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Physical work exposure and sex differences in work-related musculoskeletal disorders

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Ph.D. thesis

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I am not young enough to know everything

- Oscar Wilde

Title: Physical work exposure and sex differences in work-related musculoskeletal disorders

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Preface

The work presented in this Ph.D.-thesis was the result of the SHARM-project which was conducted between October 2010 and August 2014, at the Department of Occupational and Environmental Medicine at Bispebjerg University Hospital. The study was supported by grants from The Danish Working Environment Research Fund (grant #: 43-2010-03) and The Danish Rheumatism Association (grant #: R104-A2251).

During the completion of my master thesis entitled: “Comparison of two 3D gait analyses protocols – supported by EMG”, I first started thinking about conducting a Ph.D. I applied for two and was offered both – on the same day. I chose the SHARM-project in part because of its multidisciplinary character, allowing me to develop new skills within: questionnaires, biomechanical and physiological measurements and register epidemiology.

After completing most of my data collection, a year and a half in to my Ph.D.-study, I was lucky to have the opportunity to be a visiting scientist at Harvard School of Public Health in collaboration with Liberty Mutual Research Center, in Boston, USA. The purpose of my three month stay was to gain knowledge of novel methods for assessing exposures of physical exertion during work. I took part in several studies including a validation study of a wearable sensor system for assessing spinal loading during manual materials handling tasks. This experience gave me a lot of new perspectives, ideas and inspiration on how to develop thorough measurements of physical exposure with methods applicable at work sites.

In parallel with working on my thesis I have since 2010 given lectures on applying methods for measurement of physical activity, at Metropolitan University College. During the last year this has been intensified by giving lectures in basic epidemiology and research methods at University College Capital. At this institution I have also been principal supervisor for nine bachelor students of Physiotherapy since 2011. Recently I have been appointed to be external examiner for the bachelor-exams at the Danish Educations for Physiotherapy. Altogether I have developed many new skills on both the personal and professional level.

Birkerød, August 2014 Thomas Heilskov-Hansen

1 List of papers

This thesis is based on the following original papers which can be found in the contents under “Original papers”. Throughout the thesis the papers will be referred to in roman numerals I-III.

Paper I: Sex differences in muscular load among house painters performing identical work tasks.
(Eur J Appl Physiol 2014;1-11)

Paper II: Sex differences in task distribution and task exposures among Danish house painters: An observational study combining questionnaire data with biomechanical measurements.
(Submitted to PLOS ONE)

Paper III: Exposure-response relationship between postures and movements of the wrist and carpal tunnel syndrome among male and female house painters: a retrospective cohort study.
(Draft)

2 List of abbreviations

Abbreviations listed in alphabetical order.

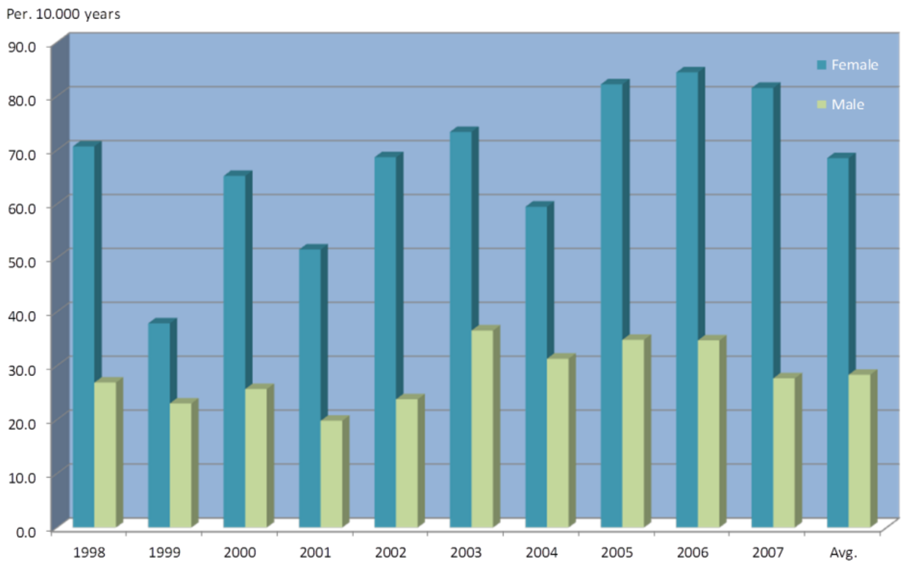
AL	Action Limits
ACGIH	American Conference of Governmental Industrial Hygienists
BMI	Body Mass Index
CRS	Danish Civil Registration System
CTS	Carpal Tunnel Syndrome
DNPR	Danish National Patient Register
EDT	Electro Diagnostic Test
EMG	Electromyography
ICD-10	International Classification of Diseases, Version 10
IRR	Incidence Rate Ratios
JEM	Job Exposure Matrix
MSD	MusculoSkeletal Disorder
MVC	Maximal Voluntary Contractions
NCSP-D	Nomesco Classification of Surgical Procedures- Danish version
NBII	National Board of Industrial Injuries
NHSR	National Health Service Register
PUD	Painters Union in Denmark
RMS	Root Mean Square
SHARM	Shoulder, Hand, ARM-project
TEM	Task Exposure Matrix
TLV	Threshold Limit Values
WMSD	Work-Related Musculoskeletal Disorder

Contents

3 Introduction

In 2009 MD Rolf Petersen from the Department of Occupational Medicine in Slagelse, Denmark, observed a seemingly high sex difference in the number of patients from the house painters profession who contacted the department with work related muscular skeletal disorders (WMSDs) of the upper extremity. In order to investigate if this difference was entirely observed by chance, he contacted The National Board of Industrial Injuries (NBII) in Denmark which is the authority to whom workers report claims regarding occupational diseases. The NBII extracted national incidence data of notified WMSD-cases among male and female house painters in the period from 1998-2007. The data showed a substantial sex difference (figure 1).

