

**NECK AND SHOULDER PAIN
IN A YOUNG POPULATION:
PREVALENCE AND
ETIOLOGICAL FACTORS**

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SIIVOLA**

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OULU 2003



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Academic Dissertation to be presented with the assent of the Faculty of Medicine, University of Oulu, for public discussion in the Auditorium of Kastelli Research Center (Aapistie 1), on August 30th, 2003, at 12 noon.

OULUN YLIOPISTO, OULU 2003

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ISBN 951-42-7100-9 (URL: <http://herkules.oulu.fi/isbn9514271009/>)

ALSO AVAILABLE IN PRINTED FORMAT

Acta Univ. Oul. D 743, 2003

ISBN 951-42-7099-1

ISSN 0355-3221 (URL: <http://herkules.oulu.fi/issn03553221/>)

OULU UNIVERSITY PRESS
OULU 2003

Siivola, Sari, Neck and shoulder pain in a young population: prevalence and etiological factors

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Oulu, Finland
2003

Abstract

This study comprised three parts: a cross-sectional survey of 826 high school students, a 7-year follow-up survey of the same sample, and a MRI study of a subgroup (n = 31) of the follow-up study population. Firstly, the aims of the study were to determine the prevalence and incidence of neck and shoulder pain (NSP) in populations 15-18 and 22-25 years old, and to evaluate sociodemographic factors, body size measurements, psychological factors and leisure time activities as possible associated and predictive factors of NSP. Secondly, the aim was to find out whether structural changes of the cervical spine detected by magnetic resonance imaging (MRI) were associated with NSP in young adults.

The results showed the prevalence of self-reported weekly NSP in 15- to 18-year-old adolescents to be 17%, and in seven years, the prevalence of weekly NSP had increased to 28%. After seven years, the six-month incidence of occasional or weekly NSP was 59% among those asymptomatic at baseline. In the cross-sectional study, female gender, low physical activity, hobbies which statically load the upper extremities, low intensity of physical exercise, self-assessed moderate physical condition and psychosomatic symptoms and depressive mood were associated with a high prevalence of NSP, and sports which dynamically load the upper extremities were associated to a low prevalence of NSP.

Symptoms in adolescence were associated with a high prevalence of NSP seven years later. Activity in sports, which dynamically load the upper extremities in adolescence, was associated with a low prevalence of NSP in adulthood. Of all variables in the study, psychosomatic symptoms were most congruently associated with a high prevalence of NSP, and psychosomatic symptoms in adolescence also predicted NSP in adulthood. In the MRI study, disc degeneration and anular tears of the cervical spine were common in asymptomatic and symptomatic subjects. Disc herniations were the only abnormal finding that was significantly more common in symptomatic subjects.

Keywords: adolescence, etiological factor, neck and shoulder pain

Acknowledgements

This study was carried out at 1) the Department of Public Health and General Practice, 2) the Department of Physical Medicine and Rehabilitation of Oulu University, and 3) the Department of Diagnostic and Interventional Radiology of Oulu University Hospital.

I owe my deepest gratitude to Professor Sirkka Keinänen-Kiukaanniemi, at the Department of Public Health and General Practice, University of Oulu, who was the main supervisor of the study. I appreciate her discrete manner in introducing me to scientific thinking and especially her flexibility in devoting time to advise me when needed. Her expertise in research and unbelievably positive way of finding solutions to all sorts of problems in the course of this project has made it possible for me to successfully conclude this study. Sinikka Levoska, MD, PhD, deserves my special gratitude. I appreciate our long and stimulating conversations, which inspired me to get involved in the present study, and her encouragement at critical moments, not only as a supervisor, but also as a friend. I am very grateful to Professor Heikki Vanharanta for his expert advice and valuable comments on discogenic neck pain.

I sincerely acknowledge Professor Arja Rimpelä and Docent Olavi Hämäläinen for reviewing the manuscript. Their constructive comments were very valuable.

I am very grateful to my co-worker Mr. Markku Koiranen, who carried out the statistical analyses. Without his patience and expertise, this study would have been much more difficult. I express my thanks to Mr. Paavo Soini for his help with analyzing the data at the beginning of the study, Mr. Martti Lampela for his help with finding literature, and other staff of the Department of Public Health and General Practice, who have helped me in practical work in so many ways during these years. I wish to thank Docent Osmo Tervonen and Docent Eero Ilkko for cooperation in assessing the magnetic resonance images. I thank Kirsi Latvala, MD, and Erika Hoskio, MD, for participation in writing the articles.

I wish to thank Sirkka-Liisa Leinonen, Lic.Phil., for flexible collaboration in revising the English text.

This study was made possible only by the collaboration of the students and teachers in the high schools of Karjasilta, Kuusiluoto, Lassinkallio, Lyseo and Merikoski (spring 1989). I owe my deepest gratitude to all of them.

I wish to thank my father Juhani for his encouragement towards education and my mother for her support and indispensable help during these years. I express my warmest

gratitude to my dear Jari for his support and invaluable technical assistance at the final phase of the study, and our wonderful children, Joel and Meri, who have given me so much joy.

Finally, I am thankful for the financial support to the study: Oulu University Hospital, The Yrjö Jahnesson Foundation, The Kalle Kaihari Foundation, The Juho Vainio Foundation, and The Duodecim Foundation.

Sari Siivola, Espoo, June 30, 2003

Abbreviations

| | |
|-----|---------------------------------|
| ANS | autonomic nervous system |
| BDI | Beck's Depression Inventory |
| BMI | body mass index |
| CDI | Children's Depression Inventory |
| CI | confidence interval |
| DD | disc degeneration |
| DS | disturbing symptom |
| EMG | electromyography |
| LBP | low back pain |
| MRI | magnetic resonance imaging |
| NDS | no disturbing symptom |
| NSG | no symptom group |
| NS | not significant |
| NSP | neck and shoulder pain |
| RR | risk ratio |
| SG | symptom group |

List of original publications

This thesis is based on the following articles, which are referred to in the text by their Roman numerals I to IV. Additionally, some unpublished data are presented.

- I Niemi S^{*1}, Levoska S, Kemilä J, Rekola K & Keinänen-Kiukaanniemi S (1996) Neck and Shoulder Symptoms and Leisure Time Activities in High School Students. *The Journal of Orthopaedic & Sports Physical Therapy* 24, 1:25-29.
- II Niemi S^{*2}, Levoska S, Rekola K & Keinänen-Kiukaanniemi S (1997) Neck and Shoulder Symptoms of High School Students and Associated Psychosocial Factors. *Journal of Adolescent Health* 20, 238-242.
- III Siivola S, Levoska S, Latvala K, Hoskio E, Vanharanta H & Keinänen-Kiukaanniemi S (2002) Predictive factors for neck and shoulder pain: a longitudinal study in young adults. *Spine*. (Revised version submitted.)
- IV Siivola S, Levoska S, Tervonen O, Ilkko E, Vanharanta H & Keinänen-Kiukaanniemi S (2003) MRI changes of cervical discs in asymptomatic and symptomatic young adults. *European Spine Journal* 11, 4:358-363.

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1. Siivola S (formerly Niemi S)
2. Siivola S (formerly Niemi S)

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1 Introduction

Neck and shoulder pain (NSP) is a common complaint in the general population, and it often causes remarkable personal suffering due to pain, disability, and impaired quality of life. Since neck pain appears to be a common reason for attending primary care physicians, patients with NSP also load markedly the public health care service (Mäntyselkä *et al.* 2001).

The natural course of NSP is not well documented, but the onset of symptoms often takes place at a young age. In young populations, 7-15% suffer from weekly NSP (Mikkelsen *et al.* 1997b, Vikat *et al.* 2000), and the proportion of young population with symptoms increased during past decade (Hakala *et al.* 2002). Mikkelsen (1997b) reported notable persistence of pain in 11- to 13-year-old children already, as 48.3% of the subjects continued to suffer from weekly neck pain in 1-year follow-up. NSP in adolescence has also been shown to predict NSP in adulthood (Hertzberg 1985).

NSP is assumed to be a multifactorial disease, and it has been suggested that there are several risk factors contributing to its development (Ariëns *et al.* 2000). The contributing factors of neck and shoulder symptoms have been a fairly common topic of both cross-sectional and longitudinal studies in adults, but particularly the progression of NSP into a chronic problem demands clarifying. Age, female gender (Viikari-Juntura *et al.* 2001), physical work loads (Ariëns *et al.* 2000), and certain psychosocial factors (Ariëns *et al.* 2001) have fairly consistently been shown to associate with NSP. Most of the studies in adult populations have concerned different occupational groups, and the main interest has focused on work-related risk factors. Studies concerning the etiology of NSP in young populations are rare, although such data would be especially beneficial for planning and implementing preventive interventions.

The risk factors of NSP can be roughly divided into three categories, i.e. physical, psychosocial, and individual risk factors (Ariëns *et al.* 2001). Bearing in mind that a number of risk factors are thought to contribute to the occurrence of NSP, only a few studies have simultaneously focused on several risk factors or several categories of risk factors in the same population.

The main purpose of this study was to determine the prevalence and incidence of NSP in a young population and investigate sociodemographic factors, body size measurements, perceived symptoms, leisure time activities, and structural changes of the cervical spine detected by magnetic resonance imaging as possible associated and predictive factors of NSP.

2 Review of the literature

2.1 Definition of neck and shoulder pain

The classification of neck and shoulder pain (NSP) has been incoherent, mainly due to a lack of well-established clinical tests and diagnostic methods that could be used to make specific diagnoses of NSP. In a majority of individuals suffering from NSP, the pain is unspecific and the etiology of pain remains unclear. Most frequently, NSP arises from functional disorders, and no tissue damage can be displayed. Diversified classifications of NSP have been presented, and they have been based on the location of pain (cervicobrachialgia), the etiology of pain (work-related), the duration of pain (acute/chronic pain), the findings of status (tension neck), radiological findings (degenerative disc disease), or dysfunction of cervical facet joints (hypo- or hypermobility) (Spitzer *et al.* 1987).

In Finland, probably the most commonly used term for unspecific NSP has been 'tension neck'. Valtonen (1968) defined it as a cluster of symptoms, related to continuous tension of the muscles of the neck and shoulder region, but with no pathological changes in the bones or soft tissues of the cervical spine. Although muscle tension often coexists with neck pain, this classification is based on the idea of neck pain originating from tension of the neck muscles. In the latest versions of commonly used classification of diseases, ICD-10 (1999, 2003), 'tension neck' has been omitted. In the literature on occupational neck and shoulder disorders, the terms 'occupational cervicobrachial disorder' (Maeda 1977), 'neck and upper limb disorder' (Kuorinka & Viikari-Juntura 1982), and 'repetitive strain injury' (Ferguson 1984) have been suggested. The classification of NSP in the current care guidelines for neck pain in Finland (2002) is based on data elicited in a clinical interview, symptoms, and clinical findings: 1) local neck pain 2) radiating neck pain 3) whiplash injury 4) myelopathy (compression of the spinal cord) 5) other neck pains, which are related to general diseases, tumors, or status following fractures of cervical spine.

To define NSP in this study, a common definition of pain approved by the International Association for the Study of Pain (Merskey 1986) was used. NSP means a subjective unpleasant sensory experience in the neck and shoulder region. It may be manifested as fatigue, tension, or pain that radiates into the upper extremities or the head. Symptoms of

the shoulder joint complex have been excluded in this study. According to ICD-10 (2003), the participants with NSP in this study could most probably have been classified medically into four diagnostic categories: 1) M54.2 Cervicalgia 2) M54.6 Thoracalgia 3) M50 Discogenic cervical pain and 4) M51 Discogenic thoracal pain. In the literature review, the term relating to NSP in each study in question has been referred to.

2.2 Pathophysiology of neck and shoulder pain

2.2.1 Neuroanatomy of pain

Several structures have been shown to cause pain in the neck and shoulder area: bones, nerves, discs, longitudinal ligaments, muscles, facet joints, and dura are capable of evoking pain, when irritated or inflamed (Spitzer *et al.* 1987, Cailliet 1991). The pain can be classified as nociceptive, neuropathic, or idiopathic in origin (Vainio 1993), of which nociceptive pain appears most often. During the acute phase, the pain is often of nociceptive origin, but when it progresses toward a chronic phase, the influence of psychologic and social factors becomes more marked (Spitzer *et al.* 1987). Some scientists regard nociceptive and neuropathic pains as entirely different entities, while others suggest that all pain is mediated by the sequential activation of a specific pain pathway (Lundeberg 1995).

The nociceptive sensation of pain originates from the activation of peripheral primary afferents. Part of myelinated A-delta fibers and unmyelinated C fibers conduct impulses evoked by noxious stimuli and transmit sensations that will be considered pain (Cailliet 1993). Primary nociceptive afferents ascend contralaterally and excite spinothalamic and spinoreticular neurons in the dorsal horn of the spinal cord by mediating neurotransmitters, such as glutamate, aspartate, substance P, and calcitonin gene-related peptide. The stimulus is then transmitted to the brain via their axons, which travel in 3 primary ascending tracts that project to the thalamus and the reticular formation. Direct spinothalamic tract projections to the ventral posterior lateral thalamus excite neurons with connections to the primary (S1) and secondary (S2) somatosensory and insular cortex. The limbic system is also involved in the nociceptive input. (Pillemer *et al.* 1997)

Neuropathic pain originates from the damage or dysfunction of peripheral nerves or the central nervous system (CNS) itself. Neurons may be sensitized to react to even an exceptionally slight stimulus that usually does not cause pain. Neuropathic pain does not require any peripheral input for its maintenance, and it often appears as chronic pain. There is considerable evidence that a reorganization of central processing is related to this pain state. Infections (herpes zoster), metabolic diseases (diabetes), traumatic injuries to the spinal cord, and strokes that involve ischemic damage to the ascending nociceptive pathways are the most common causes of neuropathic pain states. (Lundeberg 1995)

When no damage in tissues or neurons can be found, the pain is classified as idiopathic. The term 'psychogenic pain' is also used in this context (Vainio 1993). Since evidence of musculoskeletal pain associating with psychological factors has recently been

increasing, the concept of 'psychosomatic pain' (1995) or 'psychosomatic musculoskeletal pain' (Mikkelsen 1998a) has also been introduced into discussion.

2.2.2 Pain on tissue level

2.2.2.1 Muscle-related pain

Muscle tension is thought to be one cause of NSP, and the NSP in adolescents is most likely to be muscle pain in origin. Particularly isometric muscle contraction has been suggested to create intramuscular pressure, which might lead to tears of muscle fibers (Cailliet 1991). Small blood vessels collapse, and inadequate arterial circulation leads to inadequate oxygen supply, which is followed by accumulation of lactic acid and CO₂ activating nociceptors. A local decrease of pH and PO₂, K⁺ leakage from inflamed cells, and substance P have also been presented as factors that may modulate the excitability of nociceptors in muscle pain. (Lundeberg 1995)

Muscle activation can be measured by electromyography (EMG) recording. The studies concerning increased muscle activation measured by EMG and NSP have produced evidence mainly by two different study designs. Firstly, there are studies in occupational settings, where the muscle activity pattern has been recorded with surface EMG and a clinical examination of the shoulder region has been performed, and secondly, there are experimental studies, where the muscle activity patterns and pain development have been recorded in situations involving mental stress and minimal physical activity (Westgaard 1999). Especially the development of work-related complaints in the neck and shoulder region is commonly attributed to excessive loading of the shoulder muscles (Winkel & Westgaard 1992). However, the previous results on the association between increased muscle activation measured by EMG and NSP have been inconsistent. Little or no correlation between muscle activity and NSP was found by Takala & Viikari-Juntura (1991ab), whereas some other studies have shown signs of increased activation of the upper trapezius in subjects with NSP (Veierstedt & Westgaard 1993, Vasseljen *et al.* 1995, Lundberg *et al.* 1999, Westgaard *et al.* 2001). The disagreement on the findings may be explained by the fact that muscle pain may develop independently of muscle activity, or that EMG is not a relevant measure to show the putative association. No clear association between the EMG activity level and the subjective perception of tension has been reported, either. (Westgaard *et al.* 2001)

There are no studies concerning the association between NSP and EMG activity in high school students, but Vasseljen *et al.* (1995) presented a case-control study showing that the trapezius muscle activation level was not associated with NSP among office workers, whose working conditions resemble those of high schools students. In the same study, however, a consistent association between pain and signs of increased activity of the upper trapezius muscle was found in the manual group despite the equal physical demands posed by work. As the authors suggest, this seems to imply that different muscle activation patterns may explain why some individuals develop pain while others do not in similar working conditions. Edwards (1988) also noted that poor motor control of

postural muscular activity may cause work-related NSP. He proposed that the primary source of muscular pain may be the altered central motor control, which results in an imbalance between harmonious motor unit recruitment and relaxation of the muscles not directly involved in the activity.

Hagberg (1984, 1987) suggests three possible pathophysiological routes for muscle pain related to physical load: 1) mechanical failure, 2) local ischemia, and 3) disturbances of energy metabolism. Muscle pain occurring 24 to 48 hours after heavy physical exertion is presented as due to mechanical failure of muscles. This appears as rupture of the z-discs and outflow of metabolites that activate pain receptors directly or through a process of edema. Static muscular contraction or repeated muscular injuries may cause local ischemia, which causes an accumulation of muscle metabolites. When the intramuscular demands for energy exceed production, the result is muscular pain.

2.2.2.2 Discogenic pain

The pathophysiology of discogenic neck pain is not completely understood. It has been shown that the outer third of the annulus fibrosus is richly innervated (Bogduk *et al.* 1981), which constitutes an anatomic basis for discogenic pain. Disc degeneration (DD) has been postulated to be a normal age-related change (Sether *et al.* 1990, Matsumoto *et al.* 1998) and signs of DD can already be seen in 10- to 19-year-old subjects (Miller *et al.* 1988). DD increases with age (Boden *et al.* 1990, Lehto *et al.* 1994), and many external etiological factors, such as trauma (Swärd *et al.* 1990) and mechanical stress (Kelsey & White 1980), have been presented to relate to the progression of DD. However, these are rare in young populations.

It has still remained unclear whether DD is a cause of spinal pain. In the study of lumbar computed tomography/discography by Moneta *et al.* (1994), DD was shown to be unrelated to low back pain (LBP). In the same study, however, outer annular rupture was documented to relate to pain (Moneta *et al.* 1994). Several experimental and cadaveric studies have suggested that deterioration of the annulus fibrosus may be the initial event in the development of DD and disc herniation (Yu *et al.* 1988). Although there are indications that annulus rupture and disc herniation may be manifestations of different states of DD, their role as causes of NSP and the temporal aspects of the process are still under discussion.

For better understanding of discogenic pain, pathophysiological studies have recently focused on cellular and molecular activity of intervertebral disc tissue. However, many of the findings have only been documented in animal models, and the studies on humans have mainly concentrated on the lumbar spine, which findings should be verified in the cervical spine before further conclusions. One possible mechanism of discogenic pain has been suggested to be leakage of degenerative nucleus pulposus material through annular tears to irritate a nerve root (Olmarker & Larsson 1998). Saiffudin *et al.* (1999) showed in a study of the human lumbar spine that inflammatory changes were associated with annular tears. Olmarker *et al.* (1998) also indicated that nucleus pulposus exerts direct effects on nerve root function and structure, and the cytokine necrosis factor-alpha (TNF α) has been suggested to play a key role in the pathophysiologic process leading to symptoms of disc

herniation. The notion is supported by the recent finding of Karppinen *et al.* (2003), according to which intravenously administered anti-TNF α therapy (infliximab) decreased markedly sciatic pain. Interleukin-6, interleukin-8, and prostaglandin E2 have been presented as other mediators of pain in the lumbar spine (Burke *et al.* 2002).

