </ul>	

\* New compared to the CANS-model 2004

† includes rotator cuff syndrome and regional tendinopathy or bursitis

# Very strict diagnostic criteria

In the case of a trauma, it is important to realize that residual complaints can persist after a relatively long period of time. The healthcare professional can detect general or systemic disorders based on the so-called 'red flag' symptoms (Table 2).

For the purpose of the diagnosis of specific CANS, an analysis was made of both the physical and diagnostic tests that are included in the Dutch guidelines, or are described in systematic reviews on the disorder under investigation. The analysis was limited to the diagnostic categories included in the original CANS model dating from 2004. For the diagnosis of the 16 new diagnostic categories implemented in the revised CANS model, no recommendations have been made in the guideline.

Regarding the diagnostic value of the physical tests and additional diagnostic testing, only limited scientific evidence is available. In formulating the recommendations, only

**Table 2:** Red-flag symptoms, possibly related diseases and indications for specific diagnostic categories (source: Guideline 'Nonspecific complaints of arm, neck and/or shoulder'<sup>4</sup>).

---

**Possible underlying pathology (ALERT-symptoms)**

- general malaise
- involuntary weight loss
- unexplained fever
- night sweating
- 'non mechanical'-pain (pain that can not be influenced by posture or movement)
- neuropathic pain
- neurological symptoms (muscle weakness, isolated atrophy, radiculopathy)
- signs of inflammation (swelling, joint pain, limitation of joint movement, redness, warmth)
- malignancy in patient history
- dyspnea, chest pain, exercise induced shoulder or arm pain

---

**Diseases that can be related to ALERT-symptoms**

- inflammatory rheumatic disease (e.g. rheumatoid arthritis, ankylosing spondylitis, polymyalgia rheumatica)
- malignancy (e.g. tumor of the pulmonary apex (Pancoast), metastasis, axillary lymphnode pathology)
- coronary or heart disease (e.g. angina pectoris)
- irritation of the thoracic diaphragm (e.g. because of malignancy in liver, gallbladder or lungs)
- thrombosis in upper extremity

---

**Signs of specific diagnoses<sup>†</sup>**

- radicular symptoms (cervical radiculopathy / nerve root pain)
- shoulder pain with reduced range of motion in active as well as passive movements ('frozen shoulder')
- severe shoulder pain with (after some delay) paresis and atrophy of affected arm (neuralgic amyotrophy)
- muscle weakness
- typical neurological symptoms (sensory deficits or muscle weakness)
- local pain combined with swelling and redness
- limitation in flexion (painful) or extension (colliding) of thumb or finger ('trigger finger')
- palmar nodules, especially at 4th or 5th finger, flexion contracture at MCP<sup>1</sup>- or PIP<sup>2</sup>-joint (M. Dupuytren)
- persisting joint pain, increasing with joint loading, age  $\geq$  45 years, mild morning stiffness and bony thickening, especially at PIP<sup>2</sup>-joints (Bouchard's nodules) or DIP<sup>3</sup>-joints (Heberden's nodules) ('osteoarthritis'/'artrosis')

---

<sup>1</sup> MCP = metacarpal phalangeal; <sup>2</sup> PIP = proximal interphalangeal; <sup>3</sup> DIP = distal interphalangeal

<sup>†</sup>All 36 specific diagnostic categories are listed in table 1

tests that have been independently investigated in at least two studies are selected. In addition, information is included from recent evidence-based guidelines, from literature reviews, and from a report on complaints of the upper extremity. Also, advice is sought from the various members of the expert work group. Some recommendations are based on consensus within the group, others on a so-called 'case definition' and some recommendations are based on early recognition of a specific condition due to the need for specialist intervention.

Figure 1 presents a list of the recommended physical tests according to the region in which the complaints manifest: a positive test result is indicative of a specific diagnosis. In Fig. 1, in case of a low level of evidence (level 3-4) the test is printed in italics, whereas tests with a higher level of evidence (level 1-2) are printed in a normal font.

REGION OF COMPLAINTS	PHYSICAL TESTS	DIAGNOSES	OPTIONS FOR ADDITIONAL DIAGNOSTIC INTERVENTIONS
NECK	<i>Spurling test, neck traction/distraction test, Valsalva manoeuvre<sup>2</sup>, Upper-limb Tension test<sup>1</sup></i>	Cervical radiculopathy	MRI (needle EMG, other imaging)
	<i>Relocation test, Anterior release test<sup>2</sup></i>	Shoulder instability	
SHOULDER	<i>Hawkins-Kennedy test<sup>2-3</sup>; Neer test<sup>3-4</sup></i>	Labral laesion of glenoid	MRI with arthrography (arthroscopic)
	<i>Drop arm test<sup>2</sup></i>	Subacromial impingement syndrome	
UPPER ARM	<i>Passive range of motion shoulder (exorotation)</i>	Rotator-cuff tear	Ultrasound, MRI
	<i>Strength Mm. Supraspinatus and infraspinatus</i>	Frozen shoulder	
ELBOW	<i>Ω dorsal/palmar flexion of the wrist<sup>2</sup></i>	Suprascapular compression	EMG, MRI
	<i>Strength muscles innervated by N. Ulnaris</i>	Lateral/medial epicondylitis	
FOREARM	<i>Ω supination or Ω extension 3d finger</i>	Cubital tunnel syndrome	
	<i>Palpation olecranon</i>	Radial tunnel syndrome	
WRIST	<i>Positive Finkelstein's test and pain at Ω extension thumb</i>	Bursitis around elbow (olecrani)	
	<i>Limitation in flexion (painful) or extension (colliding) of thumb or finger ('trigger finger'); Palpation flexor tendon in palm of hand, just proximal to MCP-joint</i>	Medial elbow instability	MRI with arthrography
HAND	<i>Inspection and palpation palmar side of fingers especially 4th and 5th finger and palm of hand</i>	De Quervain's tendinopathy	
	<i>Strength of muscles innervated by N. Ulnaris</i>	Trigger finger	
GENERAL	<i>Reduced range of motion of joint</i>	Dupuytren's disease	
	<i>Mild morning stiffness and bony thickening (especially PIP-joints and DIP-joints), reduced range of motion of joint</i>	Guyon canal disease	
		Carpal tunnel syndrome	EMG

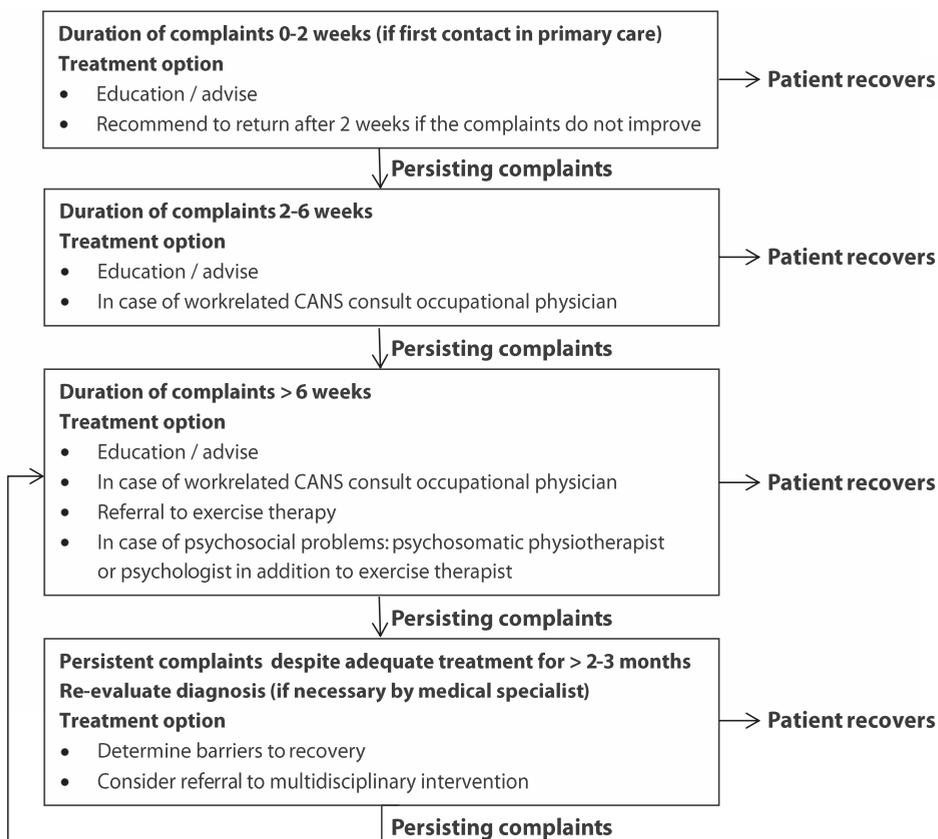
Normal font typing indicates level 1 or 2 evidence; *italic font typing indicates weak level of evidence (level 3 or 4 and other considerations).*  
 Ω = movement against resistance; MCP = metacarpophalangeal; PIP = proximal interphalangeal; DIP = distal interphalangeal.  
<sup>1</sup> Based upon primary care research; <sup>2</sup> Based upon research in referral/specialist setting; <sup>3</sup> Test positive when typical pain is provoked.

**Figure 1.** Overview of the recommended physical tests by area of complaints (positive test results provides indication for a specific diagnosis) (source: Guideline 'Nonspecific complaints of arm, neck and/or shoulder'<sup>4</sup>).

Although many specific diagnoses for CANS cannot be determined or excluded with 100% certainty, this is the aim when using the resources available. However, because of this uncertainty, initially one speaks of a working diagnosis of 'nonspecific CANS'. Over time, this diagnosis can be revised after additional diagnostic tests or after consultation with a medical specialist. It is assumed that information from medical history, physical examination and all additional diagnostics are combined.

## CLINICAL PATHWAY AND TREATMENT

Once it has been determined that nonspecific CANS is probably the correct diagnosis, a policy is followed as described in the clinical pathway (Figure 2).



**Figure 2.** Overview of the treatment according to the clinical pathway for patients with nonspecific CANS (source: Guideline 'Nonspecific complaints of arm, neck and/or shoulder'<sup>4</sup>)

The pathway covers the main decision points and the roles of the various healthcare professionals. The intended result is improvement of the coordination, collaboration and information transfer between healthcare providers, and toward the patient. The starting point is demand-driven care, whereby the input from the patient guides the decision-making process and the decisions to be taken, based on mutual agreement.

In the clinical pathway, treatment interventions are identified for which sufficient scientific evidence is available or, failing that, consensus has been reached in the working

group about the expected effectiveness of the therapy. The phases in the care process are based on the duration of the symptoms and on regular evaluation of the treatment together with counseling. When a patient seeks help only after the symptoms have persisted for a relatively long time, the care process is applied at a later stage.

In general, patients with CANS initially seek help from a general practitioner, physiotherapist, or exercise therapist. Based on the patient's history and physical examination, when healthcare professionals have established a working diagnosis of nonspecific CANS the patient is screened for factors that might impede their recovery, and for signs of inadequate illness behavior or incorrect perception of the complaints. During the first or second consultation, the caregiver provides information about the course, effective self-care options (including temporary adaptation of activities related to load-bearing) and about the possible presence of causal and prognostic factors.

If a patient is currently employed, the caregiver needs to establish whether the complaints are workrelated. If there is evidence of overload due to the work, the healthcare professional advises to reduce the load and, in case of structural overload, to consult with the supervisor. When overload appears to result from a suboptimal workplace design, the caregiver can ask the patient's employer to start an ergonomics advisory process. To support the recommendations made and the information provided, a patient leaflet is available via the CANS website (only available in Dutch: <https://www.rsi-vereniging.nl/images/phocadownload/RichtlijnKANS/Patintenvolger%20specifieke%20KANS.pdf>)

### **Duration of complaints: 0-6 weeks**

When complaints have persisted for 0-6 weeks, the working group generally recommends (with the exception of the above-mentioned advice and information) a period of 'watchful waiting' and natural recovery from the complaints. If the symptoms appear to affect the performance of paid work, the working group recommends to consult the occupational physician. Studies have shown that an ergonomic intervention can reduce both loss of productivity and sickness absence.

### **Duration of complaints: > 6 weeks**

When symptoms persist for longer than 6 weeks, exercise therapy via a physiotherapist or Cesar or Mensendieck therapist, are good evidence-based therapeutic options. There is no consensus regarding which form of exercise is to be preferred. When the symptoms are associated with work, the healthcare professional may be inclined to select a paramedic with complementary skills, such as an occupational physiotherapist or occupational therapist. Similarly, when a history of psychosocial problems has been identified, the choice may be made for a therapist with additional competencies in that

field, such as a psychosomatic physiotherapist. At this stage, when the mental factors seem to take precedence, the caregiver may consider referring the patient to a primary care psychologist.

### **Evaluation and follow-up**

As a rule, when symptoms persist for longer than 2-3 weeks after the first consultation, a re-assessment takes place to perform additional diagnostics and to determine factors that might be hampering the recovery process. During a treatment process an evaluation takes place every 4 weeks to assess the patient's recovery. After 2-3 months of adequate treatment, if insufficient recovery is achieved, then the diagnosis should be reconsidered and additional diagnostics aimed at specific complaints might be indicated. In the case of local complaints of, e.g., the shoulder, elbow, wrist or hand joints, a referral to a specialized plastic or orthopedic surgeon seems warranted. In case of more diffuse complaints associated with sensory disorders, a neurological evaluation is a good option. For patients with prolonged neck pain, referral to an anesthesiologist specializing in pain management should be considered.

If symptoms persist in the form of ongoing pain and/or disability or limitations in (work) participation, in the absence of any indication for a specific disorder and in the presence of psychosocial factors that might hinder recovery, a multidisciplinary treatment should be considered. A rehabilitation physician can determine the indication for this type of referral. An increasing number of healthcare institutions have developed treatment programs for this type of multidisciplinary therapy.

### **CONCLUSION**

This guideline provides recommendations for the diagnosis, treatment, care and (work) participation of patients with nonspecific CANS. The main goals are to improve the care process, including the coordination of and collaboration between the healthcare professionals involved, and to support and improve communication with the patients.

### **FINANCIAL SUPPORT**

For the development of this guideline a grant was provided by ZonMw in the context of the program 'Kennisbeleid Kwaliteit Curatieve Zorg (KKCZ)'. Additional financial contributions have been received from The Royal Dutch Association for Physiotherapy and the Research Center Innovations in Care of the Rotterdam university of Applied Sciences.

## ACKNOWLEDGEMENTS

Besides the authors of this article the multidisciplinary working group consisted of:

A. Beumer	Orthopedic surgeon
A. ten Cate	Exercise therapist Mensendieck/Cesar
R.A. de Bie	Expert Maastricht University
C.M.A. de Gendt	Rheumatologist
N. Doornbos	Physiotherapist/Occupational physiotherapist
M. Driessen	Expert Free University Medical Center Amsterdam
L.A.M. Elders	Occupational physician
R. God	Insurance physician
D.J. Hofstede	Plastic surgeon
I.D. Kalinitsch	Psychologist
T. Kuijpers	Expert Dutch Institute for Quality in Healthcare
C. Loo	Occupational therapist
A.M. Oudshoff	Patient representative
O.J.J.M. Rohof	Anaesthesiologist
J.B. Staal	Expert IQ Healthcare Radboud University Medical Center
N. van Alfen	Neurologist/neurophysiologist
M.D.F. van Eijsden-Besseling	Rehabilitation physician
M.W. van Tulder	Expert Free University Medical Center Amsterdam
A.P. Verhagen	Manual therapist
C.J. Vos	General practitioner

C.J.M. Schenkeveld was project leader on behalf of the Royal Dutch Association for Physiotherapy during the first two years of period in which the guideline was developed.

E. Koppelaar, A. Visser and J.P.M. van der Ploeg of the Research Center Innovations in Care of Rotterdam university of Applied Sciences provided editing support for the final text of the guideline.

## REFERENCES

1. Klein Hesselink J, Hooftman W, De Weerd M, Koppes L. Ziekteverzuim in Nederland 2009. Hoofddorp: TNO; 2011.
2. Feleus A, Bierma-Zeinstra SM, Miedema HS, Bernsen RM, Verhaar JA, Koes BW. Incidence of non-traumatic complaints of arm, neck and shoulder in general practice. *Man Ther.* 2008;13:426-33.
3. RSI. The Hague: Gezondheidsraad; 2000. Reportnr. 2000/22. Available from: <https://www.gezondheidsraad.nl/sites/default/files/0022n.pdf>.
4. Multidisciplinaire richtlijn 'Aspecifieke klachten arm, nek en/of schouders'. Amersfoort: KNGF; 2012. Available from: [https://www.fysionet-evidencebased.nl/images/pdfs/multidisciplinaire\\_richtlijnen/aspecifieke\\_kans.pdf](https://www.fysionet-evidencebased.nl/images/pdfs/multidisciplinaire_richtlijnen/aspecifieke_kans.pdf).





# CHAPTER 7

Overview of ICF categories addressed within outcome measures applied in prognostic and intervention studies for nonspecific complaints of arm, neck and shoulder.

Harald S. Miedema, Elin Koppelaar, Yvonne F. Heerkens, Anita Feleus, Alex Burdorf, Bart W. Koes.

*Submitted*



## ABSTRACT

**Background:** Non-traumatic complaints of arm, neck and shoulder (CANS) are an important health issue. Although CANS may vary in clinical expression and underlying causes, data on sick leave and healthcare use show that, especially chronic CANS, has a major impact on functioning and health. There is a need for more insight into the physical, emotional and social challenges of patients with CANS.

**Aim:** To present an overview of relevant outcomes regarding functions, activities and participation, in patients with complaints of arm, neck and shoulder (CANS) and their association with the International Classification of Functioning, Disability and Health (ICF).

**Design:** Linkage study, linking items of outcome measures to ICF-categories.

**Methods:** A literature search was made for articles on prognostic and intervention studies, as part of the development of the Dutch multidisciplinary evidence-based guideline for nonspecific CANS. Outcome measures of each article were extracted and categorized into those on physical health and mental health. All items of these measures were linked separately to the ICF following internationally developed linking rules. All ICF categories used in at least 5% of the studies are listed, following new recommendations for the development of ICF core sets. Additionally, the distribution of ICF categories across all ICF categories within the outcome measures is evaluated.

**Results:** A total of 123 original studies were included. The 'top 20' of ICF categories related to physical health and mental health are listed, together with the cumulative percentage of all the applied ICF categories. Also reported are all ICF categories used in at least 5% of the studies, as well as the frequency of the total number of applied ICF categories.

**Conclusions:** Aspects of function, activities and participation were identified in outcome measures used in studies on CANS and linked to the ICF, based on the literature included in the multidisciplinary guideline for nonspecific CANS.

**Clinical Rehabilitation Impact:** The results of this study can serve as a preparatory study for the development of an ICF core set for CANS, which can be applied in rehabilitation care for patients with (chronic) CANS.

**Keywords:** International Classification of Functioning, Disability and Health (ICF); Neck; Upper extremity; Complaints of arm, neck and shoulder; Outcome measurement

## INTRODUCTION

Non-traumatic complaints of arm, neck and shoulder (CANS) are an important health issue, with high point prevalence rates in general working age populations ranging from 12% in the USA to 33% in the Netherlands and 44-52% in the UK.<sup>1-5</sup> In the Netherlands, these complaints were often referred to as repetitive strain injury; however, this term is now considered ill-defined and leads to much confusion because it suggests an eliciting injury, whilst (often) no disorder is present that can be determined objectively.<sup>6,7</sup> In the Netherlands a terminology project was initiated to improve the nomenclature regarding neck and upper extremity disorders as a basis for more effective collaboration between care providers. In 2004 this resulted in a multidisciplinary consensus, appointed as the CANS model.<sup>8</sup> All Dutch organizations of relevant medical and allied healthcare professionals were involved in this project. CANS was defined as: '*Musculoskeletal complaints of arm, neck, and shoulder not caused by acute trauma or by any systemic disease*'. The CANS model differentiates between specific and nonspecific disorders. It provides an overview of all specific disorders that can be included under this definition of CANS. If no specific condition can be diagnosed, the complaints should be classified as nonspecific CANS. In general practice, the ratio between specific and nonspecific complaints is estimated at about 3:2.<sup>9</sup>

Although CANS may vary in clinical expression and underlying causes, data on sick leave and healthcare use show that, especially chronic CANS, has a major impact on functioning and health. In the Netherlands, about 19% of people with chronic CANS reported interdependent sick leave, of which 39% with a duration  $\geq 4$  weeks.<sup>2</sup> CANS has been registered as the cause of almost 11% of all sick leave days in the Dutch workforce.<sup>10</sup> In the USA, upper extremity disorders are accountable for about 4.4% of sick leave claims.<sup>11</sup> Although in 63-70% of registered cases no time lost from work was claimed for compensation,<sup>12,13</sup> the mean time lost was  $\geq 70$  days and much greater compared to the mean of other causes, and 3-5% of people who filed a sick leave claim were unable to return to work.<sup>14</sup> However, these data are probably an underestimation, because many workers experienced recurrent spells of sick leave due to the same complaints. In that same study, additional analyses on data from Canada indicated that 26% of workers who experience a first period of sick leave due to CANS also experience a second, and 5% a third period.<sup>14</sup>

In the Netherlands, of the patients with chronic CANS about 58% have consulted one or more healthcare professionals, most often a general practitioner (81%), medical specialist (59%), and physiotherapist (54%).<sup>2</sup> Due to the considerable uncertainty regarding the diagnosis and treatment of CANS in the Netherlands, the development of a multi-

disciplinary guideline was started in 2010.<sup>15</sup> In November 2012 the final version of the guideline was authorized by the participating professional organizations and patient association.<sup>16</sup> Because of the impact of CANS on functioning and participation, during the guideline development special attention was paid to the association between CANS and the International Classification of Functioning, Disability and Health (ICF). There is a need for more insight into the physical, emotional and social challenges of patients with CANS. The ability to adapt to these challenges, whether by self-management or with the support of health care, largely defines a person's dynamic health status.<sup>17</sup> However, the guideline development process and the resulting guideline focused mainly on the evidence for the diagnosis of specific and (by exclusion) nonspecific CANS, as well as the treatment of nonspecific CANS. No in-depth study on the association between nonspecific CANS and the ICF was feasible within the available time frame. Therefore, after publication of the guideline,<sup>15,16</sup> the present study was conducted to provide an overview of relevant outcomes regarding functions, activities and participation among patients with CANS, and their association with the ICF.

## **METHODS**

### **Literature search**

The development of the multidisciplinary guideline on nonspecific CANS followed the method of evidence-based guideline development.<sup>16,18</sup> An extensive literature search was performed by an experienced librarian of the Dutch Institute for Healthcare Improvement (CBO). The search was made in Medline and Embase in the period November 2009-May 2010 and covered the period from 1995 onwards. Only articles in English, German or Dutch were included. All search procedures and terms are reported in Appendix 3 of the guideline.<sup>16</sup>

In addition to the literature review, members of the expert group for the development of this guideline were allowed to propose additional articles that they had missed in the search results. This search strategy encompasses all studies that contributed to the evidence-based guideline on CANS, and this body of literature was also used for the present study. From the included systematic reviews, all original articles were retrieved for data extraction.

As the present study focuses on measurement of outcomes related to functions, activities or participation of patients with CANS, we selected all articles with prognostic and intervention studies. Although the search focused on studies including patients with nonspecific CANS, we assume that most of the measurements utilized are applicable for all types of CANS, whether they be specific or nonspecific, or a combination of both.

## Outcome measurement

Outcome denotes the effects of healthcare (interventions) on the health status of patients and populations, including behavioral changes, improvements in knowledge, and satisfaction with health care.<sup>19</sup> Changes in health status over time, given the availability of more or less developed health care, fall under this definition of outcome. An outcome of interest may be observed at clinical examination of the patient, or with use of imaging techniques, or as measured by a physical or laboratory test, or a patient-reported outcome. When an outcome is measured by information that comes directly from the patient (i.e. without the interpretation of the patient's responses by a (health) professional or anyone else) the term patient-reported outcome measure (PROM) can be used.<sup>20</sup> These measures were developed to investigate the personal views and experiences of the patient. PROM data may be collected via self-administered questionnaires, or by interviews. For measurement purposes, the answers to the questions are predefined so that the patient can select the best option from several possible answers, or can indicate the magnitude of the outcome on a numeric rating scale (NRS) or a visual analog scale (VAS). The measures may be generic (designed to be used in any population and to cover a broad overview of the construct under study), or condition-specific or disease-specific (developed specifically to measure aspects of outcome in a population with a specific medical condition).<sup>21</sup> However, when a measure that is intended to be specific addresses more than one construct, the traditional division into generic and specific measures becomes less clear.<sup>20</sup> Examples of constructs are (in ICF terms) impairments (often reflecting symptoms), limitations in activities, participation restrictions, environmental factors, and personal factors (including quality of life).<sup>22</sup>

Some PROMs consist of a single item or indicator, such as self-rated health or a VAS for pain. These measures assess a single underlying construct and are called unidimensional PROMs. Other PROMs are multidimensional and comprise several scales that each address a single construct.<sup>20</sup> The multiple constructs create a profile of various outcomes.<sup>23</sup> In some of these measures an overall (single summary) score is created; however, these summary scores are often difficult to interpret because the contribution of each construct remains unclear.

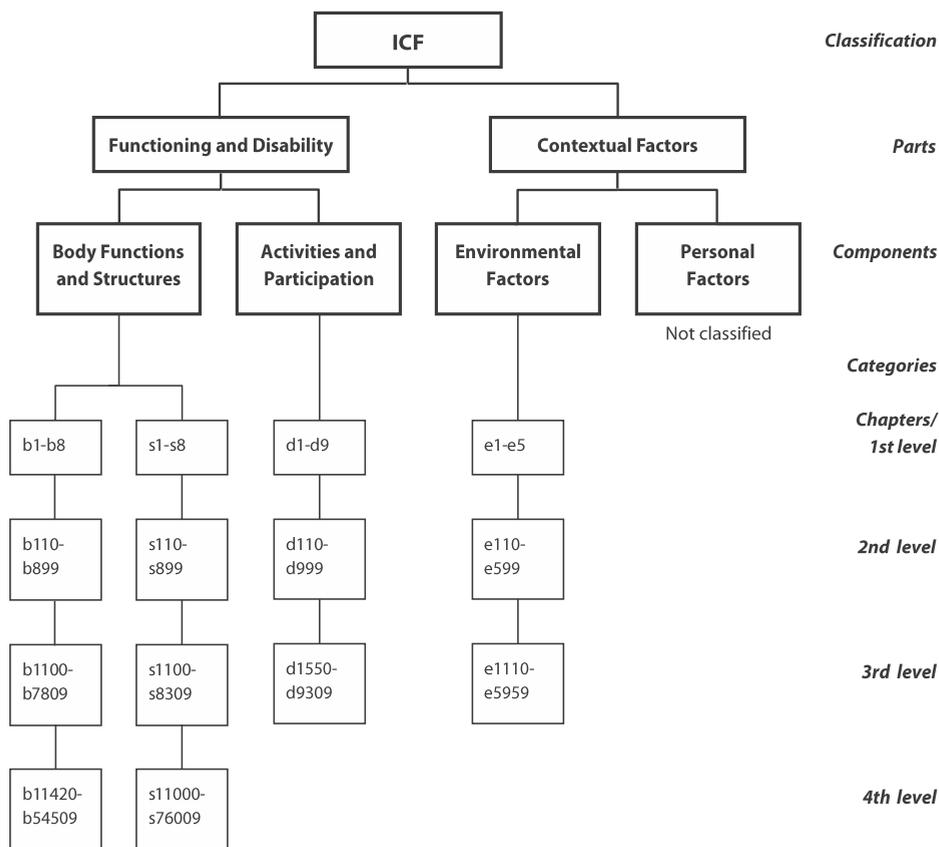
## Data extraction and linkage procedure

The outcome measurements in the selected studies are extracted from the method section of each article by two authors (AF, EK) independently. Measures of prognostic, etiological or confounding factors are not included. In the case that several articles publish results on the same research project, all outcome measures are extracted but the study is counted only once in the analyses.

In the selected studies, all items of (all constructs of) the outcome measures are linked separately to the ICF. When insufficient information was given with regard to all items of a PROM that was utilized in a study, an example is retrieved from the literature or requested from the authors. Each separate item of every outcome measure is translated into one or more meaningful concepts (MCs), in order to be linked to the corresponding ICF categories. A MC is the smallest distinct part of the item text that represents a specific common theme.<sup>24</sup> For instance, item 13 of the Disability of Arm, Shoulder and Hand Questionnaire (DASH) 'wash or blow dry your hair' contains two MCs: 'wash hair' and 'blow dry hair'.<sup>25</sup> These are linked to separate ICF categories (i.e. d5100 'washing body parts' and d5202 'caring for hair', respectively).

Figure 1 presents an overview of the structure of the ICF.<sup>26</sup> Both parts of the ICF are available for linkage of MCs and each consists of two 'Components', i.e., 'Functioning and Disability' contains 'Body Functions and Structures' and 'Activities and Participation', and 'Contextual Factors' contains 'Environmental Factors' and 'Personal Factors'. Each component (except for 'Personal Factors') has one or two categories, indicated by a letter ('b' for functions, 's' for structures, 'd' for activities and participation and 'e' for environmental factors). Within each category this letter is followed by a maximum of five numbers, indicating four possible levels of specification (because the second level contains three numbers and there is no level with two numbers). For examples, see Tables 3 and 4). The first level (with one number) is also called a chapter.

The linking procedure consists of a set of 12 linking rules.<sup>24</sup> All MCs that are contained within the selected outcome measures are formulated based on (part of) each item text and then linked to the most specified level of an ICF category. When a MC is not fully congruent with (a part of) an ICF category, additional information is noted. If a MC cannot be linked to any ICF category, it can be classified in four ways: 1) If the MC is not sufficiently specified to make a decision regarding which ICF category should be selected, but is clearly related to one of the components, the letter of that component is noted (b, d or e); 2) If a MC refers to a personal characteristic, the component 'personal factor' (pf) is noted: for example MCs referring to lifestyle, habits or attitudes are classified as pf; 3) If a MC cannot be linked to any ICF component, the option 'not definable' (nd) is chosen, combined with general health (nd-gh), physical health (nd-ph), mental health (nd-mh) or quality of life (nd-qol): for example, general concepts such as 'health', 'condition', 'symptoms' or 'recovery' are considered not to be definable for linking; 4) If a MC was outside the domain of ICF the option 'not covered' (nc) is selected.



**Figure 1.** Structure of the International Classification of Functioning, Disability and Health (ICF) <sup>26</sup>

Two authors (HM, EK) performed the linking procedure independently. Any disagreement was resolved through discussion, or through recourse to a third independent author with ample experience with the linking rules (YH). This third author also checked all other ICF categories on which consensus had already been reached. After completion of the linking procedure, this resulted in a list of ICF categories for each outcome measure. For those interested, the ICF categories that are linked to a specific outcome measure can be requested from the authors. Putting together all these lists, provides a total list of all ICF categories which are linked to one or more items in one or more outcome measures. Each outcome measure is used in one or more of the selected studies.

### Analyses

Descriptive statistics were used to examine the frequency of application of ICF categories in the selected studies. To gain insight into the ICF categories most frequently addressed in the studies, the frequency of each ICF category was calculated (counting

a specific category that appears more than once in a particular study only once). The denominator consists of the total number of studies. We listed all ICF categories that were used in at least 5% of all selected studies in the order of frequency. The level of 5% was chosen because it was in-between the levels used in previous linkage studies<sup>27,28</sup> and follows new recommendations for this kind of study.<sup>29</sup> In any particular study, ICF categories associated at a more specified lower level and a less specified higher level (originating from one or more measures) can be present simultaneously: e.g. pain in upper limb (b28014), pain in body part (b2801) and/or sensation of pain (b280). If the frequency of the lower level is  $\leq 5\%$ , we add this to the frequency of the higher level. The outcome measures are divided into those mainly related to physical health (Table 1) and those mainly related to mental health (Table 2). However, some physical health measures contain some items that refer to mental health, and vice versa. Outcome measures for quality of life are included in the category 'physical health', although some items of these measures are (often) related to mental health.

As a type of sensitivity analysis we also evaluated the distribution of ICF categories across all ICF-categories that are identified within the outcome measures, including the frequency with which they are applied in the studies. This allowed to compare the frequency of the presence of the ICF categories at study level with the frequency at the level of the applied outcome measures, with regard to measures for both physical and mental health. This additional analysis was performed at the most specified level of the ICF categories, counting each category that appears more than once in a particular measure only once. If a particular ICF category is linked to items of more than one outcome measure, it is counted just as many times. Thus, in this analysis, the denominator consists of the total number of separate ICF categories which are linked to MCs derived from all the outcome measures across all the studies. Because this denominator is  $\geq 10$  times larger than in the first analysis, we list all ICF categories with a frequency of use of  $\geq 0.5\%$  of the total number of ICF categories in order of frequency. If, in case of related ICF categories, the most specified category level reaches a frequency of use of 0.5% or more, this separate category is included. Otherwise, the frequency of this lower level is added to the associated higher level, which is included in the analysis when it is 0.5% or more. Finally, calculation of cumulative frequencies provides insight into the number of ICF categories that make up 50%, 80% or 90% of all ICF categories that are used, and in the total percentage of all ICF categories that are covered by the 10 or 20 ICF categories that are present most often.

**Table 1.** Use of measures for physical health in 123 studies on complaints of arm, neck and shoulder (CANS)

Measure	Abbreviation	No. of studies	Percentage
Visual analogue scale / Numerical rating scale for pain	VAS / NRS pain	90	73.2%
Neck disability index	NDI	20	16.3%
Short-form health survey with 36 questions	SF-36	12	9.6%
Visual analogue scale / Numerical rating scale for recovery	VAS / NRS recovery	9	7.3%
Nordic questionnaire	NQ	8	6.5%
Visual analogue scale / Numerical rating scale for general functioning	VAS / NRS general functioning	7	5.7%
Neck pain and disability	NPD	6	4.9%
Northwick Park neck pain questionnaire	NPQ	6	4.9%
EuroQol	EQ-5D	5	4.1%
Fear avoidance beliefs questionnaire	FABQ	5	4.1%
Disability of arm, shoulder and hand questionnaire	DASH	4	3.3%
Visual analogue scale / Numerical rating scale for workability	VAS / NRS workability	4	3.3%
Neck and shoulder disability questionnaire	NSDQ	3	2.4%
Numerical rating scale sleep	NRS sleep	3	2.4%
Borg rating of perceived exertion	RPE	2	1.6%
Disability index Rempel / Tittiranonda study	-	2	1.6%
Pain disability index	PDI	2	1.6%
Short-form health survey with 12 questions	SF-12	2	1.6%
Shoulder pain score	SPS	2	1.6%
Visual analogue discomfort scale	VADS	2	1.6%
West Haven-Yale multidimensional pain inventory	WHYMPI	2	1.6%
Activity discomfort Scale	ADS	1	0.8%
Disability index Croft study	-	1	0.8%
Disability index Jordan study	-	1	0.8%
Disability index Viljanen study	-	1	0.8%
Graded reduced work ability scale	GRWA	1	0.8%
Health assessment questionnaire	HAQ	1	0.8%
Nottingham health profile	NHP	1	0.8%
Numerical rating scale activities of daily living	NRS ADL	1	0.8%
Pain beliefs questionnaire	PBQ	1	0.8%
Short questionnaire to assess health	SQUASH	1	0.8%
Upper extremity function scale	UEFS	1	0.8%
Shoulder pain and disability Index	SPADI	1	0.8%
Subjective health complaints	SHC	1	0.8%
Tiredness scale	TS	1	0.8%
Three questions of the national health interview survey	-	1	0.8%
Other measure pain *	-	22	17.9%
Other measure work / sick leave **	-	20	16.3%
Other measure recovery **	-	19	15.4%
Other measure disability / Activities of daily living **	-	16	13.0%

\* Mostly pain drawing or categorical or ordinal scale; \*\* Mostly ordinal or categorical scales

**Table 2.** Use of measures for mental health in 123 studies on complaints of arm, neck and shoulder (CANS)

Measure	Abbreviation	No. of studies	Percentage
Beck depression inventory	BDI	5	2.8%
Tampa scale for kinesiophobia	TSK	3	1.7%
Numerical rating scale for distress	NRS Distress	2	1.1%
Pain coping and cognition list	PCCL	2	1.1%
Spielberger state-trait anxiety scale	STAI-II	2	1.1%
Symptom checklist-90-revised	SCL-90-R	2	1.1%
Visual analogue scale for anxiety	VAS Anxiety	2	1.1%
Arthritis helplessness index	AHI	1	0.6%
Community epidemiologic scale-depression	CES-D	1	0.6%
Depression scale	DEPS	1	0.6%
Four-dimensional complaint list	4DKL	1	0.6%
General health questionnaire	GHQ-28	1	0.6%
Hospital anxiety and depression scale	HADS	1	0.6%
Multidimensional health locus of control questionnaire	MHLC	1	0.6%
Short depression inventory (Rimon's brief depression scale)	SDI	1	0.6%
Visual analogue scale for irritability	VAS Irritability	1	0.6%
Visual analogue scale for depression	VAS Depression	1	0.6%
Other measure self-efficacy **		1	0.6%
Other measure pain beliefs **		1	0.6%
Other measure psychological wellbeing **		1	0.6%
Other measure fear of pain **		1	0.6%
Other measure coping **		1	0.6%

\*\* Mostly ordinal or categorical scales

## RESULTS

The literature search yielded 123 original prognostic and intervention studies (100 clinical trials and 23 cohort studies).<sup>16</sup> Table 1 presents the measures that address physical health. A simple VAS or NRS for pain is applied in 90 studies, in 30% of these as the only outcome measure. The Neck Disability Index and the 36-item Short Form Health Survey are the most frequently applied measures for physical health (16% and 10% of all studies, respectively). In total, 113 studies (91.9%) report the use of 32 different standardized questionnaires. In addition, a VAS or NRS scale is used 114 times, and another measure for pain or another outcome (mostly an ordinal or categorical scale) 77 times. From all these measures, 487 MCs can be extracted and linked to 167 different ICF categories. Another 23 MCs cannot be linked to specific ICF categories and are registered as pf, nd or nc. Taking into account the number of times the measures are used in the different

**Table 3.** Top 20 of the most often applied ICF categories linked to measures for physical health

ICF code	ICF category title	No. of studies	Percentage of studies	Cumulative percentage across all ICF categories
b280	Sensation of pain	112	91.1%	10.8%
d850	Remunerative employment	66	53.7%	16.5%
d920	Recreation and leisure	51	41.5%	20.5%
b134	Sleep functions	48	39.0%	23.5%
d510	Washing oneself	45	36.6%	26.5%
d540	Dressing	45	36.6%	29.5%
d640	Doing housework	40	32.5%	32.7%
b152	Emotional functions	36	29.3%	35.2%
d4300	Lifting	36	29.3%	37.5%
d475	Driving	35	28.5%	39.5%
b28010	Pain in head and neck	32	26.0%	41.4%
D	ACTIVITIES AND PARTICIPATION	32	26.0%	43.3%
d230	Carrying out daily routine	30	24.4%	45.3%
d166	Reading	29	23.6%	47.0%
d9205	Socializing	28	22.8%	49.2%
d520	Caring for body parts	26	21.1%	50.8%
s720	Structure of shoulder region	25	20.3%	52.2%
s710	Structure of head and neck region	22	17.9%	53.4%
d9201	Sports	21	17.1%	54.8%
s730	Structure of upper extremity	20	16.3%	56.2%

studies (Table 1), a total of 1773 ICF categories are applied to measure physical health (thus, the mean frequency of application per ICF category is 10.6).

Table 2 presents the measures which address mental health. The Beck Depression Inventory and the Tampa Scale for Kinesophobia are the most frequently applied measures for mental health (28% and 17% of studies that apply mental health measures, respectively). In total, 18 studies (14.6%) report the use of 13 different standardized questionnaires. In addition a VAS or NRS scale is used 6 times, and another measure for coping, self-efficacy, pain beliefs, fear of pain or psychological wellbeing (mostly an ordinal or categorical scale) 5 times. From all these measures, 241 MCs can be extracted and linked to 103 different ICF categories. Another 15 MCs cannot be linked to specific ICF categories and are registered as pf, nd or nc. Taking into account the number of times the measures are used in the different studies (Table 2), a total of 417 ICF categories are applied to measure mental health (i.e. the mean frequency of application per ICF category is 4.0).

Table 3 presents the ‘top 20’ of ICF categories related to physical health, together with

**Table 4.** Top 20 of the most often applied ICF categories linked to measures for mental health

ICF code	ICF category title	No. of studies	Percentage of studies	Cumulative percentage across all ICF categories
b152	Emotional functions	17	13.8%	5.5%
b1263	Psychic stability	16	13.0%	10.6%
b1602	Content of thought *	14	11.4%	14.9%
b1265	Optimism *	13	10.6%	18.7%
b1266	Confidence *	12	9.8%	22.5%
b1300	Energy level	12	9.8%	25.7%
b134	Sleep functions	11	8.9%	28.3%
b1470	Psychomotor control *	11	8.9%	31.0%
b4552	Fatiguability	10	8.1%	33.4%
b1302	Appetite *	9	7.3%	35.5%
b1400	Sustaining attention	9	7.3%	37.7%
b280	Sensation of pain	9	7.3%	40.3%
b1264	Openness to experience *	8	6.5%	42.2%
b164	Higher-level cognitive functions *	8	6.5%	44.2%
b340	Alternative vocalization functions *	8	6.5%	46.1%
b6400	Functions of sexual arousal phase *	8	6.5%	48.0%
b130	Energy and drive functions *	7	5.7%	49.0%
b240	Sensations associated with hearing and vestibular function *	7	5.7%	50.4%
b160	Thought functions	6	4.9%	51.1%
d5702	Maintaining one's health	6	4.9%	52.8%

\* Additional ICF categories compared to analysis of the physical measures

the cumulative percentage of all applied ICF categories. (Supplementary Table 1 presents all ICF categories that are used in  $\geq 5\%$  of the studies in order of ICF category codes, as well as the frequency of the total number of applied ICF categories).