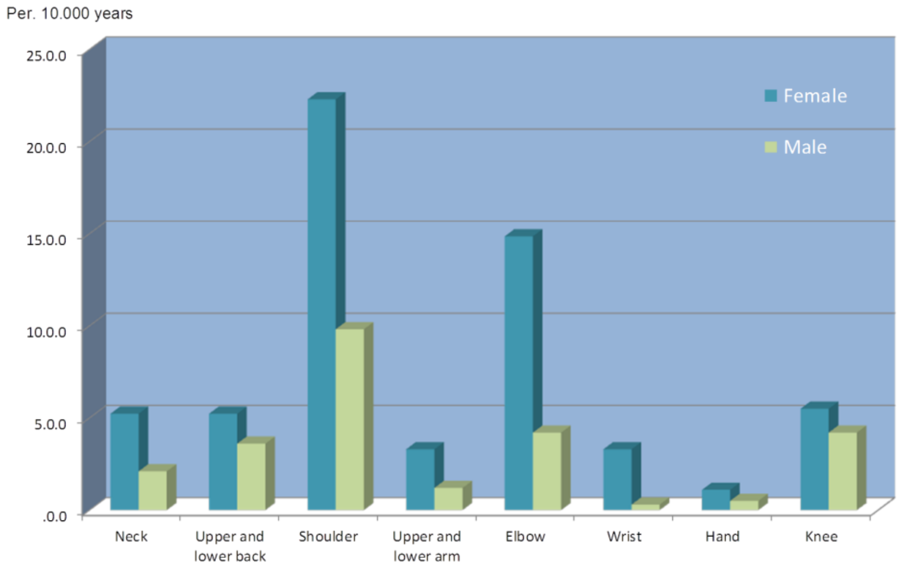
Figure 1: Incidence rates by sex of WMSDs among house painters, reported to the National Board of Industrial Injuries in the period 1998-2007



Simple inspection of data shows that women painters had approximately twice as high incidence rates of WMSD claims as men, and this ratio was quite stable across calendar years. When dividing the reported cases among house painters into specific anatomical regions, some of the highest incidence rates and sex differences were located in the upper extremity (figure 2). The largest sex difference was found for the wrist.

This data is in good accordance with the literature. Higher reporting of musculoskeletal pain, complaints or WMSDs by women is well documented (1-8), and is especially pronounced for the upper extremity (5;8-10).

***Figure 2**: Incidence rates by anatomical region of WMSDs among house painters, reported to the National Board of Industrial Injuries in the period 1998-2007*



Despite constituting about half the working population in most industrialized countries, women are still underrepresented in research of WMSDs (11-13). Sex differences in WMSDs are often explained by the following main hypotheses:

1. Women have lower thresholds for reporting musculoskeletal pain, either in a psychosocial or physiological sense (3;14-19).
2. Sex segregation in occupations and task segregation within professions results in different exposures for men and women (5;6;8;20-25).
3. Women are more vulnerable at the same exposure. Several physiological differences between men and women ranging from hormonal changes to heterogeneous muscular strength can influence the impact of an exposure (6;8;14;26).
4. Sex differences in work strategies, techniques and procedures, expressed by a diverse composition of postures and movements, even if the task is the same (27).

Many uncertainties resulting from one or more of these hypotheses could be controlled by conducting a precise sex specific exposure assessment, but this task is unresolved in most studies.
This knowledge initiated the planning of the SHARM-project (Shoulder, Hand, ARM-project), trying to apply a systematic approach for a precise exposure assessment, to be used in the evaluation of sex differences in WMSDs. This scientific approach should help identify potential sex differences in development of WMSDs and thereby ensure that preventive and rehabilitative measures favor both sexes equally.

4 Aims

Based on the prevailing hypotheses for explaining sex differences in development of WMSDs we wanted to establish a systematic approach which clarified each of the hypotheses one at a time. The aims of this thesis were:

- Within a seemingly homogenous profession to establish a precise exposure assessment, examining potential sex differences in forces, load, task distributions, postures and movements (Papers I and II).

- To explore if an exposure-response relationship can be established between three different exposure variables of the wrist, and carpal tunnel syndrome defined through diagnoses and surgery reported to the Danish national registers (Paper III).

- To investigate whether the risk of carpal tunnel syndrome is different for men and women with comparable occupational physical exposure (Paper III).

5 Background

5.1 Sex and gender terminology

The terminology regarding gender and sex research can be confusing and it is often based on tradition or habit within certain fields of research. Traditionally the term gender is used to describe social aspects related to subjective properties i.e. identity, whereas sex usually refers to biological properties (14;28). However in reality the two expressions tend to be used interchangeably and attention has been drawn to the fact that they very rarely can be excluded completely from each other. Some have taken the consequence of this and consistently use the term gender/sex irrespective of the properties in question (10). In this thesis differences between men and women are referred to as sex differences disregarding their nature.

5.2 Musculoskeletal Disorders

The term Musculoskeletal disorder (MSD) is used to describe a wide variety of conditions affecting the muscles, nerves, tendons, bones, ligaments or joints. MSDs are usually caused by inflammation or degeneration, resulting in pain and physical constraints. MSDs can have an acute or accumulative nature, but traumas resulting in fractures are usually not considered as MSDs (29). MSDs are very common and the annual costs are consequently very high (30;31). They are more prevalent among women than men and even more so in the upper extremity (29;32;33). Even within individuals performing identical work, women have more WMSDs than men (8;34). Since occupational risk factors are highly related to industrial work, WMSDs are more prevalent in the lower social classes compared to high social classes (1;32;35-37)

Risk factors for MSD are often divided into non-occupational and occupational nature. Common non-occupational or individual risk factors include: age, gender, obesity, leisure time activities, smoking, strength, socioeconomic status and ethnicity (10;37-40).

Occupational risk factors for WMSDs are many and they can be differentiated by anatomical region(35). Some of the most common risk factors for WMSDs are: repetitive motion, whole body or segmental vibration, forceful manual exertion, heavy lifting, non-neutral body postures, high velocity and other ergonomic stressors (7;10;29;35-42).

Occupational ergonomic stressors have been described by Punnet et al. (36)as a key element in the occurrence of WMSDs. Examples of frequently occurring MSDs include: Rotator cuff syndrome, CTS, lateral epicondylitis, low back pain and hip and knee osteoarthritis (29;30;37).
Many risk factors for MSDs and WMSDs are associated with physiological or psychological aspects and are therefore prone to differences between sexes herein.
Numerous studies have investigated physiological differences between men and women i.e. in relation to: Perception of pain (43), fatigability (44;45), tendon properties (46-49), hormonal differences (46;49), anthropometry and muscular entities (50;51). Regarding the latter it has been well established that the average man is approximately 50 % stronger than the average woman (26;52;53). This muscular difference will cause women to use a higher level of relative force if doing the same force demanding tasks as their male colleagues (8;54). It has then been suggested that this difference accumulated over time can contribute to the development of WMSDs (55). Others have reported that women have an alternate muscular recruitment pattern or motor strategy than men (50;51), and a different composition of muscle fibres, with women having a higher proportion of type 1 muscle fibres compared to men(45;56). These type 1 muscle fibres have been described by Hägg (57)as "Cinderella fibres", the name owing to their property of having the lowest recruitments threshold and, in addition, staying activated for prolonged periods of low intensity use. If working in repetitive low force tasks this could potentially lead to an overload, resulting in a WMSD.