Epidemiologic studies show DD to be a common finding in both symptomatic and asymptomatic populations, implying that DD of the cervical spine does not directly correlate with neck pain. In earlier studies involving roentgenographic evaluation of the cervical DD, the association between NSP and DD has not been consistent (Lawrence 1969, Teresi *et al.* 1987, van der Donk *et al.* 1991). Recent studies concerning the topic have produced evidence mainly by magnetic resonance imaging (MRI). In the study by Boden *et al.* (1990) on 63 asymptomatic volunteers, DD was detected in MRI of the cervical spine in 25% of the asymptomatic subjects under forty years old, and in almost 60% of those who were older than forty. In a few studies on young populations, the findings of DD in the cervical spine have been inconsistent. Matsumoto *et al.* (1998) showed DD of cervical intervertebral discs to be fairly common among asymptomatic subjects (n=497) in their twenties (17 % of men and 12 % of women), whereas Lehto *et al.* (1994) reported rare findings of DD in asymptomatic volunteers (n=89) DD before 30 years. The use of different MRI scanners (1.5 T and 0.1 T, respectively) may explain the inconsistent results. In the longitudinal study of Gore *et al.* (1987) (n=205), no significant relationship was found between the presence of degenerative changes evaluated roentgenographically and the level of neck pain reported by the patient.

I have not found any studies involving a comparison of MRI findings of the cervical spine in asymptomatic and symptomatic young populations, but there is such a study concerning the lumbar spine MRI findings of adolescents. Tertti *et al.* (1991) carried out an MRI imaging study of thirty-nine 15-year-old children with low back pain (LBP) and thirty-nine control children. The results showed no clear association between DD and LBP, since DD was also common in asymptomatic children. Disc protrusion in the lumbar spine was the only structural abnormality, which was more common among 15-year-old children with LBP compared to asymptomatic children. In a follow-up of the same population, DD at the age of 15 resulted in a 16-fold risk of reporting recurrence (LBP) at the age of 23 (Salminen *et al.* 1999).

Previously, the associations between anular tears, disc herniation, and NSP have mainly been investigated by CT and discography. In the study by Boden *et al.* (1990) on 63 asymptomatic subjects, a herniated disc was detected in 10% of the subjects aged under forty. Lehto *et al.* (1994) found no disc herniation in asymptomatic subjects under thirty years old. In the study of Matsumoto (1998) among asymptomatic subjects, disc protrusions before thirty years of age were also rare. Schellhas *et al.* (1996) showed, in ten lifelong asymptomatic subjects and ten chronic neck pain sufferers, that anular tears detected by MRI and discography were common in both groups.

Other painful tissues. The role of cervical facet joints as a cause of neck pain have been investigated by diagnostic nerve blocks based on the hypothesis that facet joints are the primary source of pain if anesthesia applied to them completely eliminates the pain. Bogduk *et al.* (1988) showed that 17 out of 24 patients with idiopathic neck pain experienced complete temporary relief of symptoms after a cervical medial branch block or a facet joint block by bupivacaine.

2.2.3 Psychology of pain

According to the modern view, the experience of pain is a complex phenomenon, which includes somatic as well as psychological and cultural components (Estlander 1997, Linton 2000a). In epidemiologic survey studies, attention is often attached to perceived and self-reported symptoms, which emphasizes the respondents' feeling rather than their behaviour (Morgan *et al.* 1993). In the present study, too, we focused on perceived symptoms. The concept of illness behaviour, including the patient's response to illness and the learnt patient behaviour, has also emerged as a significant factor in pain experience (Mitchell *et al.* 1987). The definition of the International Association for the Study of Pain points out that pain is always subjective, and each individual learns the application of the word through experiences related to injury in early life (Merskey 1986).

2.2.3.1 Stress-induced pain

Stress can be defined widely as a discrepancy between the demands and capacity of an individual. Therefore, stress can be evoked by any event that is an adaptational demand for an individual (Lazarus 1999). The author emphasizes that three concepts: stress, emotion, and coping, make up a conceptual unit. A stressful condition always causes an emotional arousal, after which the individual evaluates his means to manage with the situation. Moderate occasional stress may improve the capacity of an individual. Yet, using up one's capacity to cope leads to an overload state, which may manifest as physical symptoms (Lindholm & Gockel 2000). The term "psychosomatic symptom" is also commonly used in this context, implying that symptoms caused by stress may also manifest as psychological symptoms. However, the concepts of somatic versus psychosomatic symptoms arise from the traditional 'mind-body dualism' (Helman 1990), which has recently been criticized for splitting the individual into components, although the human being should rather be considered as an entity. Physiologically, psychosomatic symptoms reflect mainly two neuroendocrine systems: the sympathetic-adrenal medullary system, with the secretion of the catecholamines epinephrine and norepinephrine (Frankenhaeuser 1981), and the hypothalamus-pituitary-adrenal cortical system, with the secretion of glucocorticoids, such as cortisol (Chorous & Gold 1992). Nitric oxide may be an essential local transmitter of stress-related effects on tissue level (Zanzinger 1999).

There are only a few studies concerning the mechanism between stress and NSP. Hasselhorn and coworkers (2001) clarified the prognosis of spinal disease by investigating the biologic parameters reflecting different physiologic or psychophysiologic systems with acute onset of low back or neck-shoulder pain. Blood samples of 67 subjects 21-59 years old were taken and analyzed for 3-methyl 5hydroxyphenylethylene glycol (MHPG, reflecting sympathoadrenomedullary activity), dehydroepiandrosterone-sulphate (DHEA-s, reflecting anabolism), immunoglobulin E, interleukin 6 (immune activity), and beta-endorphin (pain regulation). The participants were followed up for 6 months after the blood samples had been taken. Among the subjects with neck and shoulder complaints, only a high interleukin 6 level was associated

with persistent disability (women and men) and pain (men). The authors suggest that the result may reflect increased immune system activity due to inflammation and/or pain, or it may also indicate psychosocial stress.

The psychophysiological stress response of the autonomic nervous system (ANS) at work, tension of the trapezius muscle, and NSP were investigated by Lundberg *et al.* (1999) among 72 female supermarket cashiers. The subjects were clinically examined by a physiotherapist, and they also completed a questionnaire including questions on NSP. Urinary catecholamines and cortisol, salivary cortisol, blood pressure, heart rate, and EMG activity of the trapezius muscle were measured at work and at rest. All parameters were at a higher level at work than at rest, and systolic and diastolic blood pressures were also significantly higher at work and at rest among the participants with severe pain compared to those with low pain. The tendency was the same with heart rate and catecholamines, but did not reach statistical significance.

Increasing interest has recently been focused on the concept of psychosomatic musculoskeletal symptom, implying musculoskeletal pain as being a psychosomatic symptoms (Alfvén 1995, Mikkelsen 1998a). This postulation can be backed up by a number of findings on the association between psychosomatic stress and depressive symptoms and NSP (Linton 1990). Cailliet (1991) also proposed that emotional tension is related to the musculoskeletal dynamics of pain. He suggested that the individual's emotional state has an influence on his posture, which may lead to spinal dysfunction, and that prolonged or intensive muscle tension may cause 1) painful 'tension myositis' on an ischemic basis, 2) increase in myostatic contracture as an adaptive shortening of the fibrous elements of the muscle, which when stretched, is painful, 3) myofascial stretch irritation of the periosteum at the point of insertion, 4) thickening of the facet capsules due to a failure to undergo periodic elongation, and 5) persistent compression of the disc, which ultimately leads to insufficient nutrition.

2.2.3.2 Depressive mood and pain

Clinical observations show that chronic NSP can be accompanied by depressive symptoms. The mechanism between NSP and depressive symptoms is, however, still under discussion. It has been suggested that chronic pain represents the expression of an underlying depressive disturbance and can be traced back to masked depression. The idea is based on the observation that there are types of depression, where some typical depressive symptoms are replaced by somatic manifestations, such as pain. Another hypothesis suggests that chronic pain causes depression, which represents the primary disorder, the mood symptom being secondary. (Magni 1987)

The term "depression" is used with various connotations. It may indicate an appropriate reaction to a disappointment or loss, a symptom, a cluster of symptoms, or a serious mental illness. In most classification systems, the syndrome of depression is defined as the combination of depressed mood with certain associated symptoms: loss of energy and interest, feelings of guilt, difficulty to concentrate, loss of appetite, and thoughts of death or suicide. Other signs and symptoms of depression include changes in

activity level, cognitive abilities, speech, and vegetative functions. (Kaplan & Sadock 1994)

Much of the data concerning the mechanisms between chronic pain and depressive symptoms still derive from experiments in animal models, and their value is therefore limited. In his review of the topic, Magni (1987) presented that two neurotransmitters, serotonin and, to a lesser extent, noradrenaline, are involved in the process of pain perception and in the pathogenic mechanism of depression and may thus serve as bridges between the two disorders.

The role of somatic symptoms as a presentation of depression seems to be even more prominent in adolescents than in adults. McCauley *et al.* (1991) presented that 70% of children and adolescents with a diagnosis of depression also had somatic complaints. The association was not secondary to or accounted for by anxiety.

2.3 Prevalence and incidence of neck and shoulder pain

In the literature, there are many studies concerning the prevalence of NSP, of which most have been carried out in different occupational groups of adult populations. There is a fairly large variation in the prevalence rates of NSP, since the symptoms have been determined and measured quite differently, mostly with self-administered questionnaires.

NSP has become an increasingly common health complaint among adolescents during the past decade (Hakala *et al.* 2002). Vikat *et al.* (2000) showed, in a large population of Finnish school children (n=11,276), that NSP was experienced about once a week or more frequently by 15% of 12- to 18-year-old adolescents (Table 1). The prevalence was higher in girls than in boys in every age group and increased with age. At the age of 12, the weekly prevalence of NSP was 7% in girls and 5% in boys, and the respective percentages at the age of 18 were 36% and 15%. Mikkelsen *et al.* (1997a) found, in their study of 1,756 school children, a weekly prevalence of neck pain in 10- to 12-year-old subjects markedly higher than Vikat's *et al.* finding: 16.2% of girls and 13.7% of boys suffered from weekly symptoms, and the persistence of these symptoms in one year was 48.3% (95% CI 41.7-54.9). Of the regional pain symptoms, neck pain had the highest persistence. In the study of Hertzberg (1985) on 16-year-old school children (n=302), the findings at the school medical examination were scored, and the results showed that 16% of girls and 3% of boys suffered from subjective complaints of cervical muscles in addition to muscular tension and tenderness. Salminen (1984) clarified the prevalence of neck and/or back pain in a study of 370 school children 13, 15, and 17 years of age. Tiredness or pain in the neck or back region was reported by 24.2% of the girls and 15.2% of the boys. 7.6% of the subjects reported previous neck and/or back pains interfering with their schoolwork or leisure time. Since neck and back pain were combined in this study, the results are not comparable to the previous ones.

In the epidemiologic studies among adolescents, the prevalence of NSP has consistently been shown to increase with age (Salminen 1984, Vikat *et al.* 2000), and the trend seems to continue through young adulthood. In the study of Palmer *et al.* (2001) on the general population (n=21,201), 19.1% of females and 12.8% of males in the subgroup of 16- to 24-year-old respondents reported having suffered from neck pain in the past

week. Barnekow-Bergkvist *et al.* (1998) presented that 43.3% of females and 25.7% of males had suffered from NSP more than once a month at the age of 34. Croft *et al.* (2001) conducted a rare study concerning the incidence of NSP among young adults. The one-year cumulative incidence of NSP was evaluated to be 16.4% (95% CI 12.6-20.2) in the 18- to 29-year-old subgroup of respondents in a general population of 7,669 adults aged 18-75.

2.4 Risk and protective factors of neck and shoulder pain

The etiology of NSP is thought to be multifactorial. According to Armstrong *et al.* (1988), the factors can be classified into three main categories: 1) work-related factors, 2) sociodemographic factors, and 3) external social factors. Theoretical models that can be applied to the etiology of NSP have been presented by Hägg *et al.* (1990), Karasek and Theorell (1990) and Maeda (1977). All of these models, however, are based on the idea of NSP originating mainly from work-related physical and psychological factors. Varni *et al.* (1996) presented a framework of the Biobehavioral Model of Pain for children and adolescents. This model hypothesizes a number of factors that may influence pediatric pain perception and associated functional status outcome parameters. In adolescence, the most significant work-related risk factor is related to ergonomics of studying at school. Yet, I have found only one preliminary study on ergonomics as associated factor of NSP. According to the preliminary results of Koskelo *et al.* (2003), use of adjustable school table and chair may reduce NSP in high-school students. Work-related factors are, however, beyond the scope of this study. Generally, the etiology of NSP might be better understood in terms of a web of causation, which was originally introduced by MacMahon and Pugh (1970) (Locker 1992). According to this notion, NSP would develop through complex interactions between many factors, which make up interlocking chains. These factors may be biophysical, social, or psychological and may promote or inhibit the symptoms at more than one point in the causal process. (Locker 1992)

In the studies concerning the etiology of NSP, the main interest has been focused on the different occupational groups in adult populations, and the data concerning the topic are mainly based on epidemiologic studies. Cross-sectional settings have been used most commonly, although increasing numbers of longitudinal studies about the predictive factors of NSP have recently been published. Hardly any of these have focused on young populations. Yet, in adolescence, the profile of exposures to NSP may differ from that seen in adults. The studies concerning associated and predictive factors of NSP in young populations have been presented in Table 1.

Table 1. Studies on NSP and associated/predictive factors in adolescents and young adults.

| Author(s) | Age group (y) | Study population | n | Study design period | Predictors | Outcome | Comments |
|--------------------------------------|---------------|--------------------|--------|---|--|---|---------------------------------------|
| Hertzberg (1985) | 16 | General population | 302 | Prospective 9-12 years | Postural deviations ? Muscular tension and tenderness + Subjective complaints in addition to muscular tension and tenderness + | One or more periods of cervical pain per year | |
| Härmä (2002) | 14-16 | General population | 17,643 | Cross-sectional | Depressive symptoms+ | Weekly neck or shoulder pain | Logistic regression analyses |
| Mikkelsson <i>et al.</i> (1998a) | 10-12 | General population | 515 | Prospective 1 year | Gender (female) + Age + Headache 0 Abdominal pain 0 Depressive feelings 0 Difficulties in falling asleep 0 Day tiredness 0 Waking up during nights 0 Large amount of exercise + Hypermobility 0 | Persistent musculo-skeletal pain at least once a week | Logistic regression analyses |
| Salminen (1984) | 11-17 | General population | 370 | Cross-sectional | BMI 0 Height 0 Physical activity 0 School performance – School mark of physical education 0 Poor abdominal muscle strength + Tightness of upper back + | Present neck and/or back pain | Stepwise logistic regression analyses |
| Viikari-Juntura <i>et al.</i> (1991) | 13 | General population | 1,084 | Prospective measures taken in adolescence and at the age of 32-44 | Youth variables: Alexithymia + Intelligence 0 Poor social confidence+ Hobbies 0 Motor development 0 Verbal development 0 Level of education of father and mother 0 Type of income of family 0 Adult variables: Alexithymia 0 Type of income 0 Twisted or bent torso >3 hr/day 0 Sitting in a forward bent posture (1-3hr/day) 0 Sitting in a forward bent posture >3 hr/day 0 Weak sense of coherence in adulthood+ Poor social confidence in adulthood+ | Mild or severe NSP | Multivariate analyses |
| Vikat <i>et al.</i> (2000) | 12-18 | General population | 11,276 | Cross-sectional | Gender (female) + Age + Psychosomatic symptoms + Long-term illness + Number of times catching cold + Wearing glasses or lenses + Early timing of puberty + Smoking + Panting or sweating a lot in physical exercise + | Weekly neck or shoulder pain | Logistic regression analyses |

+ = positive relationship, - = negative relationship, 0 = no relationship, ? = controversial relationship

2.4.1 Sociodemographic factors

In both cross-sectional and longitudinal studies, the prevalence of NSP is higher among females than in males (Mäkelä *et al.* 1991, Leclerc *et al.* 1999, Côté *et al.* 2000, Miranda *et al.* 2001a, Palmer *et al.* 2001). Mäkelä *et al.* (1991), Hagen *et al.* (1998) and Palmer *et al.* (2001) have indicated that NSP increases with age, the prevalence of NSP being highest in the elderly. According to the findings of Côté *et al.* (2000), the association between age and NSP is U-shaped, the prevalence being highest at the age of 40-49 years. In longitudinal studies, the risk of NSP has been shown to be highest at the age of 30-40 years (Pietri-Taleb *et al.* 1994, Croft *et al.* 2000). However, Viikari-Juntura *et al.* (2001) found the age of the highest prevalence of NSP to be higher; in their follow-up of 5,180 Finnish forest industry workers, the age of 45-54 years predicted radiating neck pain most strongly. The different outcome measures of neck pain may explain the inconsistent results. Neck symptoms in earlier life have been shown to predict later symptoms in adult populations (Fredriksson *et al.* 1999), and the phenomenon has been shown to exist in adolescence already (Hertzberg 1985).

According to Vikat *et al.* (2000), boys who were not enrolled at any school had a higher prevalence of NSP than those enrolled at a school. No such difference was seen in girls. Salminen (1984) found, in a study of 11- to 17-year-old school children, that the school performance of subjects with current neck and/or back symptoms was significantly poorer than that of subjects with no symptoms. There was no significant association between the marks for physical education and current neck and/or back symptoms.

2.4.2 Body size measurements

The relationship between overweight and NSP has remained unclear. Mäkelä *et al.* (1991) found, in the Mini-Finland Health Survey of 8000 Finns aged over 30 years, overweight to be a significant determinant of NSP, whereas Côté *et al.* (2000) found no such association in their population-based study of 2,184 subjects aged 20 to 69 years. In the study by Vikat *et al.* (2000) of 11,276 school children 12-18 years of age, those within the lowest 15% of the body mass index (BMI) distribution had a higher prevalence of NSP than those with higher BMI. However, Salminen (1984) found no association between neck and/or back pain and BMI in a 13- to 17-year-old population. The findings of overweight as a predictive factor of NSP have also been inconsistent. Overweight was shown to be a significant predictor of radiating neck pain by Viikari-Juntura *et al.* (2001), but no similar association was not found by Croft *et al.* (2001), who investigated non-radiating neck pain. The findings on the relationship between body height and NSP are controversial as well. According to the results of Westgaard *et al.* (1993) among 86 working females, short subjects experienced more NSP than taller ones. Yet, Salminen (1984) found no association between height and neck and/or back pain among school children.

2.4.3 Leisure time activities

The studies concerning NSP and leisure time activities have mainly focused on the positive effects of physical activity. The most common study designs have been either epidemiologic cross-sectional surveys or clinical trials of supervised exercise programs. In both, cross-sectional and longitudinal studies, the results concerning the association of NSP and leisure time physical activity have been inconsistent.

In recent clinical trials, muscle strength and endurance training (Hagberg *et al.* 2000) and concurrent co-ordination training (Waling *et al.* 2000, Ahlgren *et al.* 2001), have been compared in subjects with NSP. According to the consistent results, pain decreased in all exercise groups, and there were no significant differences in pain alleviation between the study groups. Although the results on the positive effects of exercise in decreasing NSP are promising, there has been the problem that the symptoms recur shortly after the end of the exercise trial (Levoska & Keinänen-Kiukaanniemi 1993, Waling *et al.* 2002). The finding emphasizes the significance of the motivation to engage in optional physical activities in leisure time, to gain some benefit from exercise for NSP.