The ICF category 'sensation of pain' is applied most frequently (in 91.1% of studies) and accounts for 10.8% of the total number of ICF categories related to physical health. This is followed by the categories: remunerative employment (5.6%), recreation and leisure (4.0%), sleep functions (3.0%), and washing oneself (3.0%).

The first 10 ICF categories make up about 40% of the total number of applied ICF categories for physical health. The 16 most frequently applied ICF categories (9.6% of total) account for 50%, the 47 most frequently applied ICF categories (28.1% of total) for 80%, and the 65 most frequently applied ICF categories (38.9% of total) for 90%. Of the 16 ICF categories that fall within the 50% margin, 8 (50.0%) refer to specific activities and 3 (18.8%) to participation. For the 80% margin (47 ICF categories) these figures are 25 (53.2%) and 8 (17.0%), respectively.

Table 4 presents the 'top 20' of ICF categories related to mental health, together with the cumulative percentage of all applied ICF categories. (Supplementary Table 2 presents all ICF categories which are used in  $\geq 5\%$  of the studies in order of ICF category codes, as well as the frequency of the total number of applied ICF categories).

The ICF category 'emotional functions' (including flattening of affect, lability of emotion, sadness or happiness, love or hate, joy or sorrow, fear, anger, tension or anxiety) is applied most frequently, accounting for 5.5% of the total number of ICF categories related to mental health. This is followed by the categories psychic stability (including an irritable, worried, erratic or moody disposition; 5.1%), content of thought (4.3%), optimism (3.8%), confidence (3.8%) and energy level (3.2%).

The first 10 ICF categories make up about 35% of the total number of applied ICF categories for mental health. The 18 most frequently applied ICF categories (20.5% of total) account for 50%, the 48 most frequently applied ICF categories (54.5% of total) for 80%, and the 63 most frequently applied ICF categories (71.6% of total) account for 90%.

## DISCUSSION

Based on the ICF, which provides a common language for functioning and health, it is possible to identify and compare the concepts contained in the numerous generic and condition-specific or location-specific outcome measures used in epidemiological research or clinical trials.<sup>26,30</sup> However, to support implementation of the ICF, practical tools are needed to improve its feasibility.<sup>31</sup> Considering the extent of the ICF (with  $\geq 1400$  categories) and the need for operationalization and quantification of the ICF categories, the major challenges are: 1) to select those items that are most relevant for specific conditions or healthcare contexts; and 2) linkage of the items of existing measures of health status to the ICF categories.<sup>31</sup>

The present study aimed to identify and compare the frequency of ICF categories related to the outcome measures of prognostic and intervention studies, which are used in the scientific evidence for the Dutch multidisciplinary guideline on nonspecific CANS. This provides insight into the physical, emotional and social challenges that patients with CANS need to adapt to.

Pain is an important symptom in most patients with CANS; most of the included studies (93%) include one or more measures for pain and, in 27 studies (22%), this is the only outcome measure. Therefore, pain reduction seems to be the main outcome measured in the intervention studies. Participation in work comes second (54% of studies), associated with the workrelated nature of various types of CANS and the many workrelated items that are incorporated in the applied outcome measures. The recreation and leisure activities come third (42%), suggesting that CANS also has a large impact on participa-

tion, apart from work. The fourth place is for sleep functions (39%), which may indicate the impact of sleep disturbance due to musculoskeletal pain. When pain is localized in neck or shoulder, lying on the affected body part can be particularly problematic. Of the physical health measures applied, 11 (38%) have items that are linked to this ICF category (b134), e.g. the Neck Disability Index that is applied in 20 studies. Three studies apply a special NRS for sleep problems.

The perspective of mental health measures in relation to a physical condition is new, although the psychological problems, and the mental health measures used, are not specific for CANS. The present analysis reveals the kinds of mental impairments and the related activities and participation items that are assumed by researchers to play a role in nonspecific CANS. Some ICF categories that are linked to the mental health measures also appear after analyzing the physical health measures (e.g. b152: emotional functions), whereas 11 ICF categories are added through analysis of the mental health measures. The number of ICF categories linked to mental health measures that were used in  $\geq 5\%$  of all studies is relatively small (18), since measures for mental health were only applied in 14.6% of the studies. Therefore, in the majority of studies, no special attention was paid to mental health outcomes; this implies that, until recently, the impact of CANS on mental health has been underestimated.

The present analysis yields two lists of ICF categories: one related to physical health and one to mental health. They represent the most relevant aspects of functioning and health in relation to nonspecific CANS from the perspective of the researchers that conducted those studies. This analysis could serve as a preparatory study for the development of an ICF core set (ICF-CS) for nonspecific CANS. The development of core sets started in 2003.<sup>32</sup> They can be seen as a minimal standard for the assessment and reporting of functioning and health in clinical practice and research, through inclusion of a practical number of the most relevant ICF categories.<sup>33</sup> Currently, over 30 ICF-CSs have been developed. A guide on how to develop an ICF-CS is available, in which the earlier experiences and methods used are incorporated in one protocol.<sup>29</sup> One of the obligatory preparatory studies for an ICF-CS development process is a literature review to identify the aspects of functioning that are described or evaluated in the literature related to the health condition of interest. It is assumed that the researchers select those outcome measures that are considered most relevant for persons with the health condition under consideration. The underlying concepts contained in these measures are identified and linked to ICF categories using established linking rules.<sup>24</sup> After such a review, three additional preparatory studies need to be performed:<sup>29</sup>

- 1) an empirical multicenter cross-sectional study to identify the most common problems experienced by persons with nonspecific CANS through semi-structured interviews in a clinical setting;

- 2) a qualitative study to identify the most important aspects of functioning, environmental and personal factors through focus groups or semi-structured interviews with persons with nonspecific CANS;
- 3) an expert internet-based or Delphi survey to compile expert opinions on aspects of functioning and environmental factors that are relevant for persons with nonspecific CANS.

Together with the present study, the preparatory studies can serve as the starting point for a structured decision-making and consensus process at an international conference, during which participating experts (including representatives of patients) can make definite decisions regarding which ICF categories should be included in the ICF-CS for nonspecific CANS.<sup>29</sup>

The additional analyses at the level of the outcome measures are conducted to gain more insight into the relative importance of the ICF categories. It appears that with a threshold for selecting ICF categories with a frequency of use of  $\geq 0.5\%$ , the resulting list of candidate ICF categories is almost the same as in the first analysis. This means that the list of ICF categories is a good representation of the MCs that are present in the measures that were applied in the research projects of the systematic review. However, 72 ICF categories are above this threshold, of which 32 have a frequency of less than 10% of the studies and 26 have less than 9%. With 47 ICF categories, 80% of all ICF categories incorporated in all the outcome measures (second analysis) are covered; this 80% corresponds to a threshold of about 9% of studies in which a particular ICF category is applied.

In the additional analysis, outcome measures for mental health are analyzed separately. The frequency of many more categories exceeds the threshold of 0.5% (see Supplementary Table 2), because the denominator is related to the actual use of mental health measures.

In order to compile a list of the most relevant ICF categories for a particular condition, it can be discussed whether truncation at the second level of the ICF categories should be performed before making the selection. The ICF-CS development guide suggests to only include a third or fourth level ICF category if the additional specification yielded by that category is essential to comprehensively describe the functioning of persons with the condition of interest.<sup>29</sup> In the present study the more specified levels are also included, in order to avoid losing any information that is specific to (for instance) hand or shoulder function.

An ICF-CS for hand conditions is available and has considerable overlap with the list of ICF categories in the present study.<sup>34</sup> Almost 40% of the body functions not related to skin conditions or tactile functions, and almost 60% of the activities and participation items of the ICF-CS for hand conditions, are also in the list of ICF categories linked to physical measures for CANS. Vice versa: from the present list about two thirds of the ICF categories for bodily functions and 75% of those for activities and participation, are also included in the ICF-CS for hand conditions.

### **Study limitations**

For the present study the literature search covered the period 1995 until May 2010 and was performed in Medline and Embase. Only articles in English, German or Dutch on prognostic and intervention studies were included. No additional search was performed for more recent studies, or for studies in other languages or with other designs. However, this is not a serious disadvantage given the purpose of our study. For that, a representative set of articles is needed, from which the outcome measures can be extracted. Through analysis of the outcome measures applied in 123 studies, 72 ICF categories were found that are assumed to be the most relevant for physical health in patients with CANS and 57 for mental health, covering about 90% of all ICF categories incorporated in all the outcome measures (second analysis). It is unlikely that outcome measures applied in more recent years, or included in articles in other languages, would substantially change these results.

The aim of the present study was to analyze the ICF categories that are most relevant for nonspecific CANS. This is not because a large difference is assumed in the perceived importance of aspects of functioning and health between nonspecific and specific CANS, but simply the practical consequence of using a literature search made for the development of the guideline, which made a selection of studies on nonspecific CANS. However, for some specific CANS (e.g. hand disorders or arthritis) the frequency of some specific functions or activities can differ slightly; nevertheless, most items in the lists seem to be equally relevant to both nonspecific and specific CANS.

In this study, a distinction is made between outcomes for physical health and mental health, because psychological factors are assumed to be important for patients with CANS, but are only measured as an outcome in 15% of the included studies. This low percentage may be because measures for mental health have more often been studied as a prognostic or confounding factor, rather than a relevant health outcome.

## **Conclusions**

This study has identified aspects of functions, activities and participation in outcome measures used in research on CANS and linked them to the ICF, based on the literature that was included in the multidisciplinary guideline for nonspecific CANS. This study can serve as the first preparatory study for the development of an ICF-CS for CANS.

## **FUNDING**

In kind support of the authors and their respective institutions.

## **ACKNOWLEDGMENTS**

The authors are grateful for support and help from the Dutch Institute for Healthcare Improvement (CBO), and the Development Group of the Multidisciplinary Guideline for Nonspecific CANS.

## REFERENCES

1. Morse TF, Dillon C, Warren N, Levenstein C, Warren A. The economic and social consequences of work-related musculoskeletal disorders: the Connecticut Upper-Extremity Surveillance Project (CUSP). *Int J Occup Environ Health*. 1998;4(4):209–16.
2. Huisstede BMA, Wijnhoven HA, Bierma-Zeinstra SM, Koes BW, Verhaar JA, Picavet S. Prevalence and characteristics of complaints of the arm, neck, and/or shoulder (CANS) in the open population. *Clin J Pain*. 2008;24(3):253–9.
3. Walker-Bone K, Palmer KT, Reading I, Coggon D, Cooper C. Prevalence and impact of musculoskeletal disorders of the upper limb in the general population. *Arthritis Rheum*. 2004;51(4):642–51.
4. Urwin M, Symmons D, Allison T, Brammah T, Busby H, Roxby M, Simmons A, Williams G. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis*. 1998;57(11):649–55.
5. Roquelaure Y, Ha C, Leclerc A, Touranchet A, Sauteron M, Melchior M, Imbernon E, Goldberg M. Epidemiologic surveillance of upper-extremity musculoskeletal disorders in the working population. *Arthritis Rheum*. 2006;55(5):765–78.
6. Gezondheidsraad. RSI. The Hague: Gezondheidsraad; 2000. Report No.: publicatie nr. 2000/22. Available from: <http://www.gezondheidsraad.nl/sites/default/files/0022N.PDF>
7. Van Tulder M, Malmivaara A, Koes B. Repetitive strain injury. *Lancet*. 2007;369(9575):1815–22.
8. Huisstede BMA, Miedema HS, Verhagen AP, Koes BW, Verhaar JAN. Multidisciplinary consensus on the terminology and classification of complaints of the arm, neck and/or shoulder. *Occup Environ Med*. 2007;64(5):313–9.
9. Feleus A, Bierma-Zeinstra SMA, Miedema HS, Verhaar JAN, Koes BW. Management in non-traumatic arm, neck and shoulder complaints: differences between diagnostic groups. *Eur Spine J Off Publ Eur Spine Soc Eur Spinal Deform Soc Eur Sect Cerv Spine Res Soc*. 2008;17(9):1218–29.
10. Klein Hesselink J, Hooftman W, de Weerd M, Koppes L. Ziekteverzuim in Nederland in 2009. Hoofddorp: TNO; 2011. Available from: [https://www.tno.nl/downloads/ziekteverzuim\\_in\\_nederland\\_in\\_2009.pdf](https://www.tno.nl/downloads/ziekteverzuim_in_nederland_in_2009.pdf)
11. Feuerstein M, Miller VL, Burrell LM, Berger R. Occupational upper extremity disorders in the federal workforce. Prevalence, health care expenditures, and patterns of work disability. *J Occup Environ Med Am Coll Occup Environ Med*. 1998;40(6):546–55.
12. Hashemi L, Webster BS, Clancy EA, Courtney TK. Length of disability and cost of work-related musculoskeletal disorders of the upper extremity. *J Occup Environ Med Am Coll Occup Environ Med*. 1998;40(3):261–9.
13. Silverstein B, Viikari-Juntura E, Kalat J. Work-related musculoskeletal disorders of the neck, back and upper extremity in Washington State 1990-1998. Washington DC: Washington State Department of Labor and Industries; 2000. Report No.: Technical Report Number 40-4a-2000. Available from: <http://www.elcosh.org/record/document/1204/d000376.PDF>.
14. Baldwin ML, Butler RJ. Upper extremity disorders in the workplace: costs and outcomes beyond the first return to work. *J Occup Rehabil*. 2006;16(3):303–23.
15. Miedema HS, Feleus A. Guideline 'Non-specific symptoms of arm, neck and/or shoulders'. *Ned Tijdschr Geneeskd*. 2013;157(21):A6249.
16. Multidisciplinaire richtlijn aspecifieke Klachten Arm, Nek en/of Schouders. Utrecht: Kwaliteitskoepel Medisch Specialisten; 2012. Available from: <http://www.kwaliteitskoepel.nl/assets/structured-files/2012/multidicsrichtlijnaspecifiekeKANS19092012.pdf>.

17. Huber M, Knottnerus JA, Green L, van der Horst H, Jadad AR, Kromhout D, Leonard B, Lorig K, Loureiro MI, Van der Meer JWM, Schnabel P, Smith R, Van Weel C, Smid H. How should we define health? *BMJ*. 2011;343:d4163.
18. Burgers JS, van Everdingen JJE. Evidence-based guideline development in the Netherlands: the EBRO platform. *Ned Tijdschr Geneesk*. 2004;148(42):2057–9.
19. Donabedian A. The quality of care. How can it be assessed? *JAMA*. 1988;260(12):1743–8.
20. Valderas JM, Alonso J. Patient reported outcome measures: a model-based classification system for research and clinical practice. *Qual Life Res Int J Qual Life Asp Treat Care Rehabil*. 2008;17(9): 1125–35.
21. Meadows KA. A measured decision. *International Clinical Trials*. London: Samedan Ltd. Pharmaceutical Publishing; 2011. Available from: <http://www.samedanltd.com/magazine/13/issue/162/article/3079>
22. McKenna SP. Measuring patient-reported outcomes: moving beyond misplaced common sense to hard science. *BMC Med*. 2011;9:86.
23. Meadows KA. Patient-reported outcome measures: an overview. *Br J Community Nurs*. 2011; 16(3):146–51.
24. Cieza A, Geyh S, Chatterji S, Kostanjsek N, Ustun B, Stucki G. ICF linking rules: an update based on lessons learned. *J Rehabil Med*. 2005;37(4):212–8.
25. Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder and Hand outcome measure in different regions of the upper extremity. *J Hand Ther Off J Am Soc Hand Ther*. 2001;14(2):128–46.
26. World Health Organization. *International Classification of Functioning, Disability and Health (ICF)*. Geneva: World Health Organization; 2001. Available from: [www.who.int/classifications/icf/en](http://www.who.int/classifications/icf/en)
27. Kus S, van de Ven-Stevens LA, Coenen M, Berno S, Kollerits B, Cieza A. What is our knowledge of functioning and disability in hand conditions based on? *Arch Phys Med Rehabil*. 2011;92(8): 1326–32.
28. Brockow T, Cieza A, Kuhlow H, Sigl T, Franke T, Harder M, Stucki G. Identifying the concepts contained in outcome measures of clinical trials on musculoskeletal disorders and chronic widespread pain using the International Classification of Functioning, Disability and Health as a reference. *J Rehabil Med*. 2004;(44 Suppl):30–6.
29. Selb M, Escorpizo R, Kostanjsek N, Stucki G, Ustun B, Cieza A. A guide on how to develop an international classification of functioning, disability and health core set. *Eur J Phys Rehabil Med*. 2015;51(1):105-17.
30. Cieza A, Brockow T, Ewert T, Amman E, Kollerits B, Chatterji S, Ustun TB, Stucki G. Linking health-status measurements to the international classification of functioning, disability and health. *J Rehabil Med*. 2002;34(5):205–10.
31. Cieza A, Stucki G. New approaches to understanding the impact of musculoskeletal conditions. *Best Pract Res Clin Rheumatol*. 2004;18(2):141–54.
32. Stucki G, Ewert T, Cieza A. Value and application of the ICF in rehabilitation medicine. *Disabil Rehabil*. 2002;24(17):932–8.
33. Stucki G, Grimby G. Applying the ICF in medicine. *J Rehabil Med*. 2004 Jul;(44 Suppl):5-6.
34. Rudolf K-D, Kus S, Chung KC, Johnston M, LeBlanc M, Cieza A. Development of the International Classification of Functioning, Disability and Health core sets for hand conditions--results of the World Health Organization International Consensus process. *Disabil Rehabil*. 2012;34(8):681–93.

## SUPPLEMENTARY TABLES

**Supplementary Table 1.** ICF categories linked to measures for physical health in at least 5% of the studies

ICF code	ICF category title	No. of studies	% of studies	No. of times ICF category was applied	Cumulative percentage across all ICF categories
b126	Temperament and personality functions	11	8.9%	13	0.7%
b1300	Energy level	20	16.3%	22	1.2%
b134	Sleep functions	48	39.0%	53	3.0%
b1400	Sustaining attention	22	17.9%	22	1.2%
b152	Emotional functions	36	29.3%	45	2.5%
b265	Touch function	11	8.9%	11	0.6%
b280	Sensation of pain	112	91.1%	192	10.8%
b2801	Pain in body part	12	9.8%	12	0.7%
b28010	Pain in head and neck	32	26.0%	34	1.9%
b28014	Pain in upper limb	7	5.7%	(7)	(0.4%)
b28016	Pain in joints	12	9.8%	12	0.7%
b455	Exercise tolerance functions	8	6.5%	(8)	(0.5%)
b7101	Mobility of several joints	8	6.5%	(8)	(0.5%)
b7603	Supportive functions of arm or leg	10	8.1%	10	0.6%
b840	Sensation related to the skin	13	10.6%	13	0.7%
D	ACTIVITIES AND PARTICIPATION	32	26.0%	34	1.9%
d110	Watching	9	7.3%	9	0.5%
d166	Reading	29	23.6%	30	1.7%
d170	Writing	15	12.2%	15	0.9%
d230	Carrying out daily routine	30	24.4%	36	2.0%
d2302	Completing the daily routine	8	6.5%	(8)	(0.5%)
d3601	Using writing machines	10	8.1%	10	0.6%
d4102	Kneeling	12	9.8%	12	0.7%
d4105	Bending	15	12.2%	15	0.9%
d4150	Maintaining a lying position	11	8.9%	11	0.6%
d4154	Maintaining a standing position	7	5.7%	(8)	(0.5%)
d430	Lifting and carrying objects	14	11.4%	20	1.1%
d4300	Lifting	36	29.3%	41	2.3%
d4301	Carrying in the hands	16	13.0%	18	1.0%
d440	Fine hand use	7	5.7%	13	0.7%
d4401	Grasping	11	8.9%	11	0.6%
d445	Hand and arm use	16	13.0%	26	1.5%
d4452	Reaching	15	12.2%	18	1.0%
d4453	Turning or twisting the hands or arms	7	5.7%	(8)	(0.5%)
d450	Walking	13	10.6%	14	0.8%

**Supplementary Table 1.** (continued)

ICF code	ICF category title	No. of studies	% of studies	No. of times ICF category was applied	Cumulative percentage across all ICF categories
d4500	Walking short distances	13	10.6%	13	0.7%
d4501	Walking long distances	12	9.8%	12	0.7%
d4551	Climbing	14	11.4%	14	0.8%
d4552	Running	12	9.8%	12	0.7%
d470	Using transportation	10	8.1%	10	0.6%
d475	Driving	35	28.5%	35	2.0%
d4751	Driving motorized vehicles	8	6.5%	(8)	(0.5%)
d5	Self-care	8	6.5%	(8)	(0.5%)
d510	Washing oneself	45	36.6%	53	3.0%
d520	Caring for body parts	26	21.1%	27	1.5%
d540	Dressing	45	36.6%	54	3.1%
d5400	Putting on clothes	15	12.2%	16	0.9%
d550	Eating	12	9.8%	12	0.7%
d570	Looking after one's health	11	8.9%	13	0.7%
d5702	Maintaining one's health	16	13.0%	17	1.0%
d630	Preparing meals	8	6.5%	10	0.6%
d640	Doing housework	40	32.5%	56	3.2%
d6402	Cleaning living area	7	5.7%	(8)	(0.5%)
d6403	Using household appliances	16	13.0%	17	1.0%
d6505	Taking care of plants, indoors and outdoors	11	8.9%	11	0.6%
d7	Interpersonal interactions and relationships	14	11.4%	14	0.8%
d720	Complex interpersonal interactions	13	10.6%	13	0.7%
d7500	Informal relationships with friends	8	6.5%	(8)	(0.5%)
d760	Family relationships	14	11.4%	15	0.9%
d7702	Sexual relationships	12	9.8%	13	0.7%
d8451	Maintaining a job	17	13.8%	20	1.1%
d850	Remunerative employment	66	53.7%	100	5.6%
d920	Recreation and leisure	51	41.5%	71	4.0%
d9201	Sports	21	17.1%	25	1.4%
d9202	Arts and culture	10	8.1%	10	0.6%
d9205	Socializing	28	22.8%	39	2.2%
s710	Structure of head and neck region	22	17.9%	22	1.2%
s7104	Muscles of head and neck region	8	6.5%	(8)	(0.5%)
s720	Structure of shoulder region	25	20.3%	25	1.4%
s730	Structure of upper extremity	20	16.3%	25	1.4%
e355	Health professionals	9	7.3%	9	0.5%

\* Parentheses are added when an ICF category did not exceed the threshold of 5% or more of the studies

**Supplementary Table 2.** ICF categories linked to measures for mental health in at least 5% of the studies

ICF code	ICF category title	No. of studies	% of studies	No. of times ICF category was applied	Cumulative percentage across all ICF categories
b126	Temperament and personality functions	(2)	(1.6%)	6	1.4%
b1262	Conscientiousness	(5)	(4.1%)	6	1.4%
b1263	Psychic stability	16	13.0%	21	5.0%
b1264	Openness to experience	8	6.5%	8	1.9%
b1265	Optimism	13	10.6%	16	3.8%
b1266	Confidence	12	9.8%	16	3.8%
b130	Energy and drive functions	7	5.7%	4	1.0%
b1300	Energy level	12	9.8%	13	3.1%
b1301	Motivation	(3)	(2.4%)	4	1.0%
b1302	Appetite	9	7.3%	9	2.2%
b134	Sleep functions	11	8.9%	7	1.7%
b1342	Maintenance of sleep	(4)	(3.3%)	4	1.0%
b1400	Sustaining attention	9	7.3%	9	2.2%
b1470	Psychomotor control	11	8.9%	11	2.6%
b152	Emotional functions	17	13.8%	23	5.5%
b1521	Regulation of emotion	(5)	(4.1%)	5	1.2%
b1522	Range of emotion	(3)	(2.4%)	3	0.7%
					%
b160	Thought functions	(6)	(4.9%)	3	0.7%
b1602	Content of thought	14	11.4%	18	4.3%
b1603	Control of thought	(5)	(4.1%)	6	1.4%
b164	Higher-level cognitive functions	8	6.5%	8	1.9%
b1644	Insight	(3)	(2.4%)	4	1.0%
b1645	Judgement	(5)	(4.1%)	5	1.2%
b1801	Experience of self and time functions	(3)	(2.4%)	3	0.7%
b240	Sensations associated with hearing and vestibular function	7	5.7%	**	
b2401	Dizziness	**		3	0.7%
b2402	Sensation of falling	**		3	0.7%
b280	Sensation of pain	9	7.3%	11	2.6%
b28010	Pain in head and neck	(5)	(4.1%)	5	1.2%
b28011	Pain in chest	(3)	(2.4%)	3	0.7%
b28013	Pain in back	(3)	(2.4%)	3	0.7%
b340	Alternative vocalization functions	8	6.5%	8	1.9%
b455	Exercise tolerance functions	(3)	(2.4%)	3	0.7%
b4550	General physical endurance	(3)	(2.4%)	3	0.7%

**Supplementary Table 2.** (continued)

ICF code	ICF category title	No. of studies	% of studies	No. of times ICF category was applied	Cumulative percentage across all ICF categories
b4552	Fatiguability	10	8.1%	10	2.4%
b460	Sensations regarding cardiovascular/respiratory functions	(3)	(2.4%)	3	0.7%
b535	Sensations associated with the digestive system	(4)	(3.3%)	4	1.0%
b5350	Sensation of nausea	(3)	(2.4%)	3	0.7%
b6400	Functions of sexual arousal phase	8	6.5%	8	1.9%
b760	Control of voluntary movement functions	(3)	(2.4%)	3	0.7%
b765	Involuntary movement functions	(3)	(2.4%)	3	0.7%
D	ACTIVITIES AND PARTICIPATION	(3)	(2.4%)	3	0.7%
d177	Making decisions	(4)	(3.3%)	4	1.0%
d2	General tasks and demand	(4)	(3.3%)	5	1.2%
d230	Carrying out daily routine	(5)	(4.1%)	7	1.7%
d2402	Handling crisis	(2)	(1.6%)	3	0.7%
d4602	Moving around outside the home and other Buildings	(4)	(3.3%)	5	1.2%
d4702	Using public motorized transportation	(3)	(2.4%)	3	0.7%
d570	Looking after one's health	(5)	(4.1%)	3	0.7%
d5701	Managing diet and fitness			5	1.2%
d5702	Maintaining one's health	(6)	(4.9%)	7	1.7%
d7	Interpersonal interactions and relationships	(4)	(3.3%)	4	1.0%
d920	Recreation and leisure	(4)	(3.3%)	4	1.0%
E	ENVIRONMENTAL FACTORS	(5)	(4.1%)	5	1.2%
e3	Support and relationships	(4)	(3.3%)	5	1.2%
e310	Immediate family	(3)	(2.4%)	3	0.7%
e355	Health professionals	(4)	(3.3%)	4	1.0%

\* Parentheses are added when an ICF category did not exceed the threshold of 5% or more of the studies

\*\* In the first analysis b2401 and b2402 were added under code b240; in the second the third level codes were above 0.5%



# CHAPTER 8

## Disability trajectories in patients with complaints of arm, neck and shoulder (CANS) in primary care: a prospective cohort study

Harald S. Miedema, Anita Feleus, Sita M.A. Bierma-Zeinstra, Trynke Hoekstra, Alex Burdorf, Bart W. Koes.

*Physical Therapy* 2016;96:x (Epub ahead of print Dec 5, 2015).



## ABSTRACT

**Objectives:** Prospective cohort study to identify disability trajectories and associated prognostic factors during 2 years follow-up of patients presenting with a new episode of complaints of arm, neck or shoulder (CANS) in primary care.

**Methods:** Data of 682 patients were collected through questionnaires at baseline and every six months thereafter. Disability was measured with the Disability of Arm Shoulder and Hand questionnaire (DASH). Latent Class Growth Mixture (LCGM) modelling was used to identify clinically meaningful groups of patients who are similar in their disability trajectory during follow-up. Multivariate multinomial regression analysis was used to evaluate associations between sociodemographic, complaint-related, physical and psychosocial variables and the identified disability trajectories.

**Results:** Three disability trajectories were identified: fast recovery (67.6%), modest recovery (23.6%) and continuous high disability (8.8%). A high level of somatization was the most important baseline predictor of continuous high disability. Furthermore, 'poor general health', 'widespread complaints' and 'medium level of somatization' were associated with this trajectory and '>3 months complaint duration', 'musculoskeletal comorbidity', 'female gender', 'history of trauma', 'low educational level', 'low social support' and 'high complaint severity' were associated with both continuous high disability and modest recovery. 'Age', 'kinesiophobia' and 'catastrophizing' only showed a significant association with modest recovery.

**Conclusions:** Three trajectories described the course of disabilities due to CANS. Several prognostic indicators were identified that can easily be recognized in primary care. As some of these may be amenable for change, their presence in early stages of CANS may lead to more intensive and/or additional interventions, e.g. psychological or multidisciplinary therapy. Further research focusing on the use of these prognostic indicators in treatment decisions is needed to further substantiate their predictive value.

**Keywords:** arm; neck; shoulder; prognosis; disability; outcome assessment; musculoskeletal diseases; cumulative trauma disorders; epidemiological factors.

## INTRODUCTION

Non-traumatic complaints of arm, neck and shoulder (CANS) represent an important health issue, with high actual prevalence rates in general working age populations ranging from 12% in the U.S. to 33% in the Netherlands and 44-52% in the U.K..<sup>1-4</sup> In the Netherlands, the prevalence of chronic CANS unrelated to trauma or systemic diseases was 19%.<sup>2</sup> The 12-month incidence among a primary care population aged 18-65 years was 9.7%;<sup>5</sup> about 77% of these patients experienced complaints in upper back, neck and/or shoulder, 25% in elbow and/or arm, and 19% in wrist and/or hand.

About 19% of people with chronic CANS reported CANS-related sick leave, of which 39% with a duration >4 weeks.<sup>2</sup> In 2009, CANS was registered as the cause of almost 11% of all sick leave days in the Netherlands.<sup>6</sup> The yearly costs of associated benefits are about 1.4 billion euros. Additionally, costs due to productivity losses, disability pensions and healthcare usage are estimated at 800 million, 200 million and 150 million euros, respectively.<sup>7</sup> In the U.S., upper extremity disorders account for about 4.4% of sick leave claims.<sup>8</sup> Although in about two-thirds of registered cases no sick leave claims are filed,<sup>9,10</sup> the mean time lost was >70 days and higher than the mean of other causes<sup>11</sup>. Mean claim costs ranged from \$5000-\$8000.<sup>11</sup> These data indicate that the economic impact of CANS is huge. Nevertheless, and in contrast to low back problems, only two prospective observational studies of prognostic indicators for the outcome of CANS in primary care are available.<sup>12-15</sup> Some prognostic studies have been published for subgroups of CANS, i.e. neck complaints (reviews 6 studies in general population and 7 studies in working populations<sup>8,9</sup> and one additional study<sup>16</sup>); shoulder complaints (review 3 studies within broader review<sup>17</sup> and one additional study<sup>18,19</sup>); and shoulder-arm-hand-complaints (one study<sup>20</sup>). Reasons for the low number of prognostic studies of CANS may be the different diagnostic labels applied (e.g. repetitive strain injury or cumulative trauma disorders) and the various classifications used, together with a lack of clear definitions<sup>21-23</sup>.

To improve the terminology regarding CANS, in 2004 a multidisciplinary consensus was reached in the Netherlands on a classification system, called the CANS model.<sup>24</sup> CANS was defined as '*musculoskeletal complaints of arm, neck, and shoulder not caused by acute trauma or systemic disease*'. This model makes a distinction between specific and non-specific disorders, and an overview is given of all specific disorders that can be included under this definition (supplemental table 1). If no specific condition is diagnosed, then the condition should be classified as nonspecific CANS. In Dutch primary care, the ratio between specific and nonspecific disorders was estimated at 3:2.<sup>25</sup> Thereafter, a multidisciplinary guideline for diagnosis and treatment of nonspecific CANS was developed and approved by the participating professional organizations and patient association.<sup>26,27</sup>

In the reviews performed for this guideline, the paucity of prognostic studies became apparent. This led to recommendations for further research on prognostic factors (particularly psychological and social), and the way in which they can be identified and managed in primary care.

The aim of the present study is to analyze the course of disability over 2 years in patients presenting with CANS in primary care, and to identify the prognostic factors for disability. Similar to prognostic factors for the course of low back complaints, we hypothesize that a multifactorial biopsychosocial model can explain much of the variance in the course of disabilities due to CANS.<sup>28</sup> This means that personal, clinical, physical and psychosocial characteristics need to be examined as potential prognostic indicators.

## **METHODS**

### **Design and setting**

We conducted a prospective cohort study in 21 general practices in the southwest region of the Netherlands (Rotterdam and surroundings), with a 2-year follow-up. From September 2001 through December 2002, 36 GPs recruited patients that consulted them for a new episode of CANS. Data were collected by means of five self-administered questionnaires at baseline and every six months thereafter during follow-up. The Medical Ethical Committee of Erasmus Medical Centre approved the study and each participant provided written informed consent. Additional information on the procedure, follow-up regarding non-recovery of complaints and management of this cohort within the first six-months is published elsewhere.<sup>12,29</sup> The study was observational, so the GPs provided care as usual without implementation or promotion of any diagnostic or therapeutic interventions. The present study analyzes the trajectories for the outcome disability over a follow-up period of 2 years. The Strobe checklist was utilized to prepare this paper.<sup>30</sup>

### **Participants**

Patients were aged 18-64 years and able to complete questionnaires in Dutch. The episode of CANS was considered 'new' if they had not visited their GP for the same complaint during the preceding 6 months. Patients were excluded when complaints were directly related to a preceding accident or fracture, malignancy, amputation, prosthesis or congenital defect, or to a previously diagnosed systemic disorder or generalized neurological disorder.

## Outcome

Disability was measured with the Disability of Arm Shoulder and Hand questionnaire (DASH), containing 30 questions scored on a 5-point Likert-scale.<sup>31-33</sup> The sum of these scores is transferred to a 0-100 scale (100 indicating maximum disability). In addition to the DASH, patients could indicate their level of recovery in seven response categories: complete recovery, much improved, slightly improved, same as before, slightly deteriorated, much deteriorated, and worse than ever. Furthermore, patients could indicate the number of body regions associated with persistent symptoms based on the following responses: 'no longer any complaints', '1 region', '2 regions' and '3 regions or more'.

## Prognostic indicators

In the present study, potential prognostic indicators of disability over the course of 2 years are based on current biopsychosocial models of musculoskeletal pain.<sup>28</sup> The same prognostic indicators were studied, as were reported previously with regard to recovery at 6 months.<sup>12</sup> In summary:

1. Demographical and participation characteristics: a) age; b) gender; c) educational level (low=no/primary/lower vocational education; medium=secondary/medium vocational education, high=higher vocational education/university); d) paid work (affirmative answer to question 'Are you currently (self-)employed?'); e) sports participation  $\geq 1$  hour/week (yes/no).

2. Complaint characteristics: a) location of main complaint (all locations with complaints were indicated on a manikin and three regions were designated: neck-shoulder (including upper back and upper arm), elbow-forearm, and wrist-hand; in case of the presence of multiple locations patients indicated one region with the most complaints; if not indicated, the neck-shoulder-region (if present) was chosen as the region with most complaints, otherwise the hand-wrist region); b) widespread complaints in neck-shoulder, elbow-forearm and hand-wrist regions, defined as presence of symptoms in all three regions; c) based on the CANS model, the GP diagnosis was dichotomized as specific or nonspecific<sup>24,29</sup> (supplemental table 2 lists specific diagnoses); d) complaint severity during week before baseline (11-point Numerical Rating Scale (NRS)); e) duration of complaints at baseline (<6 weeks; 6 weeks – 3 months; >3 months; based on the division in acute, subacute and chronic that is common in LBP<sup>34</sup>); e) new or recurrent complaint (in case of recurrence the GP reported prior complaints, but not in the 6 months preceding the current episode).

3. Physical characteristics: a) general health measured by the SF-12 (answer to the first question recoded to 'good' ('excellent'/'very good'/'good') or 'poor' ('fair'/'poor')); the Physical Component Scale (PCS) and Mental Component Scale (MCS) were calculated based on a scale of 0-100, with higher scores indicating better health; recoding <median=high limitations);<sup>35</sup> b) history of trauma of neck or upper extremity (yes/no);

c) musculoskeletal comorbidity (positive response to a question on present chronic (>3 months) low back pain, osteoarthritis of hip or knee, or other disorders in arm-neck-shoulder region; d) non-musculoskeletal comorbidity (positive response to a question on the presence of non-musculoskeletal disorders, such as intermittent claudication, cardiovascular disease, diabetes (type 1 and 2), neurological disorders or other chronic disease (open question); e) body mass index (BMI; self-reported weight/height<sup>2</sup>; recoding <25=normal, 25-30=overweight; >30=obese);

4. Psychosocial characteristics: a) somatization and distress, measured by subscales of the Four Dimensional Symptom Questionnaire (4DSQ) (recoding 0-10=low, 11-20=medium, 21-32=high);<sup>36</sup> b) social support, measured by the Dutch version of the Social Support Questionnaire (SSQ; recoding <median=low);<sup>37</sup> c) catastrophizing, measured by subscale of the Dutch version of the Coping Strategy Questionnaire (recoding >median=high);<sup>38</sup> d) health locus of control, assessed by question 'Do you believe you can influence your health through your behaviour?' scored on a 4-point Likert scale (scores 'considerable'/'to a large extent' recoded as 'yes'); e) kinesiphobia, measured by 13-item version of the Tampa scale (without four reversed items; recoding <23=low, 23-27=medium, >27=high).<sup>39</sup>

5. Work characteristics: a) sick leave due to CANS, measured by question 'Were you absent from work in the past 6 months due to CANS?' (yes/no);<sup>40</sup> b) perceived workrelatedness, measured by confirmative response to one of three questions: 'Do the complaints return or worsen during the activities at work?', 'Have you adapted or reduced your activities at work because of your complaints?', 'Do the complaints diminish after several days off work?'; c) physical load at work, measured by the short version of the Dutch Musculoskeletal Questionnaire (Physical Workload Questionnaire (PWQ); sum scores calculated for 'heavy physical workload' and 'long-lasting postures and repetitive movements');<sup>41</sup> d) psychosocial factors at work, measured with the Dutch version of the Job Content Questionnaire (JCQ; high job strain derived from combination of high demands (above sample median) with low control (below sample median), being the weighted sum of decision authority and skill discretion).<sup>42</sup>

### Data analysis

For all follow-up moments, the proportion of non-responders was calculated and a non-response analysis was performed using multiple logistic regression. Further, the proportion of patients with at least two completed follow-up questionnaires and with complete follow-up (four questionnaires) was calculated. The total follow-up time is defined as the sum of the respondents that completed a follow-up questionnaire at any of the four follow-up moments multiplied by the follow-up time of 0.5 years. The mean response is the sum of the responses at the follow-up moments divided by 4.

Data analysis consists of two steps:

1. Latent Class Growth Mixture (LCGM) modelling to identify clinically meaningful groups of patients who are similar in their disability trajectory during the 2-year follow-up.<sup>43-45</sup> The LCGM analysis provides expectation-maximization estimates for assumed randomly missing data during follow-up. Each trajectory is called a class and follows a similar course during follow-up, which is represented by several parameters (e.g. intercept and slope), accounting for within-class variation.<sup>46</sup> The LCGM model is built stepwise, starting with investigating several linear LCGM models, with pooled intercept and slope variance, for 1-5 classes. Next, quadratic and cubic models are explored allowing for possible non-linear developmental patterns. Then, a first choice is made between these models based on a combination of the following criteria: A) indices of fit: a) Bayesian Information Criteria (BIC); b) Vuong-Lo-Mendell-Rubin likelihood ratio test (LRT); and c) Bootstrap likelihood ratio test (BLRT); B) posterior probabilities: assignment of cases to the classes representing disability trajectories is checked to evaluate the distinction between the classes and the number of cases per class;<sup>44,45,47</sup> C) interpretability of the model: the trajectories are evaluated for their difference in course over time and possible clinical meaning for the groups of patients they represent. The most parsimonious model is preferred in case of very small differences between the criteria for two models and similar possible interpretation of the trajectories.<sup>47</sup> After this first choice a further exploration is made comparing models with pooled variance of intercept and slope with models with fixed variance set to zero and fixed variance set to the estimate of variance that is calculated in the model with pooled variance. Finally, based on the same criteria, a choice is made for the final model. Supplemental table 3 provides details of the different models.
2. Univariate and multivariate multinomial logistic regression analyses, to explore characteristics of the classes and the association with potential prognostic indicators at baseline (expressed by odds ratio (OR)). For continuous and ordinal variables the linearity of their relation with the classes and distribution were examined. In case of a linear relationship and a distribution that did not deviate from normality (Shapiro-Wilk statistic >0.95 at  $p < 0.001$ ) the indicator is included as continuous variable. In case of lack of linearity or a skewed distribution and absence of a clinically relevant categorization, the scores of a variable are split based on the median of the total population at baseline. For the Tampa-scale a split in tertiles resulted in a better performance of the resulting model. Because for the 4DSQ the (clinical) use of 3 categories per subscale is recommended, we used this categorization for the variables somatization and distress.<sup>36,48</sup>

Variables showing a significant association ( $p < 0.05$ ) with one or more trajectories in the univariate analysis are selected for multivariate multinomial regression analysis, after a check for possible multicollinearity (in which case the variable with the highest association is retained for further analyses). Because of their clinical relevance a priori

decision was made to select the variables age, gender, region with most complaints, and specific/nonspecific diagnosis independently from a significant association.