There is a growing body of evidence for psychosocial characteristics being risk factors for WMSD (35-37;39;58;59). This evidence mainly addresses the modifying role of psychosocial factors while the etiologic pathway is less established (37). The most common reported risk factors include: high perceived job stress, high job demands, non-work-related stress, low social support of co-workers, low job control, low decision authority and low job satisfaction (58-60). None of these studies reported any sex differences.

Gaining knowledge on sex differences in risk factors for WMSD could potentially be helpful in limiting new cases of WMSDs or in the development of preventive measures.

5.3 Carpal Tunnel Syndrome

Carpal tunnel syndrome (CTS) is a very common nerve entrapment (61;62). It is caused by pressure on the median nerve in the carpal tunnel, resulting in constant or recurring symptoms of numbness, burning, tingling or pain in one or more of the first three digits and the radial part of the fourth. In some cases there will be decreased grip force due to an atrophic abductor pollicis brevis muscle (63;64). CTS can be treated with wrist splints, anti-inflammatory drugs, corticoid steroid injections or in the final stage by surgery. In open or endoscopic carpal tunnel release the transverse carpal ligament is cut in order to relieve pressure from the median nerve (65-68) . CTS has been studied intensively during the last 20-30 years (69;70) and is one of the upper extremity MSDs with highest healthcare costs (71;72). Within epidemiological research several different case definitions have been used when studying CTS. Studies using only CTS symptoms for defining cases have reported higher CTS prevalence and incidence rates (70;73) and there is a widespread agreement that case definitions influence prevalence and incidence rates (63;74-77). Some studies have used dual case definitions and have divided cases into “probable CTS” and “possible CTS” depending on which diagnostic criteria were met (77;78). Many studies rely on what is referred to as “physician diagnosed”. This is defined by clinical symptoms and a physical examination at minimum, and usually includes an electro-physiological examination (79).

Reports of CTS prevalence span from 1.9 % in the general population (80) to, for example, 16.6 % among dairy workers (81). In general there is a pronounced variation in CTS prevalence and incidence rates reported in studies. Considerable differences are seen among un-exposed control groups in studies of occupational factors (82-87). In general, the prevalence is higher in studies of occupational factors compared to studies of the general population (61;80;88-91). This may in part be related to different case definitions as mentioned above, but actual differences between study populations may also have an impact (74;79;92;93).

Several personal as well as occupational risk factors for CTS have been reported. Some of the personal risk factors agreed upon are: female sex, age, high body mass index (BMI), previous fractures near the wrist, co-morbidities (e.g. hypothyroidism, diabetes, rheumatoid arthritis, gout and connective tissue disorders), low height and family predisposition (16;63;94-100). The use of oral contraceptives has been investigated by a few studies, but the results are contradictive (95;101). Similar inconclusive findings have been made for smoking (95;102;103). Studies of general populations have shown a higher CTS prevalence in women (16;61;96;97). Bland and Rudolfer (97) have shown a bi-modal age distribution of CTS for both men and women, with peaks around 45-55 years of age and 75-85 years of age.

Roquelaure et al. (104) showed a higher incidence of CTS in the working population compared to the non-working population. This corresponds with the growing scientific literature where occupational risk factors for CTS are documented in industrial settings (38;78;79;92;105;106). Tasks including exposure to vibrations have been reported by many as one of the most important risk factors for CTS although the isolated effect of vibrations has been difficult to distinguish from the concomitant effects of force and repetition (79;92;93;105;107-115). Repetitive work and highly repeated flexion/extension of the wrist (73;79;92;105;106;114-121) as well as forceful use of the hand (69;79;92;98;105;116;120;121) are also frequently reported. Violante et al. (98) showed a 3-fold increase in CTS risk when exposed to unacceptable overload, compared to acceptable load, according to the action limit (AL) and threshold limit values (TLV) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Others have also shown an increased risk of CTS when exposed to forces exceeding the TLV (94;122-124).

Combined effects of vibration, repetitious flexion/extension and force have been shown to increase the risk of CTS even more (69;116;120;125). A combination of force and repetitive movements is the most commonly reported (69;78;79;92;99;105) but others have also been reported e.g. the combination of force and posture (92;105). Few have reported results on non-neutral postures, and none of these have shown an effect on the risk of CTS (38;42;126).

Computer work has been extensively investigated as a potential risk factor for CTS (93;106;113;114;127-131), but the vast majority, including a recent meta-analysis (129), have found no effect. Andersen et al. (127) and Ali et al. (132) did however find an elevated risk of CTS when using a computer mouse and doing combined work respectively. Work related psychosocial characteristics such as low social support, job stress and high job strain has been reported (although not statistically significant) as risk factors for CTS by some (60;114;133;134), while others have found no effect (126;127). Harris-

Adamson et al. (135) showed a protective effect of experiencing social support, and an increased risk with high job strain. It is not obvious what the relevant mechanisms could be and the evidence is conflicting. Perhaps psychosocial stressors could be a proxy for job functions characterised by a high degree of manual handling and thus a result of confounding not fully accounted for.
Many studies have shown an association between certain professions and the risk of CTS. Examples of these professions are: Cashiers (73), Industrial workers (122), meat and fish processing (82), Electronics assembly (136), slaughterhouse workers (87) and dental hygienist (137). Typically, these professions can be characterised as being either subjected to a high degree of occupational vibration, repetitiveness or force requirements or any combination of these (79;92;93).
Several studies have found a higher CTS prevalence in women (32;78;96;97;100;138), but literature addressing a potential modifying effect of sex on exposures associated with an increased risk of CTS is very scarce. Some studies have reported differences in the task distribution and argue that an uncontrolled sex difference in task composition can result in sex acting as a proxy for exposure (123;139;140). Most studies addressing sex differences have only reported minor if any sex difference in CTS risk using sex stratified analyses (78;113;120;123;141).

5.4 Exposure assessment

In occupational research physical exposure has been assessed using observation, expert ratings, self-reports and direct technical measurements. Exposures have most commonly been assigned as a group mean from the entire study population or a sub-sample (142) and rarely as individually assessed exposure , let alone sex specific (8).
In many studies that have examined the effect of a work related exposure on the incidence rate of CTS, the researchers have used job title to assess the exposure (92). In a recent meta-analysis 28 out of 37 studies had used job title for assigning exposure (92). However, self-reported exposure assessments are also widely used. Studies that have compared self-reported exposure assessments with technical measurements have concluded that technical measurements are superior in precision (143-147). Furthermore, self-reports may be biased by a higher reporting of exposure in individuals experiencing pain (147;148) or systematically higher reporting of tasks that are experienced as

hard (143;147;149;150). Using self-reported exposure assessment for evaluating possible dose-response relations will therefore introduce the risk of amplification bias of the estimates.