In epidemiologic studies on leisure time activities, physical activity has been measured in various ways. The frequency and intensity of exercise or different types of sports have commonly been used as variables. Since most data have been collected by self-administered questionnaires and based on self-assessed intensity of physical activity, it is difficult to evaluate the reliability of the findings. According to a review by Hildebrandt (2000), most studies failed to show any effect, whereas some studies indicated favorable effects of physical activity. In large population-based studies by Côté *et al.* (2000) and Linton (1990), no association between the frequency of exercise and NSP was found. Holmström *et al.* (1992), however, indicated in a study of 1,773 construction workers that NSP was more prevalent among those who spent their leisure time passively compared to the active ones. Of the specific types of sports, racket sports have been related to infrequent neck and shoulder symptoms (Dimberg *et al.* 1989).

In the survey of Vikat *et al.* (2000) in 11,276 schoolchildren of 12-18 years of age, frequency and intensity of physical exercise were measured. According to the results, only moderate intensity of physical exercise was associated with low prevalence of NSP. Adolescents who reported either not to exercise or a lot of panting and sweating in connection with physical exercise had suffered weekly NSP more often than those who were exercised less intensively. The finding disagrees with the result of Salminen (1984), who found no association between the frequency of leisure time physical activity and neck and/or back pain in the study of 370 schoolchildren with 11-17- years of age. In this study, intensity of physical activity was not measured.

Pietri-Taleb *et al.* (1994) presented, in a longitudinal study of 1,015 working men, that physical exercise more than once a week protected (OR 0.62, 95% CI 0.39-0.99) from severe neck trouble. The result is consistent with the finding of Miranda *et al.* (2001a), who reported moderate physical exercise more than 52 times a year to decrease the risk of severe shoulder pain (OR 0.5, 95% CI 0.2-0.7). In the same study on Finnish forest workers, jogging (OR 0.4, 95% CI 0.2-0.9) decreased the risk of shoulder pain and cross-country skiing (OR 0.4, 95% CI 0.2-0.7) decreased the risk of persistent severe shoulder pain. Dancing slightly increased the risk of shoulder pain (OR 1.7, 95% CI 1.1-2.5), while no other types of sports nor the frequency of physical exercise were associated with

shoulder pain. Unexceptionally, in the 1-year follow-up by Miranda *et al.* (2001b), different types of sports as risk factors for musculoskeletal pain were investigated among Finnish forest industry workers. Of the specific types of sports, playing actively volleyball proved to be a risk factor for shoulder pain (OR 3.6, 95% CI 2.0-6.7).

Little data are available on the predictive value of leisure time hobbies for NSP in adulthood, but one study concerning the subject was found. Viikari-Juntura *et al.* (1991) conducted a 24-year follow-up among 154 subjects to investigate the relationship between hobbies in childhood and NSP in adulthood. The data on hobbies were collected by a 28-item questionnaire at the age of 13, and they were grouped into physical, social, creative, and passive hobbies. No association between childhood hobbies and NSP in adulthood was found.

2.4.4 Perceived symptoms

Since a multidimensional approach to the understanding of NSP has been widely accepted, different psychological factors have recently been a natural part of the studies on the etiology of NSP. There is also increasing evidence of psychological factors being significant risk factors of NSP. In the meta-analysis by Linton (2000b) of 37 longitudinal studies, psychological factors were associated with reported onset of neck pain with level A evidence, i.e. the result is supported by at least two high-quality prospective studies. The most active interest was focused on self-reported psychosomatic stress symptoms with numerous variables, and depressive symptoms, of which the evidence of being risk factors of NSP is also the strongest (Linton 2000b).

2.4.4.1 Psychosomatic symptoms

The prevalence of psychosomatic complaints in adolescents has been reported to be between 10 and 25% (Brill *et al.* 2001). In the survey of Natvig *et al.* (1999) among 13- to 15-year-old adolescents, irritability was the most common psychosomatic symptom in the total population, whereas in girls, stomach ache, headache, and low mood, and in boys, headaches, sleeplessness, and feeling nervous were the next most common symptoms. Adolescence as a period of transition from childhood to adulthood is a phase with unique physical and psychological changes as well as social demands, due to which psychosomatic symptoms among adolescents are often thought to relate to developmental stress (Zeltzer & LeBaron 1984).

In adult populations, the relation between psychosocial stress at work and NSP in different occupational groups has been well documented. The variables investigated have been diverse, including work content, social support and psychological work load (Linton 1990, Engström *et al.* 1999), authority over decisions, intellectual discretion and psychological demands (Hagen *et al.* 1998), psychosocial problems at work (Westgaard *et al.* 1993), mental stress at work (Mäkelä *et al.* 1991) and, job dissatisfaction (Levoska & Keinänen-Kiukaanniemi 1994, Krause *et al.* 1997). In these studies the association

between work-related psychological stress and NSP has been consistently found. The tendency has been similar when the target population has included young adults. According to the findings of Barnekow-Berqvist *et al.* (1998) on 34-year old subjects (n=276), worry in males and high decision latitude at work in females was associated with NSP. Palmer *et al.* (2001) also found an association between frequent tiredness and stress and NSP in the study of a large general population (n=21,201) aged 16-64 years. Although the scientific evidence of psychological factors relating to NSP is strong, few studies have aimed to explain why these variables might be important (Linton 1990), and situation is still the same.

In adolescents, the association between psychosomatic symptoms and NSP was demonstrated by Vikat *et al.* (2000) among 11,276 school children aged 12-18 years old. The number of psychosomatic symptoms perceived at least once a week was asked in the survey. The more symptoms a subject reported, the more likely one was to suffer from NSP. If the subject reported one weekly psychosomatic symptom, the risk of NSP was 1.9, while with more than three weekly psychosomatic symptoms, the risk was 4.4, the difference being significant at the 95% confidence level.

Psychosocial factors have also proved consistently to predict musculoskeletal symptoms (Leino 1989) or neck pain (Leino & Magni 1993, Fredriksson *et al.* 1999, Leclerc *et al.* 1999, Miranda *et al.* 2001a, Torp *et al.* 2001) in adults. In the 10-year follow-up by Leino and Magni (1993) of 2,653 Finnish metal workers, psychosomatic stress symptoms were measured by an 18-item questionnaire. The location and frequency of musculoskeletal symptoms during the past year was inquired, and the subjects were clinically examined at each stage of the study. According to the results, psychosomatic stress symptoms predicted NSP. In the study of Finnish forest workers, mental stress was shown to predict radiating and local neck pain (Miranda *et al.* 2001b) and shoulder pain (Miranda *et al.* 2001a).

2.4.4.2 Depressive mood

According to the Health 2000 survey among 30- to 44-year-old Finns, 5% had suffered from serious depression during past 12 months (Pirkola *et al.* 2000). In adolescents, the prevalence of major depression has been reported to vary within 2-8% in different studies (Harrington 1994, Goodman & Scott 1997, Kovacs & Devlin 1998). Haarasilta *et al.* (2001) found the 12-month prevalence of DSM-III-R major depressive episode among 15- to 19-year-old Finnish adolescents to be 5.3% (females 6.0%, males 4.4%) and that among 20- to 24-year-old young adults 9.4% (females 10.7%, males 8.1%). In the study of Aalto-Setälä *et al.* (2001) among the Finnish 20- to 24-year-old population, one-month prevalence of depression was slightly higher (10.8%). Recent studies have indicated that disorders resembling adult depression may already occur in childhood, and there is an increase in the rates of depression with age. The gender ratio of depressed children is approximately equal, whereas females dominate from middle to late adolescence. (Harrington 1994)

In the studies concerning the association between NSP and depressive symptoms, the findings have been mostly positive. In the population-based survey of Côté *et al.* (2000)

among subjects (n=2,184) 20-69 years of age, depressive symptoms were measured with the Center for Epidemiological Studies Depression Scale (CES-D). Neck pain was graded into five classes according to the disability experienced and the severity of pain, with grade 0 indicating no neck pain and grade IV indicating high disability/severely limiting neck pain. Depressive symptoms were associated with neck pain of every grade, and the statistical significance was highest in the class of the most severe neck pain. Mikkelsen (1997b) discovered in their study of 1756 school children aged 10-12 years, an association between depressive symptoms and NSP. In this study depressive symptoms were measured with Children's Depression Inventory (CDI).

Leino and Magni (1993) showed that depressive symptoms predicted musculoskeletal symptoms in a 10-year follow-up of 607 metal industry workers. When analyzed in specific occupational groups, depression was found to predict severe neck trouble among office workers, but not in the total study group in a 3-year follow-up of 1,015 working men (Pietri-Taleb *et al.* 1994). In the population-based 8-year follow-up study of Magni *et al.* (1993) among 2,341 subjects 25-74-years of age, depressive symptoms predicted chronic musculoskeletal pain. There are also some findings of depressive symptoms having no association with pain (Von Korff *et al.* 1993, Estlander *et al.* 1998). In these studies, however, the focus was on overall musculoskeletal pain or back pain, which makes the results difficult to apply directly to NSP.

Härmä *et al.* (2002) reported that depression is associated with NSP in a young population already. In their cross-sectional study of 17,643 school children (mean age 15.3 years), the prevalence of depression was higher among those who had experienced weekly NSP compared to asymptomatic subjects (OR 1.4, 95% CI 1.1-1.8 for girls, and OR 1.6, 95% 1.2-2.2 for boys). Beck Depression Inventory was used to measure depressive symptoms and a self-administered questionnaire to measure NSP.

I have not found longitudinal studies concerning specifically psychosomatic or depressive symptoms as predictors of NSP in young populations. According to the 1-year follow-up by Mikkelsen *et al.* (1998b) among 452 preadolescents 10-12 years of age, a high subjective disability index due to pain and day tiredness were the most significant predictors of musculoskeletal pain. Viikari-Juntura *et al.* (1991) showed that alexithymia (low verbal productivity in projective personality tests) and social confidence in childhood failed to predict NSP in adulthood.

2.5 Summary of epidemiologic studies in young population

Only a few studies concerning NSP and associated factors in cross-sectional or longitudinal settings have been carried out in young populations. In most of these studies data are collected by self-administered surveys, and data based on clinical findings are rare. Although the studies generally focus on several exposures associated to NSP, I have found only one preliminary study on ergonomics as associated factor of NSP (Koskelo 2003)

In cross-sectional studies, psychosomatic symptoms (Vikat *et al.* 2000, Härmä *et al.* 2002) and depressive symptoms (Mikkelsen *et al.* 1997b, Härmä *et al.* 2002) have been associated with NSP. Poor school achievement may have an association with NSP, but the

results concerning leisure time physical activity are inconsistent (Salminen 1984, Vikat *et al.* 2000).

In the follow-up study of Mikkelsson *et al.* (1998b), high subjective disability due to pain and day tiredness predicted musculoskeletal pain in preadolescents, and in the study of Viikari-Juntura *et al.* (1991), alexithymia or social confidence in childhood failed to predict NSP in adulthood.

3 Aims of the study

The primary purpose of this study was to investigate the prevalence and incidence of NSP in a young population. Different factors associated with NSP and predictors of NSP were investigated. Additionally, MRI images of asymptomatic and symptomatic subjects were compared. The original articles are indicated in the text by the Roman numeral I to IV. Answers were specifically sought to the following questions:

1. What is the occurrence of NSP among high school students and young adults? (I, III)
2. Are sociodemographic factors, body size measurements, psychosomatic symptoms, depressive mood, or leisure time activities associated with NSP among high school students? (I, II)
3. Do sociodemographic factors, body size measurements, psychosomatic symptoms, depressive mood, or leisure time activities in adolescence predict NSP in adulthood? (III)
4. Do MRI findings of the cervical spine relate to NSP in young adults? (IV)

4 Subjects and methods

4.1 Subjects

4.1.1 Baseline

In 1989, altogether 2,212 students attended the 11 high schools in the City of Oulu (120 000 inhabitants) in Finland. Five of the high schools with a total of 826 students aged 15- to 18-years were randomly selected for the study, and 718 students (87 %) completed a questionnaire. Four students were excluded because of missing questionnaires, which resulted in a final sample of 714 (408 girls and 306 boys).

4.1.2 7-year follow-up

In 1996, a postal inquiry was sent to the same series of subjects (n=826), of whom 547 responded, giving a response rate of 66 %. Of the 718 respondents of the baseline survey, 394 (55 %) subjects (247 females and 147 males) participated in both surveys.

The non-respondents differed from the respondents significantly in a few explanatory variables. There were significantly more females than males among the respondents. In addition, the respondents were slimmer, their school achievement was better, they spent more time on homework and spent their leisure time physically more passively.

Table 2. Comparisons of the 394 respondents (246 females and 146 males) and 324 (162 females and 160 males) non-respondents at 7-year follow-up.

| Factor | Respondents | | Non-respondents | | p |
|--|-------------|-----|-----------------|-----|--------|
| | n | n | n | n | |
| Gender | | | | | 0.001 |
| Female (%) | 62 | 246 | 50 | 162 | |
| Male (%) | 38 | 146 | 50 | 160 | |
| Body Mass Index (mean of kg/m ²) | 20.4 | | 21.3 | | <0.001 |
| Height (mean in cm) | | | | | |
| Female | 165 | 246 | 164.8 | 159 | 0.8 |
| Male | 178 | 146 | 178 | 157 | 1.0 |
| School achievement (mean) | 8.1 | | 7.9 | | 0.03 |
| Time spent on homework (minutes/day) | 67 | | 58 | | 0.02 |
| Leisure time activity (%) | | | | | |
| Physical activity/passivity in leisure time | | | | | 0.02 |
| Very active | 20 | 79 | 29 | 92 | |
| Fairly active | 22 | 88 | 17 | 54 | |
| Fairly passive | 33 | 131 | 28 | 88 | |
| Very passive | 24 | 94 | 26 | 83 | |
| Type of leisure time activity | | | | | 0.2 |
| Sports which dynamically load the upper extremities | 14 | 51 | 18 | 49 | |
| Other sports | 69 | 250 | 67 | 188 | |
| Hobbies which statically load the upper extremities | 6 | 23 | 3 | 9 | |
| Other hobbies | 10 | 37 | 12 | 34 | |
| Self-assessed physical condition (%) | | | | | 0.3 |
| Good or fairly good | 33 | 168 | 33 | 138 | |
| Moderate | 58 | 183 | 43 | 135 | |
| Fairly poor or poor | 10 | 40 | 15 | 47 | |
| Frequency of neck and shoulder symptoms (%) | | | | | 0.4 |
| Less than once a month | 54 | 213 | 57 | 185 | |
| 1-2 times a month | 23 | 91 | 23 | 73 | |
| Once a week | 12 | 48 | 9 | 28 | |
| More than once a week | 6 | 24 | 4 | 13 | |
| Seeking health care for neck and shoulder symptoms (%) | 24 | 94 | 19 | 62 | 0.1 |
| Depressive mood score (mean) | 6.1 | | 6.3 | | 0.9 |
| Psychosomatic symptom score (mean) | 26.2 | | 26.2 | | 0.9 |

4.1.3 Magnetic resonance imaging study

Two groups were chosen from the follow-up study for MRI scanning. The first group consisted of the participants who had reported no neck and shoulder symptoms in either of the inquiries (no symptom group=NSG). The other group included those who had been suffering from neck and shoulder symptoms once a week or more often at the time of

both surveys in 1989 and 1996 (recurrent or persistent symptom group=SG). Based on these criteria, 26 NSG subjects and 40 SG subjects were found. Since the MRI study was carried out in Oulu University Hospital, participants living outside the Oulu area were excluded, after which NSG consisted of 23 and SG of 33 subjects. 30 participants, 15 from both groups, were randomly chosen for MRI scanning. Since one symptomatic participant signed up for the study after the deadline, the ultimate number of SG subjects was 16. Therefore, the MRI study comprised 31 subjects 24-26 years of age. NSG consisted of 8 female and 7 male subjects (mean age 25.7) and SG of 13 female and 3 male subjects (mean age 25.4).

4.2 Study design

This study comprised three parts. The first part was a cross-sectional survey of 826 high school students. The second part was a 7-year follow-up of the same sample (Figure 1). The third part was a MRI study of a subgroup of the follow-up study sample.

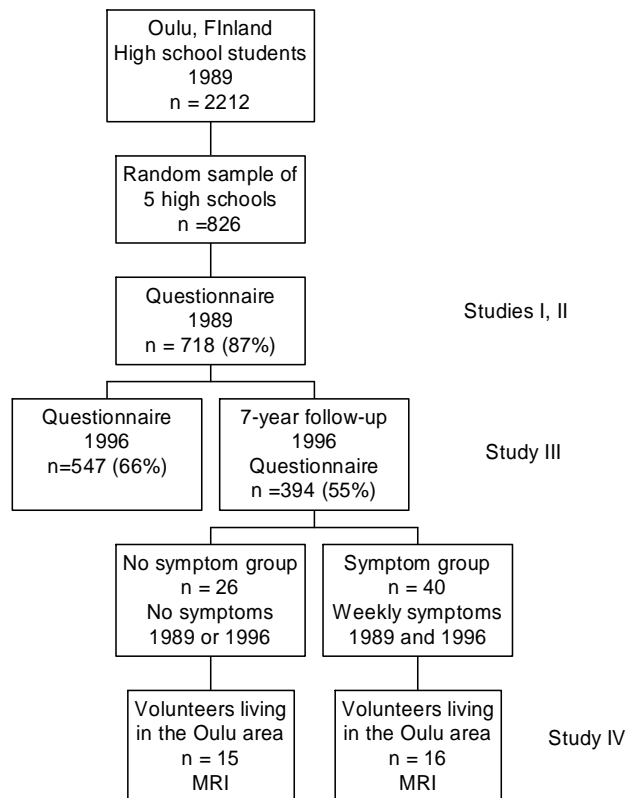


Fig. 1. Study Design.

4.3 Measurements

The first set of data was collected in 1989 by using a self-administered questionnaire, which was called a health survey. The high school students completed the questionnaire in class in the presence of a teacher and returned it in a sealed envelope. In 1996, the same subjects filled in a similar questionnaire as a postal inquiry. Those who had not returned the questionnaire in due time were sent two reminders. The instruments mentioned below were used in both surveys, with the exception of the Child Depression Inventory, which was only included in the second survey in 1996.

4.3.1 *Musculoskeletal symptoms*

A modified version of the standardized and validated Nordic musculoskeletal questionnaire was used to measure the presence, frequency, and duration of NSP (Kuorinka *et al.* 1987). A manikin was used to illustrate the anatomical area in question. In the questionnaire, the period of recollection concerning the symptoms was 12 months. This was, however, considered too long for adolescents, which is why a period of 6 months was used instead. On the basis of the frequency of NSP, the participants were divided into three groups in both surveys: 1) no symptoms, if the respondent reported never having had NSP, 2) occasional symptoms, if the respondent reported having had NSP less often than once a week over the past 6 months, 3) frequent symptoms, if the respondent reported having had NSP once a week or more often over the past 6 months. The classification of three symptom groups was used in study I. In the studies II and III, however, subjects with no symptoms and occasional symptoms were combined into one group. The subjects were also asked if they had sought care for the symptoms by visiting a physiotherapist, a nurse, or a doctor.

The incidence of NSP was estimated in the subgroup of respondents who, at baseline in 1989, had reported never having had NSP, but had suffered from an episode of NSP during the 6 months preceding the second survey.