A backward-step procedure (Wald) is performed to include only those variables that made a significant contribution to the model ( $p < 0.05$ ). The proportions of explained variance (Nagelkerke's  $R^2$ ) and correctly predicted cases are calculated to give an indication of the fit of the final model.

MPlus V6.1 is used for LCGM (MPlus 6.1 ed. 1998-2010). Non-response-analysis, description of the course of disability, analysis of the characteristics of class membership, and various multinomial and linear regression analyses (including normality and collinearity diagnostics), are performed using SPSS software V22 (SPSS, Chicago, Illinois, USA).

## RESULTS

### Sample characteristics

A total of 798 patients that consulted their GP for a new episode of CANS fulfilled the criteria to enter this 2-year prospective cohort study and were asked to participate. Of these, 682 (85.5%; mean age 44.3 years, 42% male) participated; 28% had a higher and 36% a medium education level; 78% had paid work. Table 1 lists the response at the follow-up moments. Of all participants, 86% completed 2-4 follow-up questionnaires and 69% had a complete follow-up of 4 questionnaires. Total follow-up time was 1125 person-years; the mean response was 82.5%. In general, differences between responders and non-responders were small. The chance of non-response was higher for men (at two follow-up moments) and rose slightly with age of the participants (at all follow-up moments).

### Disability trajectories

Table 2 presents the DASH scores and recovery rates at baseline and follow-up. In the first 6 months post-baseline there was considerable improvement in the mean DASH score, and in the proportion of respondents indicating a 'normal' DASH score  $< 11$ <sup>49,50</sup>, or 'absence of complaints', or 'complete recovery or much improvement'. However, during the 2-year follow-up, 40-45% of patients did not indicate complete recovery nor much improvement and an even larger group reported persisting complaints.

Supplemental table 3 lists the characteristics of the LCGM models. Based on fit criteria, posterior probabilities of the classes, clinical relevance, number of cases in the smallest trajectory and parsimoniousness of the model, a three-class linear model was preferred. The three-class model with fixed variance for the intercept and slope at the level of the estimates for variance in the model with pooled variance, fitted much better and was chosen as the final model. Figure 1 shows the three trajectories for disability in this model.

**Table 1.** Determinants of non-response at the four moments of follow-up <sup>#</sup>

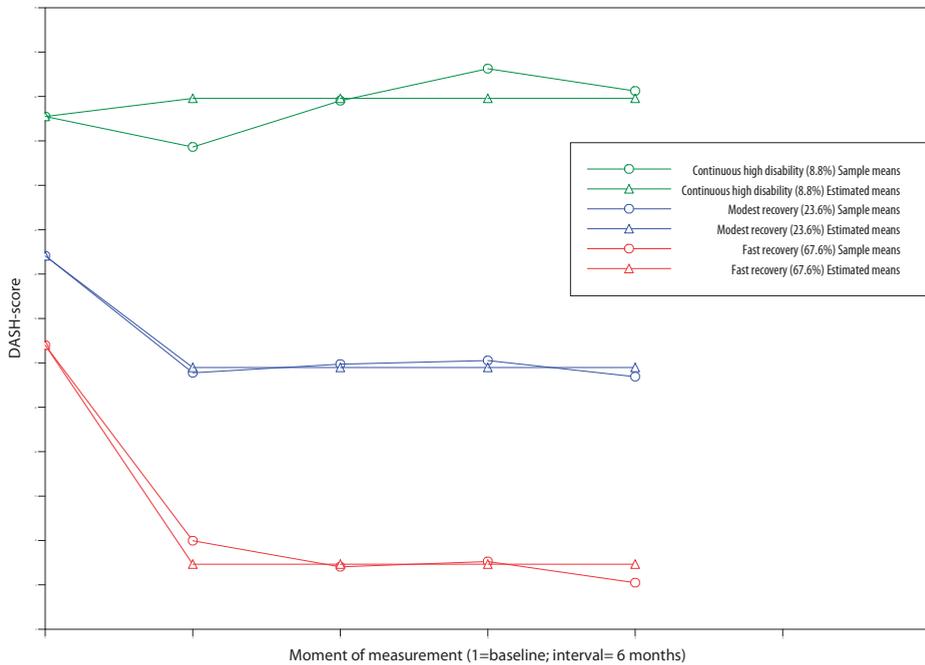
<b>Follow-up moment:</b>	6 months	12 months	18 months	24 months
<b>Number (%) of respondents</b>	612 (89.7%)	568 (83.3%)	536 (78.6%)	534 (78.3%)
<b>Participants with missing follow-up questionnaires:</b> None missing: 68.9%	1 missing 10.7%	2 missing 6.6%	3 missing 8.7%	4 missing 5.1%
<b>Association with response (OR; 95% CI):</b>				
Age	1.03 (1.00-1.05)	1.03 (1.01-1.05)	1.06 (1.04-1.08)	1.04 (1.02-1.05)
Male	1.73 (1.04-2.87)		1.67 (1.11-2.51)	
Educational level*, n (%) <sup>a</sup>	Low		0.47 (0.28-0.80)	
	Medium		0.57 (0.35-0.95)	
	High		ref	
No sports participation				0.63 (0.43-0.92)
Having paid work			0.58 (0.34-0.98)	
Low general health		1.81 (1.04-3.15)		
Mental limitations baseline SF12-MCS				1.02 (1.00-1.04)

*# see Methods section for measures that were utilized; also in models education, body mass index (BMI), paid work, specific diagnosis, region of most complaints, widespread complaints (3 regions), recurrent complaint, complaint duration, complaint severity previous week, non-musculoskeletal comorbidity, low general health, physical limitations DASH and SF-12-PCS\*, somatization and distress (4DSQ), mental limitations SF-12-MCS\*, high kinesiphobia, high catastrophizing, low social support and low health locus of control; \* Not tested with DASH and Distress-scale of 4-DSQ simultaneously due to high correlation; same other variables in model*

**Table 2.** Level of disability due to CANS at baseline and follow-up

	Baseline	6 months	12 months	18 months	24 months
<b>Mean DASH score</b>	36.8	18.8	17.0	18.3	15.9
<b>Standard deviation of DASH-score</b>	18.8	18.2	18.9	19.7	19.9
<b>Median DASH-score</b>	35.3	14.7	10.1	11.2	7.8
<b>Range in DASH-scores</b>	2.6-99.1	0-80.2	0-83.6	1.7-92.2	0-98.3
Proportion with DASH score < 11	5.9%	44.0%	51.1%	49.1%	57.7%
No longer any complaint(s)	0%	36.9%	42.1%	47.7%	42.9%
Complete recovery/much improved	0%	54.3%	56.2%	60.2%	61.5%

From a clinical standpoint we interpret class 1 as the fast recovery group (67.6% of the total; 94% correctly assigned), class 2 as the modest recovery group (23.6% of the total; 86% correctly assigned) and class 3 as the continuous high disability group (8.8% of the total; 91% correctly assigned). Class 3 included patients with a constantly high DASH score, and patients with fluctuating scores at relatively high levels. Patients in class 2 showed a decrease in DASH scores during the first 6 months post-baseline and thereafter, on average, continued disability. Patients in class 1 showed a larger decrease in DASH than class 2 patients and also, on average, continued disability at a much lower level. Both classes included patients with a relatively constant magnitude of disability and also patients with highly fluctuating disability (Figure 2).

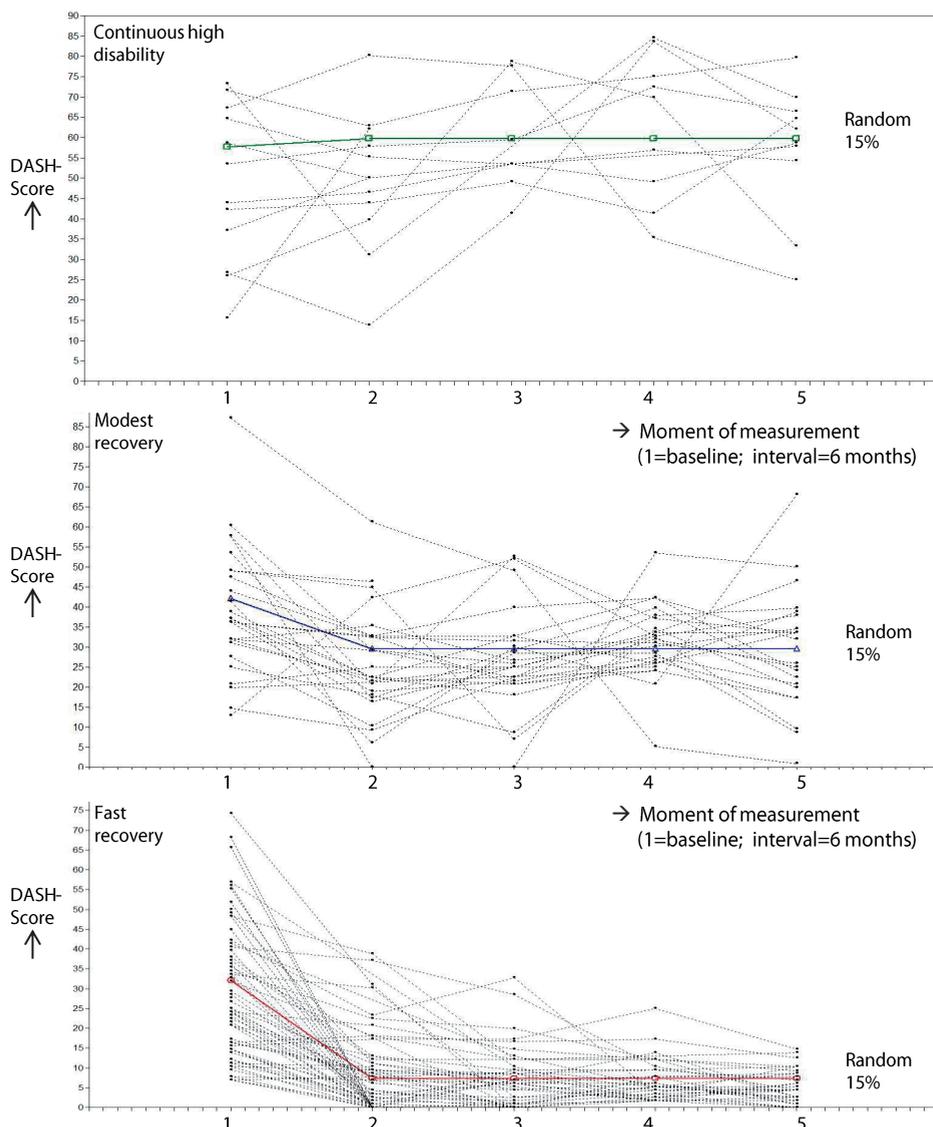


**Figure 1.** Three disability trajectories in patients with CANS in primary care

### Characteristics of the three trajectories

Table 3 presents the characteristics of the disability trajectories, and the results of the univariate multinomial regression analyses. All variables, except for 'specific diagnosis', 'region with most complaints' and 'low health locus of control', were associated with continuous high disability. All variables, except for 'specific diagnosis', 'region with most complaints', 'BMI' and 'history of trauma', were associated with modest recovery. Highest ORs, especially in relation to continuous high disability, were found for the psychosocial variables 'somatization', 'distress' and 'kinesiophobia', the complaint characteristics 'duration at baseline' and 'widespread complaints', and the physical characteristics 'poor general health', 'musculoskeletal comorbidity', and 'physical limitations at baseline' measured with the DASH or SF-12-PCS.

Those with paid work had a higher likelihood to show fast recovery. Of those with paid work, 'high static repetitive load', 'self-perception of work relatedness' and 'sick leave in 6 months before/at baseline' were associated with continuous high disability. These same variables, as well as 'full-time work', 'low co-worker support', 'high job strain' and 'low skill discretion' showed an association with modest recovery (supplemental table 4). These factors counteracted the relative advantage of paid work at the general population level.



**Figure 2.** Observed variability within each trajectory in a 15% random sample

Table 4 presents the multivariate model which summarizes the simultaneous associations of predictors at baseline with the trajectories, using a backward-step procedure (Wald). All variables showing an association with one or more trajectories in the univariate analysis (table 3) are entered in the analysis, as well as 'specific diagnosis' and 'region with most complaints' because of their clinical relevance. Of the workrelated variables only 'having paid work' is included, because at the general population level there were

**Table 3.** Characteristics of the disability trajectories and results of univariate multinomial regression analysis<sup>a</sup>

Variables	Characteristics			OR (95% CI)	
	Disability trajectory:	Fast recovery n=461	Modest recovery n=161	Continuous high disability n=60	Continuous high disability
<b>1. Demographical and participation characteristics</b>					
Age (years), mean (SD)		42.8 (11.3)	47.7 (11.6)	47.2 (9.9)	<b>1.04 (1.02-1.06)</b>
Female, n (%)		238 (51.6)	114 (70.8)	47 (78.3)	<b>3.39 (1.79-6.43)</b>
Educational level, n (%) <sup>b</sup>	Low	137 (29.8)	77 (47.8)	30 (50.0)	<b>3.72 (1.71-8.12)</b>
	Medium	170 (37.0)	52 (32.3)	21 (35.0)	1.46 (0.90-2.39)
	High	153 (33.3)	32 (19.9)	9 (15.0)	ref.
No sports participation, n (%)		232 (50.3)	106 (65.8)	42 (70.0)	<b>1.90 (1.31-2.76)</b>
Having paid work, n (%) <sup>b</sup>		382 (82.9)	114 (70.8)	38 (63.3)	<b>0.50 (0.33-0.76)</b>
<b>2. Complaint characteristics</b>					
Specific diagnosis (vs. nonspecific), n (%)		271 (58.9)	89 (55.3)	42 (70.0)	1.63 (0.91-2.91)
Region with most complaints <sup>c</sup> , n (%)	Neck or upper back or Shoulder or Upper arm	303 (65.7)	120 (74.5)	34 (56.7)	ref.
	Elbow or Forearm	98 (21.3)	25 (15.5)	16 (26.7)	1.46 (0.77-2.75)
	Wrist or Hand	60 (13.0)	16 (9.9)	10 (16.7)	1.49 (0.70-3.17)
Widespread complaints (in all three regions), n (%)		70 (15.2)	42 (26.1)	34 (56.7)	<b>1.79 (1.28-3.04)</b>
Recurrent complaint, n (%)		99 (21.5)	67 (41.6)	25 (41.7)	<b>2.61 (1.78-3.83)</b>
High complaint severity last week (NRS), mean (SD) <sup>b</sup>		5.5 (2.0)	6.1 (1.8)	7.2 (1.7)	<b>1.16 (1.06-1.28)</b>
Duration of the complaint, n (%) <sup>a</sup>	0-6 wks	269 (58.5)	61 (37.9)	14 (23.3)	ref.
	6 wks-3 months	115 (25.0)	37 (23.0)	10 (16.7)	1.42 (0.89-2.26)
	>3 months	76 (16.5)	63 (39.1)	36 (60.0)	<b>3.66 (2.37-5.65)</b>
<b>3. Physical characteristics</b>					
History of trauma arm, neck or shoulder, n (%)		71 (15.4)	32 (19.9)	22 (36.7)	<b>3.18 (1.78-5.70)</b>
Body mass index (kg/m <sup>2</sup> ), n (%) <sup>b</sup>	<25	230 (50.0)	79 (49.1)	30 (50.0)	ref.
	25-30 (overweight)	184 (40.0)	61 (37.9)	13 (21.7)	0.97 (0.66-1.42)
	>30 (obese)	46 (10.0)	21 (13.0)	17 (28.3)	<b>2.83 (1.44-5.56)</b>

**Table 3.** Characteristics of the disability trajectories and results of univariate multinomial regression analysis <sup>#</sup> (continued)

Variables	Characteristics				OR (95% CI)	
	Disability trajectory:	Fast recovery n=461	Modest recovery n=161	Continuous high disability n=60	Modest recovery	Continuous high disability
Co-morbidity musculoskeletal, n (%) <sup>a</sup>		178 (38.6)	104 (64.6)	49 (81.7)	<b>2.90 (2.00-4.21)</b>	<b>7.08 (3.59-13.98)</b>
Co-morbidity non-musculoskeletal, n (%) <sup>a</sup>		77 (16.7)	42 (26.1)	26 (43.3)	<b>1.76 (1.15-2.70)</b>	<b>3.81 (2.17-6.72)</b>
Poor general health, SF-12 1 <sup>st</sup> question, n (%) <sup>a</sup>		28 (6.1)	30 (18.6)	28 (46.7)	<b>3.53 (2.04-6.13)</b>	<b>13.50 (7.15-25.48)</b>
Physical limitations baseline SF12-PCS <45.0, n (%)		191 (42.0)	94 (59.1)	52 (86.7)	<b>2.00 (1.39-2.89)</b>	<b>8.98 (4.17-19.35)</b>
Physical limitations baseline DASH >35.4, n (%)		169 (36.7)	102 (63.7)	56 (93.3)	<b>3.04 (2.09-4.42)</b>	<b>24.19 (8.62-67.89)</b>
	mean (SD)	32.1 (17.8)	41.8 (14.8)	59.3 (16.5)	<b>1.03 (1.02-1.04)</b>	<b>1.09 (1.07-1.10)</b>
<b>4. Psychosocial characteristics</b>						
Mental limitations baseline SF12-MCS <54.6, n (%)		207 (45.5)	87 (54.7)	43 (71.7)	<b>1.45 (1.01-2.08)</b>	<b>3.03 (1.68-5.47)</b>
Somatization, 4DSQ n (%) <sup>a</sup>	Low (0-10)	387 (83.9)	99 (61.9)	17 (28.3)	ref.	ref.
	Medium (11-20)	70 (15.2)	53 (33.1)	25 (41.7)	<b>2.96 (1.95-4.50)</b>	<b>8.13 (1.30-5.39)</b>
	High (21-32)	4 (0.9)	8 (5.0)	18 (30.0)	<b>7.82 (2.31-26.49)</b>	<b>102.4 (31.2-325.8)</b>
Distress, 4DSQ, n (%) <sup>a</sup>	Low (0-10)	320 (69.6)	90 (55.9)	22 (36.7)	ref.	ref.
	Medium (11-20)	111 (24.1)	46 (28.6)	13 (21.7)	1.47 (0.97-2.23)	1.70 (0.83-3.50)
	High (21-32)	29 (6.3)	25 (15.5)	25 (41.7)	<b>3.07 (1.71-5.50)</b>	<b>12.54 (6.31-24.94)</b>
Low health locus of control, n (%)		174 (37.7)	76 (47.2)	30 (50.0)	<b>1.48 (1.03-2.12)</b>	1.65 (0.96-2.83)
Kinesiophobia, TAMPA-AV, n (%) <sup>c</sup>	Low (13-22)	203 (46.6)	47 (31.8)	9 (15.3)	ref.	ref.
	Medium (22-27)	125 (28.7)	31 (20.9)	18 (30.5)	1.07 (0.65-1.78)	<b>3.25 (1.42-7.45)</b>
	High (28-32)	108 (24.8)	70 (47.3)	32 (54.2)	<b>2.80 (1.81-4.33)</b>	<b>6.68 (3.08-14.51)</b>
High catastrophizing, CPV >9, n (%) <sup>b</sup>		186 (40.5)	105 (65.2)	41 (68.3)	<b>2.75 (1.89-4.00)</b>	<b>3.17 (1.78-5.63)</b>
Low social support, SOS < 57, n (%) <sup>a</sup>		196 (42.6)	100 (62.1)	46 (76.7)	<b>2.21 (1.53-3.19)</b>	<b>4.43 (2.37-8.28)</b>

<sup>#</sup> see Method section for measures that were utilized; Fast recovery group is reference group for multinomial regression analysis; Cut-off points for dichotomous variables are defined by median score of the total population; Number of missings: <sup>a</sup> 1 missing, <sup>b</sup> 2 missings, <sup>c</sup> 4 missings, <sup>d</sup> 5 missings, <sup>e</sup> 22 missings;

<sup>§</sup> In 12 cases with complaints at multiple locations without most painful location, neck-shoulder-forearm was chosen if present, otherwise hand-wrist.

**Table 4.** Results of multivariate multinomial regression analysis for characteristics of disability trajectories #

Variables	Disability class:	
	Modest recovery OR (95% CI)	Continuous high disability OR (95% CI)
<b>1. Demographical and participation characteristics</b>		
Age (years)	<b>1.06 (1.04-1.09)</b>	1.03 (0.99-1.07)
Female	<b>2.83 (1.70-4.72)</b>	<b>3.18 (1.28-7.91)</b>
Educational level		
Low	<b>2.23 (1.22-4.07)</b>	<b>3.13 (1.02-9.59)</b>
Medium	1.16 (0.63-2.12)	1.61 (0.52-4.96)
High	ref.	ref.
<b>2. Complaint characteristics</b>		
Specific diagnosis (vs. nonspecific)	0.73 (0.45-1.18)	2.08 (0.89-4.84)
Widespread complaints (in all three regions)	1.14 (0.64-2.06)	<b>3.99 (1.68-9.49)</b>
High complaint severity previous week	<b>1.14 (1.01-1.30)</b>	<b>1.62 (1.28-2.06)</b>
Duration of the complaint		
0-6 wks	ref.	ref.
6 wks-3 months	1.76 (0.98-3.14)	1.85 (0.61-5.64)
>3 months	<b>4.48 (2.57-7.79)</b>	<b>11.17 (4.38-28.47)</b>
<b>3. Physical characteristics</b>		
History of trauma arm, neck or shoulder	<b>2.35 (1.26-4.37)</b>	<b>4.27 (1.63-11.17)</b>
Poor general health, SF-12 1 <sup>st</sup> question	1.40 (0.69-2.85)	<b>4.79 (1.84-12.44)</b>
Co-morbidity musculoskeletal	<b>2.87 (1.79-4.61)</b>	<b>4.92 (1.91-12.66)</b>
<b>4. Psychosocial characteristics</b>		
Somatization, 4DSQ		
Low	ref.	ref.
Medium	1.65 (0.97-2.80)	<b>2.47 (1.04-5.91)</b>
High	3.04 (0.66-14.00)	<b>10.03 (1.88-53.61)</b>
Kinesiophobia, TAMPA		
Low	ref.	ref.
Medium	0.96 (0.52-1.75)	2.44 (0.81-7.35)
High	<b>2.05 (1.16-3.61)</b>	2.63 (0.87-7.93)
High catastrophizing, CPV	<b>2.25 (1.36-3.73)</b>	1.28 (0.52-3.13)
Low social support, SOS	<b>1.72 (1.08-2.76)</b>	<b>3.92 (1.65-9.32)</b>
Intercept	-7.77	-13.17

Explained variance (Nagelkerke  $R^2$ ): 0.544;

% Correctly predicted overall: 76.8% (within fast recovery group 91.5%, within modest recovery group 42.2% and within continuous high disability group 55.9%);

#see Method section for measures that were utilized; Model without SF-12-MCS because of the high correlation (0.67) with distress score (4DSQ); fast recovery group is reference group for multinomial regression analysis; cut-off points for dichotomous variables are defined by median score of the total population; the variables paid work, no sports participation, recurrent complaints, non-musculoskeletal comorbidity, low health locus of control and distress (4DSQ) were removed from the model.

no univariate associations with the trajectories. Because the trajectories are directly related to disabilities, the DASH and SF-12-PCS scores are not included in the model. SF-12-MCS is not included because of its high correlation with distress (4DSQ). All other variables have none to low correlations. The calculated proportion of explained variance (Nagelkerke  $R^2$ ) of the final model is 0.54, which indicates a good fit to the data.

The model shows that '>3 months complaint duration' and a high level of somatization are the most important baseline predictors of the continuous high disability trajectory, followed by 'musculoskeletal comorbidity', 'poor general health', 'history of trauma', 'widespread complaints', 'low social support', 'female gender', 'low educational level', 'high complaint severity' and a medium level of somatization. The indicators '>3 months complaint duration', 'musculoskeletal comorbidity', 'female gender', 'history of trauma', 'low educational level', 'low social support' and 'high complaint severity' also show an association with the modest recovery trajectory. 'Age', 'kinesiophobia' and 'catastrophizing' show only a significant association with modest recovery. However, for a high level of kinesiophobia the OR for the association with high disability is within the 95% confidence interval (CI) of the association with modest recovery, so this lack of significance can be explained by the low number of cases in this class. Distress is not associated with any trajectory.

A more parsimonious model, explaining already 46% of the variance, would include half the number of prognostic indicators: age, gender, duration and severity of complaints, musculoskeletal comorbidity, somatization and kinesiophobia (supplemental table 5).

## DISCUSSION

### Main results

This is the first prospective cohort study of primary care patients with a new episode of CANS, in which disability trajectories were analyzed over a 2-year period, together with their prognostic indicators. This cohort can be regarded as representative for Dutch patients with CANS, because the number of participating practices and GPs was large enough to account for possible local variations in patient groups, the initial response to participate was very high and relatively low non-response rates at follow-up were observed. There are no indications that patients with CANS in the South-West region of the Netherlands differ much from other regions.

Three disability trajectories were differentiated: fast recovery (67.6%), modest recovery (23.6%) and continuous high disability (8.8%). The proportion of patients with DASH

scores comparable to the normal population (<11)<sup>49,50</sup> increased from 44% at 6-month follow-up to 58% at 2-year follow-up. A slightly higher proportion (54-62%) indicated complete recovery or much improvement at all follow-up moments. However, only 43% of the patients indicated absence of complaints at 2-year follow-up.

The fast recovery trajectory represents the majority of patients that have improved outcome at 2-year follow-up (most already at 6-months post-baseline); in this group the number of recurrences is low. The modest recovery trajectory consists of patients with persisting disability at a lower level compared with baseline, as well as patients with relapses and recurrent disabilities after initial improvement. This conclusion is supported by the fact that, at all follow-up moments, the proportion of patients without complete recovery or much improvement (46-38%) or a 'normal' level of disability (56-42%) is considerably higher than the proportion of patients in the high disability trajectory (8.8%). Therefore, many of these patients must be in the modest recovery trajectory.

We present several demographical, complaint-related, physical and psychosocial characteristics that have a predictive value for the high disability and modest recovery trajectories. These characteristics can be identified by screening methods including information obtained through patient history and administering validated measures, such as the 4DSQ and Tampa-scale. This implies the feasibility for clinicians to differentiate subgroups of patients within the larger group with nonspecific complaints that might have a different prognosis based on appropriate adaptation of therapeutic management focusing on the identified predictors. This is especially relevant for physiotherapists, since the GPs referred 63% of all patients to physiotherapists during the two year follow-up. However, the exact performance of these predictive variables in this subgroup still has to be studied.

### **Study limitations**

The present study has some limitations. First, at the different follow-up moments loss to follow-up ranged from 10-22% of the cohort and for 5% of the initial cohort no follow-up data were available. Nevertheless, for a follow-up study with a large initial cohort these data are very acceptable<sup>51</sup>. Furthermore, the LCGM analysis provides estimates for missing data during follow-up and non-response analysis yielded only small differences. Overall, of the prognostic indicators present in the final models, the responders are slightly less likely to be of older age or male.

Second, a patient-reported outcome measure (DASH) was used to assess disabilities and no physical tests were performed. However, the DASH is a widely used and well-validated measure for CANS, both in total and/or at specific bodily regions.<sup>31,33,49</sup>

Third, the GP's diagnosis at the first consultation was used to differentiate between specific (59%) and nonspecific CANS (41%). However, since at that moment the CANS

model had not yet been published and no classification criteria were available, some misclassification may have occurred. In our analysis a specific diagnosis is not associated with any trajectory. However, optimal classification may slightly alter this association. Fourth, some predictor variables were assessed with measures or questions with limited or unknown validity, such as history of trauma of neck or upper extremity, musculoskeletal or non-musculoskeletal comorbidity, health locus of control, social support and catastrophizing. This might have influenced their association with the disability trajectories.

Fifth, the presented model has less explained variance (0.544) than a full model including all variables of table 3 (0.574) or a model resulting from using a backward step procedure with  $p < 0.157$  (0.552). In the latter model the only difference is the inclusion of the not significantly associated variable 'region with most complaints'. A more parsimonious model including half the number of prognostic indicators, would explain already 46% of the variance.

Finally, although LCGM is a well-established method to analyze distinct trajectories, the decision regarding the optimal number of classes and the use of a model with pooled or fixed variance remains to some extent arbitrary;<sup>52</sup> however, the number of cases and allocation to the respective trajectories proved to be good. The advantage of LCGM is that the course of CANS can be examined over time; moreover, especially the category of patients with continuous high disability can be identified, resulting in an analysis of the prognostic indicators for this specific trajectory.

### **Prognostic indicators compared to other studies**

The present study is unique in its description of disability trajectories for the whole group of CANS patients and the analysis of prognostic indicators of disability. All other studies used a single endpoint of recovery after one specific follow-up period (generally between 6 months and 5 years). Also, most earlier studies investigated only one region, mostly the neck or shoulder (supplemental table 6).

With regard to psychosocial characteristics, somatization was identified as an important prognostic indicator for continuous high disability, as also described for the CANS cohort in a physical therapy setting.<sup>14-16</sup> Only one other primary care study also looked at the predictive value of somatization in shoulder disorders, but found no association with persistent shoulder symptoms (46% of the initial group at 6-month follow-up; although there was an association in their univariate analysis).<sup>18</sup> Our results show a significant association of somatization with the high disability trajectory and a trend of association with modest recovery. Earlier, in both CANS cohorts, an association between 'high catastrophizing' and 'high kinesiophobia' with unfavorable outcome was shown at some follow-up moments, especially in nonspecific disorders;<sup>13-15</sup> this association was con-

firmed in the present study. Previously, an association with catastrophizing was found in relation to recovery of chronic shoulder complaints<sup>19</sup> and neck complaints.<sup>16</sup> With regard to kinesiophobia, earlier studies found no association with recovery in patients with neck complaints<sup>16,53,54</sup> or shoulder complaints.<sup>18</sup> In our cohort we also identified 'low social support' as a prognostic indicator for both trajectories with worse outcome, whereas others found no such association.<sup>14-16,54</sup> The variable 'distress' was investigated in both cohorts with CANS patients (and a subgroup with neck pain) as well as several cohorts with shoulder disorders; however, no association with outcome was observed.<sup>16-18</sup> Also, in both CANS cohorts, no association was found with general mental limitations or low health locus of control.<sup>12,14,15</sup>

With regard to physical characteristics, our study shows that musculoskeletal comorbidity is an important prognostic indicator, which is in line with others.<sup>17,18,53,55,56</sup> Poor self-perceived general health is consistently related to unfavorable outcome.<sup>53,55</sup> A history of trauma or injury in the region of complaints is associated with unfavorable outcome in some studies<sup>53,55</sup> and in ours, but not in other studies.<sup>14-16,57</sup> Depending on the interpretation of 'trauma' or 'injury' and the formulation of the question, preceding trauma can be indicated occasionally by respondents who experienced (for instance) bumping, pulling, or arm strain. However, such a history is difficult to link to the complaints under study when patients with diagnoses indicating a traumatic cause (e.g. contusion, distortion or whiplash) have been excluded. For non-musculoskeletal co-morbidity the evidence is inconclusive; however, there is much variation in the applied definitions. Also, evidence for an association of physical limitations at baseline with unfavorable outcome is inconclusive. In the present study, because the outcome of interest is disability, the baseline value is not included in the analysis.

Within the group of complaint characteristics, '>3 months complaint duration at baseline' is identified as a prognostic indicator, which is similar to other studies.<sup>15-18,20,55,56,58</sup> Furthermore, we identified complaints that are widespread over the arm-neck-shoulder region as prognostic indicator. However, the main location of the complaints, or having a specific diagnosis, are not associated with any disability trajectory; this is similar to the earlier CANS cohort.<sup>14,15</sup> In the present study (and in other studies), high complaint severity or pain intensity at baseline is associated with unfavorable outcome. However, this association was not present at 6-month follow-up in our cohort, or at 2-year follow-up in the earlier CANS cohort,<sup>12,15</sup> or in three studies on neck complaints.<sup>16,53,56</sup> For 'recurrent complaints' as possible prognostic indicator, the evidence is inconsistent. In the present study we found no association with any disability trajectory.

Examining the demographical and participation characteristics revealed that female gender and low educational level were associated with both disability trajectories. Older age was only associated with the modest recovery trajectory, however the associations

with both disability trajectories might be underestimated due to the fact that non-response was higher among older persons. Although results for these variables vary between different studies, for shoulder disorders the absence of an association is consistent.<sup>17-20</sup> Regarding sports participation, no association with any disability trajectory or recovery was present in the two CANS cohorts. This confirms the results of other studies, in which physical exercise or activity at baseline was included as a possible prognostic indicator.<sup>14,15,18,19,55</sup>

With regard to unemployment, we previously found an association with non-recovery at 6 months follow-up. However, in the present study a relation between unemployment and both disability trajectories was found only in the univariate analysis. In other studies in which unemployment was included as a possible prognostic indicator, no association was found with unfavorable outcome.<sup>14,15,20,53,55,58</sup>

## Conclusion

This study reveals three trajectories which describe the course of disabilities due to CANS over 2-year follow-up: fast recovery, modest recovery, and continuous high disability. We identified several sociodemographic, complaint-related, physical and psychosocial prognostic indicators that can easily be recognized in a primary care setting. It is important to identify patients at risk for continuous high disability at an early disease stage. Some prognostic indicators related to this particular outcome may be amenable for change, e.g. the psychosocial factors 'somatization, kinesiphobia and catastrophizing', and the physical factors 'poor general health' and 'musculoskeletal comorbidity'. Thus, in view of the considerable numbers of patients following a trajectory of chronic disabilities in CANS, establishing a clear prognosis can be valuable to mitigate this course. We recommend to check the indicators identified in this study at an early stage of CANS, before giving advice about treatment options. The presence of these indicators may lead to a decision for more intensive and/or additional interventions. For psychosocial indicators, the involvement of a psychosomatic physiotherapist or psychologist, or a multidisciplinary approach, can be considered and, for physical indicators, more intensive therapy may be appropriate. A similar management approach in patients with nonspecific low back pain, using a screening method to identify patients at high risk for persistent disability and providing psychologically informed physical therapy, has already shown to have promising effects compared to usual management by physiotherapists.<sup>59-61</sup> Further research focusing on the use of these prognostic indicators in treatment decision-making is needed to further substantiate their predictive value and may result in a screening tool that can be applied in patients with CANS.

## **FUNDING SOURCES**

This study was supported by internal funding from Erasmus MC Rotterdam and Rotterdam University of Applied Sciences.

## **ACKNOWLEDGEMENTS**

The authors thank the participating GPs and the patients for their valuable contribution to this study.

## BOTTOM LINES

### **‘What do we already know about this topic?’**

Non-traumatic complaints of arm, neck and shoulder (CANS) represent an important health issue, with a high prevalence in the general working age population and huge economic impact. Nevertheless, only two prospective cohort studies for the outcome of CANS are available. One reason for this low number of studies may be the lack of a generally accepted classification system. Other prognostic studies only included subgroups of CANS, i.e. neck complaints, shoulder complaints or shoulder-arm-hand-complaints. Using a recently developed classification system, called the CANS model, we performed a prognostic study to analyze the course of disabilities over 2 years in patients presenting with a new episode of CANS in primary care.

### **‘What new information does this study offer?’**

We identified three trajectories for the course of CANS: 1) fast recovery (67.6%, including patients with a large decrease in disability-scores during the first 6 months, and thereafter no or low-level disability); 2) modest recovery (23.6%, including patients with a modest decrease in disability-scores during the first 6 months and thereafter continued modest or fluctuating disability); and 3) continuous high disability (8.8%; including patients with constantly high disability-scores or fluctuating scores at relatively high levels). Our analysis showed a number of prognostic indicators that can easily be recognized in primary care, including possibly amenable psychosocial factors such as somatization and kinesiophobia.

### **‘If you’re a patient, a family member, or a caregiver, what might these findings mean for you?’**

In view of the considerable number of CANS-patients following a trajectory of chronic disabilities, establishing a clear prognosis can be valuable to mitigate this course. We recommend to check the prognostic indicators identified in this study at an early stage of CANS, before deciding upon treatment options. The presence of some indicators may lead to a decision for more intensive or additional interventions. For psychosocial indicators, the involvement of a psychosomatic physiotherapist or psychologist, or a multidisciplinary approach, can be considered. For physical indicators, more intensive therapy may be appropriate.

## REFERENCES

1. Morse TF, Dillon C, Warren N, Levenstein C, Warren A. The economic and social consequences of work-related musculoskeletal disorders: the Connecticut Upper-Extremity Surveillance Project (CUSP). *Int J Occup Environ Health*. 1998;4(4):209–16.
2. Huisstede BMA, Wijnhoven HA, Bierma-Zeinstra SM, Koes BW, Verhaar JA, Picavet S. Prevalence and characteristics of complaints of the arm, neck, and/or shoulder (CANS) in the open population. *Clin J Pain*. 2008;24(3):253–9.
3. Walker-Bone K, Palmer KT, Reading I, Coggon D, Cooper C. Prevalence and impact of musculoskeletal disorders of the upper limb in the general population. *Arthritis Rheum*. 2004;51(4):642–51.
4. Urwin M, Symmons D, Allison T, Brammah T, Busby H, Roxby M, Simmons A, Williams G. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis*. 1998;57(11):649–55.
5. Feleus A, Bierma-Zeinstra SMA, Miedema HS, Bernsen RMD, Verhaar JAN, Koes BW. Incidence of non-traumatic complaints of arm, neck and shoulder in general practice. *Man Ther*. 2008;13(5):426–33.
6. Klein Hesselink J, Hoofman W, de Weerd M, Koppes L. Ziekteverzuim in Nederland in 2009. Hoofddorp: TNO; 2011. Available from: [https://www.tno.nl/downloads/ziekteverzuim\\_in\\_nederland\\_in\\_2009.pdf](https://www.tno.nl/downloads/ziekteverzuim_in_nederland_in_2009.pdf)
7. Blatter B, Houtman I, Bossche S van den, Kraan K, Heuvel S van den. Gezondheidsschade en kosten als gevolg van RSI en psychosociale arbeidsbelasting in Nederland. Hoofddorp: TNO Kwaliteit van Leven; 2005. Available from: [http://www.monitorarbeid.tno.nl/dynamics/modules/SPUB0102/view.php?pub\\_id=100141&att\\_id=4911](http://www.monitorarbeid.tno.nl/dynamics/modules/SPUB0102/view.php?pub_id=100141&att_id=4911)
8. Feuerstein M, Miller VL, Burrell LM, Berger R. Occupational upper extremity disorders in the federal workforce. Prevalence, health care expenditures, and patterns of work disability. *J Occup Environ Med*. 1998;40(6):546–55.
9. Hashemi L, Webster BS, Clancy EA, Courtney TK. Length of disability and cost of work-related musculoskeletal disorders of the upper extremity. *J Occup Environ Med*. 1998;40(3):261–9.
10. Silverstein B, Viikari-Juntura E, Kalat J. Work-related musculoskeletal disorders of the neck, back and upper extremity in Washington State 1990-1998. Washington DC: Washington State Department of Labor and Industries; 2000. Report No.: Technical Report Number 40-4a-2000. Available from: <http://www.elcosh.org/record/document/1204/d000376.PDF>.
11. Baldwin ML, Butler RJ. Upper extremity disorders in the workplace: costs and outcomes beyond the first return to work. *J Occup Rehabil*. 2006;16(3):303–23.
12. Feleus A, Bierma-Zeinstra SMA, Miedema HS, Verhagen AP, Nauta AP, Burdorf A, Verhaar JAN, Koes BW. Prognostic indicators for non-recovery of non-traumatic complaints at arm, neck and shoulder in general practice--6 months follow-up. *Rheumatol*. 2007;46(1):169–76.
13. Keijsers E, Feleus A, Miedema HS, Koes BW, Bierma-Zeinstra SMA. Psychosocial factors predicted nonrecovery in both specific and nonspecific diagnoses at arm, neck, and shoulder. *J Clin Epidemiol*. 2010;63(12):1370–9.
14. Karels CH, Bierma-Zeinstra SMA, Burdorf A, Verhagen AP, Nauta AP, Koes BW. Social and psychological factors influenced the course of arm, neck and shoulder complaints. *J Clin Epidemiol*. 2007;60(8):839–48.
15. Karels C. Arm, neck and shoulder complaints in physical therapy practice: course and prognosis. [Dissertation]. Rotterdam: Erasmus university Medical Center; 2009.