Assessments of biomechanical exposures should preferably include measures of intensity, duration and frequency (151;152) in order to provide a precise and comprehensive unit of measure. Many studies have reported exposure on a categorical scale (94;98;122-124) typically dividing exposures into two or three groups using arbitrary threshold limits. This will hinder the possibility of making comparisons between studies using different thresholds as well as limit the determination of a precise dose-response estimate. Reporting on a continuous scale enables both the ability of comparison with other studies and the dose-response estimate. Precise measurements are required to do reporting on a continuous scale and it will therefore be associated with higher economic costs(142).

Regardless of the applied methodology, assessing physical exposure will encompass a big challenge in accounting for the variability. When doing direct measurements the optimal strategy would be to perform three or four measurements on each individual on separate days, and preferably distributed across the calendar year to capture potential seasonal changes (142;153-155). Liv et al. (154) conclude that a better measurement precision is achieved by using more data and suggests sampling of large proportions of the day per subject.

Nordander et al. (8) investigated measurement errors and individual variation, when using inclinometry and goniometry to do technical exposure assessments within homogeneous work tasks. Supported by others (156-160), they concluded that the measurement errors were small, and as a result of this 20 subjects in each group would be sufficient to demonstrate potential differences in exposure between groups.

Some have suggested that men and women doing the same task will have the same MSD risk (141;161;162), while others have proved differently (6;34;163). Uncertainties about the impact of physical exposure in reported sex differences of WMSDs are still very much an issue. Locke et al. (20) concluded that uncontrolled sex differences in task distribution may result in exposure misclassification, leading to erroneous risk estimates, and recommended subject specific exposure assessments on task level. Kennedy et al.

(21) concluded in a review that sex matters when assessing physical exposure, but at the same time they notice that the direction and magnitude not necessarily can be predicted a priori. This illustrates the importance of having as precise an exposure measure as possible combined with a valid and reliable outcome, but many existing studies have deficiencies in at least one of these.

5.4.1 Exposure matrices

An exposure matrix is basically a cross tabulation of values for different exposure variables combined with tasks, occupations or industries. A third axis can be included providing data on seasonal variations (142). Many exposure matrices are constructed on a job level (8), typically using categorical classification (164;165). The exposures of interest included in a typical job exposure matrix (JEM) are often expert assessed exclusively or in combination with measurements. Expert assessed job exposure matrices usually don't distinguish between sex within the same occupation and often professions with similar exposure are even grouped (165-167). A serious shortcoming of JEMs in general is the inability to capture exposure variation within a profession (142), thereby preventing comparisons between high and low exposed subjects.

This distinction is possible in a task exposure matrix (TEM). It will also allow an identification of a specific task that might contain elements which could potentially cause a high risk of WMSDs. In the same manner, the TEM will allow comparisons of task characteristics of men and women, identifying potential sex differences in exposure between and within professions. A study comparing cumulative exposures found significant differences between the methodology of the JEM and the TEM (168).

Although more precise, the TEM is also more costly to establish than the JEM. Therefore some authors recommend a careful consideration of the purpose and need, before constructing a TEM (169;170).

Based on previous studies it seems that recommendations for setting up a high quality study of sex specific exposure-response relationships should at best include a valid and precise definition of an outcome, assessed in an objective manner preferably using diagnostic testing, combined with an individually objectively and precisely measured assessment of exposure, reported on a continuous scale, determining the aspects of intensity, duration and frequency.

With the SHARM-project we try to initiate a systematic approach by clarifying aspects of the existing hypotheses for sex differences in the development of WMSDs one at a time. This is accomplished using a five step set-up as illustrated below (Table 1).

***Table 1**. Common potential determinants for different incidence rates of work-related musculoskeletal disorders among men and women, and how they are clarified in the studies.*

	Step 1	Step 2	Step 3	Step 4	Step 5
Potential determinants for sex differences in WMSD	Different jobs?	Different muscular load?	Different tasks?	Different physical exposure?	Different response?
Clarified by:	Design	Paper I	Paper II	Paper II	Paper III

In steps 1 and 3 we will investigate the hypothesis that sex-segregated professions and tasks may influence the occurrence of CTS, one of the frequent WMSDs, by determining potential sex differences within our study population.

In step 2 we will investigate aspects of the hypothesis of physiological disparities clarifying the size of sex differences in muscular entities within our study population.

In step 4 we will investigate the hypothesis of different work strategies, techniques and procedures of men and women even within the same profession, doing the same tasks.

In step 5 we will investigate the hypothesis that women may be more vulnerable than men at the same absolute level of exposure.

By choosing CTS as the health outcome we try to limit the influence of potential sex differences in reporting since we rely on an objective diagnostic criterion.

In Denmark one third of all house painters are women and tasks are supposed to be equally distributed between sexes. This makes the profession well suited as material for the proposed research project. Through the Painters' Union in Denmark (PUD) we had access to data on practically all house painters in Denmark. Those matching the study criteria were invited to participate.

6 Methods

6.1 Study designs

6.1.1 Paper I

This study was an observational study. In a laboratory setting, male and female painters had electromyography (EMG) recorded from four muscles while performing nine predetermined common house painter tasks on a defined area. After each task the participants were asked about their perceived exertion on the Borg CR10 scale. Comparisons of absolute forces, relative load and perceived exertion were made between men and women.

In addition to what is included in paper I, inclinometry and goniometry was simultaneously recorded as described for paper II. This will allow future comparisons between laboratory and field measurements, which can enable the use of force measurements in the field measured JEM.

6.1.2 Paper II

This observational study consisted of two parts. Part 1: Questionnaire data reporting task distributions for a common week in 12 predetermined tasks, were collected from members of the PUD. Comparisons of task distributions were made between sexes.

Part 2: In a work place setting, inclinometry measurements were made of postures and movements of the upper arms and head. Goniometry measurements were made for postures and movements of the wrists, These were used to construct TEMs and JEMs, comparing several variables for postures and movements between sexes.

6.1.3 Paper III

This was a retrospective cohort study including members of the PUD. Exposure response relationships were analysed for three different exposure variables for the right wrist (individually assessed by combining task distributions and TEMs) and an outcome of first time diagnoses of, and surgeries for, CTS identified in the Danish registers. Effects were tested for any modification by sex.