4.3.2 *Sociodemographic factors*

The gender of the respondent was asked. School achievement was recorded as the school mark average in the previous school report. The range of school mark averages is 4-10. The school mark for physical education (range 4-10) and the time spent on homework (min/day) were also asked.

4.3.3 *Body size measurements*

The survey included questions about body weight and height.

4.3.4 Leisure time activities

Leisure time activities were classified on the basis of open-ended questions, where the participants were asked to name the three leisure time activities they devoted most time to. Four classes were formed: 1) sports activities mainly involving dynamic loading of the upper extremities (basketball, volleyball, baseball, squash, tennis, badminton, table tennis, ice hockey, bandy, floor ball, golf, fitness boxing), 2) other sports activities involving dynamic loading of all muscle groups (gymnastics, skiing, aerobic, etc.), 3) hobbies involving static use of the upper extremities (needlework, handicraft, computer, playing the piano or violin, etc.), and 4) other activities (listening to music, reading books, etc.). A question about the way of spending leisure time by focusing on the type and intensity of physical activities on a 4-item scale was asked. In addition, the intensity of exercise was measured on a 4-point scale by asking whether the exercise caused panting and sweating. The respondents also assessed their physical condition on a 5-point scale from very good to very poor.

4.3.5 Psychosomatic symptom score

Self-reported psychosomatic symptoms were measured in 1989 and 1996 on a 17-item questionnaire about the presence and frequency of psychophysiological symptoms considered as manifestations of mental stress (Aro 1988). The question was formulated as follows: 'Have you had some of the following symptoms and how often during the past 6 months?' The list included the following items: abdominal pains, loss of appetite, headache, fatigue or febleness, difficulties in falling asleep or waking up at night, nausea or vomiting, anxiety or nervousness, dizziness, tremor of hands, nightmares, diarrhoea or irregular bowel function, lack of energy, excessive perspiration without physical effort, heartburn or acid troubles, irritability or fits of anger, dyspnoea without physical effort, tachycardia or irregular heart beat. Each item was scored from 1=never to 4=often or continuously. A psychosomatic symptom score was calculated after scoring the values of 1-2 (no or occasional symptoms) as 0 and the values of 3-4 (fairly often and often or constantly) as 1. The range of the psychosomatic symptom score was 0-17. The median of the psychosomatic symptom score was used as a cut-off point. The one-month test-retest correlation of the symptom checklist has been 0.85 in girls and 0.67 in boys aged 14-15 years (Paronen *et al.* 1982). The internal consistency (Cronbach alpha) was 0.72. Additionally, in the longitudinal study three categories on the basis of the change in the psychosomatic symptom score were formed (psychosomatic symptom score decreased, unchanged or increased) to evaluate the change of psychosomatic symptoms as an explanatory variable for the prevalence of NSP in adulthood.

4.3.6 Depressive mood score

Self-reported subjective symptoms related to depressive mood were investigated. Since the participants were not clinically examined, depressive mood in the present study does not relate to clinical depression. In Study II, the term “depressive symptoms” was used, but in Study IV, “symptoms of fatigue and sleep difficulties” was used to indicate the same phenomenon. For congruence, in this summary of the thesis, the two previous terms are here replaced by the concept of depressive mood. In 1989 and 1996, depressive mood was measured with questions on the presence and frequency of sleeping problems, fatigue, and lack of energy, which are considered to relate to depressive mood. A depressive mood score was calculated analogously to the psychosomatic symptom score. The range of the depressive mood score was 0-3. The median of the depressive mood score was used as a cut-off point. Cronbach alpha was 0.74. Additionally, in 1996, the Children’s Depression Inventory (CDI), a self-report inventory devised by Kovacs and Beck (1977), was used to validate the 3-item depressive mood scale. Its internal consistency was 0.86 (Kovacs 1980). As with the psychosomatic symptom score, three categories on the basis of the change in the depressive mood score were formed (depressive mood score decreased, unchanged, or increased), to evaluate the change of depressive mood as an explanatory variable for the prevalence of NSP in adulthood.

4.3.7 Magnetic resonance imaging study

The imaging was performed with a 1.5-T imaging system (Signa, General Electric, Milwaukee, WI) and a standard phased array spine coil. The imaging consisted of sagittal spine echo (SE) T1-weighted (TR=500 msec, TE=14 msec, three excitations averaged, 256x224 matrix) and sagittal fast spin-echo (FSE) T2-weighted images (TR=4000 msec, effective TE 105 msec, 8 echo train length with 15 msec echo spacing, three excitations, 256x224 matrix, 16 kHz bandwidth), with a 26-cm field of view (FOV) and 3-mm slice thickness with no interslice gap and oblique axial SE T1-weighted (TR=500 msec, TE=14 msec, three excitations averaged, 256x224 matrix) and T2*-weighted gradient echo images (GRE) (TR=600 msec, TE=20 msec, flip angle 25, three excitations averaged, 256x192 matrix) with 22-cm FOV and 4-mm slice thickness with a 1-mm interslice gap. The sagittal imaging planes were placed on a prior coronal scout image to cover the whole spine, and the oblique axial image planes, oriented along the plane of the intervertebral discs, were located on a midline T2-weighted sagittal image to cover the planes from the caudal end plate of the C2 vertebra to the cranial end plate of the first thoracic vertebra. The study was approved by the institutional ethical committee of Oulu University Hospital.

Two radiologists assessed the MR images cooperatively and unaware of the participants’ pain history. The MR images were reanalyzed separately by both radiologists for the calculation of Kappa coefficients. The morphology of the cervical spine was categorized as showing no anomaly/some anomaly. The posture of the cervical spine was evaluated as normal, slightly straightened lordosis, straightened, or kyphotic. The degrees of disc degeneration (DD), annular tear, herniation, and protrusion were

assessed separately. The degree of DD was classified by the change in signal intensity in the sagittal T2-weighted FSE images as follows: 0=normal high signal in the central annulus comparable with CSF, 1=a decrease in disc signal intensity without other morphological changes, 2=a decrease in signal intensity and end plate osteophyte, and 3=a decrease in signal intensity and disc space narrowing. Annular tear was classified in the T2*-weighted oblique axial images as follows: 0=high signal intensity in the central disc only, 1=high-intensity signal extending to the inner annulus area, 2=high-intensity signal extending to the outer annulus area, and 3=herniation. The degree of herniation was classified as: 1= slight, only visible in the sagittal image, 2=herniation filling half of the ventral liquor space in the sagittal and axial directions, 3=herniation reaching out to the spinal cord, 4=herniation reaching out to the spinal cord and classified as contained or non-contained. Protrusion was analyzed in the oblique axial T2*-weighted images as follows: 0=no protrusion, 1=slight protrusion, presenting as straightening of the dorsal concave shape of the posterior disc margin, 2=protrusion filling half of the ventral liquor space in the sagittal and axial directions, 3=protrusion reaching out to the spinal cord. The facet joints were analyzed by assessing hydrops, osteophytes, and narrowing of cartilage. The muscles of the spinal area were graded as normal or atrophied.

During the MRI visit, the participants filled in a pain drawing and a questionnaire concerning the frequency, duration, severity, location, and inconvenience of their neck and shoulder symptoms based on the Nordic musculoskeletal questionnaire of Kuorinka *et al.* (1987). The severity of the neck and shoulder symptoms was estimated on the Visual Analogue Scale (VAS). The VAS value in SG was 38.4 mm, since 13 subjects reported having had pain during the past week. In NSG, the VAS value was 0 mm.

4.4 Statistical methods

In the cross-sectional study, the associations between NSP and leisure time activities and seeking care for NSP were analyzed by cross-tabulation and the Chi-square test. Analyses of variance were used to determine the differences in the continuous variables of body height and BMI in the three study groups (Study I). In study II, the average sum scores for psychosomatic symptoms and depressive symptoms were calculated for two study groups, since the subjects with no symptoms and occasional symptoms were combined. All the above analyses were carried out with the BMDP Statistical Software package. The association between NSP and all of the explanatory variables chosen for the cross-sectional study were also analyzed by the Cox regression model (Procedure Phreg, SAS for Windows, version 8.2). The psychosomatic symptom score, the depressive mood score, and the school mark for physical education were continuous variables, and all the rest were categorical variables.

In the follow-up study, we found out the associations between the potential explanatory factors and NSP by using cross-tabulations. The factors with statistical significance at the 10% level were placed one at a time into a preliminary Cox regression model (Procedure Phreg, SAS for Windows, version 8.2). The outcome variable was weekly NSP in adulthood, and the explanatory variables were NSP in adolescence, seeking for care because of NSP, BMI, body height, school achievement, school mark in

physical education, time spent on homework, psychosomatic symptoms, change in the psychosomatic symptoms score during the follow-up, depressive mood, change in the depressive mood score during the follow-up, activity/passivity of leisure time, intensity of exercise, type of leisure time activity, and self-assessed physical condition in adolescence. Psychosomatic symptom score, depressive mood score, and school mark in physical education were used as continuous variables, while the rest of the variables were categorical.

In the first phase, Wald test scores at the level $p < 0.1$ of the maximum likelihood estimates were chosen for the adjusted logistic model. In the second phase, the variables that were too closely related to one another were excluded from the adjusted model, to avoid collinearity. Therefore, since seeking for care because of NSP and the frequency of NSP were related, we excluded seeking for care from the model. Similarly, because of the interrelation between psychosomatic symptoms and depressive mood, only psychosomatic symptoms were included in the adjusted model. Of the variables concerning physical activity, the school mark for physical education and the intensity of physical exercise were excluded for the same reason. Finally, we eliminated the least significant factors one by one from the model, until it only included statistically significant factors.

In the subgroup of those who were asymptomatic at baseline in 1989, but had suffered from occasional or weekly episodes of NSP during the 6 months preceding the second survey seven years later, the risk ratios for the predictive factors of incident NSP were calculated in the same manner as in the total study group. The possible interactions between the explanatory factors were also examined, but they were not statistically significant. To conclude, we studied the *association* of baseline variables and NSP in relation to the prevalence rates of NSP seven years later. The baseline variables as *predictors* of NSP were investigated in relation to the incidence of NSP in the subgroup of subjects asymptomatic at baseline in 1989.

In the MRI study, the proportions of DD, anular tear, herniation, and protrusion were calculated for NSG and SG. The results were analyzed by cross-tabulation. The Chi-Square Test and Fisher's Exact Test were used to determine the statistical significances between the proportions. The reliability of the MRI assessment was estimated by Kappa statistics.

4.5 Ethical considerations

The survey studies were approved by City of Oulu, Bureau for Education. The high school students enrolled as informants also had a possibility to refuse to answer the questions. In the cover letter of the postal inquiry of the follow-up survey, the participants were informed that responding was voluntary. The MRI study was approved by the institutional ethical committee of Oulu University Hospital. Written informed consent was obtained from all participants of the MRI study.

5 Results

5.1 Prevalence and incidence of neck and shoulder pain

The prevalence of self-reported weekly NSP among high school students was 17% (Table 3). A significantly greater percentage of girls (21%) than boys (11%) had weekly symptoms. The girls' neck and shoulder symptoms increased during high school: the girls in the last grade had more frequent symptoms (29%) than those in the lower grades (16 and 20%) (Table 4).

Out of the 547 respondents of the second survey in 1996, 28% experienced NSP once a week or more frequently at the age of 22-25 years by 28% of the subjects. Weekly symptoms were more prevalent among females (34%) than males (19%), the difference between the groups being statistically significant. There was also an increase in the prevalence of NSP along with age. Within seven years, the prevalence of weekly NSP among those responding to both surveys had increased from 17 to 28%. Of the 104 subjects who, in 1989, reported never having experienced NSP, 61 (59%) reported having suffered from occasional or weekly NSP during the 6 months preceding the follow-up survey seven years later.

Table 3. Prevalence of neck and shoulder pain in 15-18 and 22-25 year old populations.

| | 1989 | | | | | | 1996 | | | | | |
|---------------------|-------|----|------|----|-------|----|-------|----|------|----|-------|----|
| | Girls | | Boys | | Total | | Girls | | Boys | | Total | |
| | n | % | n | % | n | % | n | % | n | % | n | % |
| No symptoms | 87 | 22 | 102 | 37 | 189 | 28 | 46 | 13 | 50 | 26 | 96 | 18 |
| Occasional symptoms | 225 | 57 | 144 | 52 | 370 | 55 | 184 | 53 | 107 | 55 | 292 | 54 |
| Frequent symptoms | 84 | 21 | 29 | 11 | 113 | 17 | 117 | 34 | 36 | 19 | 153 | 28 |
| Total | 396 | | 275 | | 672* | | 347 | | 193 | | 541** | |

*Missing data 46 subjects. **Missing data 6 subjects.

Table 4. Prevalence of neck and shoulder pain in female and male students in different grades of high school.

| Grade | | No symptoms | | Occasional symptoms | | Frequent symptoms | | Total |
|--------|-------|-------------|----|---------------------|----|-------------------|----|-------|
| | | n | % | n | % | n | % | n |
| First | Girls | 35 | 23 | 95 | 61 | 25 | 16 | 155 |
| | Boys | 37 | 34 | 63 | 58 | 9 | 8 | 109 |
| Second | Girls | 25 | 24 | 58 | 56 | 21 | 20 | 104 |
| | Boys | 36 | 42 | 38 | 44 | 12 | 14 | 86 |
| Third | Girls | 24 | 18 | 71 | 53 | 38 | 29 | 133 |
| | Boys | 25 | 34 | 43 | 58 | 6 | 8 | 74 |
| Total | Girls | 84 | 21 | 224 | 57 | 84 | 21 | 392 |
| | Boys | 98 | 36 | 144 | 53 | 27 | 10 | 269 |
| | | | | | | | | 661* |

* missing data, 16 females, 37 males

5.2 Factors associated with neck and shoulder pain in adolescence

5.2.1 Sociodemographic factors

In the cross-sectional study (Table 5), female gender was associated with NSP (RR 1.9, 95% CI 1.1-3.3). A greater proportion of girls (14%) than boys (5%) also sought for care for their symptoms. There was no association between NSP and the school mark for physical education, the time spent on homework, or school achievement.

5.2.2 Body size measurements

BMI and body height were unrelated to NSP in the cross-sectional study.

5.2.3 Leisure time activity

Table 6 shows the profile of leisure time activities in adolescence and young adulthood. Sports were the most common hobby in both adolescence and young adulthood, but the number of subjects involved in sports which dynamically load the upper extremities had decreased, and the participation in other sports had increased over the seven years.

In study I, when the Chi-square test was used to determine the statistical significance of the differences between the proportions of the three study groups, the girls who were active in sports involving dynamic loading of the upper extremities had significantly less ($p < 0.001$) NSP than those with hobbies involving static postures of the upper limbs or those engaged in other types of physical activity ($p < 0.05$). The trend among the boys was

similar, but the differences between the four leisure time activity groups were not statistically significant.

Table 5 shows the relationship between the different types of leisure time activities and NSP obtained by a Cox regression model. In these analyses, too, the association between a low prevalence of NSP and practising sports involving dynamic loading of the upper extremities remained significant in total (RR 0.3, 95% CI 0.1-0.8). Hobbies which load statically the upper extremities, were associated with NSP both in females (RR 2.2, 95% CI 1.0-4.8) and in males (RR 3.9, 95% CI 1.1-13.9). Physical activity/passivity of leisure time was not clearly associated with NSP. On the whole, however, those who spent their leisure time fairly passively suffered from NSP more frequently than those who spent their leisure time more actively or very passively. The prevalence of NSP was higher among those who reported panting or sweating slightly or not at all (RR 2.0, 95% CI 1.0-3.8) while exercising compared to those exercising with higher intensity. Moderate self-assessed physical condition was associated with NSP in females (RR 1.9, 95% CI 1.0-3.7).

Table 5. Risk ratios (RR) and 95% Confidence Intervals (95%CI) for factors associated with self-reported weekly neck and shoulder pain in high school students.

| | Females | | | | | | Males | | | | | | Total | | | | | | |
|------------------------------------|---|---|--|---|----------------------------|---|---|---|--|---|----------------------------|---|---|---|--|---|--------------------------|---|---|
| | Subjects with- out neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude model RR 95%CI | | Subjects with- out neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude model RR 95%CI | | Subjects with- out neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude model RR 95% CI | | |
| | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n |
| Sociodemographic factors | | | | | | | | | | | | | | | | | | | |
| Gender | | | | | | | | | | | | | | | | | | | |
| Male | | | | | | | | | | | | | | | | | | | |
| Female | | | | | | | | | | | | | | | | | | | |
| School achievement | | | | | | | | | | | | | | | | | | | |
| Quartile 1 | | | | | | | | | | | | | | | | | | | |
| Quartile 2 | | | | | | | | | | | | | | | | | | | |
| Quartile 3 | | | | | | | | | | | | | | | | | | | |
| Quartile 4 | | | | | | | | | | | | | | | | | | | |
| Time spent on home work | | | | | | | | | | | | | | | | | | | |
| Quartile 1 | | | | | | | | | | | | | | | | | | | |
| Quartile 2 | | | | | | | | | | | | | | | | | | | |
| Quartile 3 | | | | | | | | | | | | | | | | | | | |
| Quartile 4 | | | | | | | | | | | | | | | | | | | |
| School mark for physical education | | | | | | | | | | | | | | | | | | | |
| 1.1 0.8-1.6 | | | | | | | | | | | | | | | | | | | |
| Body size measurements | | | | | | | | | | | | | | | | | | | |
| Body Mass Index | | | | | | | | | | | | | | | | | | | |
| Quartile 1 | | | | | | | | | | | | | | | | | | | |
| Quartile 2 | | | | | | | | | | | | | | | | | | | |
| Quartile 3 | | | | | | | | | | | | | | | | | | | |
| Quartile 4 | | | | | | | | | | | | | | | | | | | |
| Height | | | | | | | | | | | | | | | | | | | |
| Quartile 1 | | | | | | | | | | | | | | | | | | | |
| Quartile 2 | | | | | | | | | | | | | | | | | | | |
| Quartile 3 | | | | | | | | | | | | | | | | | | | |
| Quartile 4 | | | | | | | | | | | | | | | | | | | |