16. Verhagen AP, Karelis CH, Schellingerhout JM, Willemsen SP, Koes BW, Bierma-Zeinstra SMA. Pain severity and catastrophising modify treatment success in neck pain patients in primary care. *Man Ther.* 2010;15(3):267–72.
17. Kuijpers T, van der Windt DAWM, van der Heijden GJMG, Bouter LM. Systematic review of prognostic cohort studies on shoulder disorders. *Pain.* 2004;109(3):420–31.
18. Kuijpers T, van der Windt DAWM, Boeke AJP, Twisk JWR, Vergouwe Y, Bouter LM, Van der Heijden GJMG. Clinical prediction rules for the prognosis of shoulder pain in general practice. *Pain.* 2006;120(3):276–85.
19. Reilingh ML, Kuijpers T, Tanja-Harfterkamp AM, van der Windt DA. Course and prognosis of shoulder symptoms in general practice. *Rheumatol.* 2008;47(5):724–30.
20. Ryall C, Coggon D, Peveler R, Poole J, Palmer KT. A prospective cohort study of arm pain in primary care and physiotherapy—prognostic determinants. *Rheumatol.* 2007;46(3):508–15.
21. Van Eerd D, Beaton D, Cole D, Lucas J, Hogg-Johnson S, Bombardier C. Classification systems for upper-limb musculoskeletal disorders in workers: a review of the literature. *J Clin Epidemiol.* 2003;56(10):925–36.
22. Van Tulder M, Malmivaara A, Koes B. Repetitive strain injury. *Lancet.* 2007;369(9575):1815–22.
23. Burton AK, Kendall NAS, Pearce BG, Birrell LN, Bainbridge LC. Management of work-relevant upper limb disorders: a review. *Occup Med.* 2009;59(1):44–52.
24. Huisstede BMA, Miedema HS, Verhagen AP, Koes BW, Verhaar JAN. Multidisciplinary consensus on the terminology and classification of complaints of the arm, neck and/or shoulder. *Occup Environ Med.* 2007;64(5):313–9.
25. Feleus A, Bierma-Zeinstra SMA, Miedema HS, Verhaar JAN, Koes BW. Management in non-traumatic arm, neck and shoulder complaints: differences between diagnostic groups. *Eur Spine J.* 2008;17(9):1218–29.
26. Multidisciplinaire richtlijn specifieke Klachten Arm, Nek en/of Schouders. Utrecht: Kwaliteitskoepel Medisch Specialisten; 2012. Available from: <http://www.kwaliteitskoepel.nl/assets/structured-files/2012/multidicsrichtlijnaspecifiekeKANS19092012.pdf>
27. Miedema HS, Feleus A. [Guideline “Non-specific symptoms of arm, neck and/or shoulders”]. *Ned Tijdschr Geneesk.* 2013;157(21):A6249.
28. Pincus T, Kent P, Bronfort G, Loisel P, Pransky G, Hartvigsen J. Twenty-five years with the biopsychosocial model of low back pain—is it time to celebrate? A report from the twelfth international forum for primary care research on low back pain. *Spine.* 2013;38(24):2118–23.
29. Feleus A, Bierma-Zeinstra SMA, Bernsen RMD, Miedema HS, Verhaar JAN, Koes BW. Management decisions in nontraumatic complaints of arm, neck, and shoulder in general practice. *Ann Fam Med.* 2009;7(5):446–54.
30. Observational studies: getting clear about transparency. *PLoS Med.* 2014;11(8):e1001711.
31. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) [corrected]. The Upper Extremity Collaborative Group (UECG). *Am J Ind Med.* 1996;29(6):602–8.
32. Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder and Hand outcome measure in different regions of the upper extremity. *J Hand Ther.* 2001 Jun;14(2):128–46.
33. Huisstede BMA, Feleus A, Bierma-Zeinstra SM, Verhaar JA, Koes BW. Is the disability of arm, shoulder, and hand questionnaire (DASH) also valid and responsive in patients with neck complaints. *Spine.* 2009;34(4):E130–8.

34. Koes BW, van Tulder M, Lin C-WC, Macedo LG, McAuley J, Maher C. An updated overview of clinical guidelines for the management of non-specific low back pain in primary care. *Eur Spine J.* 2010; 19(12):2075–94.
35. Ware JJ, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care.* 1996;34(3):220–33.
36. Terluin B, van Marwijk HWJ, Ader HJ, de Vet HCW, Penninx BWJH, Hermens MLM, Van Boeijen CA, Van Balkom AJLM, Van der Klink JLL, Stalman WAB. The Four-Dimensional Symptom Questionnaire (4DSQ): a validation study of a multidimensional self-report questionnaire to assess distress, depression, anxiety and somatization. *BMC Psychiatry.* 2006;6:34.
37. Feij JA, Doorn CD, Kampen D van, Berg PT van den, Resing WCM. Sensation seeking and social support as moderators of the relationship between life events and physical illness/psychological distress. In: *Lifestyles, stress and health.* Leiden: DSWO Press; 1992:285–302.
38. Spinhoven P, Ter Kuile M, Linssen A. Coping with Pain Questionnaire (CPV); guide/experimental version. Lisse: Swets & Zeitlinger; 1994.
39. Goubert L, Crombez G, Van Damme S, Vlaeyen JWS, Bijttebier P, Roelofs J. Confirmatory factor analysis of the Tampa Scale for Kinesiophobia: invariant two-factor model across low back pain patients and fibromyalgia patients. *Clin J Pain.* 2004;20(2):103–10.
40. Van Poppel MNM, de Vet HCW, Koes BW, Smid T, Bouter LM. Measuring sick leave: a comparison of self-reported data on sick leave and data from company records. *Occup Med.* 2002;52(8):485–90.
41. Bot SDM, Terwee CB, van der Windt DAWM, Feleus A, Bierma-Zeinstra SM, Knol DL, Bouter LM, Dekker J. Internal consistency and validity of a new physical workload questionnaire. *Occup Environ Med.* 2004;61(12):980–6.
42. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol.* 1998;3(4):322–55.
43. Muthén B. Latent variable analysis, growth mixture modelling and related techniques for longitudinal data. In: *Handbook of Quantitative Methodology for the Social Sciences.* Newbury Park CA: Sage Publications; 2004.
44. Muthén L, Muthén B. *Mplus User's Guide.* Seventh Edition. Los Angeles: Muthén & Muthén; 2012.
45. Jung T, Wickrama K. An Introduction to Latent Class Growth Analysis and Growth Mixture Modeling. *Social and Personality Psychology Compass.* 2008;(2):302–17.
46. Hoekstra T, Barbosa-Leiker C, Koppes LLJ, Twisk JWR. Developmental trajectories of body mass index throughout the life course - an application of Latent Class Growth (Mixture) Modelling. *Longitudinal and Life Course Studies.* 2011;2(3):319–30.
47. Geiser C. *Data analysis with Mplus.* New York: Guilford Press; 2012.
48. Terluin B. De Vierdimensionale Klachtenlijst (4DKL) in de huisartspraktijk: psychodiagnostisch gereedschap. *De Psycholoog.* 1998;(33):18–24.
49. Aasheim T, Finsen V. The DASH and the QuickDASH instruments. Normative values in the general population in Norway. *J Hand Surg Eur.* 2014;39(2):140–4.
50. Hunsaker FG, Cioffi DA, Amadio PC, Wright JG, Caughlin B. The American academy of orthopaedic surgeons outcomes instruments: normative values from the general population. *J Bone Joint Surg Am.* 2002;84-A(2):208–15.
51. Kristman V, Manno M, Cote P. Loss to follow-up in cohort studies: how much is too much? *Eur J Epidemiol.* 2004;19(8):751–60.
52. Hoekstra T. *Applied latent class models for epidemiology [Dissertation].* Amsterdam: Free university Medical Center; 2013.

53. Schellingerhout JM, Heymans MW, Verhagen AP, Lewis M, de Vet HCW, Koes BW. Prognosis of patients with nonspecific neck pain: development and external validation of a prediction rule for persistence of complaints. *Spine*. 2010;35(17):E827–35.
54. Bot SDM, van der Waal JM, Terwee CB, van der Windt DAWM, Scholten RJPM, Bouter LM, Dekker J. Predictors of outcome in neck and shoulder symptoms: a cohort study in general practice. *Spine*. 2005;30(16):E459–70.
55. Carroll LJ, Hogg-Johnson S, van der Velde G, Haldeman S, Holm LW, Carragee EJ, Hurwitz EL, Cote P, Nordin M, Peloso PM, Guzman J, Cassidy JD. Course and prognostic factors for neck pain in the general population: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine*. 2008;33(4 Suppl):S75-82.
56. McLean SM, May S, Moffett JK, Sharp DM, Gardiner E. Prognostic factors for progressive non-specific neck pain: a systematic review. *Phys Ther Rev*. 2007;12(3):207–20.
57. Van der Windt DA, Koes BW, Boeke AJ, Deville W, De Jong BA, Bouter LM. Shoulder disorders in general practice: prognostic indicators of outcome. *Br J Gen Pract*. 1996;46(410):519–23.
58. Vos CJ, Verhagen AP, Passchier J, Koes BW. Clinical course and prognostic factors in acute neck pain: an inception cohort study in general practice. *Pain Med*. 2008;9(5):572–80.
59. Hill JC, Whitehurst DGT, Lewis M, Bryan S, Dunn KM, Foster NE, Konstantinou K, Main CJ, Mason E, Somerville S, Sowden G, Vohora K, Hay EM. Comparison of stratified primary care management for low back pain with current best practice (STarT Back): a randomised controlled trial. *Lancet*. 2011;378(9802):1560–71.
60. Nicholas MK, George SZ. Psychologically informed interventions for low back pain: an update for physical therapists. *Phys Ther*. 2011;91(5):765–76.
61. Beneciuk JM, George SZ. Pragmatic Implementation of a Stratified Primary Care Model for Low Back Pain Management in Outpatient Physical Therapy Settings: Two-Phase, Sequential Preliminary Study. *Phys Ther*. 2015;95(8):1120-34.

## SUPPLEMENTARY TABLES

**Supplemental table 1.** Specific and nonspecific disorders of the CANS-model <sup>26,27</sup>

### Specific Disorders of CANS-model

If no specific disorder can be diagnosed, the disorder is classified as nonspecific

<p><b>General disorders</b></p> <ul style="list-style-type: none"> <li>• Congenital disorder in upper extremity *</li> <li>• Congenital malformation in upper extremity *</li> <li>• Local Monarticular Arthritis (non rheumatoid) in upper extremity joint</li> <li>• Local Monarticular Osteoarthritis (Artrosis) in upper extremity joint *</li> <li>• Tumor of bone in upper extremity *</li> <li>• Tumor of soft tissue in upper extremity *</li> </ul>	<p><b>Disorders of the Elbow region (incl. forearm)</b></p> <ul style="list-style-type: none"> <li>• Bursitis of elbow</li> <li>• Cubital Tunnel syndrome</li> <li>• Instability of elbow</li> <li>• Lateral epicondylitis</li> <li>• Medial epicondylitis</li> <li>• Osteochondritis of elbow *</li> <li>• Other compression syndromes of N. Medianus *</li> <li>• Other compression syndromes of N. Radialis *</li> <li>• Other compression syndromes of N Ulnaris *</li> <li>• Radial tunnel syndrome</li> </ul>
<p><b>Disorders of the Neck region</b></p> <ul style="list-style-type: none"> <li>• Cervical Disc Hernia</li> <li>• Cervical Facetjoint Pain * #</li> </ul>	<p><b>Disorders of the Hand-wrist region</b></p> <ul style="list-style-type: none"> <li>• Avascular Osteonecrosis of hand *</li> <li>• Carpal Tunnel syndrome</li> <li>• De Quervain's tendinopathy</li> <li>• Dupuytren's disease</li> <li>• Guyon canal disease</li> <li>• Hand-Arm-Vibration Syndrome *</li> <li>• Instability of the wrist *</li> <li>• Local Osteoarthritis in hand-joints *</li> <li>• Other tendinopathies of finger/wrist-extensors *</li> <li>• Other tendinopathies of finger/wrist-flexors *</li> <li>• Trigger finger</li> </ul>
<p><b>Disorders of the Shoulder region (incl. upper arm)</b></p> <ul style="list-style-type: none"> <li>• Biceps tendinopathy</li> <li>• Frozen shoulder</li> <li>• Instability of shoulder</li> <li>• Labral lesion of glenoid</li> <li>• Neuralgic Amyotrophy *</li> <li>• Rotator cuff tear</li> <li>• Subacromial impingement syndrome †</li> <li>• Suprascapular nerve compression</li> </ul>	

\* New compared to the CANS-model 2004

† includes rotator cuff syndrome and regional tendinopathy or bursitis

# Very strict diagnostic criteria

**Supplemental table 2.** Specific diagnoses made by the general practitioners in this study

<p><b>Neck-shoulder region:</b></p> <ul style="list-style-type: none"> <li>- Cervical hernia</li> <li>- Frozen shoulder</li> <li>- Subacromial impingement syndrome</li> <li>- Rotator cuff syndrome or tendinosis</li> <li>- Subacromial bursitis</li> </ul>	<p><b>Forearm-wrist region:</b></p> <ul style="list-style-type: none"> <li>- Tendinosis of flexor or extensor muscles of forearm</li> <li>- Carpal tunnel syndrome</li> <li>- Guyon's tunnel syndrome</li> <li>- Ganglion</li> <li>- Quervain's syndrome</li> </ul>
<p><b>Upper arm-elbow region</b></p> <ul style="list-style-type: none"> <li>- Biceps tendinosis</li> <li>- Bursitis elbow</li> <li>- Cubital tunnel syndrome</li> <li>- Lateral epicondylitis</li> <li>- Medial epicondylitis</li> <li>- Osteoarthritis elbow</li> </ul>	<p><b>Hand-finger region:</b></p> <ul style="list-style-type: none"> <li>- Osteoarthritis in hand joints</li> <li>- Peripheral neuropathy due to exposition of hand-arm vibration</li> <li>- Raynaud's phenomenon</li> <li>- Trigger finger</li> </ul>

**Supplemental table 3.** LCGM Model fit indices

Number of classes	Type of model	Variance (intercept / slope) pooled or fixed	Bayesian Information Criterion (BIC)	Likelihood Ratio Test (LRT)	Min-Max posterior Probability	Number of Individuals per class
1	Intercept	Pooled	24389.754	Not available	100	682
		Fixed at zero	26072.129	Not available	100	682
2	Intercept	Pooled	24218.424	<0.0001	89.4 – 97.5	593 / 89
		Fixed at zero	24854.868	0.0005	93.2 – 97.2	536 / 146
	Linear	Pooled	24244.524	<0.0001	89.4 – 97.5	593 / 89
		Fixed at zero	24867.918	0.0005	93.2 – 97.2	536 / 146
	Quadratic	Pooled	24277.149	<0.0001	89.4 – 97.5	593 / 89
		Fixed at zero	24880.968	<0.0001	89.4 – 97.5	593 / 89
	Cubic	Pooled	24316.299	<0.0001	89.4 – 97.5	593 / 89
		Fixed at zero	24894.018	0.0005	93.2 – 97.2	536 / 146
3	Intercept	Pooled <sup>#</sup>	24148.709	0.0038	85.1 – 92.9	454 / 166 / 62
		Fixed at zero	24260.474	<0.0001	90.8 – 94.5	424 / 192 / 66
	Linear	Pooled <sup>#</sup>	24181.334	<0.0001	85.1 – 92.9	454 / 166 / 62
		Fixed at zero	24280.049	<0.0001	90.8 – 94.5	424 / 192 / 66
		<b>Fixed at estimate*<sup>#</sup></b>	<b>23530.967</b>	<b>&lt;0.0001</b>	<b>86.1 – 94.1</b>	<b>461 / 161 / 60</b>
	Quadratic	Pooled	24220.484	0.0038	85.1 – 92.9	454 / 166 / 62
		Fixed at zero	24299.624	0.0000	90.8 – 94.5	424 / 192 / 66
	Cubic	Pooled	24266.159	0.0038	85.1 – 92.9	454 / 166 / 62
		Fixed at zero	24319.199	0.0000	90.8 – 94.5	424 / 192 / 66
	4	Intercept	Pooled	24111.092	0.0168	85.6 – 92.9
Fixed at zero <sup>#</sup>			24139.226	0.0046	88.4 – 95.3	409 / 184 / 64 / 25
Linear		Pooled	24150.242	0.0168	85.6 – 92.9	420 / 179 / 59 / 24
		Fixed at zero <sup>#</sup>	24165.326	0.0046	88.4 – 95.3	409 / 184 / 64 / 25
		Fixed at estimate* <sup>#</sup>	23501.545	0.0206	87.1 – 93.6	428 / 169 / 58 / 27
Quadratic		Pooled	24195.917	0.0168	85.6 – 92.9	420 / 179 / 59 / 24
		Fixed at zero <sup>#</sup>	24191.427	0.0046	88.4 – 95.3	409 / 184 / 64 / 25
Cubic		Pooled	24248.118	0.0168	85.6 – 92.9	420 / 179 / 59 / 24
		Fixed at zero	24217.527	0.0046	88.4 – 95.3	409 / 184 / 64 / 25
5		Intercept	Pooled	24095.926	0.1712	79.2 – 92.2
	Fixed at zero		24089.401	0.0274	79.2 – 92.2	365 / 139 / 101 / 53 / 24
	Linear	Pooled	24141.602	0.1713	79.2 – 92.2	365 / 139 / 101 / 53 / 24
		Fixed at zero	24122.027	0.0274	79.2 – 92.2	365 / 139 / 101 / 53 / 24
	Quadratic	Pooled	24193.802	0.1737	79.2 – 92.2	365 / 139 / 101 / 53 / 24
		Fixed at zero	24154.652	0.0274	79.2 – 92.2	365 / 139 / 101 / 53 / 24
	Cubic	Pooled	24252.527	0.1712	79.2 – 92.2	365 / 139 / 101 / 53 / 24
		Fixed at zero	24187.277	0.0274	79.2 – 92.2	365 / 139 / 101 / 53 / 24

<sup>#</sup> BIC < 24200 and LRT < 0.01; \* Estimate derived from model with same type and number of classes and pooled variance; **Line with final model in bold font**; Regarding the choice between the 3- or 4-class model two criteria are especially relevant, i.e. 'Distinction between the classes and the number of cases per class' and 'The most parsimonious model is preferred in case of very small differences between the criteria for two models and similar possible interpretation of the trajectories'. In the 4-class model the smallest class would contain only 27 cases, so much of the power to detect any prognostic indicators would be lost. The difference between the 3- and 4-class model regarding the BIC and the minimum/maximum posterior probability are very small, so the more parsimonious model is preferred.

**Supplemental table 4.** Workrelated characteristics of the disability trajectories and univariate associations<sup>#</sup>

Variables	Characteristics			OR (95% CI)	
	Disability trajectory: Fast recovery n=382	Modest recovery n=114	Continuous high disability n=38	Modest recovery	Continuous high disability
<b>General and physical work characteristics</b>					
< 5 years in present job, n (%)	115 (30.1)	28 (24.6)	13 (34.2)	0.76 (0.47-1.22)	1.21 (0.60-2.44)
Job insecurity, n (%) <sup>d</sup>	47 (12.4)	12 (10.7)	7 (18.4)	0.85 (0.43-1.66)	1.60 (0.67-3.83)
High physical load, n (%) <sup>a</sup>	195 (51.2)	70 (61.4)	22 (57.9)	1.52 (0.99-2.33)	1.31 (0.67-2.58)
High static repetitive load, n (%) <sup>a</sup>	186 (48.7)	77 (67.5)	29 (76.3)	<b>2.18 (1.40-3.39)</b>	<b>3.38 (1.56-7.33)</b>
Full-time work, n (%) <sup>b</sup>	235 (61.8)	36 (49.1)	19 (50.0)	<b>1.68 (1.10-2.56)</b>	1.62 (0.83-3.16)
Self-perception of work relatedness, n (%) <sup>c</sup>	253 (66.9)	89 (78.1)	32 (84.2)	<b>1.76 (1.08-2.88)</b>	<b>2.64 (1.07-6.47)</b>
Sick leave in 6 months before/at baseline, n (%) <sup>c</sup>	80 (21.1)	31 (27.4)	16 (42.1)	1.41 (0.87-2.29)	<b>2.72 (1.36-5.42)</b>
<b>Psychosocial work characteristics</b>					
Low decision authority < 36.0, n (%) <sup>b</sup>	118 (31.0)	47 (41.6)	10 (26.3)	1.59 (1.03-2.45)	0.80 (0.38-1.69)
High quantitative job demands > 30.0, n (%) <sup>a</sup>	174 (45.7)	56 (49.1)	21 (55.3)	1.15 (0.76-1.75)	1.47 (0.75-2.87)
Low supervisor support < 11, n (%) <sup>f</sup>	166 (45.6)	61 (55.0)	21 (61.8)	1.46 (0.95-2.23)	1.93 (0.94-3.97)
Low co-worker support < 12, n (%) <sup>e</sup>	74 (16.7)	34 (21.5)	11 (19.0)	<b>1.74 (1.08-2.80)</b>	1.73 (0.81-3.68)
High job strain, n (%) <sup>a</sup>	71 (18.6)	33 (28.9)	9 (23.7)	<b>1.78 (1.10-2.87)</b>	1.36 (0.61-2.99)
Low skill discretion < 15.0, n (%) <sup>a</sup>	132 (34.6)	52 (45.6)	13 (34.2)	<b>1.58 (1.04-2.42)</b>	0.98 (0.49-1.98)

<sup>#</sup> Within the working population (n=534);

see Method section for measures that were utilized;

Fast recovery group is reference group for multinomial regression analysis;

Number of missings: <sup>a</sup> 1 missing, <sup>b</sup> 2 missings, <sup>c</sup> 4 missings, <sup>d</sup> 5 missings, <sup>e</sup> 22 missings, <sup>f</sup> 25 missings.

**Supplemental table 5.** Parsimonious model resulting from the multivariate multinomial regression analysis for characteristics of disability trajectories and selection of key factors

Variables	Disability class:	
	Modest recovery OR (95% CI)	Continuous high disability OR (95% CI)
<b>1. Demographical and participation characteristics</b>		
Age (years)	<b>1.06 (1.03-1.08)</b>	<b>1.06 (1.03-1.10)</b>
Female	<b>2.55 (1.59-4.08)</b>	<b>3.50 (1.55-7.92)</b>
<b>2. Complaint characteristics</b>		
High complaint severity previous week	<b>1.15 (1.02-1.29)</b>	<b>1.54 (1.24-1.91)</b>
Duration of the complaint		
0-6 wks	ref.	ref.
6 wks-3 months	1.52 (0.88-2.62)	1.78 (0.65-4.87)
>3 months	<b>3.71 (2.21-6.23)</b>	<b>8.20 (3.54-19.00)</b>
<b>3. Physical characteristics</b>		
Co-morbidity musculoskeletal	<b>2.68 (1.72-4.18)</b>	<b>5.57 (2.38-13.06)</b>
<b>4. Psychosocial characteristics</b>		
Somatization, 4DSQ		
Low	ref.	ref.
Medium	<b>2.20 (1.34-3.61)</b>	<b>4.82 (2.24-10.41)</b>
High	<b>4.62 (1.00-21.26)</b>	<b>33.18 (6.92-159.1)</b>
Kinesiophobia, TAMPA		
Low	ref.	ref.
Medium	1.00 (0.57-1.77)	2.64 (0.99-7.06)
High	<b>2.81 (1.69-4.67)</b>	<b>5.08 (1.97-13.10)</b>
Intercept	-6.48	-11.90

# Explained variance (Nagelkerke R<sup>2</sup>): 0.455;

% Correctly predicted overall: 75.2% (within fast recovery group 91.9%, within modest recovery group 38.8% and within continuous high disability group 42.4%);

see Method section for measures that were utilized; Model without SF-12-MCS because of the high correlation (0.67) with distress score (4DSQ); fast recovery group is reference group for multinomial regression analysis; cut-off points for dichotomous variables are defined by median score of the total population; the variables educational level, paid work, no sports participation, specific diagnosis, recurrent complaints, widespread complaints, history of trauma of arm, neck or shoulder, non-musculoskeletal comorbidity, poor general health (SF-12), low health locus of control, distress (4DSQ), high catastrophizing (CPV) and low social support (SOS) were removed from the model.

**Supplemental table 6.** Comparison of study results regarding prognostic indicators for unfavorable outcome with literature

Prognostic indicators at baseline	This study	This cohort 6/12 m <sup>r</sup>	Karels 6 m <sup>r</sup>	Karels 2 yr <sup>r</sup>	Verhagen 6 m <sup>r</sup>	Vos 1 yr <sup>r</sup>	Review Carroll <sup>*</sup> 6 m – 5 yr	Review McLean <sup>o</sup>	Schellin- gerhout; 6 m <sup>l</sup>	Ryall 1 yr. <sup>£</sup>	Review Kuijpers 6 m–3 yr <sup>h</sup>	Kuijpers/ Reilingh 6 m <sup>r</sup>
	CANS	CANS	CANS	CANS	Neck	Neck	Neck	Neck	Neck	Shoulder- arm-hand	Shoulder	Shoulder
<b>1. Demographic / lifestyle</b>												
Age > 45 years	+	+	•	•	•	•	+/ <sup>*</sup>	+	+	•	•	•
Female gender	+	•	•	+	•	+	+/ <sup>*</sup>		•	- <sup>θ</sup>	•	•
Educational level	+	•	•	+	•				•			•
Unemployment/ No paid work	•	+	•	•	•	•	•	-	-	•		•
High physical load at work	•	•					•			•		•
Sick leave						•						
High Body Mass Index	•	+	•	•								
No sport/low physical exercise	•	•	•	•			•	+				•
Smoking												
<b>2. Complaint characteristics</b>												
Specific diagnosis	•/+ <sup>o</sup>		•	•							- <sup>g</sup>	
Region with most complaints	•	•	•	•		+ <sup>£</sup>				•		
Widespread complaints	+	+						- <sup>g</sup>				
Sudden onset												-
Recurrent complaint	•/+ <sup>o</sup>	+	•	•			+	+	+		+	+
High complaint severity	+	•	+	•	•		+	+/ <sup>*</sup>	•	+	+	+
Longer complaint duration	+	+	+	+	+		+	+	•	+	+	+
GP advice to 'wait and see'												
Prior physio-/manual therapy												•
Injection												

Supplemental table 6. (continued)

Prognostic indicators at baseline	This study	This cohort 6/12 m <sup>r</sup>	Karels 6 m <sup>r</sup>	Karels 2 yr <sup>r</sup>	Verhagen 6 m <sup>r</sup>	Vos 1 yr <sup>r</sup>	Review Carroll <sup>+</sup> 6 m - 5 yr	McLean <sup>o</sup>	Schellingerhout; 6 m <sup>l</sup>	Ryall 1 yr. <sup>£</sup>	Review Kujipers 6 m-3 yr <sup>o</sup>	Kujipers/Reilingh 6 m <sup>r</sup>
	CANS	CANS	CANS	CANS	Neck	Neck	Neck	Neck	Neck	Shoulder-arm-hand	Shoulder	Shoulder
<b>3. Physical characteristics</b>												
Trauma arm/neck/shoulder in past	+	•	•	•			+ <sup>p</sup>		+ <sup>p</sup>		-	
Co-morbidity musculoskeletal	+	+	•	•			+ <sup>z</sup>	+ <sup>z</sup>	+ <sup>z</sup>		+ <sup>s</sup>	+ <sup>z</sup>
Co-morbidity non-musculoskeletal	•	•	•	+	•	+ <sup>p</sup>			+ <sup>n</sup>	• <sup>β</sup>		
Poor general health	+	+					+		+			
High physical limitations	•	•	•	•			+	+/ <sup>•</sup>		•	+	•
Restricted Range of Motion									•		+/ <sup>•</sup>	•
<b>4. Psychosocial characteristics</b>												
Mental limitations baseline	•	•	•	•								
Somatization	+	+	+	+	+							•
Distress	•	•	•	•	-							•
Depression/not being optimistic							+					•
Anxiety												•
Hypochondriasis												+
Passive coping/fear avoidance							+					
Coping using self-assurance							+					
High need to be social							+					
Low health locus of control	•	•	•	•								•
High kinesophobia	+	+	+	+	•							
High catastrophizing	+	+	+	•	+							
Low social support	+	+	•	•	•		+					

**Supplemental table 6.** (continued)

+ positive association with unfavorable outcome

- negative association with unfavorable outcome

• no association with unfavorable outcome

blank: not assessed/described

<sup>†</sup> Patients with new episode of CANS in general practice, main outcome subjective non-recovery, follow-up 6 months<sup>12</sup> and 1 year<sup>13</sup>

<sup>‡</sup> Patients with new episode of CANS in physiotherapy practice, main outcome subjective non-recovery, follow-up 6 months<sup>14</sup>

<sup>§</sup> Patients with new episode of CANS in physiotherapy practice, main outcome subjective non-recovery, follow-up 2 years<sup>15</sup>

<sup>¶</sup> Patients with new episode of neck pain in physiotherapy practice, main outcome subjective non-recovery, follow-up 6 months<sup>16</sup>

<sup>||</sup> Patients with nonspecific neck pain in primary care, main outcome subjective non-recovery<sup>58</sup>

<sup>\*</sup> Patients with neck pain in general population or primary care, outcomes persistent pain/non-recovery, follow-up varying from 6 months to 5 years, 5 cohort studies (4 in general population or primary care, 1 in rehabilitation setting), additional data from 2 RCTs<sup>55</sup>

<sup>ω</sup> Patients with nonspecific neck pain, outcome recurrent, persistent or disabling problems, follow-up 1 year and longer, 9 cohort studies<sup>56</sup>

<sup>||</sup> Data from 3 RCTs in patients with nonspecific neck pain in primary care, main outcome persisting complaints, follow-up 6 months<sup>53</sup>

<sup>£</sup> Patients with pain in shoulder (71%), elbow-forearm (25%) or wrist-hand (18%) in primary care, main outcome continuing pain in 4 weeks before follow-up at 1 year<sup>20</sup>

<sup>ψ</sup> Patients with shoulder disorders, 3 (of 16) studies took place in general population/primary care setting, outcomes persisting pain (2) or disability (1), follow-up varying from 6 months to 3 years<sup>17</sup>

<sup>€</sup> Patients with new episode of shoulder pain in general practice, main outcome persisting pain, follow-up 6 months<sup>18,19</sup>

<sup>∞</sup> Association absent with disability trajectories, but present in multivariate linear regression analysis

<sup>θ</sup> Male gender associated with less favourable outcome

<sup>β</sup> Chronic widespread pain / chronic abdominal pain / chronic fatigue

<sup>∞</sup> Perceived causal relationship

<sup>≠</sup> Concomitant back pain

<sup>§</sup> Concomitant neck pain

<sup>€</sup> Pain in upper part of the neck

<sup>∞</sup> Pain radiating to the back + / accompanying headache –

<sup>∞</sup> Accompanying headache

<sup>∞</sup> Radiation to shoulder/arm

<sup>∞</sup> Acute bursitis





# CHAPTER 9

General discussion





## GENERAL DISCUSSION

### MAIN FINDINGS

In this thesis several studies are brought together that contain information about the course, prognosis and management of the two most prevalent subgroups of MSDs, low back pain (LBP) and neck and upper extremity complaints. Together, these studies provide insight into the possibilities to identify subgroups of patients through the assessment of non-medical criteria, especially within the category of nonspecific complaints. These subgroups might profit from a different approach in treatment or guidance. In the final chapter of this thesis the main findings from these studies are discussed in a broader context.

#### **Main findings from the low back pain studies**

With regard to the part of the thesis studying LBP, the main aims were to describe the proportion of LBP-patients that develop chronic complaints during a follow-up period of 7 years as well as to identify prognostic indicators for this course, and to determine the consequences of LBP in terms of occupational diseases.

The cohort study described in chapter 2 among people with an incident episode of LBP in primary care, concluded that chronic LBP (CLBP), defined as continuous or frequently recurring complaints throughout the follow-up period of 7 years, developed in 28% of the patients. It was estimated that within one year 2.7% of the population of 20-64 years developed an incident episode of CLBP. About 38% of these persons did not have a prior episode of LBP. These patients reported more pain, much higher levels of medical consumption and worse outcome regarding physical and social functioning. Based upon the total size of the population aged 20-64 (according to [statline.cbs.nl](http://statline.cbs.nl) about 10 million people), every year about 270,000 people will suffer from an incident episode of LBP, that will develop into a chronic disorder. Prior episodes of LBP and severity of pain and disabilities were positively associated with chronicity. However, age, gender, education or having paid work were not associated with a higher risk of CLBP. Among the respondents with paid work at baseline, 15% of the patients with non-chronic LBP stopped working during follow-up of 7 years, compared to almost 26% with CLBP. As a result, the labor force participation in 1994 was much lower among patients with CLBP (59.0% versus 68.4%). Subjectively reported frequent stooping at work and difficulty with work performance were positively associated with chronicity (OR 5.9 (95% CI 2.0-17.2) and OR 5.5 (95% CI 2.6-11.5)) respectively. However, frequent walking or standing was associated with a lower risk of CLBP (OR 0.4 (95% CI 0.2-0.9)).

Because this study was conducted in the 1990s, it can be questioned whether the results are still valid for the present time. According to morbidity registers in Dutch general practice ([www.volksgezondheinzorg.info](http://www.volksgezondheinzorg.info)), since 2001 the incidence of LBP has decreased somewhat during the first decade of this century, but increased again to the previous level at the end of this decade. The prevalence of LBP has increased by 21% for men and 35% for women. This is partly due to demographical factors, but mostly to unknown factors. In these figures no clear effect is visible of possibly more frequent application of effective treatments, as a result of evidence based clinical guidelines. In the study cohort, the proportion of patients with a nonspecific diagnosis (86%) is in line with other research (85-90%).<sup>1-3</sup> So, perhaps the total number of LBP-patients will be somewhat higher than in the 1990s, but there is no reason to suppose that the proportion of patients that develops chronic complaints, nor the prognostic factors will have changed to a large extent.

However, the proportion of patients that receives compensation for sickleave or work-disability will be much reduced compared to the 1990s, mostly due to new legislations related to sickleave, return to work and permanent workdisability. The total proportion of employees on sickleave decreased from nearly 7% of all work days in 1990 to about 4% in 2015.<sup>4</sup> In the first decade of this century, the costs associated with workdisability claims due to LBP decreased with at least 30%, mainly due to the implementation of new legislation in 2006.<sup>4</sup> So it can be assumed, that a much lower proportion of respondents with paid work will stop their work due to LBP in the present time. Figures from a register of working conditions, established in 2005, showed that the proportion of workers indicating 'having to use much force frequently' was reduced from about 25% in 2005 to about 20% in 2013 ([www.monitorarbeid.tno.nl/cijfers/nea](http://www.monitorarbeid.tno.nl/cijfers/nea)). The proportions of workers indicating 'frequently working in awkward postures' and 'frequently being exposed to vibration' decreased slightly, from 11% to 10% and 10% to 9% respectively. It is very hard to predict if these limited changes in working conditions are able to influence the workrelated prognostic indicators for CLBP.

In chapter 3 data from the Netherlands Centre for Occupational Diseases (NCOD) were used to study the trends in the number of notifications of occupational diseases (OD) that were attributed to LBP, and to estimate incidence rates of notified ODs due to LBP in different branches of industry. The registration of an OD due to LBP bears upon an instrument that was developed to assess the workrelatedness of nonspecific LBP (NLBP). It provides a practical method for the determination of the contribution of various workrelated factors to the occurrence of nonspecific LBP in an individual worker.<sup>5-7</sup> After implementation of this instrument and the associated registration guideline of the NCOD (2005), a huge increase in numbers of LBP-related OD notifications was noticed, from 0.7% of all notified ODs in 2004, via 8.6% in 2005 and 13.6% in 2008, to 9.1% in

2011. The incidence rate of ODs due to LBP was estimated at 24.1 per 100,000 worker years (19.2 for NLBP), with a large difference between men and women (31.3 and 3.2 respectively). Given a total size of the working population (according to statline.cbs.nl about 7.2 million people), this means about 1,730 cases of OD due to LBP are expected to occur every year.

### **Main findings from the neck and upper extremity studies**

With regard to the part of the thesis with studies about neck and upper extremity complaints, the main aims were to develop a classification system for neck and upper extremity complaints and, subsequently, to develop a multidisciplinary guideline for diagnosis and treatment of nonspecific neck and upper extremity disorders. In addition, the studies used for this guideline were evaluated for prominent patient reported outcome measures within the framework of the International Classification of Functioning, Disability and Health (ICF). The aim of the final study was to describe the course of disabilities in patients with neck and upper extremity complaints and to identify the prognostic indicators associated with higher disability scores.

Chapter 4 describes the development of a new classification system for neck and upper extremity complaints, using a Delphi consensus strategy. After it became clear that most Dutch health care providers were opposed against continuation of the use of the term 'Repetitive Strain Injuries', 47 experts from 11 medical and paramedical professional organizations reached consensus about the definition of CANS as 'musculoskeletal complaints of arm, neck and/or shoulder not caused by acute trauma or by any systemic disease'. In this first CANS-model (2004) 23 specific disorders were distinguished, that were supposed to be well diagnosable. All other complaints that fell under the definition were called nonspecific CANS. In addition, 'alert symptoms' were listed to make clinicians aware of signs or symptoms that can be related to a systemic disease, resulting in exclusion from the model.

Chapter 5 contains a comment on a classification system for workrelated upper extremity conditions, that was published by others shortly after publication of the CANS-model.<sup>8</sup> This system also differentiated specific and nonspecific diagnoses and further classified the specific diagnoses into tendon-related, nerve-related, circulation-related and joint-related disorders and pain syndrome.

Subsequent to the CANS-model, a multidisciplinary guideline for the diagnosis and treatment of nonspecific CANS was developed, according to the principles of evidence based guideline development. The development and contents of the guideline are summarized in chapter 6. This guideline provides recommendations for the diagnosis,

treatment, care and work participation of patients with nonspecific CANS. Within this guideline an update of the CANS model was included, containing 36 specific diagnoses or diagnostic categories. With regard to nonspecific CANS, treatment interventions were identified for which sufficient scientific evidence was available or, failing that, consensus has been reached about the expected effectiveness of the therapy.

In addition, a clinical pathway was developed that focuses on optimal timing of diagnostics and treatment, and on multidisciplinary collaboration. All these elements are supposed to result in an improvement of the diagnostic and therapeutic process, in order to provide patients with CANS with faster, better targeted and most beneficial form of treatment.

Based upon the literature that was selected for the guideline, chapter 7 presents an overview of relevant outcomes regarding functions, activities and participation among patients with CANS, and their association with the ICF. From 123 prognostic and intervention studies the patient reported outcome measures, that were used to describe the disease course or the effectiveness of the interventions, were extracted. Subsequently, the relation to separate ICF-categories was determined, as well as the frequency of attention for these specified ICF-categories in this literature. The results provide insight into the physical, emotional and social challenges that patients with CANS need to adapt to. The most important challenge was pain, which was measured in 93% of the studies; in 22% of the studies it even was the only outcome considered. Participation in work came second (54% of the studies), recreation and leisure activities third (42% of the studies) and sleep functions fourth (39% of the studies). Separate attention was given to mental health measures, because they were only applied in 14.6% of the studies. The most important mental challenge regarded 'emotional impairments', that was measured in 14% of this subset of studies. 'Psychic stability', was addressed in 13% and 'content of thought', 'optimism', 'confidence' and 'energy level' each in 10-11%.

Chapter 8 reports the results of a cohort study in primary care among working age adults with an incident episode of CANS. The course of disabilities was studied during 2-year follow-up, as well as prognostic indicators that were associated with higher levels of disability. Three disability trajectories were differentiated: fast recovery (67.6% of the cohort), modest recovery (23.6% of the cohort) and continuous high disability (8.8% of the cohort). The proportion of patients with DASH scores comparable to the normal population (<11) increased from 44% at 6-month follow-up to 58% at 2-year follow-up. A slightly higher proportion (54-62%) indicated complete recovery or much improvement at all follow-up moments. However, only 43% indicated absence of complaints at 2-year follow-up.

Several demographical, complaint-related, physical and psychosocial characteristics with a predictive value for the high disability and modest recovery trajectories were identified. The most important were age, gender, complaint duration and complaint severity, musculoskeletal comorbidity and the psychosocial indicators somatization and kinesiophobia. These indicators can be identified by screening methods, including information obtained through patient history and administering validated measures, such as the Four-Dimensional Symptom Questionnaire (4-DSQ) and the Tampa-scale.<sup>9,10</sup>

## **COURSE OF NONSPECIFIC MSDS**

LBP and CANS are very common health problems in Western industrialized countries.<sup>1,11-18</sup> Both diagnostic categories contain large subgroups of patients with nonspecific complaints, with no indications for a specific pathophysiology. These subgroups are probably heterogeneous in terms of etiology, clinical characteristics, prognosis, and susceptibility to treatments.<sup>19</sup> This thesis contributes to the knowledge about: 1) the feasibility of differentiating nonspecific complaints and specific disorders; 2) the course of nonspecific LBP and CANS over time and their impact of on health related outcomes and participation; and 3) the estimation of the proportion of patients with chronic disabling complaints.

### **Is it possible to diagnose nonspecific LBP or CANS?**

Internationally there is ample consensus about the differentiation between specific and nonspecific LBP, using red flags to screen for specific disorders, such as herniated disc disease, spondylolisthesis, spinal stenosis, spondylarthritis, infectious disorders, neoplasms or metastases, osteoporosis, congenital disorders or trauma.<sup>1-3</sup> Specific disorders are medically well diagnosable, based upon more or less explicit diagnostic criteria and a recognized or at least hypothesized underlying pathophysiological process.

In contrast, nonspecific conditions are rather ill-defined and characterized by diffuse pain, discomfort, muscle weakness or tenderness and sometimes other symptoms such as movement limitation, stiffness, hyperalgesia, paraesthesia or fatigue. Central sensitization is supposed to play an important role in the persistence of pain in nonspecific as well as some specific conditions.<sup>20,21</sup> It still has to be determined, whether this is a general phenomenon or whether it mainly occurs in individuals with a higher susceptibility, that may be associated with an increased risk for chronicity.