6.2 Study populations

6.2.1 Paper I

A power calculation showed that at a double-sided significance level of 5% there would be an 80% probability of detecting a 15% sex difference in EMG measurements with 32 participants divided into two groups. On the basis of this, 16 male (mean age 25.5) and 16 female (mean age 28.3) house painters were recruited through an advertising spot on the web side of the PUD. Only right handed subjects without current disorders or complaints in the upper extremity were included.

6.2.2 Paper II

Questionnaire: 9364 members of the PUD born 1940 or later who were still alive on March 1st 2011 were contacted by mail in April 2011 and asked to fill out and return a questionnaire. 4957 (53 %) responded, 3124 men (50 % of all men, mean age 49.7) and 1833 women (59 % of all women, mean age 35.2). *Measurements of postures and movements:* All house painter companies in the capital region (Region Hovedstaden) of Denmark were identified in "The Central Business Register" which is the Danish national register containing primary data on all businesses in Denmark. They were contacted in a randomized order and asked to participate by each company providing between one and four painters (preferably the same amount of men and women) for personal measurements of postures and movements of the upper extremity during a full work day. 22 companies agreed to participate and 50 full work day measurements consisting of 25 men (mean age 45) and 25 women (mean age 32) were performed on ordinary random work days (Fridays excluded). Only right handed subjects without current disorders or complaints in the upper extremity were included.

6.2.3 Paper III

A cohort consisting of all members of the PUD born 1940 or latter who were still alive on March 1st 2011. 9364 individuals were included of which 6236 (66.6 %) were men and 3128 (33.4 %) were women. Some covariates were obtained for all cohort members from the Danish registers. Other covariates provided by the questionnaire described for paper II were only assessable for the responding part of the cohort (n=4957).

6.3 Electromyography

6.3.1 Preparations and equipment

Standard regimes for applying EMG-electrodes were followed including shaving the skin and wiping it with alcohol. In a unilateral setup for the right side, disposable surface electrodes (Multi Bio Sensors, TX, USA) were placed in a bipolar configuration on m. trapezius, m extensor carpi radialis and m. flexor carpi radialis according to recommendations by Perotto (171). Using hypodermic needles two fine wire electrodes (Spes Medica, Battipaglia(SA), Italy) were inserted into the m supraspinatus according to recommendations by Rudroff (172). The signals were transmitted wirelessly by a Bluetooth transmitter (MQ16, Marq-Medical, Farum, Denmark) to a PC were they were sampled at 2048 Hz. For a complete detailed method see paper I.

6.3.2 Maximal voluntary contractions (MVC)

Using two different standardised test positions for each muscle, MVCs were recorded in all subjects (see Table 2 for sex specific mean values).

6.3.3 EMG-to-force calibration

EMG and signals from a force transducer (Hottinger Baldwin Messtechnik, Darmstadt GmbH, Germany) were simultaneously recorded and EMG amplitude for each muscle was calibrated to an external isometric force. This was achieved using the increasing ramp contraction methodology described by Jonsson (173). A linear relationship was determined up to 30 % MVC.

6.3.4 Measurements

In collaboration with the PUD a list was made covering the most common tasks within the house painters trade. Due to some restrictions in the laboratory, only 9 tasks were possible for the participants to perform. These were done in the following order: 1: Sanding (by hand) 2: painting (brush), 3: mounting glass-felt, 4: painting wall (roll), 5: painting ceiling (roll), 6: full levelling wall, 7: full levelling ceiling, 8: sanding wall ("Giraffe" dry-wall-sander), 9: sanding ceiling ("Giraffe" dry-wall-sander)(Figure 3). All tasks were done in a predetermined area. See Figure 3 for video recordings of tasks.

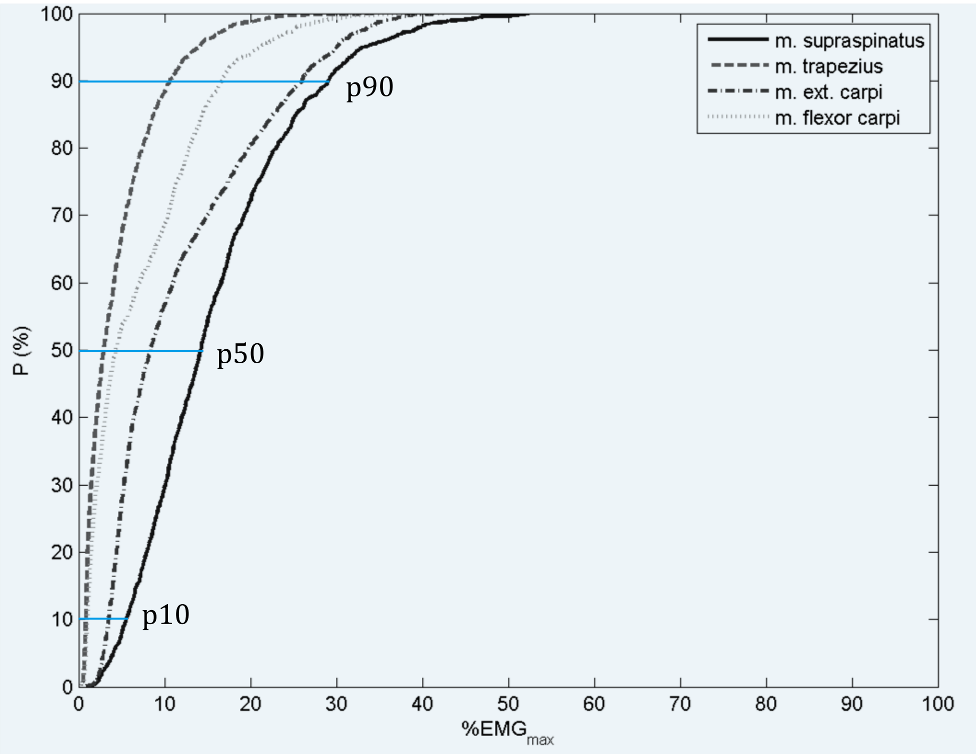
***Figure 3**. QR-code for link to video recordings of measurement examples.*

6.3.5 Data processing

EMG data was filtered and visually inspected. Root mean square (RMS) amplitudes were calculated and amplitude probability distribution functions (APDF) were constructed (Figure 4) by sorting the EMG measurements in ascending order. For the statistical analyses three percentiles were selected, representing different load intensities: The 90th percentile (p90), the 50th percentile (p50) and the 10th percentile (p10).