Table 5. Continued

| | Females | | | | Males | | | | Total | | | | | | | | | |
|--|---|----|--|----|---|----------------|--|----|---|-----|--|-----------------|-----|----|-----|-----------|------------|----------------|
| | Subjects with- out neck and shoulder pain | | Subjects with neck and shoulder pain | | Subjects with- out neck and shoulder pain | | Subjects with neck and shoulder pain | | Subjects with- out neck and shoulder pain | | Subjects with neck and shoulder pain | | | | | | | |
| | n | % | n | % | n | % | n | % | n | % | n | % | | | | | | |
| Seeking health care for neck and shoulder pain in adolescence | | | | | | | | | | | | | | | | | | |
| No | 331 | 86 | 56 | 17 | 1.0 | 259 | 96 | 25 | 10 | 1.0 | 590 | 90 | 81 | 14 | 1.0 | | | |
| Yes | 56 | 14 | 27 | 48 | 1.4 | 1.2-1.6 | 13 | 5 | 2 | 15 | 2.8 | 1.2-6.3 | 69 | 10 | 29 | 42 | 1.5 | 1.3-1.7 |
| Leisure time activities | | | | | | | | | | | | | | | | | | |
| Physical activity/passivity of spending leisure time | | | | | | | | | | | | | | | | | | |
| Very active | 75 | 19 | 13 | 17 | 1.0 | 94 | 34 | 8 | 9 | 1.0 | 169 | 25 | 21 | 12 | 1.0 | | | |
| Fairly active | 127 | 32 | 19 | 15 | 0.9 | 0.4-2.3 | 81 | 29 | 8 | 10 | 0.9 | 0.3-3.5 | 208 | 31 | 27 | 13 | 1.0 | 0.5-2.2 |
| Fairly passive | 108 | 27 | 29 | 27 | 1.7 | 0.7-3.9 | 30 | 11 | 2 | 7 | 1.4 | 0.3-7.4 | 138 | 20 | 31 | 22 | 2.0 | 1.0-4.0 |
| Very passive | 88 | 22 | 21 | 24 | 1.5 | 0.6-3.7 | 74 | 27 | 8 | 11 | 1.8 | 0.5-6.2 | 162 | 24 | 29 | 18 | 1.7 | 0.8-3.6 |
| Type of leisure time activity | | | | | | | | | | | | | | | | | | |
| Sports which dynamically load the upper extremities | 63 | 17 | 5 | 8 | 0.3 | 0.1-1.0 | 63 | 25 | 2 | 3 | 0.3 | 0.0-2.0 | 126 | 20 | 7 | 6 | 0.3 | 0.1-0.8 |
| Other sports | 253 | 69 | 59 | 23 | 1.2 | 0.6-2.1 | 142 | 57 | 15 | 11 | 1.0 | 0.3-2.8 | 395 | 64 | 74 | 19 | 1.2 | 0.7-2.0 |
| Hobbies which statically load the upper extremities | 20 | 5 | 9 | 45 | 2.2 | 1.0-4.8 | 11 | 4 | 3 | 27 | 3.9 | 1.1-13.9 | 31 | 5 | 12 | 39 | 2.5 | 1.3-4.9 |
| Other hobbies | 32 | 9 | 7 | 22 | 1.1 | 0.4-2.7 | 33 | 13 | 3 | 9 | 1.2 | 0.3-5.3 | 65 | 11 | 10 | 15 | 1.0 | 0.5-2.3 |
| Panting or sweating in physical exercise | | | | | | | | | | | | | | | | | | |
| A lot | 74 | 19 | 13 | 18 | 1.0 | | 105 | 39 | 10 | 10 | 1.0 | | 179 | 27 | 23 | 13 | 1.0 | |
| Somewhat | 244 | 63 | 55 | 23 | 2.3 | 0.8-6.6 | 115 | 43 | 9 | 8 | 1.8 | 0.6-5.2 | 359 | 55 | 64 | 18 | 1.5 | 0.9-2.5 |
| A little/not at all/no exercise | 69 | 17 | 15 | 22 | 2.2 | 0.9-5.5 | 50 | 18 | 8 | 16 | 0.4 | 0.1-1.4 | 119 | 18 | 23 | 19 | 2.0 | 1.0-3.8 |
| Self-assessed physical condition | | | | | | | | | | | | | | | | | | |
| Good or fairly good | 149 | 37 | 27 | 18 | 1.0 | | 142 | 51 | 16 | 11 | 1.0 | | 291 | 43 | 43 | 15 | 1.0 | |
| Moderate | 202 | 51 | 45 | 22 | 1.9 | 1.0-3.7 | 106 | 38 | 10 | 9 | 0.8 | 0.3-2.3 | 308 | 45 | 55 | 18 | 1.6 | 1.0-2.7 |
| Fairly poor or poor | 49 | 12 | 11 | 22 | 1.9 | 0.8-4.9 | 32 | 11 | 1 | 3 | 0.6 | 0.1-4.4 | 81 | 12 | 12 | 15 | 1.5 | 0.7-3.4 |
| Psychosomatic symptoms | | | | | | | | | | | | | | | | | | |
| Depressive mood | | | | | | | | | | | | | | | | | | |
| | | | | | 1.1 | 1.0-1.1 | | | | | 1.1 | 1.0-1.2 | | | | | 1.1 | 1.0-1.1 |
| | | | | | 1.3 | 1.1-1.4 | | | | | 1.2 | 1.0-1.5 | | | | | 1.3 | 1.1-1.4 |

For the categorical variable of type of leisure time activity, the reference category is formed of all the other three quartiles of the variable. For the other categorical variables, the reference category is indicated by a risk ratio of 1.0. The risk ratios are shown in boldface when they refer to statistically significant differences from the risks of the reference category at a 95% confidence level.

Table 6. Type of leisure time activities in 1989 and 1996 in 15- to 18- and 22- to 25- year-old populations.

| | 1989 | | | | | | 1996 | | | | | |
|--|---------|----|-------|----|-------|----|---------|----|-------|----|-------|----|
| | Females | | Males | | Total | | Females | | Males | | Total | |
| | n | % | n | % | n | % | n | % | n | % | n | % |
| Sports that dynamically load the upper extremities | 63 | 17 | 69 | 26 | 132 | 21 | 24 | 7 | 34 | 19 | 58 | 11 |
| Other sports | 258 | 69 | 148 | 56 | 406 | 63 | 281 | 85 | 123 | 68 | 405 | 79 |
| Hobbies that statically load the upper extremities | 20 | 5 | 12 | 4 | 32 | 5 | 14 | 4 | 16 | 9 | 30 | 6 |
| Other hobbies | 33 | 9 | 38 | 14 | 71 | 11 | 13 | 4 | 9 | 5 | 22 | 4 |
| Total | | | | | 641* | | | | | | 515* | |

5.2.4 Perceived symptoms

Psychosomatic symptoms were more common among girls than boys, and symptoms were most common in the third grade in both genders (Table 7). The mean psychosomatic symptom score for girls was 2.02 (SD =2.33) and that for boys 1.19 (SD = 1.88). For both genders, the psychosomatic symptom score was higher in the group with weekly symptoms (DS) than in the group with no or occasional symptoms (NDS). The differences between the NDS and DS groups were statistically significant for both genders and also for girls at each grade. In the Cox regression model (Table 5), psychosomatic symptoms were significantly associated with a higher prevalence of NSP (RR 1.1, 95% CI 1.0-1.1).

Depressive mood was also more common among girls than boys (Table 7). The average depressive mood score was 0.76 (SD = 0.95) for girls and 0.57 (SD = 0.86) for boys. The mean depressive mood score was higher in the group with weekly symptoms (DS) than in the group with no or occasional symptoms (NDS). The differences between the NDS and DS groups were statistically significant among girls at all grades. There was a similar tendency among boys, but the differences in the scores between the NDS and DS groups were not statistically significant. However, in the Cox regression model (Table 5), the depressive mood score and NSP were significantly associated in both, girls (RR 1.3, 95% CI 1.1-1.4) and boys (RR 1.2, 95% CI 1.0-1.5).

Table 7. Psychosomatic symptom score and depressive mood score in two groups with no or occasional symptoms (NDS=no disturbing symptoms) and with weekly symptoms (DS=disturbing symptoms) on the different grades of high school.

| | Girls | | | Boys | | |
|-----------------------------|----------|---------|---------------------|----------|---------|---------------------|
| | NDS mean | DS mean | Confidence interval | NDS mean | DS mean | Confidence interval |
| Psychosomatic symptom score | | | | | | |
| 1. grade | 1.62 | 3.48 | 0.96 to 2.74 | 1.04 | 1.89 | -0.5 to 2.20 |
| 2. grade | 1.59 | 3.38 | 0.79 to 2.78 | 0.99 | 1.83 | 1.49 to 0.44 |
| 3. grade | 1.68 | 3.58 | 0.95 to 2.85 | 1.34 | 2.5 | 0.73 to 3.04 |
| Depressive mood score | | | | | | |
| 1. grade | 0.64 | 1.32 | 0.30 to 1.07 | 0.47 | 0.78 | - 0.28 to 0.89 |
| 2. grade | 0.56 | 1.33 | 0.36 to 1.19 | 0.58 | 1.00 | - 0.13 to 0.97 |
| 3. grade | 0.72 | 1.19 | 0.08 to 0.86 | 0.68 | 0.33 | - 1.13 to 0.45 |

5.3 Associated and predictive factors of neck and shoulder pain at follow-up

NSP in adolescence was associated with a high prevalence of NSP in adulthood (Table 8). In a crude model, the prevalence of NSP in adulthood was significantly higher in the females who suffered from weekly NSP in adolescence than in asymptomatic ones (RR 2.5, CI 95% 1.6-3.9), but the association in males did not reach statistical significance. Seeking for care due to NSP in adolescence was also related to the prevalence of NSP in adulthood, although the association only reached statistical significance in females (RR 1.2, 95% CI 1.0-1.4) and in total (RR 2.1, 95% CI 1.1-4.1). Of the sociodemographic factors, only gender (female) was significantly associated with the prevalence of NSP in adulthood.

Of the variables related to leisure time activities, a physically passive way of spending leisure time (RR 2.1, 95% CI 1.2-3.8), moderate intensity of physical exercise (RR 1.9, 95% CI 1.0-3.4), and self-assessed poor physical condition (RR 2.7, 95% CI 1.5-4.6) in adolescence were associated with a higher prevalence of NSP in adulthood in crude models of females and total, whereas sports loading dynamically the upper extremities in adolescence were associated with a low prevalence of NSP in adulthood. In males and in total, all other sports except those loading dynamically the upper extremities in adolescence (RR 1.8, 95% CI 1.1-2.8) were associated with a higher prevalence of NSP seven years later. Other hobbies were unrelated to NSP.

In the crude model, psychosomatic symptoms in adolescence were associated with a higher prevalence of NSP in adulthood in females (RR 1.1, 95% CI 1.0-1.1) and in males (RR 1.1, 95% CI 1.0-1.2), but the transition of the symptoms during the follow-up period was unrelated to NSP in adulthood. Depressive mood in adolescence was also significantly associated with a higher prevalence of NSP in adulthood both in females (RR 1.2, 95% CI 1.0-1.3) and in males (RR 1.2, 95% CI 1.0-1.5), and as with psychosomatic symptoms, the transition of symptoms during the follow-up period was unrelated to NSP in adulthood.

In the adjusted model, NSP (RR 1.8, 95% CI 1.1-2.8) and psychosomatic symptoms (RR 1.0, 95% CI 1.0-1.1) in adolescence were significantly associated with a high prevalence of NSP in adulthood in total, whereas sports which load dynamically the upper extremities (RR 0.4, 95% CI 0.2-0.8) were associated with a low prevalence of NSP. In a separate analysis of the genders, NSP in adolescence as an associated factor reached statistical significance only in females (RR 2.0, 95% CI 1.2-3.4).

In the subgroup of those who were asymptomatic at baseline in 1989, but had suffered from occasional or weekly episodes of NSP during the 6 months preceding the second survey seven years later, only psychosomatic symptoms (RR 1.0, CI 95% 1.0-1.1) remained statistically significant predictive factors for the incidence of NSP in the univariate model.

Table 8. Risk Ratios (RR) and 95% Confidence Intervals (95% CI) for baseline factors associated with prevalent self-reported weekly neck and shoulder pain seven years later.

| | Females | | | | | | Males | | | | | | Total | | | | | |
|------------------------------------|---|----|--------------------------------------|----|-------------|---------|----------------|-------|---|----|--------------------------------------|----|------------|---------|----------------|-------|--|--|
| | Subjects without neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude model | | Adjusted model | | Subjects without neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude mode | | Adjusted model | | | |
| | n | % | n | % | RR | 95%CI | RR | 95%CI | n | % | n | % | RR | 95%CI | RR | 95%CI | | |
| Sociodemographic factors | | | | | | | | | | | | | | | | | | |
| Gender | | | | | | | | | | | | | | | | | | |
| Male | | | | | | | | | | | | | | | | | | |
| Female | | | | | | | | | | | | | | | | | | |
| School achievement | | | | | | | | | | | | | | | | | | |
| Quartile 1 | 39 | 23 | 12 | 31 | 1.0 | | | | 27 | 22 | 8 | 30 | 1.0 | | | | | |
| Quartile 2 | 39 | 23 | 13 | 33 | 0.9 | 0.4-2.0 | | | 28 | 23 | 7 | 25 | 0.8 | 0.3-2.3 | | | | |
| Quartile 3 | 46 | 27 | 14 | 30 | 1.2 | 0.7-2.1 | | | 34 | 27 | 5 | 15 | 0.5 | 0.2-1.5 | | | | |
| Quartile 4 | 47 | 27 | 14 | 30 | 0.7 | 0.4-1.3 | | | 35 | 28 | 5 | 14 | 0.5 | 0.2-1.5 | | | | |
| Time spent on home work | | | | | | | | | | | | | | | | | | |
| Quartile 1 | 69 | 29 | 24 | 35 | 1.0 | | | | 31 | 21 | 9 | 29 | 1.0 | | | | | |
| Quartile 2 | 23 | 10 | 7 | 30 | 0.8 | 0.3-2.3 | | | 37 | 26 | 6 | 16 | 0.6 | 0.2-1.6 | | | | |
| Quartile 3 | 68 | 28 | 29 | 43 | 1.4 | 0.7-2.8 | | | 35 | 24 | 5 | 14 | 0.5 | 0.2-1.5 | | | | |
| Quartile 4 | 82 | 34 | 21 | 26 | 0.6 | 0.3-1.3 | | | 42 | 29 | 9 | 29 | 0.6 | 0.2-1.5 | | | | |
| School mark for physical education | | | | | 0.8 | 0.6-1.1 | | | | | | | 0.9 | 0.6-1.3 | | | | |
| Body size measurements | | | | | | | | | | | | | | | | | | |
| Body Mass Index | | | | | | | | | | | | | | | | | | |
| Quartile 1 | 65 | 28 | 20 | 31 | 1.0 | | | | 42 | 29 | 9 | 21 | 1.0 | | | | | |
| Quartile 2 | 60 | 25 | 18 | 30 | 1.0 | 0.5-1.8 | | | 39 | 27 | 8 | 21 | 1.0 | 0.4-2.5 | | | | |
| Quartile 3 | 53 | 22 | 17 | 32 | 1.0 | 0.5-2.0 | | | 29 | 20 | 6 | 21 | 1.0 | 0.3-2.7 | | | | |
| Quartile 4 | 58 | 25 | 22 | 38 | 1.2 | 0.7-2.3 | | | 35 | 24 | 5 | 14 | 0.7 | 0.7-2.0 | | | | |
| Height | | | | | | | | | | | | | | | | | | |
| Quartile 1 | 67 | 28 | 22 | 33 | 0.9 | 0.5-1.7 | | | 38 | 26 | 7 | 18 | 0.8 | 0.3-2.3 | | | | |
| Quartile 2 | 45 | 19 | 14 | 31 | 0.9 | 0.5-1.7 | | | 32 | 22 | 4 | 13 | 0.6 | 0.2-1.9 | | | | |
| Quartile 3 | 70 | 29 | 23 | 33 | 0.9 | 0.5-1.7 | | | 40 | 27 | 9 | 23 | 1.0 | 0.4-2.6 | | | | |
| Quartile 4 | 63 | 26 | 22 | 35 | 1.0 | | | | 36 | 25 | 8 | 22 | 1.0 | | | | | |

Table 8. Continued.

| | Females | | | | | | Males | | | | | | Total | | | | | | | | | |
|--|---|----|--------------------------------------|----|-------------|----------------|----------------|----------------|---|----|--------------------------------------|----|------------|----------------|----------------|-------|----|----|------------|----------------|------------|----------------|
| | Subjects without neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude model | | Adjusted model | | Subjects without neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude mode | | Adjusted model | | | | | | | |
| | n | % | n | % | RR | 95%CI | RR | 95%CI | n | % | n | % | RR | 95%CI | RR | 95%CI | | | | | | |
| Neck and shoulder pain in adolescence | | | | | | | | | | | | | | | | | | | | | | |
| No/occasional | 188 | 77 | 46 | 24 | 1.0 | 1.0 | 1.0 | 1.0 | 119 | 88 | 22 | 18 | 1.0 | 1.0 | 307 | 81 | 68 | 22 | 1.0 | 1.0 | | |
| Frequent symptoms | 55 | 23 | 34 | 62 | 2.5 | 1.6-3.9 | 2.0 | 1.2-3.4 | 16 | 12 | 5 | 31 | 1.7 | 0.6-4.5 | 71 | 19 | 39 | 55 | 2.5 | 1.7-3.7 | 1.8 | 1.1-2.8 |
| Seeking health care for neck and shoulder pain in adolescence | | | | | | | | | | | | | | | | | | | | | | |
| No | 201 | 85 | 64 | 32 | 1.0 | | | | 127 | 93 | 22 | 17 | 1.0 | | 328 | 88 | 86 | 26 | 1.0 | | | |
| Yes | 35 | 15 | 15 | 43 | 1.2 | 1.0-1.4 | | | 9 | 7 | 4 | 44 | 1.7 | 0.9-3.2 | 44 | 12 | 19 | 43 | 2.1 | 1.1-4.1 | | |
| Leisure time activities | | | | | | | | | | | | | | | | | | | | | | |
| Physical activity/passivity of spending leisure time | | | | | | | | | | | | | | | | | | | | | | |
| Very active | 40 | 16 | 8 | 20 | 1.0 | | | | 54 | 37 | 10 | 19 | 1.0 | | 94 | 24 | 18 | 19 | 1.0 | | | |
| Fairly active | 83 | 34 | 22 | 27 | 1.3 | 0.6-3.0 | | | 48 | 33 | 5 | 10 | 0.6 | 0.2-1.6 | 131 | 34 | 27 | 21 | 1.1 | 0.6-2.0 | | |
| Fairly passive | 71 | 29 | 27 | 38 | 1.9 | 0.9-4.2 | | | 16 | 11 | 5 | 31 | 1.7 | 0.6-4.9 | 87 | 22 | 32 | 37 | 1.9 | 1.1-3.4 | | |
| Very passive | 51 | 21 | 23 | 45 | 2.3 | 1.0-5.0 | | | 28 | 19 | 9 | 32 | 1.7 | 0.7-4.3 | 79 | 20 | 32 | 41 | 2.1 | 1.2-3.8 | | |
| Type of leisure time activity | | | | | | | | | | | | | | | | | | | | | | |
| Sports which dynamically load the upper extremities | 36 | 16 | 4 | 11 | 0.3 | 0.1-0.8 | 0.4 | 0.1-1.0 | 33 | 25 | 2 | 6 | 0.2 | 0.1-1.0 | 69 | 19 | 6 | 9 | 0.3 | 0.1-0.5 | 0.4 | 0.2-0.8 |
| Other sports | 158 | 69 | 57 | 36 | 1.4 | 0.8-2.5 | | | 74 | 56 | 20 | 27 | 2.6 | 1.0-6.4 | 232 | 64 | 77 | 33 | 1.8 | 1.1-2.8 | | |
| Hobbies which statically load the upper extremities | 15 | 7 | 7 | 47 | 1.5 | 0.7-3.2 | | | 8 | 6 | 2 | 25 | 1.3 | 0.3-5.4 | 23 | 6 | 9 | 29 | 1.4 | 0.7-2.9 | | |
| Other hobbies | 21 | 9 | 7 | 33 | 1.0 | 0.5-2.2 | | | 16 | 12 | 2 | 13 | 0.6 | 0.1-2.5 | 37 | 10 | 9 | 24 | 0.9 | 0.4-1.7 | | |
| Panting or sweating in physical exercise | | | | | | | | | | | | | | | | | | | | | | |
| A lot | 44 | 19 | 11 | 25 | 1.0 | | | | 55 | 39 | 9 | 16 | 1.0 | | 99 | 26 | 20 | 20 | 1.0 | | | |
| Somewhat | 151 | 64 | 50 | 33 | 1.8 | 0.8-3.7 | | | 61 | 43 | 11 | 18 | 1.7 | 0.6-4.6 | 212 | 56 | 61 | 29 | 1.9 | 1.0-3.4 | | |
| A little/not at all/no exercise | 41 | 17 | 18 | 44 | 1.3 | 0.7-2.5 | | | 25 | 18 | 7 | 54 | 1.1 | 0.5-2.7 | 66 | 18 | 25 | 69 | 1.4 | 0.9-2.4 | | |