The study cohort of LBP-patients (chapter 2) contained about 86% nonspecific complaints and related GP-diagnoses (such as lumbago, myalgia, discopathy, spondylosis and sciatica).<sup>22</sup> The most frequent specific diagnoses were scoliosis or kyphosis (5.7%),

herniated lumbar disc (5.4%) and spondylolisthesis (0.8%). The proportion of nonspecific complaints in LBP is generally estimated to be as large as 85-90%.<sup>1-3</sup> This includes diagnoses related to abnormalities on imaging. A recent review regarding the high prevalence of imaging features related to spinal degeneration in asymptomatic populations, reconfirmed that it is justified not to base the diagnosis solely on abnormalities seen with radiological techniques.<sup>23</sup> With improving diagnostic techniques, the number of red flags is still expanding.<sup>24-28</sup> However, this reduces the proportion of patients with nonspecific complaints only to a small extent.

The overall proportion of conditions that could be determined as specific in the study cohort of CANS-patients (chapter 8) was estimated at almost 60%, so much higher than in LBP-populations.<sup>29</sup> However, there is ample variation in this proportion between different pain locations, for instance a very low proportion in neck complaints (2.4%) and a much higher in complaints of the elbow (68%).<sup>29,30</sup> The presence of nonspecific complaints has been acknowledged in many attempts to develop classification systems.<sup>8,31-33</sup> Much debate and lack of consensus involved the precise distinction between specific and nonspecific conditions, as well as the list of conditions that could be regarded as specific, for example in- or exclusion of 'pain syndrome', 'thoracic outlet syndrome' or 'repetitive strain injury'. Within the process of updating the CANS-model, the 23 specific diagnostic categories were re-evaluated, and four were no longer included in the revised model. On the other hand, after intensive discussion in the guideline developing group 17 others were added to the list (chapter 6).

The essential distinction between specific conditions and nonspecific complaints is the presence of one or more characteristic signs, symptoms or diagnostic criteria. A specific diagnosis does not rule out an etiology that is comparable to nonspecific complaints. Many specific disorders are related to the same type of overexertion of particular structures, such as tendons, insertions, bursae, nerves or joints. This has raised questions about the justification of a differentiation between those conditions and nonspecific complaints. However, the guideline developing group considered, that with regard to treatment it is much better to know the underlying pathology, in order to target specialized interventions if possible (chapter 6).

Finally, discussions focused on whether or not to develop an exclusive classification system for workrelated complaints, as opposed to involving all CANS (including non-workrelated complaints or complaints in people without work). In the development of the CANS-model and guideline (chapters 4 and 6) it was decided that a classification system, that is exclusive for workrelated conditions, has limited value for clinical practice, since the prevalence of CANS in workers is comparable to non-workers and most CANS complaints and disorders occur in both groups.<sup>17</sup> The updated CANS-model provides

a framework that incorporates a fairly complete list of specific diagnoses, apart from the category of nonspecific complaints. In the multidisciplinary guideline for diagnosis and treatment of nonspecific CANS the physical tests and diagnostic interventions are listed, that are useful to make a particular specific diagnosis. However, still much work is needed to establish the validity and reliability of the diagnostic criteria for each specific diagnosis.

In conclusion, nonspecific LBP or CANS can be diagnosed by systematically excluding specific diagnoses. This differentiation deserves attention, because identification of a specific diagnosis can have a large impact on the prediction of prognosis and choice of treatment. In the absence of established characteristic signs, symptoms or diagnostic criteria for the diagnosis of a specific condition, one should refrain from delusional diagnostic labeling of nonspecific complaints. The CANS-model supports a standardized classification for diagnosis of CANS, which is an important prerequisite for evaluation of prognosis and adequate treatment

### **Is nonspecific LBP or CANS a benign self-limiting or a chronic disabling disorder?**

Acute and subacute nonspecific LBP and CANS are traditionally seen as benign self-limiting disorders. In LBP it is generally assumed that the recovery rate is as high as 80-90% within 6-12 weeks.<sup>11,34</sup> However, in the cohort study of LBP-patients in this thesis the proportion of patients with chronic complaints after 4 and 7 year follow-up was estimated at 44% and 28% respectively (chapter 2). The cohort study of CANS-patients in this thesis also showed a large proportion with an unfavorable outcome over 2 years of follow-up, with 9% of the population following a high disability trajectory and 24% a trajectory with a moderate or fluctuating level of disability (chapter 8). At the study endpoint 43% of this cohort indicated absence of complaints.

Generally, the size of the proportion of patients developing a chronic unfavorable outcome is dependent on the type of outcome (such as severity of pain or disability, sickleave or work-disability), type of population (such as general population, primary care population or workers population), measurement methods (such as frequency of consecutive measurements or applied measures), analysis methods (such as analysis at endpoint or latent class analysis) and duration of follow-up. In addition, the episodic nature of LBP imposes a challenge for the analysis of recovery at the long-term.<sup>35</sup> Until recently, the definition of chronicity of LBP or CANS was 'non-recovery' or 'presence of pain or another unfavorable outcome' at some specific follow-up moment (for instance 1 year or 2 years).

However, at this point two groups of people still report complaints, that is people with continuous complaints throughout the follow-up period, as well as people who recovered initially but suffered from a relapse at the time of follow-up. However, some patients with chronic persisting LBP often indicate one or more painfree days per week, when measured frequently.<sup>36</sup> Patients who are asked about their LBP on a painfree day might be missed, depending on how the question is formulated.

Furthermore, patients with frequent relapses are also missed when they happen to be painfree at the time of investigation. A recent study that applied weekly measurements of LBP by text messaging in primary care LBP-patients during 1 year, showed that a recovery pattern was present in 17-37% of the patients (depending on definition of recovery), and that 4-12% followed a trajectory of constant severe pain.<sup>37</sup> The other patients suffered from more or less frequent relapses and did not become painfree within 1 year.

In conclusion, the disease courses of LBP (including about 10% specific conditions) and CANS (including about 60% of specific conditions) show much resemblance. The initial phase is characterized by recovery in a large proportion of patients. However, many of them suffer from one or more relapses in the following phases. About one in every ten patients follows a course with persistent pain and other unfavorable outcomes. Thus, large subgroups of patients with persisting or relapsing LBP or CANS show more resemblance with long-term chronic conditions such as asthma, rather than self-limiting conditions such as common cold.<sup>38</sup> It is important to shift the focus from seeing an episode of nonspecific LBP or CANS as a single entity, to regarding these conditions as a chain of episodes, with varying course of pain, disabilities and other outcome.<sup>35</sup> This shift of paradigm may result in possibilities to identify clinically meaningful subgroups of patients with particular characteristics that are associated with this course.<sup>38</sup>

### **Is the proportion of patients with chronic nonspecific MSDs underestimated?**

A consequence of identifying a subgroup of patients with nonspecific MSDs, that suffer from either continuous complaints that may fluctuate in intensity, or a chain of episodes with periods free of complaints in between, is that a much larger proportion should be regarded as having a chronic health problem. The two cohort studies in this thesis showed that this subgroup is much larger than previously assumed. In the LBP primary care cohort the size of this subgroup was determined at 28% (chapter 2). In this group a higher number of people stopped working during the 7 years of follow-up than in the non-chronic subgroup. In addition, health care consumption was much higher. In another Dutch study, regarding LBP in the general population, the prevalence of long-standing LBP over a 10 year period was estimated at 20%, with 6% suffering from persistent complaints.<sup>39</sup> Foreign cohort studies showed proportions of non-recovery of LBP

after 1 year ranging from 24-61%.<sup>40</sup> In the study in this thesis, involving the primary care cohort of CANS-patients, the proportion of patients that followed one of the trajectories with persisting disabilities during 2 years was 33% (chapter 8). Another Dutch study regarded several body regions of new primary care episodes of CANS, and reported proportions of patients with poor outcome (<30% improvement) after 1 year follow-up of 49% in case of neck pain, 43% in shoulder pain, 41% in elbow pain and 47% in hand/wrist pain.<sup>41</sup> A Dutch primary care study of patients with a new episode of neck pain, revealed that 24% did not report full recovery or much improvement after 1 year and 47% still experienced neck pain.<sup>42</sup> This is in line with the results of a review regarding the course of neck pain, reporting that 1 to 5 years after an initial episode, 50-75% will still report neck pain.<sup>43</sup>

In conclusion, the subgroups of patients with chronic LBP or CANS are relatively large (25-50% after 1 year and 20-35% after multiple years) and much larger than previously reported in guidelines. This has important consequences for work participation and health care consumption. Comparison of data from various cohorts is difficult, due to differences in type of populations, outcomes measured and duration of follow-up.

## **DIFFERENTIATING PATIENTS WITH NONSPECIFIC MSDS BASED ON WORKRELATED FACTORS OR PROGNOSTIC INDICATORS**

The diagnostic entity nonspecific LBP or CANS probably contains a large subgroup of patients, that is heterogeneous in terms of etiology, location of complaints, clinical and psychosocial characteristics, and susceptibility to treatments. Etiological research has shown that a number of workrelated risk factors enhance the probability of occurrence of nonspecific LBP or CANS.<sup>5,44</sup> Prognostic research has shown that also many non-workrelated indicators are related to better or worse outcome.<sup>45,46</sup>

However, the strength of these relationships vary to a large extent depending on the study population and methods, including choice of outcomes and measures, duration of follow-up and analysis techniques.<sup>45,46</sup> Because a specific diagnosis is not possible in patients with nonspecific MSDs, it might be an option to place prognosis in the center of clinical thinking and decision making.<sup>47</sup> For patients with long-term complaints, a model framed by prognosis would integrate etiologic, diagnostic and treatment information and place evidence about the probability of future outcomes at the forefront.<sup>47</sup> In such a model it seems worthwhile to identify subgroups of patients, that share a common etiological or prognostic indicators. Priority should be given to prognostic indicators that are amenable to change by interventions that already are available, or that can be developed with this particular targeted indicator in mind. This thesis contributes to three

key points in that respect: 1) validity of the identification method regarding a subgroup of LBP-patients that can be defined as occupational disease (OD); 2) identification of prognostic indicators in patients with LBP; and 3) identification of prognostic indicators in patients with CANS and differences compared to patients with LBP.

### **How valid is it to identify a subgroup of LBP-patients as having an occupational disease?**

The instrument for the assessment of the workrelatedness of nonspecific LBP and the associated OD registration guideline has satisfied a need in Dutch occupational health-care to distinguish those work environments, that possess a combination of risk factors that result in such high physical load, whereby the combined attribution of the LBP of an individual worker to the physical load will exceed 50%. In this particular situation it is assumed that the LBP is caused by the physical load at work (chapter 3). In Europe, this system of notification of LBP as OD is quite unique, considering that in less than half of European countries LBP can be recognized as OD, and that no other country applies such an objective assessment method, including all important workrelated risk factors.<sup>48</sup> In the development of the instrument for the assessment of the workrelatedness of nonspecific LBP there has been ample discussion about the cut-off of 50%. In case of a lower cut-off point, the criteria of Dutch law would not be met, given the definition that an OD is 'a disease or complaint mainly due to risk factors occurring at work or in a work environment'.<sup>49</sup> However, this cut-off is linked to a very high physical load and should not be used as a minimum to implement ergonomic interventions. In workers with LBP and a score above 30% or very high exposure to one of the workrelated risk factors, a workplace intervention can be important to prevent sickleave or to initiate and support a sustainable return to work (RTW).

In case of substantial exceeding of the exposure limit of one particular risk factor, the LBP can also be regarded as OD.<sup>6,7</sup> In the instrument and the registration guideline this is operationalized for manual materials handling with a NIOSH score  $\geq 2$  and for whole body vibration with the excess criteria of the Directive of European Parliament and Council (2002).

The decision model that is applied in the instrument is based upon research performed in workers populations and – except for age – does not take into account individual characteristics, such as prior episodes (perhaps before the present working environment), female gender, physical constitution and condition, lack of exercise, overweight or obesity, smoking, genetic factors and other non-workrelated risk factors.<sup>1,50</sup> When such risk factors are clearly present, they should be taken into account as well, so that the focus of intervention is not only directed towards the workrelated risk factors. On the other hand, the research of workrelated factors has often taken place in highly

exposed workers populations, in which many workers that are susceptible for physical overload are already underrepresented, due to a healthy worker effect. This might lead to an underestimation of the effect of workrelated physical load on the average worker.

The number of LBP-patients that is notified in the NCOD-register is much lower than the actual number of LBP-patients in the Dutch workforce that is expected to have an OD (chapter 2). It was noticed that in the special group of occupational physicians that participated in a three year dynamic cohort study, the number of registered ODs due to LBP was more than twice as high compared to the usual registration. Thus, probably there is much under-reporting of ODs.

Only 16% of all notified ODs are registered among female workers. In case of ODs due to NLBP this proportion is only 4%. This lower number of notified ODs among female workers cannot be explained by a lower incidence of LBP, because most Dutch epidemiological studies show a slightly higher incidence and prevalence among women.<sup>17,18,22</sup> However, these are estimates at general population level. In several studies in workers populations, men seemed to have a slightly higher risk of LBP (ratio male to female workers 1.5), given comparable exposure to lifting.<sup>51,52</sup> This might be a coincidental finding, since this phenomenon was not observed for other exposures, such as awkward postures, heavy physical work and whole body vibration. Furthermore, there was no gender difference in risk of sickness absence due to LBP, given comparable exposure to lifting.<sup>52</sup> Looking at the disability pension statistics of 2010 and 2011 (the same period as the study in chapter 3), the ratio of male to female workers with a MSD diagnosis was about 1.18 (statline.cbs.nl; LBP is related to about 54% of these disability pensions)<sup>53</sup> This difference is too small to explain the difference in incidence of ODs due to LBP between men and women. In a NCOD-report the reason for the low number of female cases is attributed to the relatively high number of notifications in the economic sector 'Construction', in which only few female workers are present, due to implementation of a systematic registration procedure for ODs.<sup>54</sup> Indeed, 39% of notifications of ODs due to NLBP occurred in this sector, as part of 70% of all OD-notifications. This much higher number of male workers with severe health problems in this sector, due to the relative absence of female workers, can also be observed in the disability pension statistics, in which the ratio of male to female cases in 2010/2011 was 27.7 (statline.cbs.nl). So, underrepresentation of other sectors than 'Construction' may also explain a part of the gender difference in OD due to LBP. Still, a general trend also seems to be present towards less reporting of ODs among female workers, because in the NCOD-register of 2009-2011 84% of all OD-cases were male and of OD-cases due to NLBP 96%. This explanation is supported by the fact that the OD incidence rate in the sector 'Healthcare', with a high proportion of female workers, was low. This is in contrast with ample evidence regarding

workrelated risk factors for NLBP in this sector.<sup>55</sup> In addition, a considerable number of disability pensions (14% of total) originated from this sector in 2010/2011, with a ratio of female to male workers of 6.4.

In conclusion, the implementation of the instrument for assessment of workrelatedness of nonspecific LBP and the associated OD registration guideline has resulted in the notification of a considerable number of LBP-related ODs. However, accurate registration of ODs among male and female workers in all economic sectors should take place to gain insight in the total number of LBP-related ODs. Since workrelated factors have also been identified as prognostic indicators, preventive measures should already be implemented at lower levels of physical load than required for recognition as OD.<sup>45,56</sup>

### **Which prognostic indicators for patients with LBP have been identified?**

Subsequent to the introduction of the biopsychosocial model for the etiology and prognosis of LBP 25 years ago, many prognostic indicators have been identified in various contexts and populations. Since the introduction of the concept of 'yellow flags' in 1997 for psychosocial factors, in the last 15 years this type of indicator has been addressed increasingly.<sup>57,58</sup> In addition, workrelated factors have received much attention, especially in workers populations.<sup>56</sup> In the cohort study of LBP-patients in this thesis, it was concluded that prior LBP-episodes and severity of pain and disabilities were associated with chronicity, but age, gender, education or having paid work were not. In the subgroup of working LBP-patients frequent stooping at work and difficulty with work performance were predictive for chronicity, in contrast to a protective effect of frequent walking or standing (chapter 2).

In numerous reviews (n>20) a considerable number of prognostic indicators for various outcomes in patients with (sub)acute LBP are presented, including (non-)recovery, pain intensity, chronic disabling pain, disabilities, RTW, work disability and insurance claim for sickleave or workdisability.<sup>59-61</sup> A review of reviews summarized the following prognostic factors that were consistently reported in 6 (out of 18) reviews with sufficiently comparable research questions and methods:<sup>61</sup>

- older age;
- poor general health;
- increased psychological or psychosocial stress;
- poor relations with colleagues;
- physically heavy work;
- high level of disabilities;
- leg pain (sciatica);
- presence of compensation.

A quantitative meta-analysis over 20 original studies with sufficient quantitative data, yielded as most important prognostic indicators:<sup>45</sup>

- high level of disabilities;
- presence of non-organic signs (Waddle);
- poor general health;
- high level of fear avoidance;
- psychiatric comorbidity.

Prognostic indicators with somewhat less predictive value were:

- high pain intensity;
- leg pain;
- high physical work demands;
- work dissatisfaction.

In contrast to the other review of reviews it was concluded that the indicators older age and presence of compensation did not have sufficient predictive value for a poorer prognosis.

In conclusion, a number of prognostic indicators of the cohort study in this thesis were confirmed by some reviews, but not by others. Overall, the most consistently reported prognostic indicators are:

- high level of disabilities;
- leg pain (sciatica);
- poor general health;
- presence of non-organic signs;
- increased psychological or psychosocial stress, including high level of fear avoidance;
- psychiatric comorbidity;
- high physical work demands;
- poor relations with colleagues.

In addition, the prognostic indicators high pain intensity and work dissatisfaction are reported frequently, but somewhat less consistent, while no consistent evidence is present for older age, female gender, higher psychological work demands and presence of compensation.

### **Do the prognostic indicators for disability in patients with CANS differ from patients with LBP?**

In general, research regarding CANS lags some 20 years behind that of NLBP. The evidence for prognostic indicators with regard to various outcomes in CANS-patients is still scarce. A recent review found only 5 studies that analyzed CANS as one group (including

the short term results of the study in chapter 8), next to 15 cohorts of patients with a separate location in the neck or upper extremity region.<sup>46</sup> Two of the 5 studies took place in primary care, one in specialist care and two others in workers populations. Analyses included all studies together, and identified as prognostic indicators for non-recovery at short term follow-up (<6 months):<sup>46</sup>

- longer complaint duration;
- higher symptom severity;
- higher level of disabilities;
- use of passive coping styles (distraction, retreating);
- accident as perceived cause.

These indicators are also reported in LBP-research, except for 'accident as perceived cause', which seems rather specific for CANS. At long-term follow-up ( $\geq 6$  months), only longer complaint duration was predictive for non-recovery. This is also in accordance with some LBP-studies.

The CANS cohort study in chapter 8 regarded disability trajectories during 2 years of follow-up, whereas most other studies of patients with NLBP, arm pain, neck pain, or shoulder pain have applied a single endpoint of recovery after a specific follow-up period (generally between 6 months and 5 years). In contrast to many other studies, the explained variance of the multivariate model in this study was considerable ( $r^2=0.54$ ). Many prognostic indicators were revealed, some of which showed a strong association with one or both trajectories of higher disability.

A higher level of somatization was the most important predictor of continuous high disability. In addition, low social support was associated with both disability trajectories. These findings are remarkable, because these particular psychosocial indicators do not seem to play an important role in LBP until now. This may be due to lack of attention for these indicators in most LBP studies.<sup>62</sup> It is also possible that these factors have a predictive value in CANS-patients, but not in LBP-patients. The review of prognostic studies in CANS found inconclusive evidence for the predictive value of somatization for non-recovery as outcome, and strong evidence for a lack of association between social support and disability.<sup>46</sup>

A specific diagnosis was not associated with higher disability in the study in this thesis. This may be due to the fact that many specific diagnoses in the neck and upper extremity region share their etiology with nonspecific complaints, such as overexertion of tendons, insertions, bursae, nerves or joints. Apparently, the course of disabilities in patients with these disorders did not deviate much from that of patients with nonspecific complaints. However, in the review of prognostic studies in CANS, limited evidence was found for an

association between specific diagnosis and disability.<sup>46</sup> It cannot yet be excluded that some specific disorders may have a different course and other prognostic indicators, that can only be revealed if the subgroup of patients with this disorder within the study population is large enough.

In accordance with research in LBP, kinesophobia, catastrophizing, complaint duration, complaint severity, widespread complaints (corresponds with leg pain in LBP) and poor general health were revealed as prognostic indicators for disability in the CANS-cohort. In contrast to LBP-research, also older age, female gender, educational level and musculoskeletal comorbidity were associated with higher disability. These differences can be the result of differences in study populations, outcomes included and analyses methods. Further research of prognostic indicators in CANS-patients is necessary to confirm the similarities and differences regarding prognostic indicators in CANS and LBP.

In conclusion, many prognostic indicators for disability that were revealed in the CANS cohort study were also found in LBP-research:

- kinesophobia;
- catastrophizing;
- complaint duration;
- complaint severity;
- widespread complaints;
- poor general health.

Some prognostic indicators for outcome in CANS-patients were not found prominently in LBP-research:

- somatization;
- low social support;
- musculoskeletal comorbidity;
- older age;
- female gender
- educational level.

It seems clear that the role of psychosocial indicators in CANS-patients is as large as in LBP-patients, or even larger. In addition, complaint related indicators seem to be more important.

## **CLINICAL MANAGEMENT OF NONSPECIFIC MSDS**

For the clinical management of LBP already many national and international guidelines are available.<sup>63</sup> Apart from exercise therapy, that has proven to be beneficial for the majority of both specific and nonspecific disorders, the evidence supporting the effectiveness of many treatment options for nonspecific LBP and CANS is limited.<sup>63-68</sup> This may in part be due to the fact that many interventions are not targeted to subgroups of patients that might benefit most, because there is insufficient knowledge on how to identify such subgroups. Furthermore, often particular impairments, disabilities or other health aspects are addressed in an intervention, while other aspects, that may hamper recovery to a large extent, are ignored. An example is the sole provision of a clinical intervention, while ignoring workrelated factors such as high physical work demands, or psychosocial factors such as somatization. This raises the following questions regarding the clinical management of patients with nonspecific MSDs: 1) Which prognostic factors are to be addressed; and 2) What kind of approach regarding the choice of interventions is needed.

The CANS-model and the multidisciplinary guideline for diagnosis and treatment of nonspecific CANS, that are described in this thesis, are meant to provide guidance for optimal management of this patient group (chapter 4-6). Their implementation has not been subject of research in this thesis, but from observations of clinical practice an impression can arise about their application in various settings of healthcare.

### **Which prognostic factors are to be addressed?**

Healthcare professionals are challenged to apply strategies, that provide minimal, but sufficiently effective treatment – without referral or further diagnostic investigation – to the majority of patients with low risk of an unfavorable outcome, as opposed to more intensive or additional interventions to patients with moderate or high risk.<sup>47</sup> After exclusion of specific disorders, the attention of the healthcare provider in patients with nonspecific MSDs needs to shift from diagnosis towards appraisal of the prognostic indicators for unfavorable long-term outcomes, such as non-recovery, persistence of complaints, chronic disabilities or work loss. The cohort studies in this thesis have contributed to the body of knowledge about such prognostic indicators (chapters 2 and 8). Some of these are characteristic for a particular location of complaints. Others are related to general life style and ability to maintain a good health. In studies regarding chronic disabling pain as outcome, prognostic factors such as general fitness, poor general health, low educational level, older age, co-morbidity, psychological predisposition and inadequate coping styles have been identified.<sup>69</sup> They are assumed to contribute to a pre-existing vulnerability for future chronic disabling pain, and appear to be shared across a variety of common pain phenotypes. Accumulation of symptom experience

over time, by frequent pain episodes, high pain intensity, pain at multiple sites, and other somatic symptoms, such as fatigue, may also contribute to this vulnerability.<sup>69</sup>

The next step is to weigh the relative importance of each indicator, to be able to incorporate this information in the clinical decision making process. Especially the indicators that might be amenable to change are important to identify, provided that their relative importance is large enough and effective interventions can be applied or developed. Clinical decision support (CDS) tools, such as clinical prediction rules, classification systems, treatment algorithms and care pathways or clinical pathways, can support the choice for optimal treatment by identifying subgroups of patients with worse prognosis or better chance to benefit from an intervention. A recent review found 52 articles describing prediction rules or classification systems for LBP-patients and 18 for patients with neck pain.<sup>70</sup> However, only few were externally validated and it was concluded that the evidence-based support for CDS tools is still preliminary and lacks evidence of generalizability across different populations and settings. So at this moment this hampers the provision of interventions tailored to the expected prognosis of LBP.

For patients with nonspecific CANS a clinical identification method for prognostic indicators still needs to be developed. Based upon the results of the CANS cohort study in this thesis (chapter 8), a CDS including somatization, kinesiophobia, and catastrophizing could be developed in order to identify patients at risk for chronic disabilities and susceptible for a psychological intervention or psychologically informed physiotherapy. In the clinical pathway that was incorporated in the guideline for diagnosis and treatment of nonspecific CANS, these treatment options were already indicated (chapter 6). However, it was necessary to mention that at the time of development of the guideline the evidence to support the need for such an intervention, as well as effective treatment protocols were lacking.

In conclusion, the prognostic factors that are most useful to address in (additional) interventions in nonspecific MSDs are not fully established yet. Further prognostic research is necessary, especially in CANS. It seems worthwhile to improve available identification tools for prognostic indicators in LBP, and develop such tools for CANS. These tools should be able to make an accurate differentiation in clinically meaningful subgroups of patients, that are susceptible to psychological, physical or ergonomic interventions. For these subgroups, improvement of available treatment protocols or development of new interventions will be necessary.

### **What kind of approach regarding the choice of interventions is needed?**

In order to minimize the number of patients with nonspecific MSDs progressing to a chronic condition, appropriate medical treatment in (sub-)acute stages should be tar-

geted to patient groups with a high risk of an unfavorable outcome. In stratified care initial treatment choices can be based on the presence of prognostic indicators. In this approach, attempts are made to identify clinically relevant subgroups that need specific or more intensive treatment. This is different from a stepped care approach, in which more intensive or additional therapies are provided only when a previously provided therapy has failed. A stratified care approach is preferred, with regard to timely delivery of optimal treatment.

An interesting example of stratified care was a recent clinical trial in the UK in patients with nonspecific LBP, wherein an identification method for psychosocial prognostic indicators (STarT Back) was used to identify patients at high risk for persistent disability.<sup>59-61</sup> For these patients, psychologically informed physical therapy was provided and compared to usual management by physiotherapists. This study has shown promising and cost-effective results, but the effects were still small and 38% of patients in the intervention group still had not recovered after 12 months of follow-up. A further implementation trial confirmed the moderate results of the study.<sup>74</sup> Reasons for the limited effectiveness could be that:

- a) the screening tool was not sensitive enough to identify and differentiate the various types of psychological impairments associated with LBP (in that case a tailored intervention is less feasible);
- b) there was only one type of intervention addressing psychosocial problems, but it is possible that the required content of such an intervention differs between psychosocial indicators. Previously most LBP-related research in this field has focused on information strategies to influence pain beliefs (with poor results) and cognitive behavioral therapy targeted at improvement of coping skills (with very low quality evidence of moderate effectiveness for pain, function, quality of life, work issues and healthcare use);<sup>75</sup>
- c) there was no attention for workrelated factors, despite the body of knowledge that supports a relationship between the workplace and the occurrence of LBP.<sup>76,77</sup> In this respect, application of the instrument for assessment of the workrelatedness of nonspecific LBP would be an option (chapter 3);
- d) the 'psychologically informed' physiotherapists may not have been optimally prepared for this task, because they only received a few weeks of additional training about interventions to address the psychological factors. In general, regarding a psychological or psychologically informed intervention, questions remain in relation to issues such as timing, necessary skills, optimal treatment protocols, and context.<sup>78</sup> In the Netherlands, the added value of targeted psychosomatic physiotherapy could be studied, since these type of physiotherapists have two years of extra training in the identification and treatment of psychological problems.

If several prognostic indicators are present, it is unlikely that any intervention focusing on a single factor would fit the needs of most patients. Thus, in addition to interventions targeting psychosocial indicators, the presence of physical, complaint-related or workrelated factors might also require additional or more intensive interventions. With regard to workrelated factors, a recent review showed that workplace interventions among sicklisted workers with MSDs reduced the time to first and to lasting RTW more than usual care; also pain improved, as well as functional status.<sup>79</sup> Also in CANS-patients the identification of workrelated factors can be important, considering the promising results of a recent trial in Turkey that combined a targeted ergonomic intervention with exercise therapy.<sup>80</sup> In the Netherlands a tool for identification of workrelated risk factors for CANS has been developed, however its application did not result in cost-effective results yet.<sup>81,82</sup>

The simultaneous provision of multiple interventions, targeting determinants from several fields (biomechanical, psychosocial, and occupational), is called integrated care.<sup>75</sup> This can be provided as a multidisciplinary treatment program, in which professionals from various disciplines collaborate as a team to achieve common treatment goals. An example is a multidisciplinary rehabilitation intervention. Integrated care can also consist of coordinated interventions by different clinical or occupational health-care professionals. For example, exercise therapy by a physiotherapist, combined with cognitive behavioral therapy by a psychologist and an ergonomic work intervention by an occupational health professional. Dependent on the type of intervention, communication between these care providers is more or less necessary. Thus, the challenge to optimize available treatments and clinical pathways and to develop new treatments or combinations of treatments is substantial.

In conclusion, at this moment psychosocial and workrelated prognostic indicators are disregarded in the management of many patients with nonspecific MSDs, because evidence is too scarce about which indicators can be targeted by interventions that are available or may be developed. As a consequence, chances to improve the results of treatment of these patients might be missed. In LBP-patients the implementation of an identification tool for psychosocial indicators was promising, but the tool as well as the tailored interventions need further improvement. The effectiveness of interventions for patients with LBP and CANS may be enhanced by also addressing non-psychosocial indicators, as well as workrelated factors that may obstruct recovery. More research is needed to improve protocols for stratified and integrated care and to study their effectiveness. In the absence of this evidence, in clinical practice it seems worthwhile to try to identify clinically relevant prognostic indicators and take them in consideration in the decisions about treatment.

### **Observations regarding the application of the CANS-model and CANS-guideline in practice**

The CANS-model has clearly satisfied a need among Dutch health care providers to replace the term 'Repetitive Strain Injuries' with a term that causes less confusion and debate (chapter 4). Furthermore, occupational and insurance physicians and occupational physiotherapists supported the use of the terminology of the CANS-model. In addition to the English publication in 2007, nine articles in Dutch language were published in 2007 and 2008 for most professional groups involved. Since then the CANS-model seems to have been applied frequently in the professional groups of physiotherapists, occupational therapists and rehabilitation physicians. However, often the term CANS is mentioned along with 'RSI', probably to indicate the connection and to prevent missing referrals of patients from colleagues who prefer the term RSI.

General practitioners, orthopedic surgeons and rheumatologists acknowledged the content of the CANS-model, but seem to prefer terminology that is linked to the location of the complaints and, if possible, the specific diagnosis. Within the broader framework of the CANS-model, there is no objection to this approach. Two professional groups (physiotherapists and occupational physicians) developed a monodisciplinary guideline that uses the diagnostic framework of the CANS-model.<sup>83,84</sup> The professional organization of neurologists seems to renounce the use of the CANS-model and did not want to invest time in the development of the multidisciplinary guideline, but it is not clear which diagnostic framework they prefer instead. Among occupational health professionals within trade and industry the CANS-model has settled to a lesser extent and, with the exception of occupational physicians, many professionals still seem to prefer the term RSI.

The goal that was set before development of the CANS-model, to increase accurate and meaningful communication among healthcare workers, appears to have been met to a large extent. Furthermore, also a few results are visible regarding the second goal, to influence the definition of musculoskeletal neck and upper extremity complaints in scientific research, so that eventually results can be compared. Several research publications have appeared from Dutch research groups, that use the CANS-model as diagnostic framework.<sup>85,86</sup>

Internationally, the CANS-model or discussion about alternative models has received only modest attention. Although the initial publication of the CANS-model has been cited in international publications over 80 times, about half of which by foreign researchers, until now a discussion towards international consensus is missing. An attempt to start such a discussion was made in a reaction to an article from New Zealand, that proposed

an alternative classification system for the subgroup of workrelated upper extremity complaints (chapter 5). However, the discussion of this concept seems to have been limited to that.

In 2012 the multidisciplinary guideline for diagnosis and treatment of nonspecific CANS was published, which included an update of the list of specific diagnoses and diagnostic categories within the CANS-model (chapter 6). Implementation of the guideline is now ongoing, but could benefit from more promotional and educational activities. The guideline embraces the updated CANS-model as a necessary diagnostic framework to distinguish specific from nonspecific complaints, and applies an evidence based approach for the selection of diagnostic methods and interventions, that corroborate the recommendations.

With regard to the management of nonspecific CANS, the guideline bears upon a biopsychosocial approach, that aims at helping people to return to normal productive activity as soon as possible, considering that both treatment of symptoms, including psychological dysfunction, as well as interventions targeting workrelated problems may be necessary.

For this purpose stratified care, stepped care as well as integrated care are recommended at particular phases in the clinical pathway. A stratified care approach is applied, indicating different or additional interventions when workrelated problems of psychosocial factors are identified. In addition, a stepped care approach is recommended when monodisciplinary interventions have failed to be effective, in which case a multidisciplinary intervention is advised. In the clinical pathway a structure for integrated care is described, that incorporates attention for workrelated and psychosocial factors from the start of the episode. Many recommendations in the guideline need further substantiation by scientific research, because evidence regarding effectiveness of interventions was scarce.

To date, it is not known to what extent the CANS guideline is used in clinical practice, nor what the added value is in terms of substitution of unnecessary referrals to secondary care and more frequent application of effective interventions in primary and occupational health care. Implementation efforts were limited due to budget restrictions and should be enhanced, to provide primary and occupational health care providers with the necessary skills, resources, support and feedback and to support their collaboration. Because of lack of evidence at the time of development, the guideline should be updated regularly, to keep up with research results in this field.

## RECOMMENDATIONS FOR CLINICAL PRACTICE

1. When a working individual consults an occupational physician for NLBP, an assessment should be made of the contribution of workrelated factors to the development of the LBP, using the instrument for the assessment of the workrelatedness of nonspecific LBP. In case of a higher score (for example >30% probability that workrelated factors can be attributed as cause of the LBP) the possibilities to reduce the physical workload must be evaluated and addressed by appropriate interventions. Improvement of the notification system, in which the work organization as well as the occupational physician share a responsibility, is necessary to gain insight into the true magnitude of ODs due to LBP (and other disorders) among male as well as female workers and to monitor the success of primary and secondary preventive interventions in terms of incidence of ODs.
2. After exclusion of specific disorders in patients with LBP or CANS, the attention of the healthcare provider needs to shift from diagnosis towards appraisal of the prognostic indicators for unfavorable long-term outcomes, such as non-recovery, persistence of complaints, chronic disabilities or workdisability. In the absence of sufficient evidence for stratified or integrated care interventions, the health care providers should consider interventions that are developed to target particular prognostic indicators.
3. The CANS-guideline, including the updated CANS-model, needs to be implemented in clinical practice in order to improve clinical management of CANS and to foster collaboration between all regular and occupational healthcare providers involved.
4. In patients with a new episode of CANS, already in early stages psychosocial factors play an important role in the development of long-term disabilities. Thus, it seems worthwhile to evaluate these factors through validated questionnaires shortly after first consultation and to recommend additional interventions by psychologically trained professionals when indicated.

## RECOMMENDATIONS FOR FUTURE RESEARCH

1. The evidence for time-dependent prognostic indicators in patients with CANS or LBP is still scarce. A number of prognostic factors in LBP or CANS may be specific for particular stages or for particular outcomes. Thus, more research is needed to identify the most relevant prognostic indicators that are associated with various outcomes over time. The exploration of clinically relevant subgroups based on trajectories needs further attention, preferably using repeated measurements over extended periods of time. Based upon such prognostic studies, a structured development of clinical decision tools that incorporate the most relevant prognostic indicators is urgently needed.
2. The development and evaluation of tailored interventions in patients with nonspecific LBP and CANS deserves high priority. Stratified care, that is based upon accurate differentiation of subgroups and tailored interventions, is very promising to improve the results of treatment of these large patient groups. Research should be directed towards effective interventions to reduce the length and intensity of episodes, to prevent relapses and to identify suitable methods to lessen the impact of persistent problems.
3. Ten years after the development of the instrument for the assessment of workrelatedness of nonspecific LBP, a thorough revision is necessary in order to incorporate new insights into the role of workrelated factors in the development of LBP.
4. Knowledge about the added value of the multidisciplinary guideline for diagnosis and treatment of nonspecific CANS, in terms of more frequent and timely application of effective interventions in primary and occupational care and prevention of unnecessary referrals to secondary care, is important to enhance the implementation.

**REFERENCES**

1. Krismer M, van Tulder M. Strategies for prevention and management of musculoskeletal conditions. Low back pain (non-specific). *Best Pract Res Clin Rheumatol*. 2007;21(1):77–91.
2. Deyo RA, Weinstein JN. Low back pain. *N Engl J Med*. 2001;344(5):363–70.
3. Deyo RA. Diagnostic evaluation of LBP: reaching a specific diagnosis is often impossible. *Arch Intern Med*. 2002;162(13):1444–7.
4. Versantvoort M, Van Echtelt P. Belemmerd aan het werk Trendrapportage ziekteverzuim, arbeidsongeschiktheid en arbeidsdeelname personen met gezondheidsbeperkingen. The Hague: Sociaal en Cultureel Planbureau; 2012. Report No.: 2012-17. Available from: [www.scp.nl/dsresource?objectid=32694&type=org](http://www.scp.nl/dsresource?objectid=32694&type=org)
5. Lötters F, Burdorf A, Kuiper J, Miedema H. Model for the work-relatedness of low-back pain. *Scand J Work Environ Health*. 2003;29(6):431–40.
6. Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijjer PPFM, Spreeuwiers D, Lötters F, Miedema HS. Criteria for determining the workrelatedness of nonspecific low-back pain. Amsterdam: Coronel Institute of Occupational Health, AMC; 2004. Available from: <http://www.occupationaldiseases.nl/content/criteria-nonspecific-low-back-pain-published>
7. Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijjer PPFM, Spreeuwiers D, Lötters F, Miedema HS. Assessing the work-relatedness of nonspecific low-back pain. *Scand J Work Environ Health*. 2005; 31(3):237–43.
8. Boocock MG, Collier JMK, McNair PJ, Simmonds M, Larmer PJ, Armstrong B. A framework for the classification and diagnosis of work-related upper extremity conditions: systematic review. *Semin Arthritis Rheum*. 2009;38(4):296–311.
9. Terluin B, van Marwijk HWJ, Ader HJ, de Vet HCW, Penninx BWJH, Hermens MLM, Van Boeijen CA, Van Balkom AJLM, Van der Klink JJJ, Stalman WAB. The Four-Dimensional Symptom Questionnaire (4DSQ): a validation study of a multidimensional self-report questionnaire to assess distress, depression, anxiety and somatization. *BMC Psychiatry*. 2006;6(34).
10. Goubert L, Crombez G, Van Damme S, Vlaeyen JWS, Bijttebier P, Roelofs J. Confirmatory factor analysis of the Tampa Scale for Kinesiophobia: invariant two-factor model across low back pain patients and fibromyalgia patients. *Clin J Pain*. 2004;20(2):103–10.
11. Andersson GB. Epidemiological features of chronic low-back pain. *Lancet*. 1999;354(9178):581–5.
12. Hoy D, March L, Brooks P, Blyth F, Woolf A, Bain C, Williams G, Smith E, Vos T, Barendregt J, Murray C, Burstein R, Buchbinder R. The global burden of low back pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis*. 2014;73(6):968–74.
13. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, Woolf A, Vos T, Buchbinder R. A systematic review of the global prevalence of low back pain. *Arthritis Rheum*. 2012;64(6):2028–37.
14. Hoy D, Brooks P, Blyth F, Buchbinder R. The Epidemiology of low back pain. *Best Pract Res Clin Rheumatol*. 2010;24(6):769–81.
15. Van Tulder M, Koes B, Bombardier C. Low back pain. *Best Pract Res Clin Rheumatol*. 2002;16(5): 761–75.
16. Global Burden of Disease Study 2013 Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries. *Lancet*. 2015;386(9995):743–800.