The EMG-to-force calibration was used to obtain a measure exerted force in Newtons (N). The EMG amplitudes were normalised to EMG_{max}, describing a relative load.

***Figure 4**. APDF curves of a typical subject in one of the harder tasks (#8 paper I). Light blue lines indicate the 10th, 50th and 90th percentiles.*



6.4 Borg CR-10

After the completion of each task (Paper I) the participants were asked to rate their perceived exertion using the Borg CR-10 scale (appendix I).

6.5 Questionnaire

A questionnaire was constructed (appendix IV). This consisted of 100 items, including questions on task distributions within a typical week since 1990, for the 12 most common tasks within the house painters trade. Additionally it had questions on covariates thought to be possible confounders. To increase numbers of responders a news article in the magazine of the PUD promoting the survey was made. Also a prize was offered to be drawn among responders and two friendly reminders were sent out.

6.6 Goniometry and inclinometry measurements

Measurements of postures and movements for the wrists were made using biaxial goniometers (SG75, Biometrics Ltd, Newport, UK). Postures and movements for the head and upper arms were measured using triaxial inclinometers (Logger Teknologi HB, Åkarp, Sweden). The signals were recorded by person worn data loggers (Logger Teknologi HB, Åkarp, Sweden) sampling at 20 Hz. Data was recorded for a full work day and analyses were performed for both sides. The technical measurements were performed using the methodology described by the group of Hansson et al. (156-159;174-176).

6.7 Log book

A log book was constructed covering the 12 most common tasks in the house painters trade (appendix II). In the log book participants in goniometry and inclinometry measurements wrote down the clock time for changes between tasks. They were given a clock with a large digital display in order to secure a precise indication for changes in tasks.

6.8 Job and Task exposure matrices

Several variables were computed for the 12 tasks individually (TEM) and for total work and pause (JEM)(Tables 5 and 6).

6.9 Danish registers

One of the keystones in Danish register research is the Danish Civil Registration System (CRS). Since 1968 every person with residency in Denmark has been assigned a unique ten digit personal identification number (PIN) consisting of data on date of birth (first 6 digits) followed by a sex-specific random number (last 4 digits). This unique individual number enables linkage of register information on multiple aspects (177). Data on diagnoses and surgeries for

CTS was obtained from the Danish National Patient Register (DNPR) and the Danish National Health Service Register (NHSR).
A measure of work duration in a given year was constructed by combining data from the Danish Register for Evaluation of Marginalisation (DREAM) with the Integrated Database for Labour Market Affiliation for Persons (IDAP). Information on births was obtained from the DNPR.

6.10 Data preparation

In preparation for the Poisson regression analyses the data was tabulated into blocks of risk time using a public accessible macro (178) based on the principles of a Lexis diagram (179).

6.11 Statistical analyses

In all three studies, the level of significance was set to 5 %. All analysis was performed in SAS 9.2 and 9.3 (SAS Institute Inc., Cary, NC, USA).

6.11.1 Paper I

Sex differences in relative muscular load and exerted forces were analysed using a two factor mixed model. This examined the task*sex interaction and dependencies of sex and tasks. Analysis for sex differences in ratings of perceived exertion (Borg CR-10) was made using an un-paired double sided t-test with unequal variance. Pearson's correlations coefficient was used to test for correlation between Borg ratings and $\%EMG_{max}$.

6.11.2 Paper II

Sex differences in task proportions within each age-group were tested using Cochran-Mantel-Haenszel statistics. An unpaired double sided t-test with post hoc Bonferroni correction was used to test for sex differences in task exposures. A paired double sided t-test was used to test for differences between sides.

6.11.3 Paper III

The effect of three exposure variables: median velocity, MPF (average frequency of wrist movements used as a measure of repetitiveness) or non-neutral postures (% time exceeding 45° flexion/extension or 20° ulnar radial deviation), on CTS diagnoses and surgeries was analysed using a log-linear Poisson regression model adjusted for potential confounders. We examined the sex*exposure interaction for any modifying effects. The exposure intensity*duration interaction was also tested.

The effect of pregnancies was also tested in the models.

Analyses were performed both on questionnaire responders and on the full cohort as well as stratified by sex.

Sensitivity analyses were made using only the outcome reported in DNPR.

6.12 Ethics statement and approvals

All parts of the study were conducted in accordance with current international ethical standards. Participants in measurements gave informed written consent.

First part of the study (Paper I) was approved by the Regional Scientific Ethics Committee (j.no.:H-3- 2012-157). Other parts of the project (paper II and III) were assessed by the Regional Scientific Ethics Committee (j.no.:H-C-FSP-2010-036), which concluded that these investigations were not notifiable according to Danish laws in this field (Committee Act).

The Danish Data Protection Agency gave permission to store data regarding every aspect of the project (j.no.:2010-41-5325).

The Danish Health and Medicines Authority approved the project for use of data from the NHSR. (J.nr. 7-505-29-1947/1).

7 Results

7.1 Male and female strength (Paper I)

Men were significantly stronger than women in all measurements of absolute force reported in Newton (N) ($P < 0.001$). On average men were 50-70 % stronger than women.
No significant differences were found between men and women in EMG_{max} reported in millivolts (Table 2)

***Table 2**: Mean MVC and EMG_{max} of men and women, P-values are difference between men and women, significant are set in bold.*

	MVC (N)					EMG_{max} (mV)				
	Men		Women			Men		Women		
	Mean	SD	Mean	SD	P	Mean	SD	Mean	SD	P
M. supraspinatus										
Abd45	109	21	66	15	**<0.001**	1.40	0.63	1.10	0.56	0.169
Abd90	268	39	176	35	**<0.001**	1.44	0.66	1.14	0.59	0.186
M. trapezius										
Elevation	467	120	299	137	**<0.001**	0.72	0.51	0.66	0.45	0.705
Abd90	268	39	176	35	**<0.001**	0.99	0.59	1.10	0.60	0.595
M. ext carpi radialis										
Dorsiflexion	203	56	125	34	**<0.001**	1.31	0.56	1.00	0.58	0.136
Power grip	500	92	333	42	**<0.001**	1.00	0.59	0.80	0.46	0.280
M. flex carpi radialis										
Plantarflexion	230	51	135	42	**<0.001**	1.36	0.56	1.10	0.40	0.143
Power grip	500	92	333	42	**<0.001**	0.58	0.18	0.51	0.20	0.273

7.2 Time expenditure (Paper I)

The duration of the tasks varied between all participants, but no sex difference was found in total duration of the nine tasks.

7.3 Relative muscular load (Paper I)

For all muscles, percentiles and task, women had a higher relative muscular load (with the exception of task 9, percentile 10 for m. trapezius).