Table 8. Continued.

| | Females | | | | | | Males | | | | | | Total | | | | | |
|---|---|----|--------------------------------------|----|-------------|----------------|----------------|-------|---|----|--------------------------------------|----------------|-------------|-------|----------------|-------|------------|--|
| | Subjects without neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude model | | Adjusted model | | Subjects without neck and shoulder pain | | Subjects with neck and shoulder pain | | Crude model | | Adjusted model | | | |
| | n | % | n | % | RR | 95%CI | RR | 95%CI | n | % | n | % | RR | 95%CI | RR | 95%CI | | |
| Self-assessed physical condition | | | | | | | | | | | | | | | | | | |
| Good or fairly good | 88 | 36 | 20 | 23 | 1.0 | | 80 | 55 | 13 | 16 | 1.0 | | 168 | 43 | 33 | 20 | 1.0 | |
| Moderate | 129 | 53 | 44 | 34 | 1.5 | 0.9-2.5 | 53 | 36 | 11 | 21 | 1.3 | 0.6-2.9 | 182 | 47 | 30 | 30 | 1.5 | |
| Fairly poor or poor | 27 | 11 | 16 | 59 | 2.6 | 1.4-5.0 | 13 | 9 | 5 | 38 | 2.4 | 0.8-6.6 | 40 | 10 | 53 | 53 | 2.7 | |
| Psychosomatic symptoms | | | | | | | | | | | | | | | | | | |
| As continuous variable | | | | | 1.1 | 1.0-1.1 | | | | | 1.1 | 1.0-1.2 | | | | | 1.1 | |
| Symptoms decreased | 110 | 46 | 35 | 32 | 0.9 | 0.6-1.4 | 63 | 44 | 11 | 17 | 0.8 | 0.4-1.6 | 172 | 45 | 131 | 76 | 0.9 | |
| Symptoms unchanged | 18 | 7 | 7 | 39 | 1.0 | | 17 | 12 | 4 | 24 | 1.0 | 1 | 35 | 9 | 11 | 31 | 1.0 | |
| Symptoms increased | 113 | 47 | 39 | 35 | 1.1 | 0.7-1.6 | 63 | 44 | 14 | 22 | 1.2 | 0.6-2.5 | 176 | 46 | 53 | 30 | 1.1 | |
| Depressive mood | | | | | | | | | | | | | | | | | | |
| As continuous variable | | | | | 1.2 | 1.0-1.3 | | | | | 1.2 | 1.0-1.5 | | | | | 1.2 | |
| Symptoms decreased | 115 | 48 | 39 | 34 | 1.0 | 0.7-1.6 | 70 | 49 | 16 | 23 | 1.3 | 0.6-2.7 | 175 | 45 | 46 | 27 | 1.1 | |
| Symptoms unchanged | 61 | 25 | 17 | 28 | 1.0 | | 29 | 20 | 5 | 17 | 1.0 | | 90 | 23 | 23 | 25 | 1.0 | |
| Symptoms increased | 66 | 27 | 25 | 38 | 1.3 | 0.7-1.9 | 45 | 31 | 8 | 18 | 0.8 | 0.4-1.9 | 111 | 29 | 33 | 30 | 1.1 | |

The risk ratios are shown in boldface when they refer to a statistically significant difference from the risk of the reference category at a 95% confidence level.

Table 9. Continued.

| | Females | | | | | | Males | | | | | | Total | | | | | | |
|--|---|----|-----|--------------------------------------|-----|----------|---|----|-----|--------------------------------------|----|---------|---|----|---------|--------------------------------------|----|--------|---------|
| | Subjects without neck and shoulder pain | | | Subjects with neck and shoulder pain | | | Subjects without neck and shoulder pain | | | Subjects with neck and shoulder pain | | | Subjects without neck and shoulder pain | | | Subjects with neck and shoulder pain | | | |
| | n | % | RR | n | % | 95%CI | n | % | RR | n | % | 95%CI | n | % | RR | n | % | 95% CI | |
| Leisure time activities | | | | | | | | | | | | | | | | | | | |
| Physical activity/passivity of spending leisure time | | | | | | | | | | | | | | | | | | | |
| Very active | 13 | 23 | 1.0 | 8 | 62 | 1.0 | 15 | 31 | 1.0 | 6 | 40 | 1.0 | 28 | 27 | 1.0 | 14 | 50 | 1.0 | |
| Fairly active | 17 | 30 | 1.0 | 10 | 59 | 0.4-2.4 | 20 | 42 | 0.6 | 11 | 55 | 0.2-1.9 | 37 | 36 | 0.2-1.9 | 21 | 57 | 1.1 | 0.6-2.2 |
| Fairly passive | 15 | 27 | 1.3 | 12 | 80 | 0.5-3.2 | 4 | 8 | 0.8 | 1 | 25 | 0.3-2.2 | 19 | 18 | 0.3-2.2 | 13 | 68 | 1.4 | 0.6-2.9 |
| Very passive | 11 | 20 | 1.0 | 7 | 64 | 0.4-2.9 | 9 | 19 | 0.4 | 6 | 67 | 0.0-3.1 | 20 | 19 | 0.0-3.1 | 13 | 65 | 1.3 | 0.6-2.8 |
| Type of leisure time activity | | | | | | | | | | | | | | | | | | | |
| Sports which dynamically load the upper extremities | 11 | 22 | 0.8 | 6 | 55 | 0.3-1.9 | 10 | 23 | 0.8 | 4 | 40 | 0.3-2.2 | 21 | 23 | 0.3-2.2 | 10 | 48 | 0.8 | 0.4-1.5 |
| Other sports | 32 | 65 | 1.4 | 23 | 72 | 0.6-2.9 | 28 | 64 | 1.0 | 14 | 50 | 0.4-2.4 | 60 | 64 | 0.4-2.4 | 37 | 62 | 1.2 | 0.7-2.1 |
| Hobbies which statically load the upper extremities | 1 | 2 | 1.5 | 1 | 100 | 0.2-11.3 | 2 | 5 | 1.0 | 1 | 50 | 0.1-7.4 | 3 | 3 | 0.1-7.4 | 2 | 67 | 1.2 | 0.3-4.7 |
| Other hobbies | 5 | 10 | 0.6 | 2 | 40 | 0.1-2.5 | 4 | 9 | 1.6 | 3 | 75 | 0.5-5.3 | 9 | 10 | 0.5-5.3 | 5 | 56 | 1.0 | 0.4-2.4 |
| Panting or sweating in physical exercise | | | | | | | | | | | | | | | | | | | |
| A lot | 11 | 21 | 1.0 | 7 | 64 | 1.0 | 16 | 35 | 1.0 | 6 | 38 | 1.0 | 27 | 28 | 1.0 | 13 | 48 | 1.0 | |
| Somewhat | 32 | 62 | 1.4 | 20 | 63 | 0.5-3.9 | 24 | 52 | 1.5 | 15 | 63 | 0.5-2.7 | 56 | 57 | 0.5-2.7 | 35 | 63 | 1.5 | 0.7-3.4 |
| A little/not at all/no exercise | 9 | 17 | 1.0 | 8 | 89 | 0.4-2.3 | 5 | 11 | 1.0 | 3 | 60 | 0.2-3.1 | 15 | 15 | 0.2-3.1 | 11 | 73 | 1.3 | 0.7-2.5 |
| Self-assessed physical condition | | | | | | | | | | | | | | | | | | | |
| Good or fairly good | 22 | 40 | 1.0 | 13 | 59 | 1.0 | 27 | 56 | 1.0 | 13 | 48 | 1.0 | 49 | 48 | 1.0 | 26 | 53 | 1.0 | |
| Moderate | 29 | 53 | 1.2 | 21 | 72 | 0.6-2.4 | 15 | 31 | 1.2 | 9 | 60 | 0.5-2.9 | 44 | 43 | 0.5-2.9 | 30 | 68 | 1.3 | 0.8-2.2 |
| Fairly poor or poor | 4 | 7 | 1.3 | 3 | 75 | 0.4-4.5 | 6 | 13 | 0.7 | 2 | 33 | 0.2-3.1 | 10 | 10 | 0.2-3.1 | 5 | 50 | 0.9 | 0.4-2.5 |
| Psychosomatic symptoms | | | | | | | | | | | | | | | | | | | |
| As continuous variable | | | 1.0 | | | 0.9-1.1 | | | 1.1 | | | 1.0-1.2 | | | 1.0 | | | 1.0 | 1.0-1.1 |
| Symptoms decreased | 23 | 41 | 0.5 | 10 | 43 | 0.3-1.1 | 23 | 49 | 0.7 | 9 | 39 | 0.3-1.6 | 46 | 45 | 0.3-1.6 | 19 | 41 | 0.6 | 0.3-1.0 |
| Symptoms unchanged | 3 | 5 | 1.0 | 2 | 67 | 1.0 | 5 | 11 | 1.0 | 4 | 80 | 1.0 | 8 | 8 | 1.0 | 6 | 75 | 1.0 | |
| Symptoms increased | 30 | 54 | 1.8 | 25 | 83 | 0.9-3.6 | 19 | 40 | 1.1 | 10 | 53 | 0.5-2.6 | 49 | 48 | 0.5-2.6 | 35 | 71 | 1.5 | 0.9-2.6 |
| Depressive mood | | | | | | | | | | | | | | | | | | | |
| As continuous variable | | | 1.0 | | | 0.8-1.2 | | | 1.2 | | | 0.9-1.4 | | | 1.1 | | | 1.1 | 0.9-1.2 |
| Symptoms decreased | 22 | 40 | 0.8 | 13 | 59 | 0.4-1.7 | 19 | 41 | 1.2 | 11 | 58 | 0.5-2.7 | 41 | 41 | 0.5-2.7 | 24 | 59 | 1.0 | 0.6-1.6 |
| Symptoms unchanged | 15 | 27 | 1.0 | 8 | 53 | 1.0 | 10 | 22 | 1.0 | 4 | 40 | 0.1 | 25 | 25 | 0.1 | 12 | 25 | 1.0 | |
| Symptoms increased | 18 | 33 | 1.5 | 15 | 83 | 0.8-2.8 | 17 | 37 | 1.7 | 9 | 53 | 0.3-8.2 | 35 | 35 | 0.3-8.2 | 24 | 69 | 1.3 | 0.8-2.1 |

The risk ratios are shown in boldface when they refer to statistically significant difference from the risk of the reference category at 95% confidence level. Subjects with neck and shoulder pain include those with occasional and weekly symptoms.

5.4 Magnetic resonance imaging study

The Subjects for the MRI study were recruited from the group that participated in the 7-year follow-up. Of the 394 subjects, 26 (7%) individuals reported having had no symptoms in 1989 or 1996, while 40 (10%) individuals having had weekly symptoms in 1989 and 1996. On the MR images, altogether 186 discs of 31 individuals were analyzed. No MR image was excluded due to inadequate visibility or artifacts. One anomaly of the cervical spine was found in both study groups (a blocked vertebra and a developmental anomaly involving lowered sagittal height). The postures of 26 (84 %) subjects were evaluated as abnormal, a slightly straightened cervical spine being the most common finding (n=12). There were no statistically significant differences in the abnormal posture findings between SG (=recurrent or persistent symptom group) and NSG (=no symptom group). No abnormal findings were detected in the facet joints or muscles of the spinal area.

The numbers of subjects with abnormal MRI findings are presented in Table 10. The Kappa scores for the two radiologists were 0.67 for DD, 0.44 for anular tears, 0.52 for disc protrusions, and 1.0 for hernias. They show fair to strong agreement. There were 4 disc herniations visible in the images, all of which were in SG. According to the pain drawing, one of the four subjects suffered from radicular pain in the upper arm. The difference in the proportion of herniated discs between the study groups was statistically significant (Table 11).

Altogether forty-six discs (25 %) were degenerated, of which 38 (83 %) were classified as slightly degenerated (grade 1) and 8 (17 %) as moderately degenerated (grade 2). The SG subjects had 20 and the NSG subjects 26 degenerated discs (Table 11). Thirty-two (17 %) anular tears were found, of which 21 (66 %) were slight, 9 (28 %) moderate and 2 (6 %) severe. Fourteen of the tears were in SG and 18 in NSG. Forty-seven disc protrusions were detected, 37 of which (79 %) were classified as slight and 6 (21 %) as moderate. The SG subjects had 18 and the NSG subjects 29 disc protrusions.

Table 10. Subjects with abnormal MR findings in NSG (=no symptom group) and SG (recurrent or persistent symptom group).

| | NSG subjects (n=15) | SG Subjects (n=16) | p |
|-------------------|---------------------------|--------------------------|------|
| Disc degeneration | 11 | 9 | 0.46 |
| Anular tear | 10 | 8 | 0.47 |
| Disc protrusion | 13 | 11 | 0.39 |
| Disc herniation | - | 4 | 0.10 |
| No finding | 2 | 4 | 0.27 |

Table 11. Proportions of abnormal disc findings on MRI in NSG (=no symptom group) and SG (=recurrent or persistent symptom group).

| | NSG (n=90) | | SG (n=96) | | Total (n=186) | | p |
|-------------------|------------|----|-----------|----|---------------|----|------|
| | n | % | n | % | n | % | |
| Disc degeneration | 26 | 29 | 20 | 21 | 46 | 25 | 0.2 |
| Degree 1 | 19 | | 19 | | 38 | | 0.07 |
| Degree 2 | 7 | | 1 | | 8 | | |
| Anular tear | 18 | 20 | 14 | 15 | 32 | 17 | 0.33 |
| Degree 1 | 13 | | 8 | | 21 | | |
| Degree 2 | 5 | | 4 | | 9 | | |
| Degree 3 | - | | 2 | | 2 | | |
| Disc protrusion | 29 | 32 | 18 | 19 | 47 | 25 | 0.03 |
| Degree 1 | 24 | | 13 | | 37 | | |
| Degree 2 | 5 | | 4 | | 9 | | |
| Degree 3 | - | | 1 | | 1 | | |
| Disc herniation | - | - | 4 | 4 | 4 | 2 | 0.05 |

6 Discussion

6.1 Subjects

The subjects were selected from among the high school students of a city with 120,000 inhabitants. The random sample in this study included 33% of all high school students (n=2,212) in the City of Oulu. Since, in Finland, 60% of the adolescent population attend optional high school, the sample can be considered to represent the urban high school students in Finland. The rest of the age group usually attends vocational schools. Low level of education has been indicated to relate to low socioeconomic class, which has been suggested to associate with increased prevalence of musculoskeletal symptoms (Bergman *et al.* 2001). However, the findings on the possible association between low socioeconomic class and NSP have been inconsistent (Bongers *et al.* 1993, Côté *et al.* 2000), and the effect of selection bias in this respect is therefore difficult to evaluate.

The response rate (87%) in the baseline study was good. The non-respondents were absent from school at the time of the survey. Since no data of the non-respondents were available, it is possible that they differ from the respondents on the main characteristics and thereby cause bias. In the second survey seven years later, 60% of the females and 40% of the males who had participated in the first survey responded. Although the non-response rate at the follow-up was fairly high, the non-respondents differed from the respondents significantly only on two statistically significant explanatory variables (gender and physical activity/passivity of leisure time). Yet, the fact that there was a significantly greater proportion of females among the respondents than in the non-respondents may have caused some bias in the results by overestimating the prevalence and incidence rates of NSP, by emphasizing the results of females, and by reducing the significance of the results of males in the analysis evaluating both genders together.

The limitation of the MRI study was the fairly small sample size. However, the study groups were carefully selected based on their neck pain history. The study groups were originally derived from a large population consisting of 718 high school students. On the basis of the results of the 7-year follow-up, subjects at the two extremes of the population for MRI study were chosen: a group of subjects who had reported never having had NSP in both surveys and another group of subjects who had reported suffering from neck and shoulder pain at least weekly at both times. To confirm that the study groups represented

subjects with frequent NSP and pain free controls, the participants filled in VAS during their MRI visit. The remarkable difference in VAS between the symptom group and no symptom group supports the notion of a difference between the study groups as far as neck and shoulder pain is concerned.

6.2 Study design

The purpose of the study was to investigate extensively the etiology of NSP in a young population. The findings of the cross-sectional study allowed us only to describe the factors associated with NSP, but the longitudinal design of the study made it possible to evaluate the effects of different hypothetical associated factors on the prevalence of NSP seven years later. Based on the analyses of the subgroup with a new episode of NSP during the 6 months preceding the second survey, evaluation of the predictive factors for 7-year incidence of NSP was possible.

Several sociodemographic factors, leisure time activities, some psychological factors, and organic changes of the cervical spine detected by MRI made up the framework within which the etiology of NSP was investigated. An important cluster of contributing factors was, however, beyond the scope of this study, since the ergonomic background of the informants was not evaluated. Yet, for a high school student, the long days at school with a lot of homework afterwards may constitute a considerable physical exposure to NSP (Ariëns *et al.* 2000).

A well-known problem of self-reported data is recall error (Dawson *et al.* 2002). In this study, the classification of NSP was based on the question concerning the symptoms experienced during the past 6 months. Psychosomatic symptoms and depressive mood were also classified according to the responses concerning the symptoms during the past 6 months. It can be argued whether this is too long period for adolescents and young adults to recall their symptoms. To avoid the respondents focusing too much attention on their neck and shoulder pain, the questionnaire was called a health survey.

6.3 Methodological aspects

6.3.1 Musculoskeletal symptoms

For the assessment of NSP, a modification of the standardized and validated Nordic musculoskeletal questionnaire was used. The reliability and validity of the questionnaire have previously been evaluated to be good (Kuorinka *et al.* 1987). It can be questioned whether self-reported data of pain are accurate enough to reveal the nature of symptoms. Yet, pain is, by definition, a subjective phenomenon, which should be taken into account in the assessment. Another problem was the classification of NSP, which was based only on the frequency of symptoms. The severity and duration of NSP were not considered.

The frequency of symptoms, however, is commonly used in epidemiological studies concerning NSP, which makes the comparison of the results easier (Vikat *et al.* 2000). In this study, acute, subacute, and chronic pain were not differentiated, either, although various contributing factors may have had effects on pain development at different time points.

The factors associated with the prevalence of NSP in adulthood were investigated in two surveys separated by a 7-year follow-up period. The outcome variable was weekly NSP in adulthood. Since symptoms were measured only at the end of the follow-up period, we do not know about the symptoms of the subjects or other intervening factors such as exposures at work, health status, psychological status, or possible injuries during the follow-up period. Therefore, it can be argued that the result on the occurrence of NSP might have been different if the time of the survey had been different. To confirm the results, we analyzed the predictive factors of NSP for the subgroup of respondents who, at baseline in 1989, had reported never having had NSP, but had suffered from NSP during the 6 months preceding the second survey. The trend of the results in this group was similar to that in the original study population, implying that the results are fairly reliable in this respect.

The episodic nature of NSP causes problems in evaluating the incidence of symptoms. We analyzed the incidence of NSP for the subgroup of respondents who, at baseline in 1989, had reported never having had NSP, but had suffered from an episode of NSP during the 6 months preceding the second survey. It could not be ascertained, however, whether these cases were truly incident cases or only cases with recurrent symptoms.