17. Picavet H, Van Gils, HWV, Schouten, JSAG. Klachten van het bewegingsapparaat in de Nederlandse bevolking, prevalenties, consequenties en risicogroepen. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu; 2000. Report No.: 266807002. Available from: <http://www.rivm.nl/bibliotheek/rapporten/266807002.pdf>
18. Picavet HSJ, Schouten JSAG. Musculoskeletal pain in the Netherlands: prevalences, consequences and risk groups, the DMC(3)-study. *Pain*. 2003;102(1-2):167–78.
19. Koes B. Management of low back pain in primary care: a new approach. *Lancet*. 2011;378(9802):1530–2.
20. Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. *Pain*. 2011;152(3 Suppl):S2–15.
21. Nijs J, Van Houdenhove B, Oostendorp RAB. Recognition of central sensitization in patients with musculoskeletal pain: Application of pain neurophysiology in manual therapy practice. *Man Ther*. 2010;15(2):135–41.
22. Miedema HS. Reuma-Onderzoek Meerdere Echelons (ROME): basisrapport. Leiden: TNO-Netherlands Organization for Applied Scientific Research; 1994 Jan p. 227. Report No.: 93.099 NIPG.
23. Brinjikji W, Luetmer PH, Comstock B, Bresnahan BW, Chen LE, Deyo RA, Halabig S, Turner JA, Avins AL, James K, Wald JT, Kallmesa DF, Jarvik JG. Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. *Am J Neuroradiol*. 2015;36(4):811–6.
24. Sieper J, Rudwaleit M, Baraliakos X, Brandt J, Braun J, Burgos-Vargas R, Dougados M, Hermann KG, Landewé R, Maksymowych W, Van der Heijde D. The Assessment of SpondyloArthritis international Society (ASAS) handbook: a guide to assess spondyloarthritis. *Ann Rheum Dis*. 2009;68 Suppl 2:ii1–44.
25. Henschke N, Maher CG, Refshauge KM. A systematic review identified five “red flags” to screen for vertebral fracture in patients with low back pain. *J Clin Epidemiol*. 2008 Feb;61(2):110–8.
26. Enthoven WTM, Geuze J, Scheele J, Bierma-Zeinstra SMA, Bueving HJ, Bohnen AM, Peul WC, Van Tulder MW, Berger MY, Koes BW, Luijsterburg PAJ. Prevalence and Red Flags Regarding Specified Causes of Back Pain in Older Adults Presenting in General Practice. *Phys Ther*. 2016;96(3):305–12.
27. Van Hoeven L, Luime J, Han H, Vergouwe Y, Weel A. Identifying axial spondyloarthritis in Dutch primary care patients, ages 20-45 years, with chronic low back pain. *Arthritis Care Res*. 2014 Mar;66(3):446–53.
28. Van Hoeven L, Vergouwe Y, de Buck PDM, Luime JJ, Hazes JMW, Weel AEAM. External Validation of a Referral Rule for Axial Spondyloarthritis in Primary Care Patients with Chronic Low Back Pain. *PLoS One*. 2015;10(7):e0131963.
29. Feleus A, Bierma-Zeinstra SMA, Miedema HS, Verhagen AP, Nauta AP, Burdorf A, Verhaar JAN, Koes BW. Prognostic indicators for non-recovery of non-traumatic complaints at arm, neck and shoulder in general practice--6 months follow-up. *Rheumatol*. 2007;46(1):169–76.
30. Feleus A, van Dalen T, Bierma-Zeinstra SMA, Bernsen RMD, Verhaar JAN, Koes BW, Miedema HS. Kinesiophobia in patients with non-traumatic arm, neck and shoulder complaints: a prospective cohort study in general practice. *BMC Musculoskelet Disord*. 2007;8.
31. Gezondheidsraad. RSI. Den Haag: Gezondheidsraad; 2000 Nov. Report No.: publicatie nr 2000/22. Available from: <http://www.gezondheidsraad.nl/sites/default/files/0022N.PDF>
32. Sluiter JK, Rest KM, Frings-Dresen MH. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. *Scand J Work Environ Health*. 2001;27(Suppl 1):1–102.
33. Helliwell PS, Bennett RM, Littlejohn G, Muirden KD, Wigley RD. Towards epidemiological criteria for soft-tissue disorders of the arm. *Occup Med*. 2003;53(5):313–9.

34. Van Tulder M, Becker A, Bekkering T, Breen A, del Real MTG, Hutchinson A, Koes B, Laerum E, Malmivaara A. Chapter 3. European guidelines for the management of acute nonspecific low back pain in primary care. *Eur Spine J*. 2006;15(Suppl 2):S169–91.
35. Dunn KM, Hestbaek L, Cassidy JD. Low back pain across the life course. *Best Pract Res Clin Rheumatol*. 2013;27(5):591–600.
36. Leboeuf-Yde C, Lemeunier N, Wedderkopp N, Kjaer P. Evidence-based classification of low back pain in the general population: one-year data collected with SMS Track. *Chiropr Man Ther*. 2013; 21:30 Epub.
37. Kongsted A, Kent P, Hestbaek L, Vach W. Patients with low back pain had distinct clinical course patterns that were typically neither complete recovery nor constant pain. A latent class analysis of longitudinal data. *Spine J Off J North Am Spine Soc*. 2015;15(5):885–94.
38. Axen I, Leboeuf-Yde C. Trajectories of low back pain. *Best Pract Res Clin Rheumatol*. 2013;27(5): 601–12.
39. Van Oostrom SH, Monique Verschuren WM, de Vet HCW, Picavet HSJ. Ten year course of low back pain in an adult population-based cohort—the Doetinchem cohort study. *Eur J Pain*. 2011;15(9): 993–8.
40. da Cunha Menezes Costa L, Maher CG, Hancock MJ, McAuley JH, Herbert RD, Costa LOP. The prognosis of acute and persistent low-back pain: a meta-analysis. *Can Med Assoc J*. 2012;184(11): E613–24.
41. Henschke N, Ostelo RWJG, Terwee CB, van der Windt DAWM. Identifying generic predictors of outcome in patients presenting to primary care with nonspinal musculoskeletal pain. *Arthritis Care Res*. 2012;64(8):1217–24.
42. Vos CJ, Verhagen AP, Passchier J, Koes BW. Clinical course and prognostic factors in acute neck pain: an inception cohort study in general practice. *Pain Med*. 2008 Aug;9(5):572–80.
43. Carroll LJ, Hogg-Johnson S, van der Velde G, Haldeman S, Holm LW, Carragee EJ, Hurwitz EL, Cote P, Nordin M, Peloso PM, Guzman J, Cassidy JD. Course and prognostic factors for neck pain in the general population: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine*. 2008;33(4 Suppl):S75–82.
44. National Research Council and the Institute of Medicine. *Musculoskeletal Disorders and the Workplace; low back and upper extremities*. Panel on Musculoskeletal Disorders and the Workplace. Commission on Behavioral and Social Sciences and Education. Washington: National Academy Press; 2001. Available from: [http://www.nap.edu/openbook.php?record\\_id=10032&page=R1](http://www.nap.edu/openbook.php?record_id=10032&page=R1)
45. Chou R, Shekelle P. Will this patient develop persistent disabling low back pain? *JAMA*. 2010; 303(13):1295–302.
46. Bruls VEJ, Bastiaenen CHG, de Bie RA. Prognostic factors of complaints of arm, neck, and/or shoulder: a systematic review of prospective cohort studies. *Pain*. 2015;156(5):765–88.
47. Croft P, Altman DG, Deeks JJ, Dunn KM, Hay AD, Hemingway H, LeResche L, Peat G, Perel P, Petersen SE, Riley RD, Roberts I, Sharpe M, Stevens RJ, Van Der Windt DA, Von Korff M, Timmis A. The science of clinical practice: disease diagnosis or patient prognosis? Evidence about “what is likely to happen” should shape clinical practice. *BMC Med*. 2015;13:20.
48. Lastovkova A, Nakladalova M, Fenclova Z, Urban P, Gad’ourek P, Lebeda T, Ehler E, Ridzon P, Hlavkova J, Borikova A. Low back pain disorders as occupational diseases in the Czech Republic and 22 European countries: comparison of national systems, related diagnoses and evaluation criteria. *Cent Eur J Public Health*. 2015;23(3):244–51.

49. Ministry of Employment and Social Affairs. Arbeidsomstandighedenregeling (BWBR0008587; WBJA/W2/97/0086) artikel 1.11 lid 1. The Hague: Ministry of Employment and Social Affairs; 2016. Available from: <http://wetten.overheid.nl/BWBR0008587/Hoofdstuk1/Paragraaf14/Artikel111>
50. Balague F, Mannion AF, Pellise F, Cedraschi C. Non-specific low back pain. *Lancet*. 2012;379(9814):482–91.
51. Hoofman WE, van Poppel MNM, van der Beek AJ, Bongers PM, van Mechelen W. Gender differences in the relations between work-related physical and psychosocial risk factors and musculoskeletal complaints. *Scand J Work Environ Health*. 2004;30(4):261–78.
52. Hoofman WE, van der Beek AJ, Bongers PM, van Mechelen W. Is there a gender difference in the effect of work-related physical and psychosocial risk factors on musculoskeletal symptoms and related sickness absence? *Scand J Work Environ Health*. 2009;35(2):85–95.
53. Picavet H. Een multimedia campagne gericht op de preventie van lage rugpijn: de potentiële gezondheidswinst. Bilthoven; 2004. Report No: 260401001. Available from: <http://www.rivm.nl/bibliotheek/rapporten/260401001.pdf>
54. Van der Molen HF, Kuijjer PPFM, Smits PBA, Schop A, Moeijes F, Spreeuwers D, Frings-Dresen MHW. Annual incidence of occupational diseases in economic sectors in The Netherlands. *Occup Environ Med*. 2012;69(7):519–21.
55. Burdorf A, Jansen JP. Predicting the long term course of low back pain and its consequences for sickness absence and associated work disability. *Occup Environ Med*. 2006;63(8):522–9.
56. Steenstra IA, Verbeek JH, Heymans MW, Bongers PM. Prognostic factors for duration of sick leave in patients sick listed with acute low back pain: a systematic review of the literature. *Occup Environ Med*. 2005;62(12):851–60.
57. Pincus T, Kent P, Bronfort G, Loisel P, Pransky G, Hartvigsen J. Twenty-five years with the biopsychosocial model of low back pain-is it time to celebrate? A report from the twelfth international forum for primary care research on low back pain. *Spine*. 2013;38(24):2118–23.
58. Kendall NAS, Linton SJ, Main CJ. Guide to assessing psychosocial yellow flags in acute low back pain: risk factors for long term disability and work loss. Wellington: Accident Compensation Corporation and the New Zealand Guidelines Group; 1997. Available from: [http://kendallburton.com/Library/Resources/Psychosocial\\_Yellow\\_Flags.pdf](http://kendallburton.com/Library/Resources/Psychosocial_Yellow_Flags.pdf)
59. Staal JB, Hendriks EJM, Heijmans M, Kiers H, Lutgers-Boomsma AM, Rutten G, Van Tulder MW, Den Boer J, Ostelo R, Custers JWH. KNGF-richtlijn lage rugpijn. Koninklijk Nederlands Genootschap voor Fysiotherapie; 2013. Available from: <https://www.fysionet-evidencebased.nl/index.php/richtlijnen/richtlijnen/lage-rugpijn-2013>
60. Kwaliteitsinstituut voor de Gezondheidszorg CBO. Ketenzorrichtlijn Aspecifieke Lage Rugklachten. Kwaliteitsinstituut voor de Gezondheidszorg CBO; 2010. Available from: [www.diliguide.nl/document/3272/file/pdf](http://www.diliguide.nl/document/3272/file/pdf)
61. Hayden JA, Chou R, Hogg-Johnson S, Bombardier C. Systematic reviews of low back pain prognosis had variable methods and results: guidance for future prognosis reviews. *J Clin Epidemiol*. 2009;62(8):781–96.e1.
62. Ramond A, Bouton C, Richard I, Roquelaure Y, Baufreton C, Legrand E, Huez J. Psychosocial risk factors for chronic low back pain in primary care—a systematic review. *Fam Pract*. 2011;28(1):12–21.
63. Koes BW, van Tulder M, Lin C-WC, Macedo LG, McAuley J, Maher C. An updated overview of clinical guidelines for the management of non-specific low back pain in primary care. *Eur Spine J*. 2010;19(12):2075–94.

64. Rodrigues EV, Gomes ARS, Tanhoffer AIP, Leite N. Effects of exercise on pain of musculoskeletal disorders: a systematic review. *Acta Ortop Bras.* 2014;22(6):334–8.
65. Barker AL, Talevski J, Morello RT, Brand CA, Rahmann AE, Urquhart DM. Effectiveness of aquatic exercise for musculoskeletal conditions: a meta-analysis. *Arch Phys Med Rehabil.* 2014;95(9):1776–86.
66. O'Connor SR, Tully MA, Ryan B, Bleakley CM, Baxter GD, Bradley JM, McDonough SM. Walking exercise for chronic musculoskeletal pain: systematic review and meta-analysis. *Arch Phys Med Rehabil.* 2015;96(4):724–34.e3.
67. Van Middelkoop M, Rubinstein SM, Kuijpers T, Verhagen AP, Ostelo R, Koes BW, Van Tulder MW. A systematic review on the effectiveness of physical and rehabilitation interventions for chronic non-specific low back pain. *Eur Spine J.* 2011;20(1):19–39.
68. Multidisciplinaire richtlijn specifieke Klachten Arm, Nek en/of Schouders. Utrecht: Kwaliteitskoepel Medisch Specialisten; 2012. Available from: <http://www.kwaliteitskoepel.nl/assets/structured-files/2012/multidicsrichtlijnaspecifiekeKANS19092012.pdf>
69. Blyth FM, Van Der Windt DA, Croft PR. Chronic Disabling Pain: A Significant Public Health Problem. *Am J Prev Med.* 2015;49(1):98–101.
70. Gross DP, Armijo-Olivo S, Shaw WS, Williams-Whitt K, Shaw NT, Hartvigsen J, Qin Z, Ha C, Woodhouse LJ, Steenstra IA. Clinical Decision Support Tools for Selecting Interventions for Patients with Disabling Musculoskeletal Disorders: A Scoping Review. *J Occup Rehabil.* 2015;Epub.
71. Hill JC, Whitehurst DGT, Lewis M, Bryan S, Dunn KM, Foster NE, Konstantinou K, Main CJ, Mason E, Somerville S, Sowden G, Vohora K, Hay EM. Comparison of stratified primary care management for low back pain with current best practice (STarT Back): a randomised controlled trial. *Lancet.* 2011;378(9802):1560–71.
72. Nicholas MK, George SZ. Psychologically informed interventions for low back pain: an update for physical therapists. *Phys Ther.* 2011;91(5):765–76.
73. Beneciuk JM, George SZ. Pragmatic Implementation of a Stratified Primary Care Model for Low Back Pain Management in Outpatient Physical Therapy Settings: Two-Phase, Sequential Preliminary Study. *Phys Ther.* 2015;95(8):1120–34.
74. Foster NE, Mullis R, Hill JC, Lewis M, Whitehurst DGT, Doyle C, Konstantinou K, Main C, Somerville S, Sowden G, Wathall S, Young J, Hay EM. Effect of stratified care for low back pain in family practice (IMPACT Back): a prospective population-based sequential comparison. *Ann Fam Med.* 2014;12(2):102–11.
75. Ramond-Roquin A, Bouton C, Gobin-Tempereau A-S, Airagnes G, Richard I, Roquelaure Y, Huez J-F. Interventions focusing on psychosocial risk factors for patients with non-chronic low back pain in primary care—a systematic review. *Fam Pract.* 2014;31(4):379–88.
76. Lambeek LC, van Mechelen W, Knol DL, Loisel P, Anema JR. Randomised controlled trial of integrated care to reduce disability from chronic low back pain in working and private life. *BMJ.* 2010;340:c1035.
77. Lambeek LC, Bosmans JE, Van Royen BJ, Van Tulder MW, Van Mechelen W, Anema JR. Effect of integrated care for sick listed patients with chronic low back pain: economic evaluation alongside a randomised controlled trial. *BMJ.* 2010;341:c6414.
78. Nicholas MK, Linton SJ, Watson PJ, Main CJ. Early identification and management of psychological risk factors (“yellow flags”) in patients with low back pain: a reappraisal. *Phys Ther.* 2011;91(5):737–53.

79. Van Vilsteren M, van Oostrom SH, de Vet HCW, Franche R-L, Boot CRL, Anema JR. Workplace interventions to prevent work disability in workers on sick leave. *Cochrane Database Syst Rev*. 2015;10:CD006955.
80. Esmailzadeh S, Ozcan E, Capan N. Effects of ergonomic intervention on work-related upper extremity musculoskeletal disorders among computer workers: a randomized controlled trial. *Int Arch Occup Environ Health*. 2014;87(1):73–83.
81. Spekle EM, Hoozemans MJM, van der Beek AJ, Blatter BM, van Dieen JH. The predictive validity of the RSI QuickScan questionnaire with respect to arm, shoulder and neck symptoms in computer workers. *Ergonomics*. 2012;55(12):1559–70.
82. Spekle EM, Heinrich J, Hoozemans MJM, Blatter BM, van der Beek AJ, van Dieen JH, Van Tulder MW. The cost-effectiveness of the RSI QuickScan intervention programme for computer workers: Results of an economic evaluation alongside a randomised controlled trial. *BMC Musculoskelet Disord*. 2010;11:259.
83. Heemskerk MAMB, Staal JB, Bierma-Zeinstra SMA, Haan G de, Hagenaars LHA, Lanser K, Van der Windt DAWM, Oostendorp RAB, Hendriks EJM. KNGF-richtlijn Klachten aan de arm, nek en/of schouder (KANS). KNGF; 2010. Available from: [http://www.fysionet-evidencebased.nl/images/pdfs/richtlijnen/kans\\_2010/kans\\_praktijkrichtlijn.pdf](http://www.fysionet-evidencebased.nl/images/pdfs/richtlijnen/kans_2010/kans_praktijkrichtlijn.pdf)
84. Elders L, Kramer E, Kuin EAJM, Kok L, Hulshof CTJ. Richtlijn Handelen van de bedrijfsarts bij werknemers met klachten aan arm, nek of schouder (KANS); (gedeeltelijk herziene versie, 2014). NVAB; 2014. Available from: [https://www.nvab-online.nl/sites/default/files/bestanden-webpagina/02-04-2015%20Herziene%20R%20KANS\\_0.pdf](https://www.nvab-online.nl/sites/default/files/bestanden-webpagina/02-04-2015%20Herziene%20R%20KANS_0.pdf)
85. Hutting N, Staal JB, Engels JA, Heerkens YF, Dettaille SI, Nijhuis-van der Sanden MWG. Effect evaluation of a self-management programme for employees with complaints of the arm, neck or shoulder: a randomised controlled trial. *Occup Environ Med*. 2015;72(12):852–61.
86. Bruls VEJ, Bastiaenen CHG, de Bie RA. Non-traumatic arm, neck and shoulder complaints: prevalence, course and prognosis in a Dutch university population. *BMC Musculoskelet Disord*. 2013; 14:8.



# SUMMARY





## SUMMARY

Musculoskeletal disorders (MSDs) are extremely common and are usually associated with pain and loss of physical function. MSDs may have either an acute or a gradual onset and their outcomes may vary from complete restoration of health to a chronic progressive course. This course is not always predictable, although certain patterns predominate. MSDs may cause psychological distress and dysfunction, but also psychological factors and coping style may influence the course of these disorders. Besides causing pain and decreased functional capacity, MSDs have a substantial influence on work capacity and quality of life. Altogether, they inflict an enormous financial burden on society through both direct medical costs as well as indirect costs due to loss of productivity and social security benefits. The yearly burden of disease for the two most important groups of MSDs, low back pain (LBP) and neck and upper extremity complaints, can be estimated at more than € 5.500 million.

The majority of MSDs fall into the category of so-called nonspecific disorders, that can be defined as disorders with no known underlying pathophysiology or diagnosis and the absence of evidence that a specific structure is linked to the pain or other symptoms. Often these nonspecific disorders are related to overload, deconditioning or workrelated overexertion. These MSDs are universally prevalent among all age and gender groups and across all socio-demographic strata of society. There is still much debate about their course and the main prognostic indicators for unfavorable outcomes. Although much research has been performed, especially with regard to nonspecific LBP (NLBP), knowledge about the long-term pain patterns or predictors over the life course is limited. For many possible prognostic indicators, especially regarding the psychosocial domain, consistent evidence is lacking. Early identification of patients more likely to develop persistent disabling symptoms could help to guide decisions regarding medical management. However, the optimal management strategies, including attention for psychological and workrelated factors, are still unclear.

In this thesis several studies are brought together that contain information about the course, prognosis and management of LBP and neck and upper extremity complaints. Together, these studies provide insight into the possibilities to identify subgroups of patients through the assessment of non-medical criteria, especially within the category of nonspecific complaints. These subgroups might profit from a different approach in treatment or guidance. In the final chapter of this thesis the main findings from these studies are discussed in a broader context.

With regard to the part of the thesis studying LBP, the main aims were to describe the proportion of LBP-patients that develop chronic complaints during a follow-up period of 7 years as well as to identify prognostic indicators for this course, and to determine the consequences of LBP in terms of occupational diseases.

Chapter 2 contains a cohort study of 441 people of working age, who consulted with their general practitioner in 1987-1988 for an incident episode of LBP. After a follow-up of 7 years the health outcomes and work participation of people with and without chronic back problems were compared and determinants of chronicity were identified. The conclusion was that chronic back problems, defined as continuous or frequently recurring complaints throughout the follow-up period, developed in 28% of the patients in the study cohort. It was estimated that within one year 2.7% of the population of 20-64 years developed an incident episode of chronic LBP. These patients reported more pain, much higher levels of medical consumption and worse outcomes regarding physical and social functioning. However, mental health outcomes were comparable with patients with non-chronic LBP. Previous episodes of LBP and severity of pain and disabilities were positively associated with chronicity. However, age, gender, education or having a paid job were not associated with a higher risk of development of chronic back problems. In this study no measures of mental health were applied as possible predictors of health outcome. Among the respondents with paid work at baseline, 15% of the non-chronic group stopped working after 1987, compared with almost 26% of the chronic group. As a result, the labor force participation in the chronic group was much lower (59.0% versus 68.4%). Subjectively reported frequent stooping at work and difficulty with work performance were significantly positively associated with chronicity (OR 5.9 and 5.5 respectively). However, frequent walking or standing was significantly associated with a lower risk of development of chronic back problems (OR 0.4).

In chapter 3, a study is described, in which data were used from the Occupational Disease Registry and from a dynamic prospective cohort study with 3 years of follow-up, both conducted by the Netherlands Centre for Occupational Diseases (NCOD). With these data the trends in the number of notifications of occupational diseases (OD) that were attributed to LBP could be studied, as well as the incidence rate of notified ODs due to LBP. The registration of an OD due to LBP bears upon an instrument that was developed to assess the workrelatedness of NLBP, which provides a practical method for the determination of the contribution of various workrelated factors to the occurrence of NLBP in an individual worker. This instrument can be used to identify workers with LBP, that need an adaptation of their working conditions in order to reduce their workload caused by manual materials handling, frequent bending or twisting of the trunk and whole body vibration, so that return to work can be facilitated. Since the implementa-

tion of this instrument and an associated registration guideline of the NCOD, a huge increase in numbers of LBP-related notifications was noticed, from 0.7% of all notified ODs in 2004, via 8.6% in 2005 and 13.6% in 2008, to 9.1% in 2011. The incidence rate of ODs due to LBP was estimated at 24.1 per 100,000 worker years (19.2 for NLBP), with a large difference between men and women (31.3 and 3.2 respectively). Given a total size of the working population of about 7.2 million people, this means about 1,730 cases of OD due to LBP are expected to occur every year.

The instrument for the assessment of workrelatedness of NLBP played an important role in the recognition of LBP-related ODs. It provides a basis for a more uniform and objective evaluation of the role of workrelated risk factors in the occurrence of NLBP. This knowledge can be used to initiate or direct preventive actions towards subgroups of workers with a higher probability of developing LBP. Furthermore, when the incidence rates are studied in more detail regarding economic branches, certain professions or workrelated risk factors, preventive measures could be implemented in populations of workers with higher incidence rates.

With regard to the part of the thesis with studies about neck and upper extremity complaints, the main aims were to develop a classification system for neck and upper extremity complaints and, subsequently, to develop a multidisciplinary guideline for diagnosis and treatment of nonspecific neck and upper extremity disorders. In addition, the studies used for this guideline were evaluated for prominent patient reported outcome measures within the framework of the International Classification of Functioning, Disability and Health (ICF). The aim of the final study was to describe the course of disabilities in patients with neck and upper extremity complaints and to identify the prognostic indicators associated with higher disability scores.

In Chapter 4 the development of a new classification system for neck and upper extremity complaints is described, using a Delphi consensus strategy. After it became clear that most Dutch health care providers were opposed against continuation of the use of the term 'Repetitive Strain Injuries', 47 experts from 11 medical and paramedical professional organizations reached consensus about the definition of complaints of arm, neck or shoulder (CANS) as 'musculoskeletal complaints of arm, neck and/or shoulder not caused by acute trauma or by any systemic disease'. In this first CANS-model (2004), 23 specific disorders were distinguished, that were supposed to be well diagnosable. All other complaints that fell under the definition were called nonspecific CANS. In addition, 'alert symptoms' were listed to make clinicians aware of signs or symptoms that can be related to a systemic disease, resulting in exclusion from the model.

Chapter 5 contains a comment on another classification system, that was developed by a research group from New Zealand for workrelated upper extremity conditions. Their study was published shortly after the publication of the CANS-model. Their classification system also differentiated specific and nonspecific diagnoses. Furthermore, it classified specific diagnoses into tendon-related, nerve-related, circulation-related and joint-related disorders and pain syndrome. Apart from the outdated statement that in The Netherlands 'Repetitive Strain Injury' (RSI) still was the leading term for the classification of upper-extremity conditions, the main points of criticism on this other classification system were the restriction to the so-called 'workrelated' disorders, while many of the specific conditions also occur in non workrelated settings, as well as the confusing inclusion of the category 'pain syndrome' in the group of specific disorders.

Subsequent to the CANS-model, a multidisciplinary guideline for the diagnosis and treatment of nonspecific CANS was developed, according to the principles of evidence based guideline development. The development and contents of the guideline are summarized in Chapter 6. This guideline provides recommendations for the diagnosis, treatment, care and work participation of patients with nonspecific CANS. Within this guideline an update of the CANS model was included, containing 36 specific diagnoses or diagnostic categories. With regard to nonspecific CANS, treatment interventions were identified for which sufficient scientific evidence was available or, failing that, consensus has been reached about the expected effectiveness of the therapy. In addition, a clinical pathway was developed that focuses on optimal timing of diagnostics and treatment, and on multidisciplinary collaboration. All these elements are supposed to result in an improvement of the diagnostic and therapeutic process, in order to provide patients with CANS with faster, better targeted and most beneficial form of treatment.

Based upon the literature that was selected for the guideline, Chapter 7 presents an overview of relevant outcomes regarding functions, activities and participation among patients with CANS, and their association with the ICF. From 123 prognostic and intervention studies, the patient reported outcome measures were extracted that were used to describe the disease course or the effectiveness of the interventions. Subsequently, the relation to separate ICF-categories was determined, as well as the frequency of attention for these specified ICF-categories in this literature. The results provide insight into the physical, emotional and social challenges that patients with CANS need to adapt to. The most important challenge was pain, which was measured in 93% of the studies; in 22% of the studies it even was the only outcome considered. Participation in work came second (54% of the studies), recreation and leisure activities third (42% of the studies) and sleep functions fourth (39% of the studies). Separate attention was given to mental health measures, because they were only applied in 14.6% of the studies. The

most important mental challenge regarded 'emotional impairments', that was measured in 14% of this subset of studies. 'Psychic stability', was addressed in 13% and 'content of thought', 'optimism', 'confidence' and 'energy level' each in 10-11%.

Chapter 8 reports the results of a cohort study in primary care among working age adults with an incident episode of CANS. The course of disabilities was studied during 2-years of follow-up, as well as prognostic indicators that were associated with higher levels of disability. Three disability trajectories were differentiated: fast recovery (67.6% of the cohort), modest recovery (23.6% of the cohort) and continuous high disability (8.8% of the cohort). The proportion of patients with DASH scores comparable to the normal population (<11) increased from 44% at 6-month follow-up to 58% at 2-year follow-up. A slightly higher proportion (54-62%) indicated complete recovery or much improvement at all follow-up moments. However, only 43% indicated absence of complaints at 2-year follow-up. Several demographical, complaint-related, physical and psychosocial characteristics with a predictive value for the high disability and modest recovery trajectories were identified. The most important were age, gender, complaint duration and complaint severity, musculoskeletal comorbidity and the psychosocial indicators somatization, kinesiphobia and social support. These indicators can be identified by screening methods, including information obtained through patient history and administering validated measures, such as the Four-Dimensional Symptom Questionnaire (4-DSQ) and the Tampa-scale.

In Chapter 9 the main results of the studies in this thesis are summarized and discussed in relation to the course, prognosis and management of nonspecific MSDs. With regard to the diagnosis of MSDs, the differentiation between specific and nonspecific conditions deserves attention, because identification of a specific diagnosis can have a large impact on the prognosis and choice of treatment. In the absence of established characteristic signs, symptoms or diagnostic criteria for the diagnosis of a specific condition, one should refrain from delusional diagnostic labeling of nonspecific complaints. The CANS-model supports a standardized classification for diagnosis of CANS, which is an important prerequisite for evaluation of prognosis and adequate treatment.

With regard to the disease courses, LBP (including about 10% specific conditions) and CANS (including about 60% of specific conditions) show much resemblance. The initial phase is characterized by recovery in a large proportion of patients. However, many of them suffer from one or more relapses in the following phases. About one in every ten patients follows a course with persistent pain and other unfavorable outcomes. Thus, large subgroups of patients with persisting or relapsing LBP or CANS show more resemblance with long-term chronic conditions such as asthma, rather than self-limiting conditions such as common cold. It is important to shift the focus from seeing an episode

of nonspecific LBP or CANS as a single entity, to regarding these conditions as a chain of episodes, with varying course of pain, disabilities and other outcome. This shift of paradigm may result in possibilities to identify clinically meaningful subgroups of patients with particular characteristics that are associated with this course. The subgroups of patients with a chronic course are relatively large (25-50% after 1 year and 20-35% after multiple years) and seem to be much larger than previously reported in guidelines. This has important consequences for work participation and health care consumption. However, comparison of data from various cohorts is difficult, due to differences in type of populations, outcomes measured and duration of follow-up.

With regard to prognostic indicators for the course of LBP, the most consistently reported baseline factors are: a) high level of disabilities; b) leg pain (sciatica); c) poor general health; d) presence of non-organic signs; e) increased psychological or psychosocial stress, including high level of fear avoidance; f) psychiatric comorbidity; g) high physical work demands; and h) poor relations with colleagues. In addition, the prognostic indicators high pain intensity and work dissatisfaction are reported frequently, but somewhat less consistent, while no consistent evidence is present for older age, female gender, higher psychological work demands and presence of compensation.

The application of the instrument for assessment of workrelatedness of nonspecific LBP supports the identification of a subgroup of patients with LBP that can be classified as OD. In these cases ergonomic interventions to reduce the workload are obligatory and a necessary condition for return to work. Since workrelated factors also have been identified as prognostic indicators, preventive measures should already be implemented at lower levels of physical load than required for recognition as OD.

Many baseline prognostic indicators for disability, that were revealed in the CANS cohort study in this thesis, were also found in LBP-research: a) kinesiophobia; b) catastrophizing; c) complaint duration; d) complaint severity; e) widespread complaints; and f) poor general health. In contrast, some other prognostic indicators were not found prominently in LBP-research: a) somatization; b) low social support; c) musculoskeletal comorbidity; d) older age; e) female gender and f) educational level. It seems clear that the role of psychosocial indicators in CANS-patients is as large as in LBP-patients, or even larger. In addition, complaint related indicators seem to be more important.

With regard the management of nonspecific MSDs, it is concluded that the prognostic factors, that are most useful to address in (additional) interventions, are not fully established yet. Further prognostic research is necessary, especially in CANS. It seems worthwhile to improve available identification tools for prognostic indicators in LBP, and develop such tools for CANS. These tools should be able to make an accurate differentiation in clinically meaningful subgroups of patients, that are susceptible to psychological, physical or ergonomic interventions. For these subgroups, improvement of available treatment protocols or development of new interventions will be necessary.

At this moment, in many patients psychosocial and workrelated prognostic indicators are disregarded, because evidence is too scarce about which indicators can be targeted by interventions that are available or may be developed. As a consequence, chances to improve the results of treatment of these patients might be missed. In LBP-patients the implementation of an identification tool for psychosocial indicators was promising, but the tool as well as the tailored interventions need further improvement. The effectiveness of interventions for patients with LBP and CANS may be enhanced by also addressing non-psychosocial indicators, as well as workrelated factors that may obstruct recovery. More research is needed to improve protocols for stratified and integrated care and to study their effectiveness. In the absence of this evidence, in clinical practice it seems worthwhile to try to identify clinically relevant prognostic indicators and take them in consideration in the decisions about treatment.

Finally, some recommendations for clinical practice and future research are given:

### **Recommendations for clinical practice**

- When a working individual consults an occupational physician for NLBP, the instrument for the assessment of the workrelatedness of nonspecific LBP should be used to address the workrelated factors that contributed to its development;
- After exclusion of specific disorders in patients with LBP or CANS, the attention of the healthcare provider needs to shift from diagnosis towards appraisal of the prognostic indicators for unfavorable long-term outcomes, such as non-recovery, persistence of complaints, chronic disabilities or work disability;
- The CANS-guideline, including the updated CANS-model, needs to be implemented in clinical practice in order to improve clinical management of CANS and to foster collaboration between all regular and occupational healthcare providers involved;
- In patients with a new episode of CANS, attention for psychosocial factors is necessary to consider additional interventions by psychologically trained professionals when indicated.

### **Recommendations for future research**

- Identification of the most relevant prognostic indicators that are associated with various outcomes over time in LBP and CANS, preferably using repeated measurements over extended periods of time;
- Development and evaluation of tailored interventions in patients with nonspecific LBP and CANS, resulting in new opportunities for stratified care;
- Ten years after the development of the instrument for assessment of workrelatedness of NLBP a thorough revision is necessary to incorporate new insights into the role of workrelated factors in LBP;

- Research of the added value of the multidisciplinary guideline for diagnosis and treatment of nonspecific CANS for clinical practice is important to enhance its implementation.





# SAMENVATTING





## SAMENVATTING

Klachten en aandoeningen van het houdings- en bewegingsstelsel (KAHB) komen extreem veel voor en gaan gewoonlijk gepaard met pijn en verminderd lichamelijk functioneren. KAHB kunnen acuut of geleidelijk ontstaan. Daarna varieert het ziektebeloop van volledig herstel tot een chronisch progressief ziektebeeld. Dit beloop is niet altijd voorspelbaar, hoewel bepaalde patronen op de voorgrond staan. KAHB kunnen ook psychische distress en disfunctioneren tot gevolg hebben. Omgekeerd kunnen psychische factoren en de manier van omgaan met de klachten (coping stijl) ook van invloed zijn op het beloop van KAHB. Naast het veroorzaken van pijn en verminderd functioneren, hebben KAHB ook een behoorlijke invloed op het werkvermogen en op de kwaliteit van leven. Alle KAHB samen veroorzaken een enorme financiële last voor de maatschappij vanwege directe medische kosten, maar vooral door indirecte kosten ten gevolge van uitkeringen voor ziekteverzuim en arbeidsongeschiktheid. De geschatte jaarlijkse ziektelast door de twee belangrijkste groepen KHAB, lage rugpijn (LR) en klachten van de nek of bovenste ledematen (KNBL), belopen meer dan 5,5 miljard euro.

De meerderheid van de KAHB vallen in de categorie van de zogenaamde aspecifieke aandoeningen, te definiëren als aandoeningen met een onbekend onderliggend ziekmakend proces en zonder bewijs voor een specifieke structuur die verband houdt met de pijn of andere symptomen. Vaak zijn deze aspecifieke aandoeningen gerelateerd aan overbelasting, de-conditionering of overmatige belasting op het werk. Deze aspecifieke KAHB komen zeer veel voor bij zowel mannen als vrouwen in alle leeftijdscategorieën en in alle lagen van de bevolking. Er is nog steeds veel discussie over hun beloop en de belangrijkste prognostische indicatoren voor ongunstige gezondheids-uitkomsten na verloop van tijd. Hoewel veel onderzoek is verricht, vooral met betrekking tot aspecifieke LR, is onze kennis over mogelijke patronen in het beloop op de lange termijn en de voorspellende factoren vanuit levensloop perspectief nog zeer beperkt. Er is ook gebrek aan consistente onderbouwing voor veel prognostische factoren, vooral met betrekking tot het psychosociaal domein. Het vroegtijdig identificeren van patiënten die een grotere kans hebben op ontwikkeling van persisterende beperkingen, zou kunnen helpen bij de keuze voor de medische of paramedische aanpak van de KAHB in die vroege fase. Ook is meer duidelijkheid nodig welke behandelstrategieën optimaal zijn, waarbij ook aandacht voor psychologische en werkgerelateerde factoren is inbegrepen.

In dit proefschrift zijn een aantal onderzoeken gebundeld, die informatie bevatten over het beloop, de prognose en het medisch management van LR en KNBL. Tezamen verschaffen deze studies inzicht in de mogelijkheden om subgroepen van patiënten te identificeren door het vaststellen van niet-medische criteria, met name in de categorie

van aspecifieke klachten. Bij deze subgroepen zou een andere benadering in de behandeling of begeleiding gunstig kunnen zijn. In het laatste hoofdstuk van dit proefschrift worden de belangrijkste resultaten van deze onderzoeken in een breder perspectief geplaatst.

Een deel van de onderzoeken had betrekking op LR. De belangrijkste doelstellingen hiervan waren om de proportie van patiënten met LR te beschrijven, die chronisch persisterende klachten ontwikkelde tijdens een follow-up periode van 7 jaar, alsmede prognostische factoren voor dit beloop te identificeren en de gevolgen van de LR vanuit beroepsziekten (BZ) perspectief.

Hoofdstuk 2 beschrijft een cohort studie met 441 mensen op arbeidzame leeftijd, die in 1987 of 1988 hun huisarts consulteerden vanwege een nieuwe episode van LR. Na een follow-up van 7 jaar zijn de gezondheidsuitkomsten en de arbeidsparticipatie van mensen met en zonder chronisch beloop vergeleken en zijn de determinanten voor chroniciteit geïdentificeerd. De conclusie was, dat bij 28% van de patiënten uit dit cohort zich chronische LR ontwikkelden, gedefinieerd als voortdurende of frequent recidiverende klachten gedurende de gehele follow-up periode. Op basis hiervan kon worden geschat dat in een jaar tijd bij ongeveer 2,7% van de populatie met een leeftijd van 20-64 jaar een nieuwe (incidente) episode van chronische LR ontstaat. Deze patiënten rapporteerden meer pijn, een veel hoger gebruik van gezondheidszorg en een slechtere gezondheidstoestand ten aanzien van fysiek en sociaal functioneren. De gezondheidstoestand op mentaal gebied was wel vergelijkbaar met die van patiënten met een niet-chronisch beloop. Eerdere episodes van LR en de ernst van pijn of beperkingen waren positief geassocieerd met chroniciteit. Daarentegen waren leeftijd, geslacht, opleiding of het hebben van betaald werk niet geassocieerd met een hogere kans op het ontwikkelen van chronische LR. In deze studie zijn geen meetinstrumenten op gebied van mentale gezondheid toegepast als mogelijke voorspellers van gezondheidsuitkomsten. Onder de respondenten met betaald werk op baseline, was in de subgroep met een niet-chronisch beloop 15% gestopt met werken, vergeleken met bijna 26% in de subgroep met een chronisch beloop. Dientengevolge was de arbeidsparticipatie in de subgroep met een chronisch beloop veel lager (59,0% versus 68,4%). De subgroepen van werkende respondenten, die aangaven op hun werk frequent te moeten bukken of moeite te hebben met het uitvoeren van hun werktaken, vertoonden een significant positieve associatie met chroniciteit (OR 5,9 resp. 5,5). Daarentegen had de subgroep van werkende respondenten, die aangaven op hun werk frequent te lopen of staan, een significant lagere kans op het ontwikkelen van chronische LR (OR 0,4).

Hoofdstuk 3 gaat over een onderzoek waarin data zijn gebruikt van de nationale beroepsziekten-registratie én van een dynamische prospectieve cohortstudie met 3 jaar follow-up, beide uitgevoerd door het Nederlands Centrum voor Beroepsziekten (NCvB). Met deze data was het mogelijk om onderzoek te doen naar de trends in het aantal (geregistreerde) meldingen van BZ die toegeschreven werden aan LR, én naar de incidentie van meldingen van BZ (BZM) wegens LR. De BZM vanwege LR was gebaseerd op een instrument dat is ontwikkeld om de arbeidsgerelateerdheid van specifieke LR vast te stellen. Dit instrument voorziet in een praktisch werkbare methode voor het vaststellen van de bijdrage van diverse werkgerelateerde factoren aan het optreden van specifieke LR bij een individuele werknemer. Het instrument is te gebruiken als methode om werknemers met LR te identificeren, bij wie aanpassingen van de werkomstandigheden nodig zijn om de werkbelasting door tillen en dragen van lasten, frequent buigen en draaien van de romp en lichaamstrillingen te verminderen ten einde de werkhervatting te faciliteren. Sinds de implementatie van dit instrument en de daaraan verbonden registratie richtlijn van het NCvB, is het aantal BZM vanwege LR enorm gestegen: van 0,7% van alle BZM in 2004, via 8,6% in 2005 en 13,6% in 2008, tot 9,1% in 2011. De incidentie van BZ vanwege LR kon worden geschat op 24,1 per 100.000 werknemersjaren (19,2 wegens specifieke LR), met een groot verschil tussen mannen en vrouwen (respectievelijk 31,3 en 3,2). Uitgaande van een totale omvang van de werkende beroepsbevolking van 7,2 miljoen mensen, betekent dit dat ieder jaar ongeveer 1.730 gevallen van BZ vanwege LR ontstaan. Het instrument voor het vaststellen van de arbeidsgerelateerdheid van specifieke LR heeft een belangrijke rol gespeeld in het herkennen van aan LR gerelateerde BZ. Het verschaft een basis voor een meer uniforme en objectieve evaluatie van de rol van werkgerelateerde factoren bij het ontstaan van specifieke LR. Dit type kennis kan worden gebruikt om preventieve maatregelen te initiëren of bij te sturen, die gericht zijn op subgroepen van werkenden met een hogere kans op het ontwikkelen van LR. Door gedetailleerde bestudering van de incidentiecijfers in verschillende economische sectoren of branches, of onder werkenden met een bepaalde beroep of een hogere mate van blootstelling aan een werkgerelateerde risicofactor, is het mogelijk om preventieve maatregelen te implementeren in werknemerspopulaties met een hogere incidentie van BZ vanwege LR.