There was no significant interaction between sex and task.

Significant effects of sex adjusted for task were found in all three percentiles for m. supraspinatus, m. extensor carpi radialis and m. flexor carpi radialis. No significant effect was found in any percentiles for m. trapezius (Table 3). All significant effects were caused by women being exposed to a higher load than men.

Table 3**. Estimated sex effect of relative muscular loads, adjusted for task. Load in women compared to that in men (male level being 100%).* ***Bold indicate significant effects

	p10 (%)		p50 (%)		p90 (%)	
	mean	95% CI	mean	95% CI	mean	95% CI
M. supraspinatus	**187 [b] (P=0.001)**	**131 to 266**	**156 [b] (P=0.003)**	**118 to 207**	**131 [b] (P=0.005)**	**109 to 158**
M. trapezius	119 (P=0.339)	83 to 171	120 (P=0.162)	93 to 155	127 (P=0.055)	99 to 162
M. ext. carpi radialis	**180 [b] (P=0.006)**	**120 to 270**	**164 [b] (P=0.009)**	**114 to 237**	**149 [a] (P=0.019)**	**107 to 207**
M. flex. carpi radialis	**159 [a] (P=0.012)**	**112 to 225**	**140 [a] (P=0.037)**	**102 to 193**	**136 [a] (P=0.043)**	**101 to 183**

[a] 0.010 < P < 0.050
[b] 0.001 < P < 0.010

7.4 Exerted forces (Paper I)

The interaction between sex and task was significant for a single case of the 10th percentile for m. trapezius. Post hoc analysis revealed it to be in task 9 (sanding ceiling with the “Giraffe” dry-wall-sander).
Significant effects of sex adjusted for task were only found in the 50th percentile for m. trapezius, (Table 4). The significant effect was caused by women exerting less force than men.

***Table 4**. Estimated sex effect of exerted force, adjusted for task. Force exerted by women compared to that of men (male level being 100%).* **Bold indicate significant effects**

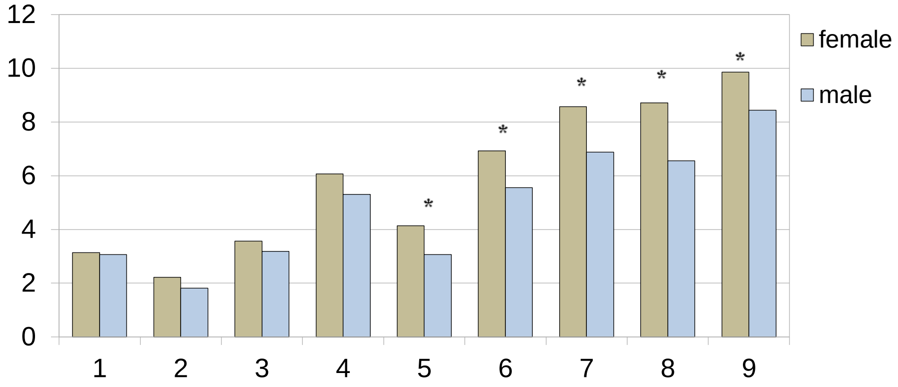
	p10 (%)		p50 (%)		p90 (%)	
	mean	95% CI	mean	95% CI	mean	95% CI
M. supraspinatus	111 (P=0.564)	78 to 158	95 (P=0.733)	70 to 129	80 (P=0.145)	62 to 103
M. trapezius	70 (P=0.059)	48 to 101	**70[a] (P=0.043)**	**49 to 99**	74 (P=0.113)	50 to 108
M. ext. carpi radialis	104 (P=0.831)	69 to 158	95 (P=0.786)	67 to 136	86 (P=0.379)	62 to 121
M. flex. carpi radialis	116 (P=0.438)	79 to 171	103 (P=0.888)	71 to 148	99 (P=0.968)	70 to 141

[a] 0.010 < P < 0.050

7.5 Borg CR-10 scale (Paper I)

On average women rated their perceived exertion higher than men in all tasks. In tasks 5-9 the sex difference was statistically significant ($P < 0.05$)(Figure 5).

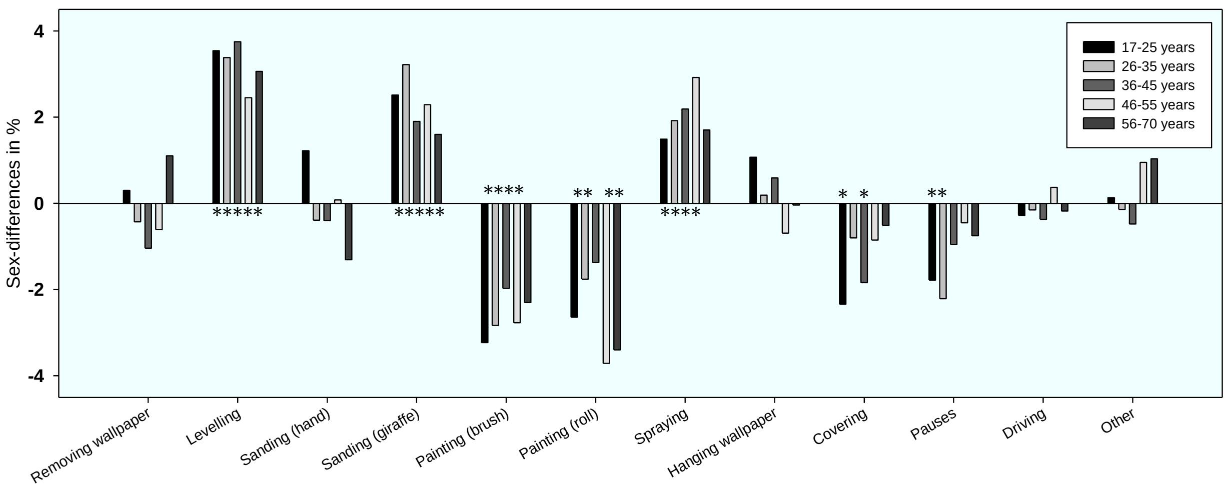
***Figure 5**. Ratings of Borg CR-10 scale for perceived exertion. * indicates significant differences between men and women*



7.6 Sex specific task distributions (Paper II)

Comparing male and female age specific task distributions ascertained from the questionnaire, several differences were observed although none exceeded ± 4 %. Men had higher proportions than women in the tasks usually considered the hardest (figure 6).