6.3.2 Leisure time activities

Self-administered questionnaires are considered fairly valid measures, when assessing physical activity in epidemiologic studies (Chasan-Taber *et al.* 1996). However, self-assessed physical activity may also include some bias. Firstly, since exercising is a commonly appreciated hobby, respondents may overestimate the true amount of exercise. Yet, physical exercise was only a minor aspect of the present study, due to which bias in this respect is unlikely. Secondly, there are variable interpretations of the concept of physical activity, ranging from light walking to intense exercise with heavy panting and sweating. To evaluate the intensity of physical activity, the respondents were asked to assess the amount of panting and sweating in connection with physical exercise, which also includes a possibility for bias.

6.3.3 Psychosomatic symptoms

Psychosomatic symptoms were investigated indirectly by asking the subjects about the occurrence of symptoms assumed to be common in people undergoing a stressful life period. The internal consistency of the psychosomatic symptom scale was high. Moreover, it closely resembles the various distress symptom lists that have been in used

for a long time (Langner 1962). The possibility that the symptoms on the list are rather associated with somatic diseases has not been excluded. However, in population-based studies of adolescents and young adults, the prevalence of somatic diseases is small.

6.3.4 Depressive mood

Depressive mood was measured with questions on the presence and frequency of sleeping problems, fatigue, and lack of energy. All the three symptoms included in the scale can be found in well-known self-rating depressive symptom scales, such as the Zung Self-Rating Depression Scale (Zung 1967) and the Beck Depression Inventory (BDI) (Beck *et al.* 1961). The problem of the instrument used was that it was not validated adequately except for internal consistency. As the correlation between the psychosomatic symptom score and the depressive mood score was fairly high (0.8), it may be that the symptoms of depressive mood in question also reflected psychosomatic symptoms. To confirm the validity of the 3-item scale, we also used CDI in addition to the 3-item scale in the second survey, and the correlation between the scales was fairly high (0.6). Yet, this does not prove that the scales measure the same construct. Self-reported sleep/low energy problems might have been a more appropriate label for this parameter. Alternatively, being non-specific symptoms, they may indicate many other health-related or emotional problems. To conclude, the 3-item scale of depressive mood used in the study lacks an adequate test of validity for clinical depression or depressive symptoms, due to which the results are to be interpreted with caution.

6.3.5 Magnetic resonance imaging study

Two radiologists assessed the MR images cooperatively unaware of the participants' pain history. The MR images were reanalyzed separately by both radiologists for the calculation of Kappa coefficients. The Kappa scores for the two radiologists were 0.67 for DD, 0.44 for annular tears, 0.52 for disc protrusions, and 1.0 for herniations. These show fair to strong agreement.

6.4 Results

6.4.1 Prevalence and incidence of neck and shoulder pain

The results confirmed that weekly NSP was common in 15- to 18-year old adolescents (21% of girls and 11% of boys). The prevalence in our study was slightly lower than that in the study of Hertzberg (1985) on Norwegian high school students. He found the occurrence of neck and shoulder pain to be 33% for girls and 12% for boys. The result

was based on the findings of school medical examinations, while we measured the frequency of symptoms. The different measurements may explain the discrepancy of the results. In a study by Vikat *et al.* (2000), the prevalence rate of weekly NSP at 12-18 years of age was higher than ours; 36% for females and 15% for males at the age of 18. It has been shown that the prevalence rate of NSP among adolescents has risen during the past decade (Hakala *et al.* 2002). This may partly explain the difference in the results, since their study was carried out two years later. In our study, a greater proportion of the female students doing their last high school year had suffered from NSP compared to the females doing their first or second year. This might be explained by the fact that preparing for the final exams requires intensive homework, including reading and writing, which exposes the student to a considerable physical and psychological workload. The reason for the boys' lower occurrence of NSP during the last year of high school might be due to the relatively small number of symptomatic boys. It can be also speculated as to whether boys spend less time in academic activities, or have different ways to cope with stress than girls.

The prevalence of NSP increased with age. The finding is consistent with the result of Vikat *et al.* (2000), although their subjects were younger (12-18 years) than ours. On the other hand, our prevalence rate of young adults 22-25 years of age was higher than that reported by Palmer *et al.* (2001), who showed, in the subgroup of 16- to 24-year-old respondents, that 19.1% of females and 12.8% of males had reported having suffered from neck pain in the past week.

Our finding on NSP in adolescence associating with a high prevalence of NSP in young adulthood agrees with the results of Hertzberg (1985) on school children. We also found that seeking care at baseline was associated with a high prevalence of NSP in adulthood, that when high school students seek for health care services due to NSP, the complaint is likely to easily turn into a persistent symptom. Seeking for care may also be an indicator of pain severity, and this may explain the strong association with prevalent NSP in adulthood. The finding was congruent in the cross-sectional study, but not in the follow-up study, since the result was significant in the follow-up study only in females and in the total population. It should also be pointed out that the number of subjects exposed to this variable is small, especially in males. Therefore, the statistical power of in the analyses is not sufficient to warrant further conclusions.

Takala *et al.* (1992) proposed that there might be some seasonal variation in the prevalence of NSP. In a study among bank tellers, the prevalence of NSP was highest in the autumn and decreased towards the spring. In our study, the first survey was carried out in January-February and the follow-up in March. It can be argued that the prevalence of NSP in the second survey could have been higher if it had also been conducted at the same time of the year. The finding of seasonal variation of NSP, however, has not been documented in adolescents, and the temporal difference of two months between the surveys is fairly short. Therefore, bias in this respect is unlikely.

6.4.2 Associated and predictive factors of neck and shoulder pain

6.4.2.1 Sociodemographic factors

In the longitudinal study, female gender was the only sociodemographic factor associated with prevalent NSP in adulthood in univariate analyses. The tendency of females to suffer from NSP more than men can already be seen in childhood (Mikkelsen *et al.* 1997b), and it is also a common finding in studies concerning the prevalence of NSP in adult populations (Linton 1990, Viikari-Juntura *et al.* 1991, Barnekow-Berqvist *et al.* 1998). It has been suggested that females recognize and report their symptoms more sensitively than men.

6.4.2.2 Body size measurements

Our finding of BMI and body height being unrelated to NSP agrees with the results obtained by Salminen (1984) among Finnish 13- to 17-year-old school children, although neck and back symptoms were combined in this study. However, the findings of BMI and height relating to NSP are incongruent in both young and adult populations. Vikat *et al.* (2000) showed that a low BMI was associated with NSP among 12- to 18-year-old school children, and in the follow-up study of Viikari-Juntura *et al.* (2001) among an adult population, overweight predicted radiating neck pain. There is no clear explanation available for this discrepancy in the results.

6.4.2.3 Leisure time activity

In general, our results showed that there is an association between physical activity in leisure time and NSP. Yet, there were also some notable inconsistencies in the findings. For instance, in the follow-up study, spending one's leisure time mostly by resting, reading, listening to music, and in other physically passive ways in adolescence was associated with a higher prevalence of NSP in adulthood compared to the more active ways of spending one's leisure time. However, NSP in adulthood was also more prevalent among subjects who participated in sports other than those that load dynamically the upper extremities and ones with other hobbies. Since we did not differentiate between the types of sports in this category, interpretation of the result is difficult. Our finding of physically passive ways of spending leisure time being associated with NSP is contrary to the finding of Vikat *et al.* (2000) about subjects actively exercising their aerobic capacity having more NSP than more passive subjects. Different measures of physical activity may explain the difference in the results. In the study of Miranda *et al.* (2001b) on Finnish forestry workers, exercising more than once a week decreased the risk of persistent shoulder pain. They also discovered that, of the different specific types of

sports, cross-country skiing and jogging decreased the risk of shoulder pain. The anatomical focus of this study was, however, different from ours.

The finding of the subjects participating in sports that dynamically load the upper extremities having less NSP was congruent in the cross-sectional and the follow-up studies. It also remained significant in the adjusted model of the follow-up study. The result is in agreement with the finding of Dimberg *et al.* (1989). They found, in a study of industrial workers, that playing racket sports was associated with a low prevalence of NSP more strongly than other sports. It has been suggested that neck and shoulder pain derive from impaired metabolism and fatigue of the muscles during static loading of the neck and shoulder muscles (Jonsson 1982). Dynamic loading of the upper extremities might reduce the effects of static loading on the neck and shoulder by improving the metabolism and strengthening the muscles of this region apart from relieving mental stress.

It was somewhat surprising that moderate or poor self-assessed physical condition was congruently associated with NSP in the cross-sectional study and in the crude model of the follow-up study among females, but not among males. Since the study population included more females than males suffering from NSP, the finding may reflect the physical symptom in that NSP prevents exercise. Self-assessed poor health might therefore be rather a consequence than a cause of NSP. Croft *et al.* (2001) found poor self-assessed health to be a risk factor for NSP in an adult population. The results raise the question of whether self-assessment reflects adequately one's health or physical condition or rather indicates a poor sense of coherence, which has been shown to associate with NSP (Viikari-Juntura *et al.* 1991).

It is difficult to interpret the incongruent result of NSP relating to the intensity of physical exercise measured by panting or sweating, since low intensity of physical exercise in the cross sectional study and moderate intensity of physical exercise in the follow-up study were associated with a higher prevalence of NSP. The finding also differs from the results of Vikat *et al.* (2000). They found adolescents who reported either a lot of panting or sweating or no panting or sweating at all in connection with physical exercise to be more likely to experience weekly NSP. In both studies, the intensity of exercise was measured and classified in the same manner by asking a question of panting and sweating in connection with exercise.

6.4.2.4 Psychosomatic symptoms

Of all explanatory variables, psychosomatic symptoms were most congruently associated with NSP. They were significantly associated with the increased prevalence of NSP in the cross-sectional as well as in the longitudinal study, in which it also remained significant in the adjusted model. Additionally, psychosomatic symptoms in adolescence predicted NSP in adulthood in the subgroup of subjects symptom-free at baseline. The result is consistent with the finding of Vikat *et al.* (2000), according to which NSP was associated with the number of psychosomatic symptoms perceived at least once a week among high school students. These results also agree with the findings in adult populations. Levoska (1993) found an association between stress symptoms and NSP among female office

workers, and Leino (1989) reported that psychosomatic stress symptoms predicted musculoskeletal disorders in metal industry employees. In both studies, the same psychosomatic symptom scale was used as in this study.

Our finding of psychosomatic symptoms in adolescence predicting NSP in adulthood supports the idea of NSP being rather a psychosomatic symptom than nociceptive in origin. The promising results of using psychological techniques in the treatment of neck and back pain (Linton & Rydberg 2001) also support the notion that NSP might represent 'psychosomatic musculoskeletal pain' (Mikkelsen 1998a). The association between psychosomatic symptoms and musculoskeletal pain may also be explained by increased muscle tension. However, clinical parameters of muscle tension should have been measured to verify this.

6.4.2.5 Depressive mood

Depressive mood was also significantly associated with the increased prevalence of NSP in the cross-sectional as well as in the longitudinal study among both females and males, although the statistical significance of this difference did not remain in the adjusted model. The result is in concordance with other cross-sectional findings among young populations. Mikkelsen (1997b) reported the association between NSP and depressive symptoms in 10- to 12-year-old school children. Härmä *et al.* (2002) also found the prevalence of depression to be higher among 14- to 16-year-old adolescents with recurrent NSP. In these studies, CDI and modified BDI, respectively, were used to assess depressive symptoms. Since the 3-item depressive mood scale was included in the scale of psychosomatic symptoms, it is likely that these two variables measure partly the same concept.

There are no longitudinal studies concerning specifically the association between NSP and depressive symptoms in young populations, with which to compare our result of depressive mood being associated with a higher prevalence of NSP in adulthood. Mikkelsen *et al.* (1998b) showed that day tiredness at least once a week predicted independently the persistence of musculoskeletal pain. In the study of Viikari-Juntura *et al.* (1991) psychosocial factors, such as intelligence, alexithymia and social confidence, in childhood did not predict NSP in adulthood. Our finding is consistent with the results of Leino and Magni (1993) in an adult population, who reported that depressive symptoms predicted musculoskeletal pain in a 10-year follow-up. The use of depressive symptom rating scales, designed specifically for young people, would have better confirmed the result (Myers & Winters 2002).

6.4.3 Magnetic resonance imaging study

The present study is the first to compare MRI changes of the cervical spine in asymptomatic and symptomatic young adults. The results showed that pathological changes of the cervical spine in a 24- to 26-year-old population were equally common in

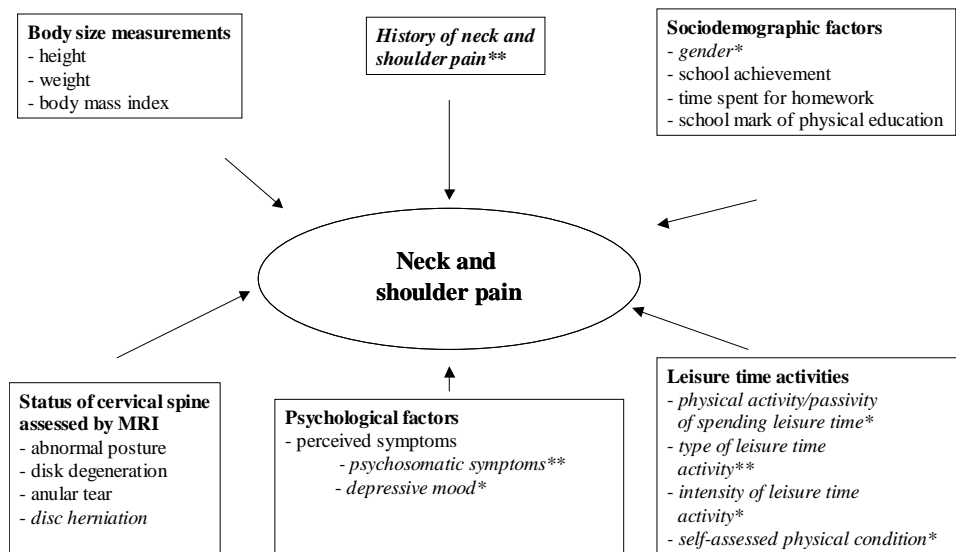
symptomatic and asymptomatic subjects. Disc herniation was the only finding significantly associated with NSP. The finding is in agreement with the study of Schellhas *et al.* (1996) in that abnormal MRI findings are also common in asymptomatic subjects. However, they found pathological findings to be more common in symptomatic participants; 73 % of the discs were morphologically abnormal in the pain group. The main interest in their study was to assess the accuracy of MRI and discography in identifying the sources of cervical discogenic pain. The age variation was wider (21-48 years) and the mean age higher (34.1 years) than in our study. The criterion of neck pain was also different, as the participants with cervical symptoms had been suffering from pain for a minimum of 6 months before referral for discography. The classification of abnormalities of the cervical spine was analyzed dichotomously as morphologically normal/abnormal. The age variation of the study population and the criterion of neck pain may have caused the differences in the results.

All the four disc herniations detected were found in symptomatic subjects, which indicates that possibly only severe pathophysiological changes of discs are associated with neck pain. We could not, however, ascertain the causality between herniation and neck pain in this study.

We found that DD and disc protrusion were the most common abnormalities. The prevalence rates of DD and disc protrusion were higher than those reported by Lehto *et al.* (1994), who found DD in 3 of their 21 (14 %) asymptomatic 20- to 23-year-old young adults, and no disc protrusions were detected. Matsumoto *et al.* (1998) also found the prevalence of DD and disc protrusion in a 20- to 29-year-old population to be lower than in our study. Since DD and disc protrusion were more common findings in NSG than SG, the difference between the study populations in cervical symptoms does not explain the discrepancy of the results. Instead, the difference in the imaging system and the classification of DD and disc protrusion may have caused the different results.

7 Summary and conclusions

To summarize the results (Figure 2), the prevalence of self-reported weekly NSP in 15- to 18-year-old adolescents was 17% at baseline, and within seven years the prevalence of NSP had increased to 28%. In both surveys, females suffered from weekly symptoms significantly more often than males. After seven years, the six-month incidence of occasional or weekly NSP was 59% among those who were asymptomatic at baseline. Weekly NSP in adolescence was associated with a high prevalence of NSP in adulthood in females and in total.



Factors associated with neck and shoulder pain in the cross-sectional study are in italics.

*Associated with neck and shoulder pain in the crude model of the follow-up.

** Associated with neck and shoulder pain in the adjusted model of the follow-up.

Fig. 2. The main results of the present study.

Of the sociodemographic factors, only female gender was associated with the prevalence of NSP seven years later in the crude model. In female adolescents, a passive way of spending one's leisure time and self-assessed poor physical condition were associated with a high prevalence in adulthood in the crude model and sports dynamically loading upper extremities with a low prevalence of NSP in adulthood also in the adjusted model.

Of all variables in the study, psychosomatic symptoms were most congruently associated with NSP in females and males. The result was confirmed in the longitudinal study, according to which psychosomatic symptoms of adolescence were significantly associated with a high prevalence of NSP in adulthood. Additionally, psychosomatic symptoms in adolescence predicted NSP in adulthood among those who were symptom-free at baseline. Depressive mood was also associated with a high prevalence of NSP in adulthood, but because of the unvalidated measuring instrument, the finding must be considered as suggestive.

In the MRI study, DD and anular tears of the cervical spine were common in asymptomatic and symptomatic subjects. Disc herniations were the only abnormal finding that was significantly more common in symptomatic subjects. However, we could not ascertain the causality between disc herniations and NSP.

In present study, the study design was multietiological based to the idea of NSP developing in response to several concurrent exposures. To sum up the results in this respect, it seems that psychological factors and possibly factors related to leisure time activities, contribute more strongly to NSP than do pathological changes detected by MRI.

In recent studies concerning NSP and associated factors, the results have been congruent in that psychological factors have a significant role in the development of NSP even in young populations (Mikkelsen 1998a, Vikat *et al.* 2000, Härmä *et al.* 2002), and our findings agree with this. Based on these and our results, some recommendations can be given to clinicians, school health care workers, and teachers of physical exercise. Since NSP in adolescence is associated with a high prevalence of these symptoms in adulthood, school nurses and physicians are recommended to identify the adolescents with recurrent NSP, and a psychosocial evaluation might be useful addition to the physical examination. Instead, MRI is rarely helpful on diagnosing and making decisions on the treatment of young adults with NSP. In physical education at high schools, it is recommendable to emphasize the benefits of exercise on health, instead of fostering a competitive spirit. Since psychosomatic symptoms seem to have a significant role in the development of NSP, students might be encouraged to learn relaxation techniques as well as ways to cope with stress. Students might be also encouraged to adopt physically active lifestyle and to choose, from among the different types of sports, specifically those that dynamically load upper extremities, such as racket sports.

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Appendix

NUORTEN TERVEYSTUTKIMUS

KYSELYLOMAKE

Vastausohjeet:

Vastaa kysymyksiin rengastamalla oikean tai sopivimman tuntuksen vaihtoehdon edessä oleva numero. Joihinkin kysymyksiin vastataan kirjoittamalla kysytyt tiedot sitä varten varattuun tilaan. Lue ensin koko kysymys huolellisesti ja merkitse sitten vastauksesi. Rengasta vain yksi vastausvaihtoehto siihen kysymykseen, jossa niin pyydetään. Oikealla ja alareunassa olevia hakasarakkeita ei tarvitse täyttää.