Het andere deel van de onderzoeken had betrekking op KNBL. De belangrijkste doelstellingen hiervan waren om een classificatiesysteem voor KNBL te ontwikkelen, gevolgd door een multidisciplinaire richtlijn voor de diagnose en behandeling van specifieke KNBL. De studies die bij de richtlijnontwikkeling zijn gebruikt, zijn ook benut voor evaluatie van de belangrijkste patient reported outcome measures (PROMs) binnen het raamwerk van de International Classification of Functioning, Disability and Health (ICF).

Het doel van het laatste onderzoek was om het beloop van beperkingen bij patiënten met KNBL te beschrijven en de prognostische indicatoren te identificeren die verband houden met een hoger niveau van beperkingen.

Hoofdstuk 4 bevat een beschrijving van de ontwikkeling van een nieuw classificatiesysteem voor KNBL, waarbij gebruik is gemaakt van consensusvorming door middel van de Delphi-methode. Nadat duidelijk was geworden dat de meeste Nederlandse zorgprofessionals gekant waren tegen continuering van gebruik van het begrip 'Repetitive Strain Injuries' (RSI), hebben 47 afgevaardigde deskundigen vanuit 11 medische en paramedische beroepsorganisaties consensus bereikt over de definitie van klachten van arm, nek of schouder (KANS) als: klachten van het houdings- en bewegingsstelsel in de arm, nek en/of schouder, die niet veroorzaakt zijn door een acuut trauma of enige systemische ziekte. In het eerste KANS-model (2004) zijn 23 specifieke aandoeningen onderscheiden, waarvan verondersteld werd dat ze goed gediagnosticeerd konden worden. Alle andere klachten die onder de definitie vielen werden aspecifieke KANS genoemd. Er werd een lijst van zogenaamde 'alert symptomen' opgesteld om zorgverleners alert te maken op kenmerken of symptomen die mogelijk gerelateerd zijn aan een systemische ziekte, resulterend in exclusie van het model.

Hoofdstuk 5 bevat een commentaar op een ander classificatiesysteem, dat was ontwikkeld door een Nieuw-Zeelandse onderzoeksgroep voor werkgerelateerde aandoeningen van de bovenste ledematen. Hun studie werd korte tijd na publicatie van het KANS-model gepubliceerd. Ook hun classificatiesysteem differentieerde specifieke en aspecifieke aandoeningen. Aanvullend werden de specifieke aandoeningen onderverdeeld in pees-, zenuw-, circulatie- of gewrichts-gerelateerde aandoeningen of pijnsyndroom. Naast de gedateerde stelling dat in Nederland 'Repetitive Strain Injury' (RSI) nog steeds de geprefereerde term was voor de classificatie van aandoeningen van de bovenste ledematen, waren er twee punten van kritiek op dit andere classificatiesysteem: 1) het systeem was beperkt tot de zogenaamde werkgerelateerde aandoeningen, terwijl veel van deze aandoeningen ook voorkomen in niet werkgerelateerde context; en 2) de categorie pijnsyndroom was geïnccludeerd in de groep van specifieke aandoeningen, hetgeen verwarrend is omdat in veel gevallen hierbij juist geen specifieke oorzaak aanwijsbaar is.

Na publicatie van het KANS-model is een multidisciplinaire richtlijn voor diagnose en behandeling van aspecifieke KANS ontwikkeld, in overeenstemming met de principes van de evidence based richtlijn ontwikkeling (EBRO). De ontwikkeling en inhoud van de richtlijn zijn samengevat in hoofdstuk 6. Deze richtlijn geeft aanbevelingen voor de diagnostiek, de behandeling en zorg en de arbeidsparticipatie van patiënten met aspe-

cifieke KANS. In de richtlijn is een update van het KANS-model opgenomen, bestaande uit 36 specifieke diagnoses of diagnose-categorieën. Met betrekking tot specifieke KANS zijn behandel-interventies geïdentificeerd waarvoor voldoende wetenschappelijke onderbouwing beschikbaar was of, bij gebrek daaraan, consensus was bereikt over de te verwachten effectiviteit. In aanvulling daarop is een zorgpad ontwikkeld, dat gericht is op de optimale timing van diagnostiek en behandeling en op multidisciplinaire samenwerking. De veronderstelling is dat al deze elementen samen kunnen resulteren in een verbetering van het diagnostisch en therapeutisch proces, ten einde aan patiënten met KANS een snellere en meer gerichte behandeling te kunnen bieden, die hen het meeste voordeel oplevert.

Hoofdstuk 7 bevat een overzicht van relevante gezondheidsuitkomsten met betrekking tot functies, activiteiten en participatie bij patiënten met KANS en hun relatie tot de ICF. Dit overzicht is gebaseerd op de voor de richtlijn geselecteerde wetenschappelijke literatuur. Uit 123 prognostische en interventie studies zijn de PROMs geselecteerd die zijn toegepast om het ziektebeloop of de effectiviteit van de interventies te beschrijven. Vervolgens is de relatie gelegd tussen (de items van) elke PROM met de afzonderlijke ICF-categorieën en is de frequentie vastgesteld waarmee aan deze ICF-categorieën aandacht is gegeven binnen de onderzoeken in dit literatuurbestand. De resultaten van dit onderzoek geven inzicht in de lichamelijke, emotionele en sociale uitdagingen waaraan patiënten met KANS zich moeten aanpassen. De belangrijkste uitdaging was pijn, die in 93% van de studies werd gemeten; in 22% van de studies was het zelfs de enige uitkomstmaat. Arbeidsparticipatie kwam op de tweede plaats (54% van de studies), activiteiten op het gebied van recreatie en vrije tijd kwamen op de derde plaats (42% van de studies) en slaap kwam op de vierde plaats (39% van de studies). In een separate analyse werd aandacht gegeven aan PROMs die gericht zijn op mentale gezondheidsuitkomsten, omdat deze slechts in 14,6% van de studies werden toegepast. Op dit gebied werd de belangrijkste uitdaging gevormd door functies gerelateerd aan 'stemming', die in 14% van deze subset van studies werden gemeten. Aan 'psychische stabiliteit' werd in 13% van de studies aandacht besteed en aan 'inhoud van het denkproces', 'optimisme', '(zelf)vertrouwen' en 'energieniveau' elk in 10-11% van de studies.

Hoofdstuk 8 gaat over de resultaten van een cohort studie in de eerstelijns zorg onder volwassenen in de arbeidzame leeftijd met een nieuwe episode van KANS. Het beloop van beperkingen werd gedurende 2 jaar follow-up onderzocht, alsmede de prognostische indicatoren die geassocieerd waren met hogere beperkingenniveaus. Ten aanzien van het beloop van beperkingen werden drie groepen onderscheiden: snel herstel (67,6% van het cohort), beperkt herstel (23,6% van het cohort) en continu hoog beperkingenniveau (8,8% van het cohort). Het deel van de populatie dat een niveau

van beperkingenhad (gemeten met de DASH-vragenlijst) dat vergelijkbaar was met de algemene bevolking, steeg van 44% bij 6-maand follow-up tot 58% bij 2-jaar follow-up. Een iets groter deel van de populatie (54-62%) gaf compleet herstel of grote verbetering aan op de verschillende follow-up momenten. Daarentegen gaf slechts 43% van het cohort volledige afwezigheid van KANS aan bij 2-jaar follow-up. Er konden diverse op baseline gemeten demografische, klacht-gerelateerde, lichamelijke en psychosociale kenmerken worden geïdentificeerd met een voorspellende waarde voor een beloop in de subgroep van beperkt herstel of continu hoog beperkingenniveau. De belangrijkste waren leeftijd, geslacht, ernst en duur van de klachten, co-morbiditeit op gebied van KAHB en de psychosociale indicatoren somatisatie, bewegingsangst (kinesiofobie) en gebrek aan sociale steun. Deze indicatoren kunnen worden geïdentificeerd door daarop te screenen in de anamnese en door middel van toepassing van gevalideerde meetinstrumenten, zoals de Vierdimensionale Klachten Lijst (4-DKL) en de Tampa schaal.

In hoofdstuk 9 zijn de belangrijkste resultaten van de onderzoeken in dit proefschrift samengevat en bediscussieerd in de context van de beschikbare kennis over het beloop, de prognose en het medisch management van specifieke KAHB.

Wat betreft de diagnostiek van KAHB verdient het onderscheid van specifieke en aspecifieke klachten aandacht, omdat het vaststellen van een specifieke diagnose een grote impact kan hebben op de prognose en keuze voor behandeling. Bij gebrek aan karakteristieke kenmerken, symptomen of diagnostische criteria die nodig zijn voor het diagnosticeren van een specifieke aandoening, dient te worden afgezien van misleidende diagnostische termen die in feite duiden op aspecifieke klachten. Het KANS-model biedt een goede basis voor een gestandaardiseerde classificatie bij de diagnostiek van KANS. Dit is een belangrijke voorwaarde voor een goede inschatting van de prognose en voor het instellen van adequate behandeling.

Wat betreft het ziektebeloop vertonen LR (met inbegrip van 10% specifieke aandoeningen) en KANS (met inbegrip van 60% specifieke aandoeningen) veel gelijkenis. De beginfase wordt gekarakteriseerd door herstel bij een groot deel van de patiënten. Maar velen van hen krijgen te maken met recidieven in de periode daarna. Ongeveer één op de tien patiënten heeft een beloop met persistente pijn en andere ongunstige gezondheidsuitkomsten. Er is dus sprake van een grote subgroep van patiënten met persisterende of recidiverende LR of KANS, die beter vergelijkbaar is met een langdurige chronische ziekte zoals astma, dan met een in klachtenduur beperkte aandoening zoals een gewone verkoudheid. Het is belangrijk om de focus te verleggen van het kijken naar een episode van aspecifieke LR of KANS als een op zichzelf staande gebeurtenis, naar het inzicht dat deze aandoeningen zich presenteren als een keten van episodes, met een vaak wisselend beloop ten aanzien van pijn, beperkingen en andere gezondheidsuitkomsten. Deze paradigmashift kan resulteren in mogelijkheden om klinisch

betekenisvolle subgroepen van patiënten te onderscheiden die gepaard gaan met een bepaald beloop. De subgroepen van patiënten met een chronisch beloop zijn relatief groot (25-50% na één jaar en 20-35% na meerdere jaren) en lijken veel groter dan voorheen gerapporteerd in diverse richtlijnen. Dit heeft belangrijke consequenties voor de arbeidsparticipatie en het gebruik van gezondheidszorgvoorzieningen. Het is echter nog moeilijk om de data van verschillende cohortstudies met elkaar te vergelijken, vanwege verschillen in type populaties, toegepaste uitkomstmaten en follow-up-duur.

De meest consistent gerapporteerde prognostische indicatoren (op baseline) voor het beloop van LR zijn: a) een hoog beperkingenniveau; b) uitstralende pijn in het been; c) slechte algemene gezondheidstoestand; d) aanwezigheid van biomedisch niet plausibele kenmerken; e) verhoogde psychische of psychosociale stress, met inbegrip van een hoog niveau van bewegingsangst; f) psychiatrische co-morbiditeit; g) hoge lichamelijke werkbelasting; en h) slechte relatie met collega's. Daarbij worden de prognostische indicatoren hoge pijnintensiteit en ontevredenheid met het werk ook frequent gerapporteerd, maar iets minder consistent. Het bewijs is inconsistent voor de indicatoren oudere leeftijd, vrouwelijk geslacht, hoge psychische werkbelasting en aanwezige compensatie voor loonderving.

De toepassing van het instrument voor het vaststellen van de arbeidsgerelateerdheid van specifieke LR ondersteunt de identificatie van een subgroep van patiënten, bij wie sprake is van een BZ. Bij deze patiënten is het treffen van ergonomische maatregelen om de werkbelasting te reduceren verplicht en een noodzakelijke voorwaarde voor werkhervatting. Aangezien werkgerelateerde factoren ook zijn geïdentificeerd als prognostische indicatoren, lijkt het van belang om preventieve maatregelen al te implementeren bij lagere niveaus van werkbelasting dan nodig voor de registratie als BZ.

Veel prognostische indicatoren (op baseline) voor het beloop van beperkingen, die in het KANS-cohort in dit proefschrift zijn aangetoond, zijn ook gevonden in onderzoek naar LR: a) bewegingsangst; b) catastroferende gedachten; c) klachtenduur; d) ernst van de klachten; e) uitbreiding van klachten; en f) slechte algemene gezondheidstoestand. Daarentegen zijn sommige andere prognostische factoren niet zo duidelijk naar voren gekomen in onderzoek naar LR: a) somatisatie; b) gebrek aan sociale steun; c) co-morbiditeit door KAHB; d) oudere leeftijd; e) vrouwelijk geslacht; en f) opleidingsniveau. Psychosociale indicatoren lijken bij KANS-patiënten een net zo grote, zo niet grotere rol te spelen dan bij LR-patiënten. Bovendien lijken klacht-gerelateerde indicatoren belangrijker te zijn.

Met betrekking tot het medisch management bij specifieke KAHB kan worden geconcludeerd, dat er nog onvoldoende inzicht is welke prognostische factoren het meest bruikbaar zijn om op te sporen en aan te pakken met (additionele) interventies.

Verder prognostisch onderzoek is nodig, vooral bij KANS. Het lijkt de moeite waard om beschikbare instrumenten om prognostische indicatoren voor LR te identificeren te verbeteren, en soortgelijke instrumenten voor KANS te ontwikkelen. Met deze instrumenten moet een accuraat onderscheid in klinisch betekenisvolle subgroepen van patiënten gemaakt kunnen worden, die ontvankelijk zijn voor psychologische, fysieke of ergonomische interventies. Vervolgens is het noodzakelijk om, gericht op deze subgroepen, de beschikbare behandelprotocollen te verbeteren of nieuwe interventies te ontwikkelen. Op dit moment worden bij veel patiënten psychosociale of werkgerelateerde prognostische factoren genegeerd, omdat er te weinig wetenschappelijke onderbouwing is voor de indicatoren waarop beschikbare of nieuw te ontwikkelen interventies gericht kunnen worden. Dientengevolge worden wellicht kansen gemist om het resultaat van behandeling van deze patiënten te verbeteren. Bij patiënten met specifieke LR was de implementatie van een instrument om psychosociale factoren op te sporen veelbelovend, maar zowel dit instrument als de op maat gesneden interventie behoeven nog verbetering. De effectiviteit van interventies voor patiënten met LR en KANS kan verder vergroot worden door aandacht te besteden aan de geïdentificeerde niet-psychosociale indicatoren, alsmede aan werkgerelateerde herstelbelemmerende factoren. Er is behoefte aan verder onderzoek naar de effectiviteit van nieuwe protocollen voor 'stratified care' en 'integrated care'. Bij gebrek hieraan lijkt het vooralsnog zinvol om te proberen in de klinische praktijk de meest relevante prognostische factoren te identificeren en deze mee te nemen in de overwegingen ten aanzien van behandelkeuzes.

Tenslotte zijn een aantal aanbevelingen gedaan voor de klinische praktijk en voor toekomstig onderzoek:

### **Aanbevelingen voor de klinische praktijk**

- Wanneer iemand die werkt een bedrijfsarts consulteert wegens specifieke LR, moet het instrument voor het vaststellen van de arbeidsgerelateerdheid van specifieke LR gebruikt worden om aandacht te besteden aan de werkgerelateerde factoren die hebben bijgedragen aan de ontwikkeling van de klachten;
- Na exclusie van specifieke aandoeningen bij patiënten met specifieke LR of KANS, moet de aandacht van de zorgverlener verlegd worden van de diagnostiek naar de evaluatie van prognostische indicatoren voor een ongunstige gezondheidstoestand op de lange termijn, zoals gebrek aan herstel, persisteren van klachten, chronische beperkingen of arbeidsongeschiktheid;
- Er moet nog verdere implementatie plaatsvinden van de KANS-richtlijn (inclusief het KANS-model), ten einde het medisch management van KANS te verbeteren en de

samenwerking tussen alle professionals in de reguliere zorg en arbozorg te bevorderen;

- Bij patiënten met een nieuwe episode van KANS is aandacht voor psychosociale factoren noodzakelijk om de afweging te kunnen maken of een additionele interventie door een psycholoog of een therapeut met psychologische en sociale behandelcompetenties geïndiceerd is.

### **Aanbevelingen voor toekomstig onderzoek**

- Onderzoek naar de meest relevante prognostische factoren, die geassocieerd zijn met de verschillende gezondheidsuitkomsten die zich na verloop van tijd kunnen voordoen bij LR en KANS, bij voorkeur met gebruik van herhaalde metingen gedurende langdurige follow-up;
- Onderzoek gericht op de ontwikkeling en evaluatie van interventies die zijn toegesneden op subgroepen van patiënten met specifieke LR en KANS, resulterend in nieuwe mogelijkheden voor 'stratified care';
- Tien jaar na de ontwikkeling van het instrument voor het vaststellen van de arbeidsgerelateerdheid van specifieke LR is een grondige revisie noodzakelijk om nieuwe inzichten ten aanzien van de rol van werkgerelateerde factoren bij specifieke LR te incorporeren;
- Onderzoek naar de toegevoegde waarde van de multidisciplinaire richtlijn voor diagnostiek en behandeling van specifieke KANS voor de klinische praktijk is van belang om haar implementatie te versterken.



DANKWOORD



## DANKWOORD

*ALEA IACTA EST.* Dat spreekwoord uit mijn gymnasiumtijd komt bij mij op, bij dit moment van afronding van mijn proefschrift. Nu is het onherroepelijk, na een lange en soms barre tocht, mag ik nu door naar de verdediging van dit werk op 6 juli 2016. Aan dit proefschrift is een lange historie vooraf gegaan met zelfs een switch van promotietraject, toen duidelijk werd dat het eerste spoor doodliep en een nieuw, tweede spoor, nodig was om tot dit resultaat te komen. Dat betekent dus, dat ik lang bezig ben geweest met 'promoveren' en zo kennen veel mensen mij ook (' ik durf het bijna niet te vragen, maar ...'). Toen ik eind 2011 eenmaal de richting voor dit proefschrift had gevonden, was de duur van dit gewijzigde promotietraject gelukkig vrij gemiddeld. Ik ben erg blij dat ik op dit punt ben aanbeland en wil graag mijn grote dank uitspreken aan ALLE mensen die mij direct of indirect tijdens deze tocht hebben geholpen, begeleid, ondersteund en aangemoedigd. Wanneer je al zo lang met onderzoek en het 'promoveren' bezig bent, zijn dat er teveel om allemaal te noemen. Daarom wil ik hier de belangrijkste mensen benoemen, die in mijn promotieleger met mij de Rubicon zijn overgetrokken.

Ik wil beginnen met de drie mensen die mij, nadat ik als net afgestudeerde geneeskunde student het plan had opgevat om mij verder te bekwamen in onderzoek, van het spoor van 'onderzoek doen' op het spoor van 'wetenschap bedrijven' hebben gezet. De eerste daarvan is wijlen Hans Valkenburg, die gaandeweg het ROME-onderzoek ging inzien dat de kennis die we genereerden een beter lot verdiende dan een TNO-rapport in enkele boekenkasten en bureaulades. Van zijn hartelijke, humorvolle, pragmatische en relaxte manier van begeleiden heb ik veel geleerd. Zijn mening werd hartstochtelijk ondersteund door Hans Rasker. Zelfs toen het eerste traject stakte bleef jij mij onophoudelijk stimuleren om die promotie na te streven. Dank voor de fijne samenwerking, intensief in mijn TNO-tijd, en vriendschappelijk in al die jaren erna. Daarin ben jij altijd een virtuele co-promotor geweest, hoewel je niet direct bij de inhoud van dit proefschrift betrokken was. De derde persoon uit die periode is Sjef van der Linden. Jij ging op verzoek van Hans Valkenburg en Hans Rasker de uitdaging aan mij te begeleiden in het schrijven van artikelen voor een proefschrift, gebaseerd op het ROME-materiaal. Hieraan ben je enthousiast begonnen, maar langdurige belemmeringen in mijn privé-leven, afstand tot Maastricht, beperkingen in de dataset en tenslotte veroudering van het materiaal werden uiteindelijk een te grote hindernis. Uit waardering voor jouw steun heb ik het artikel dat we op grond van een follow-up studie over rugklachten hebben geschreven meegenomen in dit proefschrift. Gelukkig voelde jij je destijds ook aangesproken door mijn initiatief om de relatie tussen reumatische ziekten en werk te onderzoeken en hebben we op dat terrein twee onderzoekers kunnen laten promoveren.

Eind 2011 ontwikkelde ik het plan voor een nieuw promotietraject, gebaseerd op data en andere materialen uit onderzoek van Kenniscentrum Arbeid en Klachten Bewegingsapparaat (AKB) van Erasmus MC en enkele vervolgstudies daarop. Toen ik dat besprak met Bart Koes en Lex Burdorf, oud bestuursleden van dit kenniscentrum, en hen vroeg mij als promotoren daarbij te ondersteunen, stemden zij meteen daarmee in. Wat mij betreft een schot in de roos. Jullie begeleiding op zowel inhoud als proces was top. Enerzijds was er voldoende ruimte en begrip voor mijn vaak drukke agenda bij Hogeschool Rotterdam en mijn bedrijfsmatige activiteiten, waardoor er soms minder voortgang was. Anderzijds waren er ook aansporing en verzoek om nieuwe concepten wanneer er enige tijd geen productie leek te zijn. Inhoudelijk vulden jullie elkaar heel goed aan, waardoor we echt gezamenlijk konden optrekken om nieuw onderzoek op te zetten of nieuwe analyses uit te voeren op reeds verzamelde data. Altijd kwamen jullie snel met reactie op concepten, met zinvol en bruikbaar commentaar en goede suggesties voor verbetering. Net zoals onze samenwerking al lang vóór dit promotietraject begonnen was, hoop ik dat deze ook ná deze mijlpaal nog lang zal voortduren.

De vele co-auteurs die met mij hebben samengewerkt bij het opstellen van de artikelen in dit proefschrift wil ik ook graag van harte bedanken voor hun bijdrage. Bij het oudste artikel waren dit, naast Sjef van der Linden, Astrid Chorus en Cees Wevers. Fijn dat we de samenwerking destijds hebben kunnen doortrekken in de bestudering van de relatie tussen reumatoïde artritis en werk.

Voor het onderzoek naar beroepsziekten veroorzaakt door rugklachten heb ik contact gezocht met Paul Kuijer en Henk van der Molen van het Nederlands Centrum voor Beroepsziekten (Academisch Medisch Centrum Amsterdam), die meteen positief reageerden en enthousiast meewerkten aan de analyses en het schrijven van het artikel. Het is mooi dat we dit artikel ook hebben kunnen bewerken in enkele Nederlandstalige publicaties, waarvoor bijna nog meer internationale belangstelling kwam dan voor het origineel.

Bionka Huisstede was 1<sup>e</sup> auteur van het artikel over de ontwikkeling van de eerste versie van het KANS-model. Fijn dat je destijds mijn idee voor de ontwikkeling van dit model als alternatief voor de term RSI voortvarend hebt opgepakt, destijds de start van je eigen promotietraject. Naast Bart en ik waren Arianne Verhagen en Jan Verhaar ook co-auteur op dit artikel.

Met Anita Feleus heb ik nauw samengewerkt bij drie artikelen in dit proefschrift, maar ook in vele andere projecten sinds jouw komst naar Hogeschool Rotterdam. Toen Carla Schenkeveld halverwege het richtlijnproject wegviel, nam jij de rol van coördinator met enthousiasme over. Mede hierdoor konden we dit project tot een goed einde brengen. Dank voor je grote inzet en je altijd constructief kritische blik. Carla, bedankt voor de eerste periode van het richtlijnproject, waarin we gezamenlijk vanuit alle soms heftige

discussies in de werkgroep konden toewerken naar consensus. In de redactiefase van het richtlijnproject hebben ook Elin Koppelaar en Adriaan Visser nog hard meegewerkt om het lijvige document zo leesbaar mogelijk op papier te krijgen. Dank ook aan alle werkgroepleden en adviseurs, zonder wiens inzet en inbreng de richtlijn niet tot stand had kunnen komen.

Met Elin heb ik verder gewerkt aan het 'ICF'- artikel, waarbij ook Yvonne Heerkens, als expert bij uitstek op dit terrein, ons heeft geholpen met het leggen van de verbanden tussen de PROMs en de ICF-categorieën en met het hanteren van de juiste terminologie. Bij het laatste artikel heeft Trynke Hoekstra enorm geholpen door Anita en mij wegwijs te maken in het statistisch doolhof van de LCGM. Veel dank voor je geduldige en heldere uitleg en feedback. Sita Bierma-Zeinstra was destijds co-promotor van Anita's promotietraject, waarin de data voor dit artikel zijn verzameld en gaf ook feedback op de concepten.

Tenslotte een woord van dank aan Laraine Visser-Isles voor de altijd snelle hulp bij het Engels van vijf artikelen in dit proefschrift.

De leden van de leescommissie, Mieke Hazes, Han Anema en Raymond Ostelo, wil ik hartelijk danken voor hun beoordeling van het manuscript voor dit proefschrift en hun oppositie. Mieke, speciaal dank voor de vele jaren van samenwerking, onder meer in het bestuur van het 'Decennium van het Bewegingsapparaat' (Bone and Joint Decade). Ook wil ik graag de overige leden van de promotiecommissie, Josephine Engels, Pim Assendelft en Clemens Dirven bedanken voor hun aanwezigheid en oppositie op de promotiedag. Josephine, dank ook voor de fijne samenwerking in een aantal projecten op gebied van 'Arbeid en Gezondheid'.

Dit proefschrift heb ik voor het grootste deel in mijn 'eigen tijd' geschreven, maar op een aantal momenten heb ik wat extra tijd mogen vrijmaken binnen mijn aanstelling bij Kenniscentrum Zorginnovatie van Hogeschool Rotterdam. Steeds heb ik hierbij enorm veel steun ervaren van mijn collega lectoren en (docent)-onderzoekers. Een aantal wil ik speciaal bedanken. Allereerst Chris Kuiper, die mij eind 2004 vroeg of ik de vrijgekomen lector-positie bij de kenniskring 'Arbeid en Gezondheid' wilde invullen. In die tijd kon dat nog zonder voorafgaande doctors-titel, als dat gecompenseerd werd door ruime ervaring en expertise, maar ons beider streven was die titel wel zo snel mogelijk in te vullen. Dat heb jij veel sneller gerealiseerd dan ik, maar altijd was je betrokken en stimulerend in mijn traject. Samen pionierden wij met de introductie van onderzoek in het HBO rond het thema Arbeid en Gezondheid en later ook Participatie in bredere zin. Ik kijk met veel warme gevoelens op die periode terug. Ten tweede Marleen Goumans, programmadirecteur sinds de uitvinding van die functie in 2011 en fijne collega en leidinggevende. Ook jij liet mij de ruimte nemen voor mijn promotiewerk wanneer dat

even nodig was, hoewel vaker extra werkzaamheden voor het lectoraat of kenniscentrum de voortgang van het promotietraject in de weg stonden. Ik ben erg blij met ons werk voor de kritische reflectie op ons kenniscentrum en de externe visitatie in 2015, met als resultaat een prachtige beoordeling. Dank aan Hogeschool Rotterdam zelf voor de ondersteuning van de drukkosten van dit proefschrift.

Tijdens mijn onderzoekswerk bij Hogeschool Rotterdam en daarvoor bij Erasmus MC en TNO heb ik met heel veel collega's uitstekend kunnen samenwerken en vele artikelen en soms rapporten, boekbijdrages of boeken kunnen publiceren. Veel promovendi heb ik als een soort informele co-promotor mogen begeleiden in hun traject, waarvan ik ook zelf veel heb kunnen leren. Dank aan Astrid Chorus en Annelies Boonen (TNO), Anita Feleus, Jolanda Luime, Elske Faber, Bionka Huisstede en Elin Koppelaar (Erasmus MC) en Karin Verkerk en Joan Verhoef (Hogeschool Rotterdam). Bij een groot aantal van de promovendi die nu bezig zijn, Marlies Wagener, Stefanie van Opstal, Marjolijn Bal, Sara van der Venne, Hannah de Boer, Jos Kox en Ellen Bakker, hoop ik straks zelf achter de tafel te mogen plaatsnemen. Naast Anita, Joan, Marlies en Marjolijn werk ik ook met Pepijn Roelofs, Inge Bramsen, Sander Hilberink, en Nicolette van Zanten al vele jaren samen in het lectoraat Arbeid en Gezondheid en de bijbehorende minor. Ook met mijn collega lectoren van Kenniscentrum Zorginnovatie is het fijn samenwerken, waarbij ieder zich met grote motivatie en hart voor de zaak inzet voor onderzoek, onderwijs en de verbinding daartussen. Naast Marleen zijn dat mijn collega's in het dagelijks bestuur Henk Rosendal en Patricia Vuijk, de collega's in de lijn Zelfmanagement en Participatie Anneloes van Staa, Mieke Cardol en Jacomine de Lange en de overige lectoren Connie Dekker, Hanneke Torij, Linda Wauben, Ton Bakker en nog een beetje Chris Kuiper. In de dagelijkse hektiek is er in onze part-time lectoraten veel te vaak bar weinig tijd voor uitwisseling en reflectie, maar gelukkig komen steeds meer gezamenlijke projecten van de grond. Het ondersteuningsbureau van het Kenniscentrum Zorginnovatie ondersteunt mij altijd snel en adequaat bij al het werk en ook bij onderdelen van dit proefschrift. Veel dank daarvoor, met name aan Hanneke de Bruijn, Elly Katoen, Brigit van Gulik, Heleen Hanny en Ilona van der Lee. De vele andere collega's bij TNO, ZON (nu ZONMw), Erasmus MC, Rijndam Revalidatiecentrum en Hogeschool Rotterdam en alle externe partners met wie ik in de loop der jaren in onderzoek en onderwijs heb samengewerkt zijn te talrijk om allemaal persoonlijk te noemen en wil ik daarom met deze ene zin bedanken, bedenkend dat veel projecten zonder deze samenwerking niet gerealiseerd hadden kunnen worden.

Deze dag zou niet compleet zijn zonder twee fiere en hooggeleerde paranimfen aan mijn zijde, Michiel Westenberg en Joost Schokkenbroek. Dank voor jullie jarenlange vriendschap en steun op deze dag en de voorbereiding daarvan.

Ik heb al vele deelnemers aan mijn promotieleger genoemd, maar zonder de enorme en niet aflatende steun aan het thuisfront zou de Rubicon een onneembare hindernis zijn gebleven. Ik realiseer mij terdege dat het lange traject dat ik heb doorlopen, meestal naast mijn andere 'gewone' werk, een fors beslag heeft gelegd op kostbare 'eigen tijd' die ook aan andere dingen besteed had kunnen worden. Lieve Suzanne en Iris, jullie hebben wellicht daarvan het meeste 'last' gehad door momenten van aandacht te moeten missen. Jullie zijn opgegroeid tot prachtige en intelligente dochters, waarop ik heel erg trots ben. Ik ben blij met alle gesprekken en discussies die we nu kunnen hebben. Lieve Hanke en Siebe, vooral de laatste jaren werden jullie je bewust van het tijdsbeslag dat gepaard ging met het schrijven van het proefschrift, waardoor pappa vaak niet mee ging naar familie of uitjes, maar ook veel klussen in huis bleven liggen. Ook jullie hebben je ontwikkeld tot hele mooie en slimme kinderen die al bijna de basisschool gaan verlaten en mij ook erg trots en blij maken. Het is nu de hoogste tijd dat ik aan jullie nieuwe slaapkamers ga werken, als thuisbasis voor jullie periode van voortgezet onderwijs. En Siebe, nog bedankt voor de aanzet voor mijn laatste stelling. Liefste Hannerieke, ik ben heel blij dat ik jou heb leren kennen en dat we ons leven met elkaar kunnen delen. Nadat ik jou heb kunnen ondersteunen bij jouw promotie, alweer 13 jaar geleden, heb jij je geweldig ingezet om ook mijn promotietraject te doen slagen, ondanks soms lastige tijden waarin er sterke tegenwind was. Gelukkig zal er nu wat meer ruimte komen voor ons en ons gezin.

Ik wil dit dankwoord afsluiten met de twee mensen die aan de basis stonden van mijn leven en loopbaan en mij altijd hebben gestimuleerd en gesteund, eerst in opleiding en loopbaan en later ook bij de promotieplannen. Lieve Martien, ik ben erg blij dat jij in goede gezondheid de afronding van dit promotietraject kunt beleven. Dank voor de steun en altijd grote interesse in mijn promotietraject en loopbaan. Lieve Siebren, jij wilde zo mogelijk nog het liefst dat ik ging promoveren, maar moest jouw strijd helaas op veel te jonge leeftijd opgeven. Ik ben je dankbaar voor alle steun die jij me hebt gegeven zolang dat kon, en draag dit proefschrift graag aan jou op.



# ABOUT THE AUTHOR



## ABOUT THE AUTHOR

Harald Miedema was born on January 22, 1963 in Groningen, the Netherlands. He graduated from the secondary school Willem Lodewijk Gymnasium in Groningen in 1981. He started to study Medicine at the University of Groningen (formerly Rijksuniversiteit Groningen) in 1982 and performed his medical internship at the hospital Ziekenzorg in Enschede, the Netherlands. In 1989 he obtained his medical degree, after which he moved to Leiden to be able to further specialize in research at the Netherlands Organization for Applied Scientific Research TNO. In 1991 he obtained his degree as Epidemiologist A.

At TNO, Harald started to work in two projects of the Committee for Research in Rheumatology (CR-TNO), the ROME-study (Reuma Onderzoek Meerdere Echelons) and the Standard Diagnosis Register of Rheumatic Diseases (SDR). After finishing the ROME-study, he was appointed as coordinator of the CR-TNO. In this period he also performed further studies regarding epidemiology of musculoskeletal disorders in the Netherlands and the results of rheumatic diseases research in the Netherlands. Furthermore, he started research regarding the relationship between several rheumatic diseases, especially rheumatoid arthritis and ankylosing spondylitis, and work, which resulted in two PhD projects.

In 1998 Harald was appointed as research-program coordinator at the Netherlands Organization for Health Research and Development (ZON, later ZONMw) in The Hague, the Netherlands. As a result of the special attention of ZON for implementation, he was able to extend his knowledge on this subject, especially in the field of musculoskeletal disorders and occupational healthcare. In 2000, this combination led to the request of Erasmus university Medical Center (Erasmus MC) in Rotterdam, the Netherlands, to set up and manage the Knowledge Center for Workrelated Musculoskeletal Disorders (Kenniscentrum Arbeid en Klachten Bewegingsapparaat, AKB). Harald held this position until 2010. During this period he initiated and supported many implementation projects as well as scientific studies, including five PhD projects. In 2005 the government grants for this knowledge center were cut, resulting in the start of a number of other professional activities. In 2005 and 2006 Harald supported the start of the Development Center for Pain Rehabilitation at Rijndam Rehabilitation Center in Rotterdam, in collaboration with the Department of Rehabilitation of Erasmus MC. In addition, he started and directed EMcare, a private occupational outpatient clinic for workers with long lasting or complex musculoskeletal disorders. End 2012 this company was taken over by Ergatis. Furthermore, from 2009 onwards he started and directed Preferred Care Physiotherapy Quality Network. This company ended its activities in 2015 due to changing business conditions.

In 2005 Harald was appointed as applied research professor (lector) Work and Health at the Rotterdam university of Applied Sciences (Hogeschool Rotterdam). In 2009 his unit was combined with several others into the Research Center of Innovations in Care (Kenniscentrum Zorginnovatie). During his lectureship many scientific studies and educational projects were started, including nine PhD projects, two of which were finished recently, and a minor Work and Health.

Harald also worked on his own PhD thesis, but pursued a dead-end project for a long time. End 2011, he started a new PhD project, that is described in this thesis, using data from previous research projects as well as new data from recent studies.

Harald lives in Leiderdorp, the Netherlands, and is married to Hannerieke van den Hout. He has four children: Suzanne (25), Iris (23), Hanke (11) and Siebe (9).





# LIST OF PUBLICATIONS



## Articles in this PhD-thesis

### Chapter 2:

- Miedema HS, Chorus AM, Wevers CW, Van der Linden S. Chronicity of back problems during working life. *Spine*. 1998;23:2021-8.

### Chapter 3:

- Miedema HS, Van der Molen HF, Kuijer PPFM, Koes BW, Burdorf A. Incidence of low back pain related occupational diseases. *Eur J Pain*. 2014;18(6):873-82.

### Chapter 4:

- Huisstede BMA, Miedema HS, Verhagen AP, Koes BW, Verhaar JAN. Multidisciplinary consensus on terminology and classification of complaints of arm, neck and/or shoulder. *Occup Environm Med*. 2007;64(5):313-9.

### Chapter 5:

- Miedema HS, Huisstede BM. Comment on: Boocock MG et al. A framework for the classification and diagnosis of work-related upper extremity conditions: systematic review. *Semin Arthritis Rheum*. 2009;38(5):407-8.

### Chapter 6:

- Miedema HS, Feleus A. Richtlijn 'Aspecifieke klachten arm, nek en/of schouders'. *Ned Tijdschr Geneesk*. 2013;157:A6249.

### Chapter 7:

- Miedema HS, Koppelaar E, Heerkens YF, Feleus A, Burdorf A, Koes BW. Overview of ICF categories addressed within outcome measures applied in prognostic and intervention studies for nonspecific complaints of arm, neck and shoulder. Submitted.

### Chapter 8:

- Miedema HS, Feleus A, Hoekstra T, Bierma-Zeinstra SMA, Burdorf A, Koes BW. Disability trajectories in patients with complaints of arm, neck and shoulder (CANS) in primary care: a prospective cohort study. *Phys Ther*. 2016;x (Epub ahead of print Dec 5, 2015).

## Other research articles

2016

- Bal MI, Sattoe JNT, Roelofs PDDM, Bal R, Van Staa A, Miedema HS. Exploring effects and effective intervention components of self-management support for young people with chronic conditions: A systematic review. *Patient Educ Couns*. 2016;99:pii-S0738-3991(16)30079-9 (Epub ahead of print).
- Bal MI, Sattoe JNT, Van Schaardenburgh NR, Floothuis MCSG, Roebroek ME, Miedema HS. A vocational rehabilitation intervention for young adults with physical disabilities: participants' perception of beneficial attributes. *Child Care Health Dev*. 2016. Accepted.
- Bal MI, Sattoe JNT, Miedema HS, Van Staa A. Participation and psychosocial outcomes of young adults with chronic conditions: Comparing disability benefit recipients and non-recipients. Submitted.
- Bal MI, Roelofs PDDM, Miedema HS, Kuiper CHZ. Working alliance on the road to independence: a qualitative study on support needs of adolescents with autism spectrum disorders, their parents and teachers. Submitted.

- Durán Millán JI, Feleus A, Roelofs PDDM, Miedema HS. Effectiveness of extracorporeal shock wave therapy (ESWT) and radial pressure wave therapy (RPWT) in the treatment of non-calcific supraspinatus tendinosis: Systematic review and meta-analysis. Submitted.
- Feleus A, Miedema HS, Hoekstra T, Bierma-Zeinstra SMA, Koes BW, Burdorf A. Sick leave in patients with arm, neck and/or shoulder complaints; defining occurrence and discriminative trajectories over a 2-year time period. Submitted.
- Verhoef JAC, Bal MI, Roelofs PDDM, Borghouts JAJ, Roebroek ME, Miedema HS (Submitted). Effectiveness of interventions to improve work participation in adults with chronic physical conditions: a systematic review. Submitted.
- Wagener MN, Van den Dries L, Van Exel J, Miedema HS, Van Gorp ECM, Roelofs PDDM. Determinants of employment in people living with HIV in the Netherlands. Submitted.

2015

- Sattoe JNT, Bal MI, Roelofs PDDM, Bal R, Miedema HS, Van Staa A. Self-management interventions for young people with chronic conditions: A Systematic Overview. *Patient Educ Couns*. 2015;98(6):704-15.
- Verkerk K, Luijsterburg PAJ, Heymans MW, Ronchetti I, Pool-Goudzwaard A, Miedema HS, Koes BW. Prognosis and course of pain in patients with chronic non-specific low back pain: a 5 and 12-months follow-up cohort study. *Eur J Pain*. 2015;19(8):1101-10.
- Verkerk K, Luijsterburg PAJ, Pool-Goudzwaard A, Heymans MW, Ronchetti I, Miedema HS, Koes BW. Prognosis and course of work participation in patients with chronic non-specific low back pain: a 12-months follow-up cohort study. *J Rehabil Med*. 2015;47(9):854-9.
- Verkerk K, Luijsterburg PAJ, Heymans MW, Ronchetti I, Miedema HS, Koes BW, Pool-Goudzwaard A. Prognostic factors and course for successful clinical outcome quality of life and patients' perceived effect after a cognitive behaviour therapy for chronic non-specific low back pain: A 12-months prospective study. *Man Ther*. 2015;20(1):96-102.
- Wagener MN, Roelofs PDDM, Miedema HS, Brandjes DPM, Dahmen R, Van Gorp ECM. The development of a multidisciplinary, evidence-based guideline for 'HIV and employment'. *Aids Care*. 2015;27(2):133-41.
- Wagener MN, Roelofs PDDM, Kleijn L, Miedema HS, Van Gorp ECM. Vocational counseling of HIV-infected people: the role of the HIV nurse. *J Assoc Nurses AIDS Care*. 2015;26(4):330-9.