1. Syntymäaika - henkilötunnus _____
2. Sukupuoli 1 poika 2 tyttö
3. Paino _____ kg
4. Pituus _____ cm
5. Isän ammatti _____ äidin ammatti _____
6. Oletko tällä hetkellä
 - a) opiskelija, oppilaitos _____
 - b) työssä, ammatti _____
 - c) työtön (ammatti), mistä alkaen ? _____
 - d) muu, mikä ? _____
7. Tällä hetkellä
 - a) en seurustele vakituisesti
 - b) seurustelen
 - c) elän avoliitossa
 - d) elän avioliitossa
 - e) olen eronnut
 - f) lasten lukumäärä _____

8. Asun tällä hetkellä
- vanhempieni kanssa
 - yksin
 - soluasunnossa
 - yhdessä elämäkumppanini kanssa

HARRASTUKSET

9. Mihin seuraavista ryhmistä vapaa-ajanviettopasi perusteella mielestäsi kuulut
- Vietän vapaa-ajan etupäässä lepäillen, lueskellen, musiikkia kuunnellen ja televisiota tai videota katsellen
 - Harrastan vapaa-aikanani kevyitä kotitöitä, kevyttä liikuntaa, käveleskelyä, samoilua tms. (et hengästy tai hikoile harrastuksissasi)
 - Harrastan melko säännöllisesti reipasta virkistysliikuntaa, kuten voimistelua, pyöräilyä, uintia jne. (hengästyit ja hikoilet jonkin verran)
 - Harrastan säännöllisesti ruumiillisesti rasittavaa liikuntaa, jonka aikana hengästyin ja hikoilen selvästi
10. Merkitse ne kolme (3) vapaa-ajan harrastustasi, joihin käytät viikoittain eniten aikaa. Merkitse myös, paljonko käytät kuhunkin yhdellä kertaa keskimäärin aikaa ja montako kertaa viikossa kutakin harrastat.

| harrastus | harrastus- aika/min. | päivien lukumäärä pv/viikko |
|---------------------|-------------------------|--------------------------------|
| esim. valokuvaus | 120 min/päivä | 2 |
| a) _____ | _____ | _____ |
| b) _____ | _____ | _____ |
| c) _____ | _____ | _____ |

11. Kuinka usein harrastat urheilua tai liikuntaa vapaa-aikanasi. Rengasta vain yksi vaihtoehto.
- en koskaan
 - harvemmin kuin kerran kuukaudessa
 - 1-2 kertaa kuukaudessa
 - noin kerran viikossa
 - useamman kerran viikossa (2-3 kertaa viikossa)
 - suunnilleen joka päivä (5-7 kertaa viikossa)
12. Kun harrastat liikuntaa, harrastatko sitä yleensä niin, että
- et hengästy etkä hikoile
 - hengästyit, mutta et hikoile
 - hikoilet, mutta et hengästy
 - hengästyit ja hikoilet jonkin verran
 - hengästyit ja hikoilet runsaasti

13. Tässä tiedustelemme säännöllisiä liikuntaharrastuksiasi viimeisen vuoden aikana. Merkitse enintään viisi (5) lajia, joita harrastat eniten.

| | laji | montako kertaa kk keskim. | kuinka kauan kerrallaan (aika keskim.) |
|----|----------------------------|---------------------------------|--|
| | esim. | | |
| 8 | kävely | 12 | 30 min. |
| 1 | voimistelu | _____ | _____ min |
| 2 | telinevoimistelu | _____ | _____ min |
| 3 | squash, tennis, sulkapallo | _____ | _____ min |
| 4 | pöytätennis | _____ | _____ min |
| 5 | koripallo | _____ | _____ min |
| 6 | aerobic | _____ | _____ min |
| 7 | pyöräily | _____ | _____ min |
| 8 | kävely | _____ | _____ min |
| 9 | tanssi | _____ | _____ min |
| 10 | uinti | _____ | _____ min |
| 11 | kuntosali | _____ | _____ min |
| 12 | hölkkä | _____ | _____ min |
| 13 | pesäpallo | _____ | _____ min |
| 14 | lentopallo | _____ | _____ min |
| 15 | murtomaahiihto | _____ | _____ min |
| 16 | laskettelu | _____ | _____ min |
| 17 | ratsastus | _____ | _____ min |
| 18 | muu, mikä _____ | _____ | _____ min |
| | 1. | | |
| | 2. | | |
| | 3. | | |
| | 4. | | |
| | 5. | | |

14. Mikä on oma arviosi fyysisestä (ruumiillisesta) kunnostasi, lähinnä suorituskyvystäsi ja lihasvoimastasi. (Rengasta vain yksi vaihtoehto)

Kuntoni on

- 1 erittäin hyvä
- 2 melko hyvä
- 3 keskinkertainen
- 4 melko huono
- 5 erittäin huono

15. Kerro, miksi harrastat liikuntaa ?

16. Rengasta seuraavista väittämistä se, joka sopii sinuun parhaiten.

Vastausvaihtoehdot:

- 1 = ei sovi ollenkaan, 2 = ei sovi kovin hyvin, 3 = sopii jonkin verran,
4 = sopii melko hyvin, 5 = sopii täysin

Liikunta tuottaa minulle mielihyvää 1 2 3 4 5
Harrastan liikuntaa velvollisuudentunnosta 1 2 3 4 5

17. Liikuntaharrastukseni on mielestäni lukioaikaan verrattuna ?

- 1 vähentynyt
- 2 pysynyt samana
- 3 lisääntynyt

KÄSITYS ITSESTÄSI

Seuraavassa on sinuun itseesi ja läheisiisi liittyviä väitteitä. Rengasta jokaisen väittämän kohdalla yksi vastausvaihtoehto sen mukaan, minkä verran väittäämä mielestäsi sopii sinuun itseesi tai elämäntilanteeseesi. Vastaa lähinnä ensimmäisen mieleentulevan vaihtoehdon mukaan.

18. Oletko tyytyväinen siihen, mitä olet tähän mennessä saavuttanut työ- tai opiskelurallasi

- 1 erittäin tyytyväinen
- 2 melko tyytyväinen
- 3 en osaa sanoa
- 4 melko tyytymätön
- 5 erittäin tyytymätön

19. Seuraavassa on esitetty joitakin väittämiä. Rengasta kustakin kohdasta se vaihtoehto, joka sopii sinuun parhaiten.

Vastausvaihtoehdot:

1 = ei sovi ollenkaan, 2 = ei sovi kovin hyvin, 3 = sopii jonkin verran, 4 = sopii melko hyvin, 5 = sopii täysin

| | | | | | |
|--|---|---|---|---|---|
| Uskon itseeni ja mahdollisuuksiini | 1 | 2 | 3 | 4 | 5 |
| Tunnen itseni epävarmaksi muiden ihmisten seurassa | 2 | 3 | 4 | 5 | |
| Koen kotini ilmapiirin hyväksi | 1 | 2 | 3 | 4 | 5 |
| Haluaisin olla erilainen kuin olen | 1 | 2 | 3 | 4 | 5 |
| En uskalla esittää omia mielipiteitäni seurassa | 1 | 2 | 3 | 4 | 5 |
| Minulla on selkeitä tulevaisuuden suunnitelmia | 1 | 2 | 3 | 4 | 5 |
| Vietän vapaa-aikani pääasiassa perheen parissa | 1 | 2 | 3 | 4 | 5 |
| Minua vaivaavat alemmuuden tunteet | 1 | 2 | 3 | 4 | 5 |
| Riitelen usein äitini kanssa | 1 | 2 | 3 | 4 | 5 |
| Riitelen usein isäni kanssa | 1 | 2 | 3 | 4 | 5 |
| Minusta tuntuu, että muiden on paljon helpompi saada ystäviä kuin minun | | | | | |
| Yleensä vanhempani luottavat minuun | 1 | 2 | 3 | 4 | 5 |
| Olen epävarma tulevaisuudestani | 1 | 2 | 3 | 4 | 5 |
| Olen varmaankin niin ikävystyttävä, ettei kukaan todella viihdy seurassani | 1 | 2 | 3 | 4 | 5 |
| Harrastukset täyttävät lähes kaiken vapaa-aikani | 1 | 2 | 3 | 4 | 5 |
| Minusta tuntuu usein, ettei äitini ymmärrä minua | 1 | 2 | 3 | 4 | 5 |
| Minusta tuntuu usein, ettei isäni ymmärrä minua | 1 | 2 | 3 | 4 | 5 |
| Mielestäni minulla on paljon hyviä ominaisuuksia | 1 | 2 | 3 | 4 | 5 |
| Vanhempani antavat minun päättää omista asioistani | 1 | 2 | 3 | 4 | 5 |
| Tunnen kipeästi, että minulta puuttuu itseluottamustani | 2 | 3 | 4 | 5 | |
| Vanhemmillani on paljon keskinäisiä ongelmia | 1 | 2 | 3 | 4 | 5 |
| Tunnen itseni vapautuneeksi vieraassakin seurassa | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|--|---|---|---|---|---|
| Minusta tuntuu usein, että olen erilainen kuin vanhempani toivoisivat | 1 | 2 | 3 | 4 | 5 |
| Pystyn siihen mihin muutkin | 1 | 2 | 3 | 4 | 5 |
| Vanhempani eivät ole kiinnostuneita mielipiteistäni | 1 | 2 | 3 | 4 | 5 |
| Vanhempani toivoisivat minun menestyvän opinnoissa/työelämässä paremmin | 1 | 2 | 3 | 4 | 5 |
| Pidän siinä määrin juttelemisesta, että keskustelen mielelläni aivan vieraidenkin kanssa | 1 | 2 | 3 | 4 | 5 |
| Minulla on ystäviä, joita vanhempani eivät hyväksy | 1 | 2 | 3 | 4 | 5 |
| Olen usein tyytymätön itseeni | 1 | 2 | 3 | 4 | 5 |
| Äitini on minulle läheinen | 1 | 2 | 3 | 4 | 5 |
| Isäni on minulle läheinen | 1 | 2 | 3 | 4 | 5 |
| Saan eloa ikävääkin porukkaan | 1 | 2 | 3 | 4 | 5 |

20. Onko sinulla viimeisen puolen vuoden aikana ollut joitakin seuraavista oireista, ja jos on niin kuinka usein ?

Rengasta sopivin vaihtoehto joka riviltä.

Vastausvaihtoehdot: 1 = ei lainkaan, 2 = silloin tällöin, 3 = melko usein, 4 = usein tai jatkuvasti

| | | | | |
|--|---|---|---|---|
| Vatsakipu | 1 | 2 | 3 | 4 |
| Ruokahaluttomuutta | 1 | 2 | 3 | 4 |
| Päänsärkyä | 1 | 2 | 3 | 4 |
| Haluttomuutta tai tarmottomuutta | 1 | 2 | 3 | 4 |
| Vaikeuksia päästä uneen tai heräilemistä öisin | 1 | 2 | 3 | 4 |
| Pahoinvointia tai oksentelua | 1 | 2 | 3 | 4 |
| Jännittyneisyyttä tai hermostuneisuutta | 1 | 2 | 3 | 4 |
| Huimauksen tunnetta | 1 | 2 | 3 | 4 |
| Käsien vapinaa | 1 | 2 | 3 | 4 |
| Painajaisunia | 1 | 2 | 3 | 4 |
| Ripulia tai epäsäännöllistä vatsan toimintaa | 1 | 2 | 3 | 4 |
| Väsymystä tai heikotusta | 1 | 2 | 3 | 4 |
| Runsasta hikoilua ilman ruumiillista ponnistelua | 1 | 2 | 3 | 4 |
| Närästystä tai happovaivoja | 1 | 2 | 3 | 4 |
| Ärtyneisyyttä tai kiukunpurkauksia | 1 | 2 | 3 | 4 |
| Hengitysvaikeuksia tai ahdistuksen tunnetta ilman ruumiillista ponnistelua | 1 | 2 | 3 | 4 |
| Sydämen tykytystä tai epäsäännöllisiä sydämenlyöntejä | 1 | 2 | 3 | 4 |

Vain tytöille:

21. Ovatko jotkut mainitsemistasi oireista sellaisia, jotka mielestäsi esiintyvät vain kuukautisten aikana tai ovat yhteydessä kuukautiskiertoon

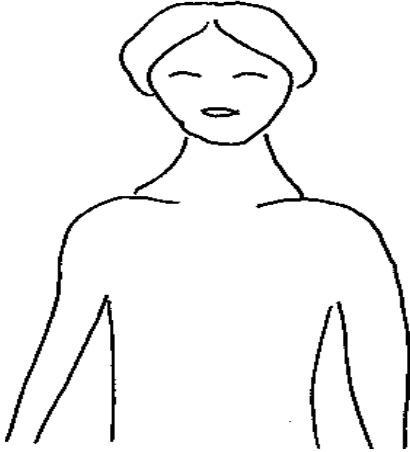
- 1 ei
2 kyllä, mitkä oireet ? _____

22. Miten tyytyväinen olet kokonaisuutena ottaen elämäsi ?

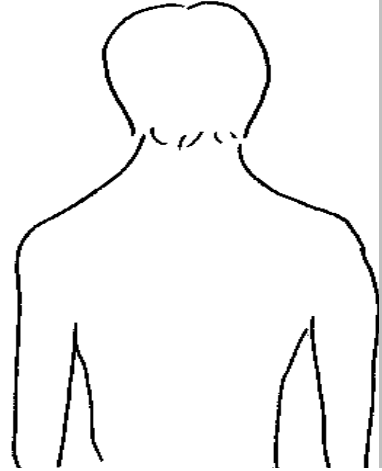
- 1 erittäin tyytyväinen
2 tyytyväinen

29. Varjosta kaavakuvasta ne alueet, joissa niska-hartiavaivasi tuntuvat.

kuva 1



kuva 2



30. Rengasta seuraavista väittämistä itseesi sopivampi vaihtoehto.

Oletko saanut seuraavia hoitoja niska-hartiavaivaasi ?

| | | |
|-----------------------|-------|----|
| En ole saanut hoitoja | kyllä | ei |
| Hierontaa | kyllä | ei |
| Särkyläkkeitä | kyllä | ei |
| Fysioterapiaa | kyllä | ei |
| Muuta, mitä _____ | | |

31. Rengasta seuraavista väittämistä itseesi sopivampi vaihtoehto.

Oletko ollut niska-hartiavaivojesi vuoksi tutkittavana?

| | | |
|--|-------|----|
| En ole katsonut sitä tarpeelliseksi. | kyllä | ei |
| En ole ollut tutkittavana, mutta olen hoitanut niska-hartiavaivoja itse. | kyllä | ei |
| Lääkärillä | kyllä | ei |
| Terveystoimijalla | kyllä | ei |
| Fysioterapeutilla | kyllä | ei |
| Hierojalla | kyllä | ei |

32. Merkitse alla olevalle viivalle X sille kohdalle, mikä parhaiten vastaa kokemaasi kipua viimeisen 7 vuorokauden aikana.

ei lainkaan kipua _____ pahin mahdollinen kipu

MIELIALA

Nuorilla on erilaisia ajatuksia ja tunteita, joita olemme seuraavassa luetelleet. Valitse jokaisesta kolmen lauseen ryhmästä yksi lause, joka parhaiten kuvaa, millaiselta Sinusta on tuntunut viime aikoina.

33.
 - 1 Olen joskus surullinen
 - 2 Olen useasti surullinen
 - 3 Olen aina surullinen
34.
 - 1 Asiat eivät koskaan suju minun kohdallani.
 - 2 En ole varma, miten asiat minun kohdallani sujuvat.
 - 3 Asiat sujuvat minun kohdallani ihan hyvin.
35.
 - 1 Teen useimmat asiat ihan oikein.
 - 2 Teen monet asiat väärin.
 - 3 Teen kaiken väärin.
36.
 - 1 Minulla on usein hauskaa.
 - 2 Minulla on joskus hauskaa.
 - 3 Minulla ei ole koskaan hauskaa.
37.
 - 1 Olen aina huono.
 - 2 Olen usein huono.
 - 3 Olen joskus huono.
38.
 - 1 Ajattelen joskus, että minulle tapahtuu jotain kamalaa.
 - 2 Pelkään, että minulle tapahtuu jotain kamalaa.
 - 3 Olen varma, että minulle tapahtuu jotain kamalaa.
39.
 - 1 Vihaan itseäni.
 - 2 En pidä itsestäni.
 - 3 Pidän itsestäni.
40.
 - 1 Kaikki kamalat asiat ovat minun syytäni.
 - 2 Useat kamalat asiat ovat minun syytäni.
 - 3 Kamalat asiat eivät yleensä ole minun syytäni.
41.
 - 1 Minua itkettää joka päivä.
 - 2 Minua itkettää useasti.
 - 3 Minua itkettää silloin tällöin.
42.
 - 1 Monet asiat vaivaavat mieltäni jatkuvasti.
 - 2 Monet asiat vaivaavat mieltäni usein.
 - 3 Monet asiat vaivaavat mieltäni silloin tällöin.
43.
 - 1 Minusta on mukavaa olla toisten kanssa.
 - 2 Olen mieluummin itsekseni.
 - 3 En halua ollenkaan olla toisten kanssa.
44.
 - 1 En pysty tekemään päätöksiä.
 - 2 Minusta on vaikea tehdä päätöksiä.
 - 3 Minusta on helppo tehdä päätöksiä.
45.
 - 1 Olen elestäni mukavan näköinen.
 - 2 Ulkonäössäni on joitain vikoja.
 - 3 Näytän rumalta.
46.
 - 1 Minun on jatkuvasti pakotettava itseni tehtäviin.

- 2 Minun on usein pakotettava itseni tehtäviin.
3 Tehtäväni eivät ole minulle ongelmia.
47. 1 Minulla on joka yö univaikeuksia.
2 Minulla on usein univaikeuksia.
3 Nukun ihan hyvin.
48. 1 Olen väsynyt silloin tällöin.
2 Olen usein väsynyt.
3 Olen jatkuvasti väsynyt.
49. 1 Ruokahaluni on aina huono.
2 Ruokahaluni on usein huono.
3 Ruokahaluni on ihan hyvä.
50. 1 En ole huolestunut särystä ja kivuista.
2 Säröt ja kivut huolestuttavat minua useasti.
3 Olen jatkuvasti huolissani särystä ja kivuista.
51. 1 En tunne itseäni yksinäiseksi.
2 Tunnen itseni usein yksinäiseksi.
3 Tunnen itseni aina yksinäiseksi.
52. 1 Koulussa/työssä ei ole koskaan hauskaa.
2 Koulussa/työssä on joskus hauskaa.
3 Minusta koulussa/työssä on joskus hauskaa.
53. 1 Minulla on paljon ystäviä.
2 Minulla on joitain ystäviä, mutta toivon, että heitä olisi enemmän.
3 Minulla ei ole yhtään ystävää.
54. 1 Koulu/työ sujuu ihan hyvin.
2 Koulu/työ ei suju yhtä hyvin kuin ennen.
3 Menestyn huonosti asioissa, joissa ennen olin hyvä.
55. 1 En koskaan pysty olemaan yhtä hyvä kuin toiset ikäiseni.
2 Pystyn olemaan yhtä hyvä kuin toiset ikäiseni, jos vain haluan.
3 Olen yhtä hyvä kuin toiset ikäiseni.
56. 1 Kukaan ei todella välitä minusta.
2 En ole varma, välittääkö kukaan minusta.
3 Olen varma, että joku välittää minusta.
57. 1 Teen yleensä sen, mitä minulta pyydetään.
2 En kovin usein tee sitä, mitä minulta pyydetään.
3 En koskaan tee sitä, mitä minulta pyydetään.
58. 1 Tulen toisten kanssa toimeen.
2 Joudun usein riitaan toisten kanssa.
3 Joudun jatkuvasti riitaan toisten kanssa.