2014

- Huiszoon E, De Vreede PL, Bramsen I, Kuiper CHZ, Miedema HS. Assessment of Daily Activity Performance: Exploring the Option of Shortening the Test. *J Aging Phys Act* 2014;22(1):44-51. Erratum in *J Aging Phys Act*. 2014;22(4).
- Verhoef JAC, Roebroek ME, Van Schaardenburgh N, Floothuis MCSG, Stam HJ, Miedema HS. Improved Occupational Performance of Young Adults with a Physical Disability After a Vocational Rehabilitation Intervention. *J Occup Rehabil*. 2014;24(1):42-51.
- Verhoef JAC, Bramsen I, Miedema HS, Stam HJ, Roebroek ME. Work participation and experienced work barriers and limitations of young adults with Cerebral Palsy. *J Rehab Med*. 2014;46(7):648-55.
- Wagener MN, Van Opstal SEM, Miedema HS, Brandjes DPM, Dahmen R, Van Gorp ECM, Roelofs PDDM. Employment-related concerns of HIV-positive people in the Netherlands. *J Occup Rehabil*. 2014;24(4):790-7.

2013

- Koppelaar E, Knibbe JJ, Miedema HS, Burdorf A. The influence of individual and organisational factors on nurses' behaviour to use lifting devices in healthcare. *Appl Ergon*. 2012;44(4):532-7.

- Verhoef JAC, Miedema HS, Van Meeteren J, Stam HJ, Roebroek ME. A new intervention to improve work participation of young adults with physical disabilities: a feasibility study. *Developm Med Child Neurol.* 2013;55(8):722-8.
  - Verkerk K, Luijsterburg PAJ, Heymans MW, Ronchetti I, Pool-Goudzwaard A, Miedema HS, Koes BW. Prognosis and course of disability in patients with chronic non-specific low back pain: a 5 and 12-months follow-up cohort study. *Phys Ther.* 2013;93(12):1603-14.
- 2012
- Koppelaar E, Knibbe HJ, Miedema HS, Burdorf A. The influence of ergonomic devices on mechanical load during patient handling activities in nursing homes. *Ann Occup Hyg.* 2012;56(6):708-18.
  - Verhoef JA, Miedema HS, Bramsen I, Roebroek ME. Using the work limitations questionnaire in patients with a chronic condition in the Netherlands. *J Occup Environ Med* 2012;54(10):1293-9.
  - Verkerk K, Luijsterburg PA, Miedema HS, Pool-Goudzwaard A, Koes BW. Prognostic factors for recovery in chronic nonspecific low back pain: a systematic review. *Phys Ther.* 2012;92(9):1093-1108.
- 2011
- Bramsen I, Tomesen I, Voorham A, Miedema H. Activating welfare recipients with health complaints: The reasons for failure of a Dutch version of a good practice. *J Social Interv - Theory Pract.* 2011;20(1):57-75.
  - Koppelaar E, Knibbe HJ, Miedema HS, Burdorf A. Individual and Organisational Determinants of Use of Ergonomic Devices in Healthcare. *Occup Environ Med.* 2011;68(9):659-665.
  - Verkerk K, Luijsterburg P, Miedema HS, Pool A, Koes BW. Course and prognosis of recovery for chronic non-specific low back pain: design, therapy program and baseline data of a prospective cohort study. *BMC Musculoskelet Disord.* 2011;12(11):252.
- 2010
- Keijsers E, Feleus A, Miedema HS, Koes BW, Bierma-Zeinstra SMA. Psychosocial factors predict non-recovery in both specific and non-specific diagnoses at arm, neck and shoulder. *J Clin Epidemiol.* 2010;63(12):1370-9.
- 2009
- Feleus A, Bierma-Zeinstra SM, Bernsen RM, Miedema HS, Verhaar JA, Koes BW. Management decisions in nontraumatic complaints of arm, neck, and shoulder in general practice. *Ann Fam Med.* 2009;7(5):446-54.
  - Koppelaar E, Knibbe JJ, Miedema HS, Burdorf A. Determinants of implementation of primary preventive interventions on patient handling in healthcare: a systematic review. *Occup Environ Med.* 2009;66(6):353-60.
- 2008
- Feleus A, Bierma-Zeinstra SMA, Miedema H, Bernsen RMD, Verhaar JAN, Koes BW. Incidence of non-traumatic complaints of arm, neck and shoulder in general practice. *Man Ther.* 2008;3(5):426-33.
  - Feleus A, Bierma-Zeinstra SM, Miedema HS, Verhaar JA, Koes BW. Management in non-traumatic arm, neck and shoulder complaints: Differences between diagnostic groups. *Eur Spine J.* 2008;17(9):1218-1229.
  - Huisstede B, Miedema HS, Van Opstal T, De Ronde MT, Verhaar JA, Koes BW. Interventions for treating the radial tunnel syndrome: a systematic review of observational studies. *J Hand Surg Am.* 2008;33(1):72-8.
- 2007
- Feleus A, Van Dalen T, Bierma-Zeinstra SM, Bernsen RM, Verhaar JA, Koes BW, Miedema HS. Kinesiophobia in patients with non-traumatic arm, neck and shoulder complaints: a prospective cohort study in general practice. *BMC Musculoskelet Disord.* 2007;8(11):117.

- Feleus A, Bierma-Zeinstra SMA, Miedema HS, Verhagen AP, Nauta AP, Burdorf A, Verhaar JAN, Koes BW. Prognostic indicators for non-recovery of nontraumatic complaints at arm, neck and shoulder in general practice: 6-months follow-up. *Rheumatology*. 2007;46(1):169-76.

2006

- Faber E, Burdorf A, Van Staa A, Miedema HS, Verhaar JA. Qualitative evaluation of a form for standardized information exchange between orthopedic surgeons and occupational physicians. *BMC Health Serv Res*. 2006;2(6):144.
- Faber EF, Kuiper JI, Burdorf A, Miedema HS, Verhaar JAN. Treatment of impingement syndrome, a systematic review of the effects on functional limitations and return to work. *J Occup Rehabil*. 2006; 16(1):7-25.
- Faber E, Burdorf A, Bierma-Zeinstra SM, Miedema HS, Koes BW. Determinants for improvement in different back pain measures and their influence on the duration of sickness absence. *Spine*. 2006; 31(13):1477-83.
- Huisstede BMA, Miedema HS, Van Opstal T, De Ronde MTM, Kuiper JI, Verhaar JAN, Koes BW. Interventions for treating the posterior interosseus nerve syndrome. A systematic review of observational studies. *J Peripher Nerv Syst*. 2006;11(2):101-10.

2005

- Faber E, Bierma-Zeinstra SM, Burdorf A, Nauta AP, Hulshof CT, Overzier PM, Miedema HS, Koes BW. In a controlled trial training general practitioners and occupational physicians to collaborate did not influence sickleave of patients with low back pain. *J Clin Epidemiol*. 2005;58:75-82.
- Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijjer PPFM, Spreeuwiers D, Lötters F, Miedema HS. Assessing the workrelatedness of non-specific low-back pain. *Scand J Work Environ Health*. 2005;31:237-43.

2004

- Boonen A, Van der Heijde D, Landewe R, Chorus A, Van Lankveld W, Miedema H, Van der Tempel H, Van der Linden S. Is avoidant coping independent of disease status and stable over time in patients with ankylosing spondylitis? *Ann Rheum Dis*. 2004;63:1264-8.
- Luime JJ, Koes BW, Hendriksen IJ, Burdorf A, Verhagen AP, Miedema HS, Verhaar JA. Prevalence and incidence of shoulder pain in the general population; a systematic review. *Scand J Rheumatol*. 2004; 33:73-81.
- Luime JJ, Kuiper JI, Koes BW, Verhaar JA, Miedema HS, Burdorf A. Work-related risk factors for the incidence and recurrence of shoulder and neck complaints among nursing-home and elderly-care workers. *Scand J Work Environ Health*. 2004;30:279-86.
- Luime JJ, Verhagen AP, Miedema HS, Kuiper JI, Burdorf A, Verhaar JA, Koes BW. Does this patient have an instability of the shoulder or a labrum lesion? *JAMA* 2004;292(16):1989-99.
- Van Duijn M, Miedema H, Burdorf A. Barriers for Early Return-to-work of Workers With Musculoskeletal Disorders According to Occupational Health Physicians and Human Resource Managers. *J Occup Rehabil*. 2004;14:31-41.

2003

- Chorus AM, Miedema HS, Boonen A, Van der Linden S. Quality of life and work in patients with rheumatoid arthritis and ankylosing spondylitis of working age. *Ann Rheum Dis* 2003;62:1178-84.
- Lötters F, Burdorf A, Kuiper J, Miedema H. Model for the workrelatedness of low-back pain. *Scand J Work Environ Health*. 2003;29:431-40.

2002

- Boonen A, Chorus A, Landewe R, Van der Heijde D, Miedema H, Van der Tempel H, Van der Linden S. Manual jobs increase the risk of patients with ankylosing spondylitis withdrawing from the labour force, also when adjusted for job related withdrawal in the general population. *Ann Rheum Dis.* 2002; 61:658.
- Chorus AM, Boonen A, Miedema HS, Van der Linden S. Employment perspectives of patients with ankylosing spondylitis. *Ann Rheum Dis.* 2002;61:693-9.
- Van Tulder MW, Croft PR, Van Splunteren P, Miedema HS, Underwood MR, Hendriks HJ, Wyatt ME, Borkan JM. Disseminating and implementing the results of back pain research in primary care. *Spine.* 2002;27:E121-7.

2001

- Boonen A, Chorus A, Miedema H, Van der Heijde D, Van der Tempel H, Van der Linden S. Employment, work disability, and work days lost in patients with ankylosing spondylitis: a cross sectional study of Dutch patients. *Ann Rheum Dis.* 2001;60:353-8.
- Boonen A, Chorus A, Miedema H, Van der Heijde D, Landewe R, Schouten H, Van der Tempel H, Van der Linden S. Withdrawal from labour force due to work disability in patients with ankylosing spondylitis. *Ann Rheum Dis.* 2001;60:1033-9.
- Chorus AM, Miedema HS, Wevers CW, Van der Linden S. Work factors and behavioural coping in relation to withdrawal from the labour force in patients with rheumatoid arthritis. *Ann Rheum Dis.* 2001; 60:1025-32.

2000

- Chorus AM, Miedema HS, Wevers CW, Van der Linden S. Labour force participation among patients with rheumatoid arthritis. *Ann Rheum Dis.* 2000;59:549-54.
- Sprangers MA, De Regt EB, Andries F, Van Agt HM, Bijl RV, De Boer JB, Foets M, Hoeymans N, Jacobs AE, Kempen GI, Miedema HS, Tijhuis MA, De Haes HC. Which chronic conditions are associated with better or poorer quality of life? *J Clin Epidemiol.* 2000;53:895-907.

1999

- Meulenbelt I, Bijkerk C, De Wildt SC, Miedema HS, Breedveld FC, Pols HA, Hofman A, Van Duijn CM, Slagboom PE. Haplotype analysis of three polymorphisms of the COL2A1 gene and associations with generalised radiological osteoarthritis. *Ann Hum Genet.* 1999;63:393-400.

1998

- Meulenbelt I, Bijkerk C, Miedema HS, Breedveld FC, Hofman A, Valkenburg HA, Pols HA, Slagboom PE, Van Duijn CM. A genetic association study of the IGF-1 gene and radiological osteoarthritis in a population-based cohort study (the Rotterdam Study). *Ann Rheum Dis.* 1998;57:371-4.
- Miedema HS, Van der Linden S, Rasker JJ, Valkenburg HA. National database of patients visiting rheumatologists in The Netherlands: the standard diagnosis register of rheumatic diseases. A report and preliminary analysis. *Br J Rheumatol.* 1998;37:555-561.

1997

- Meulenbelt I, Bijkerk C, De Wildt SC, Miedema HS, Valkenburg HA, Breedveld FC, Pols HA, Te Koppele JM, Sloos VF, Hofman A, Slagboom PE, Van Duijn CM. Investigation of the association of the CRTM and CRTL1 genes with radiographically evident osteoarthritis in subjects from the Rotterdam study. *Arthritis Rheum.* 1997;40:1760-5.

## Articles in professional journals

2015

- Hagendijk MM, Van Rossum E, Miedema HS, Bal MI (2015). Van participatiewet naar duurzame arbeidsparticipatie door mensen met een chronische aandoening. Een kwalitatieve studie naar behoeften van werkgevers aan ondersteuning bij de uitvoer van de participatiewet. *Sociaal Bestek*. 2015;2:46-7.
- Verhoef JAC, Roebroek ME, Van Meeteren J, Floothuis M, Van Schaardenburgh N, Stam HJ, Miedema HS. Een nieuwe interventie om de arbeidsparticipatie te bevorderen van jongvolwassenen met een lichamelijke beperking: een pilotstudie. *Tijdschr Bedrijfs Verzekeringngen*. 2015;23:406-412.

2014

- Kuijer PPFM, Miedema HS, Van der Molen HF, Burdorf A, Frings-Dresen MHW. Aspecifieke lage rugklachten door het werk. *Quintesse*. 2014;3;3:27-32.
- Miedema HS, Van der Molen HF, Kuijer PPFM, Koes BW, Burdorf A. Aan lage rugpijn gerelateerde beroepsziekten in Nederland: (1) Een instrument voor de beoordeling van de werkgerelateerdheid van aspecifieke lage rugklachten. *Tijdschr Bedrijfs Verzekeringngen*. 2014;22;8:371-375.
- Miedema HS, Van der Molen HF, Kuijer PPFM, Koes BW, Burdorf A. Aan lage rugpijn gerelateerde beroepsziekten in Nederland: (2) Incidentie van aan lage rugpijn gerelateerde beroepsziekten in Nederland: een prospectieve cohortstudie. *Tijdschr Bedrijfs Verzekeringngen*. 2014;22;9:422-430.

2013

- Bramsen I, Spaan I, Miedema H. Dialooggestuurde re-integratie helpt. Een onderzoek bij mensen met Post-Whiplash Syndroom, ME/CVS en Prikkelbare Darm Syndroom. *Aan de Slag*. 2013;1/2:30-31.
- Miedema HS. Tillen en rugklachten, een complexe relatie. *Tijdschr Bedrijfs Verzekeringngen*. 2013; 8(10):316-7.
- Verhoef JAC, Miedema HS, Van Meeteren J, Stam HJ, Roebroek ME. Een nieuwe interventie om de arbeidsparticipatie te verbeteren van jongeren met een lichamelijke beperking: een pilot-studie. *Wetensch Tijdschr Ergother*. 2013;4:4-18.
- Verkerk K, Luijsterburg PAJ, Heymans MW, Ronchetti I, Pool-Goudzwaard A, Miedema HS, Koes BW. Prognosis and Course of Disability in Patients With Chronic Nonspecific Low Back Pain: a 5- and 12-Month Follow-up Cohort Study. *Fysiopraxis*. 2013;12:40.

2012

- Bramsen I, Miedema HS. Zicht op participatie bij bijstandontvangers met gezondheidsproblemen: een nieuwe gespreksmethode voor klantmanagers. *Sociaal Bestek*. 2012;10:9-11.
- Van 't Spijker-Van Kempen PM, Miedema HS. Kwaliteit van zorg: jou een 'kop'zorg. *InFysio*. 2012;8(7): 17-19.
- Van 't Spijker-Van Kempen PM, Miedema HS. Kwaliteit van fysiotherapeutische zorg: Hoe maak je die tastbaar. *InFysio*. 2012;8(8):17-21.

2009

- Feleus A, Bierma-Zeinstra SM, Miedema HS, Verhaar JA, Koes BW. Non-traumatic arm, neck and shoulder complaints in general practice: Incidence, course, and management. *Ned Tijdschr Pijn Pijnbeestr*. 2009;28(37):9-18.

2008

- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Het CANS model; de multidisciplinaire consensus in Nederland over terminologie en indeling van arm-, nek- en schouderklachten. *Tijdschr Bedrijfs Verzekeringngen*. 2008;16(2):51-58.

- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Het CANS model; de multidisciplinaire consensus in Nederland over terminologie en indeling van arm-, nek- en schouderklachten. *Beweegreden*. 2008;4(1):30-35.
- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Een eenduidige kijk op arm-, nek- en schouderklachten: het CANS-model. *Huisarts Wetensch*. 2008;51(11):567-569.
- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Het CANS model; de multidisciplinaire consensus in Nederland over terminologie en indeling van arm-, nek- en schouderklachten. *Ned Tijdschr Ergother*. 2008;1(1).
- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Het CANS model; de multidisciplinaire consensus in Nederland over terminologie en indeling van arm-, nek- en schouderklachten. *Revalidata* 2008;30.

## 2007

- Faber EF, Burdorf A, Miedema HS, Verhaar JAN. Kan optimale samenwerking tussen orthopedisch chirurgen en bedrijfsartsen ziekteverzuim door bewegingsapparaat-klachten beïnvloeden? *Tijdschr Bedrijfs Verzekeringngen*. 2007;15(1):16-20.
- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Het CANS model; de multidisciplinaire consensus in Nederland over terminologie en indeling van arm-, nek- en schouderklachten. *Ned Tijdschr Reumatol*. 2007;4:45-47.
- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Het CANS model; de multidisciplinaire consensus in Nederland over terminologie en indeling van arm-, nek- en schouderklachten. *Ned Tijdschr Orthop*. 2007;14(4):129-136.
- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Het CANS model; de multidisciplinaire consensus in Nederland over terminologie en indeling van arm-, nek- en schouderklachten. *Fysiopraxis*. 2007;16.
- Huisstede BMA, Miedema HS, Koes BW, Verhaar JAN. Het CANS model; de multidisciplinaire consensus in Nederland over terminologie en indeling van arm-, nek- en schouderklachten. *Ned Tijdschr Handther*. 2007;16(2).
- Kuiper JI, Kuijer PPFM, Burdorf A, Lötters FJ.B, Spreeuwers D, Frings-Dresen MHW, Miedema HS. Instrument om werkgerelateerdheid van specifieke lage rugklachten te bepalen; rugklachten: is werk de oorzaak? *Stimulus*. 2007;26(1):74-79.

## 2006

- Kuiper JI, Kuijer PPFM, Burdorf A, Lötters FJB, Spreeuwers D, Frings-Dresen MHW, Miedema HS. Nieuw instrument om arbeidsgerelateerdheid van specifieke lage rugklachten te bepalen. *Tijdschr Oefenther Mensendieck*. 2006;1(1).

## 2005

- Kuijer PFM, Kuiper JI, Burdorf A, Lötters FJB, Spreeuwers D, Frings-Dresen MHW, Miedema HS. Nieuw instrument om arbeidsgerelateerdheid van specifieke lage rugklachten te bepalen. *Tijdschr Ergonom* 2005;6:19-21.
- Kuiper JI, Kuijer PFM, Burdorf A, Lötters FJB, Frings-Dresen MHW, Spreeuwers D, Miedema HS. Specifieke lage-rugklachten: Is werk de oorzaak? *Tijdschr Bedrijfs Verzekeringngen*. 2005;13.
- Van Kempen P, Miedema HS. Arm-Nek-SchouderCongres II. *Tijdschr Bedrijfs Verzekeringngen*. 2005; 13(3).

## 2004

- Nauta AP, Miedema HS. Heeft een integrale benadering bij KANS effect? *Tijdschr Bedrijfs Verzekeringngen*. 2004;12(6):194.

2003

- Burdorf A, Miedema HS, Verhoeven AC. Risicofactoren voor lage rugklachten in het beroep. Tijdschr Bedrijfs Verzekering. 2003;11(1):6-13.
- Huisstede B, Nauta A, Miedema H. Klachten van arm-nek-schouder, het Kenniscentrum AKB maakt er werk van. Ned Tijdschr Handther. 2003;12.
- Nauta AP, Miedema HS. Kun je van zwaar werk heupartrose krijgen? Tijdschr Bedrijfs Verzekering. 2003;11(9):286.
- Nauta AP, Miedema HS. Arbeidsrelevante klachten van arm, nek of schouder (RSI) I De stand van zaken. Tijdschr Huisarts. 2003;20.
- Nauta AP, Miedema HS. Arbeidsrelevante klachten van arm, nek of schouder (RSI) II. Wat vinden huisartsen zelf van hun deskundigheid? Tijdschr Huisarts. 2003;20.

2002

- Hulshof CTJ, Nauta AP, Van der Klink JLL, Faber E, Broersen JPJ, Miedema HS, Jacobs JW, Fortuin R, Bierma SMA. Project Afstemming Richtlijnen Arbeid en Gezondheid (PARAG). Special De Huisarts / Tijdschr Bedrijfs Verzekering; 2002.
- Miedema HS. De Nederlandse Kenniscentra Arbeidsrelevante Aandoeningen en Arbocuratieve Samenwerking. Tijdschr Soc Geneesk. 2002;80:147-148.
- Miedema HS. Behandelprogramma's lage rugklachten gewogen. Arbeidsomstandigheden 2002;78: 37-39.
- Nauta AP, Miedema HS. Effectieve publieksinterventie om meningen over lage-rugpijn te beïnvloeden en arbeidsongeschiktheid te verminderen. Tijdschr Bedrijfs Verzekering. 2002;10(1).

1997

- Hopman-Rock M, Miedema HS, Van Buuren S, De Kleijn-De Vrankrijker MW. WHO collaborating centre for ICIDH in the Netherlands. Towards revision of the severity of disability scale of the ICIDH. Newsletter CSIZ. 1997;3:3-4.

1994

- Miedema HS, Valkenburg HA, Van der Linden S. Incidentie en prevalentie van genetische bepaalde aandoeningen in Nederland: een literatuuronderzoek (comment). Ned Tijdschr Geneesk. 1994;138: 22-23.

1993

- Miedema HS, Van de Laar M, Bernelot Moens HJ, Rasker JJ. Opnamefrequentie wegens M. Reiter in de periode 1981-1987 (commentaar). Ned Tijdschr Geneesk. 1993;137:928.

## **Books, book chapters or guidelines**

2015

- Miedema HS, Engels JE. Werkhervatting en re-integratie. Zorgbasics reeks. Den Haag: Boom Lemma; 2015.

2014

- Rasker JJ, Miedema HS. Belangrijke Rol Commissie Reumaonderzoek TNO in Reumatologisch Nederland. In: Putte L van der (red.). Canon van de Reumatologie. Haarlem: DCHG medische communicatie; 2014.

2012

- Werkgroep ontwikkeling multidisciplinaire richtlijn specifieke klachten arm, nek en/of schouder. Multidisciplinaire richtlijn specifieke klachten arm, nek en/of schouder (KANS). Utrecht: Kwaliteitskoepel Medisch Specialisten; 2012. Available from: <http://www.kwaliteitskoepel.nl/assets/structured-files/2012/multidicsrichtlijnaspecifiekeKANS19092012.pdf>.

2011

- Engels J, Miedema H, Nauta A. Spelers op het veld arbeid en gezondheid. In: Kuiper C, Heerkens Y, Balm M, Bieleman A, Nauta A. *Arbeid en Gezondheid; een handboek voor paramedici en arboprofessionals*. Houten; Bohn Stafleu Van Loghum; 2011:91-147.

2010

- Kuiper C, Wagener M, Roelofs P, Miedema H. Arbeidsrelevante rugklachten. In: Wittink H, Engelbert R. *Klinisch redeneren volgens de HOAC II*. Houten: Bohn Stafleu Van Loghum; 2010:252-270.

2005

- Miedema HS. Fibromyalgie en werk. In: Crul BJP, Van Houdenhove B (red.). *Katern Fibromyalgie. Pijninfo 7*. Houten: Bohn Stafleu Van Loghum; 2005.

2004

- Blatter BM, Bongers PM, Van Dieën JH, Van Kempen PM, De Kraker H, Miedema HS, Reijneveld CN, De Vet HCW. *RSI-maatregelen: preventie, behandeling en reïntegratie*. Doetinchem; Reed Business Information; 2004.
- Miedema HS, Rasker JJ (red.). *Katern Reumatische Ziekten (update)*. Handboek Arbeid en Belastbaarheid. Houten: Bohn Stafleu Van Loghum; 2004.
- Miedema HS. Chronische ziekte en werk: arbeidsparticipatie en sociale zekerheid. In: Pool G, Heuvel F, Ranchor AV, Sanderman R (red.). *Handboek psychologische interventies bij chronisch-somatische aandoeningen*. Assen: Van Gorcum; 2004.
- Picavet S, Miedema H. Klachten en aandoeningen van het bewegingsapparaat. In: Witte K, Busch M, Maassen I, Schuit A (red.). *Brancherapport Preventie 2000-2003*. Bilthoven: RIVM; 2004.

2003

- Miedema H, Loon L van (red.). *Rugscholing in beweging. Een overzicht van rugscholingsprogramma's in Nederland*. Maarssen; Elsevier Gezondheidszorg; 2003.

2001

- Miedema HS. RSI: Is preventie via de werkplek mogelijk. In: Walburg JA, Jansen J, Vaandrager L. *Leefstijl en werk*. Houten: Bohn Stafleu Van Loghum; 2001.

2000

- Hazes JMW, Miedema HS. Epidemiologie. In: Bijlsma JWJ, Voorn T (red). *Praktische huisartsgeneeskunde: Reumatologie*. Houten: Bohn Stafleu Van Loghum; 2000.
- Miedema HS, Hendriks AC, Rasker JJ. Werk en Sociale Zekerheid. In: Bijlsma JWJ, Voorn T (red). *Praktische huisartsgeneeskunde: Reumatologie*. Houten: Bohn Stafleu Van Loghum; 2000.

1998

- Miedema HS, Rasker JJ (red.). *Katern Reumatische Ziekten*. Handboek Arbeid en Belastbaarheid. Houten: Bohn Stafleu Van Loghum; 1998.
- Miedema HS. Epidemiologie van reumatische pijnsyndromen. In: *Nascholing Reumatologie. PAOG Boerhaave cursus, oktober 1998 te Hilversum*. Leiden: Rijksuniversiteit Leiden; 1998.

1997

- Van der Linden S, Miedema HS. Reumatoïde Artritis. In: RIVM. *Volksgezondheid Toekomst Verkenningen (VTV), deel B2, hoofdstuk 13: Ziekten van het bewegingsstelsel en bindweefsel*. Den Haag: SDU; 1997.

1995

- Miedema HS. Verwijzingen door huisartsen naar medisch specialisten vanwege klachten en aandoeningen van het houdings- en bewegingsapparaat. In: Dijkmans BAC (red.). 10 topics uit de reumatologie. PAOG Boerhaave cursus, 27 april 1995 te Leiden. Leiden: Rijksuniversiteit Leiden; 1995.
- Hopman-Rock M, Miedema HS. Het ontwikkelen van een voorstel voor de revisie van de ernst van beperkingen schaal van de ICIDH. In: Hirs WM (red.). 20 jaar WCC, verslag van een conferentie op 30 september 1994. Zoetermeer: Nationale Raad voor de Volksgezondheid; 1995.

1994

- Miedema HS, Van der Linden S. Incidence of back pain in general practice and resulting health care events. In: Auquier L, Paolaggi JB (eds.). *Atelier de Travail sur l'Epidemiologie et le Traitement des Lombalgies*. Paris: BLD Communication; 1994.

## Research reports

2015

- Van Staa A, Miedema H, Sattoe J, Bal M, Roelofs P, Hilberink S, Ista E, Roebroek M, Peeters M. Eindrapportage SPIL: Self-management and Participation Lab. Rotterdam: Kenniscentrum Zorginnovatie Hogeschool Rotterdam; 2015.

2012

- Bal MI, Hilberink SR, Verhoef JAC, Miedema HS, Roebroek ME. Eindverslag proefimplementatie TraJect aan het werk. Rotterdam; Erasmus MC/Kenniscentrum Zorginnovatie; 2012.

2010

- Koppelaar E, Knibbe JJ, Miedema HS, Burdorf A. Impact of ergocoaches in healthcare organisations on implementation of preventive measures aimed at musculoskeletal disorders, especially low back pain. Eindrapportage project 63200014. Rotterdam: Erasmus MC; 2010.

2008

- Van Schaardenburgh N, Verhoef JAC, Miedema HS, Roebroek ME. Implementatieplan TraJect; Training: Aan het Werk?! Implementatierapport. Rotterdam: Erasmus MC/Kenniskring Participatie, Arbeid en Gezondheid, Hogeschool Rotterdam; 2008.
- Verhoef JAC, Miedema HS, Roebroek ME. Eindverslag Project TraJect: TRansitie naar Arbeidsparticipatie van Jongeren met Een Chronische ziekTe aan het werk!? Rotterdam: Erasmus MC/Kenniskring Participatie, Arbeid en Gezondheid Hogeschool Rotterdam; 2008.

2005

- Huisstede BMA, Miedema HS. De consensus, het CANS-model. Eindverslag Multidisciplinair Consensustraject Arm-Nek-Schouderklachten. Rotterdam: Nederlands Kenniscentrum Arbeid en Klachten Bewegingsapparaat Erasmus MC; 2005.

2004

- Huisstede BMA, Miedema HS. Nieuwe terminologie en indeling van arm-, nek- en/of schouderklachten. Rotterdam: Nederlands Kenniscentrum Arbeid en Klachten Bewegingsapparaat Erasmus MC; 2004.
- Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijer PPFM, Spreeuwens D, Lötters F, Miedema HS. Criteria for determining the workrelatedness of nonspecific low-back pain. Amsterdam: Coronel Institute of Occupational Health Academic Medical Center (AMC); 2004; Available from: <http://www.occupationaldiseases.nl/content/criteria-nonspecific-low-back-pain-published>.
- Kuiper JI, Burdorf A, Frings-Dresen MHW, Kuijer PPFM, Spreeuwens D, Lötters F, Miedema HS. Rugklachten door werk: instrument voor het bepalen van de arbeidsgerelateerdheid van specifieke

lage rugklachten. Rotterdam: Kenniscentrum AKB Erasmus university Medical Center (Erasmus MC); 2004. Available from: <http://www.beroepsziekten.nl/datafiles/instrumentarbeidsgerelateerdheidlrk.pdf>.

- Van Kempen P, Janssen Y, Miedema H. Effectmeting door reïntegratiebedrijven, scenario's voor het monitoren van effectiviteit. Rotterdam: Nederlands Kenniscentrum Arbeid en Klachten Bewegingsapparaat Erasmus MC; 2004.

2003

- Van Kempen PM, Miedema HS. Reïntegratie bij Arm-Nek-Schouderklachten. Een overzicht van het aanbod. Rotterdam: Nederlands Kenniscentrum Arbeid en Klachten Bewegingsapparaat Erasmus MC; 2003.

1997

- Miedema HS, Chorus AM, Wevers CW. Arbeidsparticipatie en arbeidsomstandigheden bij reumatoïde artritis. Leiden: TNO Preventie en Gezondheid; 1997.
- Miedema HS. Reuma in Nederland: de cijfers. Het aantal patiënten met chronisch reumatische aandoeningen in Nederland. Leiden: TNO Preventie en Gezondheid; 1997.

1996

- Bongers PM, Westhof MH, Miedema HS, Bloemhoff A, Davidse W, Van der Grinten MP, Urlings I. Preventie van klachten en aandoeningen aan het bewegingsapparaat: een verkenning van epidemiologie, mogelijkheden voor preventie en preventieve activiteiten. Uitgebreid rapport. Leiden: TNO Preventie en Gezondheid; 1996.
- Miedema HS, Westhof MH, Bongers PM. Preventie van klachten en aandoeningen aan het bewegingsapparaat: een verkenning van epidemiologie, mogelijkheden voor preventie en preventieve activiteiten. Samenvattend rapport. Leiden: TNO Preventie en Gezondheid; 1996.
- Miedema HS, Rasker JJ. Het Nederlandse reumaonderzoek in de jaren tachtig en begin jaren negentig. Leiden: TNO Preventie en Gezondheid; 1996.
- Van Buuren S, Hopman-Rock M, Miedema HS. The development of a proposal for revision of the severity of disabilities scale of the ICIDH. Personal care, body disposition, locomotor and dexterity disabilities. Phase 3. Leiden: TNO Preventie en Gezondheid; 1996.

1995

- Chorus AMJ, Van Poppel MNM, Miedema HS, Wevers CWJ, Andries F, Hildebrandt VH. Beperkingen in de arbeidssituatie van werknemers met reumatische aandoeningen; tussenrapportage. Leiden: TNO Preventie en Gezondheid; 1995.
- Hopman-Rock M, Miedema HS. The development of a proposal for revision of the severity of disabilities scale of the ICIDH. Personal care, body disposition, locomotor and dexterity disabilities. Phase 1 and 2. Leiden: TNO Preventie en Gezondheid; 1995.

1994

- Davidse W, Miedema HS, Chorus AMJ. Selectie van ziekten ten behoeve van enquêtes. Leiden: TNO Preventie en Gezondheid; 1994.
- Miedema HS. Reuma-Onderzoek Meerdere Echelons (ROME): basisrapport. Leiden: TNO-Netherlands Organization for Applied Scientific Research; 1994. Report No.: 93.099.
- Ooijendijk WTM, Bloemhoff A, Chorus AMJ, Miedema HS. Investeren in de preventie van nierziekten, een investering in de toekomst. Leiden: TNO Preventie en Gezondheid; 1994.



# PHD PORTFOLIO



## PORTFOLIO PERTAINING TO PHD-THESIS 'COURSE, PROGNOSIS AND MANAGEMENT OF NONSPECIFIC MUSCULOSKELETAL DISORDERS'

### Personal information:

Name PhD student:	Harald Miedema
Erasmus MC Department:	General Practice
Rotterdam university of Applied Sciences Department:	Research Center Innovations in Care
Position at Rotterdam university of Applied Sciences:	Lector Work and Health
PhD period:	December 2011 – July 2016
Promotor 1:	Prof.dr B.W. Koes
Promotor 2:	Prof.dr A. Burdorf

### Summary of training and teaching during PhD period (2012-2015)

	Workload (hours; ECT)	Date
<i>Training:</i>		
Univariate, bivariate and multivariate analysis; internal training Rotterdam university of Applied Sciences	16 (0.57)	October-November 2014
<i>Conferences attended:</i>		
Conference Work for All, International SOFT Federation, Debrecen, Hungary.	16 (0.57)	February 16-17, 2012
Preconference workshop and Conference WEON, Rotterdam	12 (0.43)	June 13-14, 2012
Workshop KANSen genoeg, KNGF-congres, Maastricht	8 (0.29)	November 3, 2012
Nationaal Verzuimcongres, Utrecht	8 (0.29)	June 6, 2013
RGF congres Pijnneurowetenschappen in praktijk, Rotterdam	3 (0.11)	July 17, 2013
Congres 45 jaar opleiding Fysiotherapie Rotterdam, Rotterdam	4 (0.14)	October 16, 2013
Congres ZorgNL, Utrecht	8 (0.29)	November 4, 2013
Symposium Zorg voor Werk, SER Den Haag	3 (0.11)	February 13, 2014
5th International Conference on the History of Occupational and Environmental Health, Erasmus MC Rotterdam.	16 (0.57)	April 24-25, 2014
Combating Young Disabled People's Worklessness: An International Network. Leverhulme International Network Symposium, Third Meeting Network expert group. Casa 400 Amsterdam	8 (0.29)	May 6, 2014
3rd International Conference on Orthopedics & Rheumatology, San Francisco USA	24 (0.86)	July 28-30, 2014
Revalideren naar/door Participeren. Congres Nederlandse Vereniging Klinische Arbeidsgeneeskunde, Woudschoten/Zeist.	8 (0.29)	September 26, 2014
Denk anders debat, Hogeschool Rotterdam	4 (0.14)	November 13, 2014
Symposium E-health in de Fysiotherapie, Amsterdam	3 (0.11)	June 3, 2015
Symposium Verweven verhalen. Rotterdam	2 (0.07)	October 15, 2015
KNGF-congres Dag van de Fysiotherapie, Maarssen	8 (0.29)	November 6, 2015
Symposium Evidence based fysiotherapie en aspecifieke nekpijn, Rotterdam	2 (0.07)	November 18, 2015
UWV Congres Participatie en Wetenschap, Rotterdam	3 (0.11)	December 1, 2015

*Teaching:*

Module Visie op Arbeid en Gezondheid, minor Arbeid en Gezondheid, Instituut voor Gezondheidszorg Hogeschool Rotterdam	80 (2.86)	September-October every year
Module Re-integratie en Arbeidsomstandigheden, minor Arbeid en Gezondheid, Instituut voor Gezondheidszorg Hogeschool Rotterdam	20 (0.71)	September-October 2012
College Re-integratie 2 <sup>e</sup> jaar opleiding Ergotherapie	16 (0.57)	September/October every year
Workshop en begeleiding afstuderen opleiding Verpleegkunde thema Preventie en Participatie	40 (1.43)	February-June 2014, 2015
Workshop en informatie Kenniscentrum Zorginnovatie studenten Honours Degree programma Instituut voor Gezondheidszorg	40 (1.43)	January-February every year
College Reuma en werk aan reumaverpleegkundigen i.o., Antonius Academie Nieuwegein	40 (1.43)	Spring 2012-2014

*Other activities relevant for PhD portfolio:*

Chair development committee for multidisciplinary guideline for nonspecific complaints of arm, neck and shoulder (CANS)	200 (7.14)	Januari 2010 – November 2012
Member of scientific advisory board Royal Dutch Physiotherapy Society	5 (0.18)	2001-2012
Member of Fit for Work platform	30 (1.07)	2013-present
Member of Editorial working group of Tijdschrift Bedrijfs- en Verzekeringsgeneeskunde (TBV)	30 (1.07)	2013-present
Member of evaluation committee of ZONMw-program 'Sport, Bewegen en Gezondheid'	30 (1.07)	September 2014 – December 2014
Participant Invitational conference ZONMw Arbokennisinfrastructuur	3 (0.11)	October 16, 2015
Participant Invitational conference SER Chronisch zieken en werk	3 (0.11)	December 15, 2015

*Presentations during PhD period:*

Occupational performance of young adults with a physical disability: experience in Rotterdam (Netherlands) with an intervention aimed at improving work participation. Conference Work for All, International SOFT Federation. Debrecen Hungary	8 (0.29)	February 17, 2012
Dagprogramma KANSen genoeg; een multidisciplinaire richtlijn in de praktijk. KNGF-jaarcongres. Maastricht	16 (0.57)	November 3, 2012.
Multidisciplinaire richtlijn aspecifieke KANS. Congres Bedrijfsfysiotherapie. Etten-Leur	8 (0.29)	November 23, 2013
9x Workshop voor bedrijfsartsen over Multidisciplinaire richtlijn aspecifieke KANS. Delft, September 9, 2013; Veghel, September 16, 2013; Arnhem, October 22, 2013; Rijswijk, November 18, 2013; Arnhem, December 18, 2013; Enschede, March 28, 2014; Den Bosch, June 6, 2014; Arnhem, June 18, 2014; Den Bosch, June 20, 2014.	72 (2.57)	2013-2014
Het valide meten van dynamische stabiliteit: utopie of realiteit? Veldon Netwerk Bijeenkomst. Houten	8 (0.29)	March 26, 2014
Incidence of low back pain related occupational diseases in the Netherlands. 5th International Conference on the History of Occupational and Environmental Health. Rotterdam	8 (0.29)	April 24, 2014
Improved work participation and occupational performance of young adults with a physical disability after a new vocational rehabilitation intervention. Leverhulme International Network Symposium. Amsterdam	8 (0.29)	May 6, 2014

Dutch multidisciplinary guideline for diagnosis of complaints of arm, neck and/or shoulder (CANS) and treatment of aspecific CANS. 3rd International Conference on Orthopedics & Rheumatology. San Francisco USA	8 (0.29)	July 29, 2014
Incidence of low back pain related occupational diseases in the Netherlands. 3rd International Conference on Orthopedics & Rheumatology. San Francisco USA	8 (0.29)	July 30, 2014
Samenwerking tussen kenniscentra en opleidingen in praktijkgericht onderzoek. Werkconferentie Regieorgaan Onderwijs en Onderzoek. Rotterdam	8 (0.29)	February 5, 2015
Mono- en multidisciplinaire richtlijnen bij lage rugklachten. Nascholing bedrijfs- en verzekeringsartsen. Naarden	8 (0.29)	March 2 2015
Samenwerken in (tijdelijke) teams. Derde halfjaarlijkse bijeenkomst Academische Werkplaats Autisme Samen Doen! Utrecht	8 (0.29)	May 21, 2015
Reflectie op thema's en aanbevelingen uit project 'Loopbaantrajecten'. Symposium Verweven Verhalen. Rotterdam	4 (0.14)	October 15, 2015
Arbeidsparticipatie van mensen met klachten van arm nek, schouder (KANS): Kans voor arbeidsdeskundigen? Jaarcongres Arbeidsdeskundig Kenniscentrum (AKC). Ede	8 (0.29)	November 12, 2015
<i>Total hours / ECT</i>	873 (31.2)	2012-2015