***Figure 6**. Sex differences in mean task proportions, by age-group. Women constitute the reference-group.*
** Indicates a statistically significant (p<0.05) sex difference in the specific age-group.*



7.7 Sex specific exposure assessment of postures and movements (Paper II)

7.7.1 TEM and JEM for the right wrist

Table 5 shows the TEM for postures and movements of the right wrist for each sex. "Total work" represents the JEM. No statistically significant sex differences were observed. For both sexes, there were clear differences in exposures between tasks. For example, the median velocity for flexion/extension during painting (brush) was approximately 4 °/s less than for sanding (hand) for both men and women. Some measures seem to reflect the same task properties to a great extent. For example, the 50th percentiles for flexion/extension and non-neutral postures showed the same difference between men and women within tasks.

***Table 5**. Task exposure matrix for postures and movements of the right wrist for each sex. Data is displayed for the 7 tasks that constitute the work. Additionally, data is shown for total work and pause (job exposure matrix). For flexion/extension and ulnar/radial deviation, positive angles denote flexion and ulnar deviation, respectively, and negative angles extension and radial-deviation, respectively, [SD=standard deviation; MPF= mean power frequency].* **Continues on next page.**

			Levelling		Sanding (hand)		Painting (brush)		Painting (roll)	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
Flexion/extension										
Percentile (°)	10th	Men	-57	16	-47	6	-50	12	-43	11
		Women	-46	8	-51	9	-52	10	-47	9
	50th	Men	-26	10	-15	3	-23	10	-17	11
		Women	-18	8	-26	13	-25	7	-23	8
	90th	Men	0	10	10	2	3	9	8	13
		Women	6	8	0	11	5	9	6	11
Range of motion	5th-95th	Men	75	10	74	9	69	10	65	12
		Women	67	4	65	11	74	14	70	15
Median velocity (°/s)		Men	18.1	8	19.3	5	15.5	7	17.6	6
		Women	21.2	7	19.1	4	15.3	5	16.3	5
Repetitiveness (MPF; Hz)		Men	.28	.05	.29	.04	.26	.06	.30	.08
		Women	.33	.05	.28	.06	.25	.04	.28	.06
Ulnar/radial deviation										
Percentile (°)	10th	Men	-8	5	-19	5	-15	10	-18	9
		Women	-13	8	-21	16	-21	11	-22	9
	50th	Men	9	3	-4	5	1	11	-2	7
		Women	3	6	-4	16	-5	10	-5	9
	90th	Men	27	5	11	4	18	12	17	10
		Women	19	6	14	12	12	10	12	8
Range of motion	5th-95th	Men	44	11	40	3	42	8	44	9
		Women	41	8	44	7	44	5	43	6
Median velocity (°/s)		Men	10.9	6	11.5	3	10.8	6	12.9	7
		Women	12.3	5	15.3	6	9.9	3	13.1	6
Repetitiveness (MPF; Hz)		Men	.29	.06	.33	.04	.28	.06	.30	.08
		Women	.33	.06	.30	.06	.27	.06	.31	.07
Combined wrist postures										
Non-neutral postures (% time)		Men	43	16	20	2	33	19	28	14
		Women	26	9	39	21	36	13	32	13
Number of recordings		Men	5	-	5	-	14	-	13	-
		Women	7	-	8	-	17	-	15	-
Mean recording duration (minutes)		Men	82	-	76	-	162	-	138	-
		Women	127	-	51	-	149	-	102	-

Table 5 Continued*. Task exposure matrix for postures and movements of the right wrist for each sex. Data is displayed for the 7 tasks that constitute the work. Additionally, data is shown for total work and pause (job exposure matrix) . For flexion/extension and ulnar/radial deviation, positive angles denote flexion and ulnar deviation, respectively, and negative angles extension and radial-deviation, respectively, [SD=standard deviation; MPF= mean power frequency]*

			Covering		Driving		Other		Total work		Pause	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Flexion/extension												
Percentile (°)	10th	Men	-42	14	-46	14	-45	18	-48	12	-44	17
		Women	-52	12	-47	13	-48	8	-50	8	-48	8
	50th	Men	-17	18	-20	13	-20	14	-20	11	-15	12
		Women	-23	13	-13	9	-21	11	-22	8	-22	10
	90th	Men	10	15	5	13	5	12	7	11	12	15
		Women	5	9	11	8	7	10	7	8	9	14
Range of motion	5th-95th	Men	66	20	67	12	65	11	72	7	70	17
		Women	72	13	76	14	74	9	75	10	74	11
Median velocity (°/s)		Men	13.3	8	10.0	5	14.0	8	14.5	5	5.5	4
		Women	14.2	8	7.9	3	14.5	6	14.6	4	4.8	4
Repetitiveness (MPF; Hz)		Men	.29	.08	.28	.06	.29	.03	.27	.04	.29	.06
		Women	.26	.06	.24	.05	.28	.06	.27	.04	.20	.03
Ulnar/radial deviation												
Percentile (°)	10th	Men	-9	8	-9	6	-13	11	-15	9	-15	9
		Women	-20	12	-17	9	-20	11	-19	11	-18	10
	50th	Men	6	9	6	6	4	10	1	9	0	9
		Women	-4	8	-2	8	-4	11	-2	10	-3	10
	90th	Men	19	10	21	7	19	9	18	9	14	9
		Women	13	8	13	7	11	10	14	9	12	10
Range of motion	5th-95th	Men	36	10	38	9	42	7	42	8	37	8
		Women	42	9	38	8	41	6	43	6	39	7
Median velocity (°/s)		Men	8.1	4	5.7	3	8.8	4	9.0	3	3.6	3
		Women	8.9	7	4.8	1	8.9	4	9.2	3	3.2	2
Repetitiveness (MPF; Hz)		Men	.31	.06	.29	.08	.27	.03	.28	.05	.21	.06
		Women	.28	.07	.25	.06	.28	.06	.28	.06	.20	.05
Combined wrist postures												
Non-neutral postures (% time)		Men	24	22	29	18	31	18	30	15	22	14
		Women	34	16	25	9	28	17	32	12	31	15
Number of recordings		Men	12	-	8	-	10	-	24	-	23	-
		Women	16	-	8	-	15	-	25	-	25	-
Mean recording duration (minutes)		Men	46	-	45	-	94	-	280	-	48	-
		Women	55	-	41	-	78	-	309	-	59	-

7.7.2 TEMs and JEMS for the head and right shoulder

Table 6 shows the TEM for postures and movements of the head and right upper arm for each sex; again, JEMs are presented as well. There were no statistically significant sex differences. Between-minute variation was higher for "total work" than for any of the tasks that constituted the work. This shows that, unlike the rest of the exposure measures, job exposures in terms of between-minute variation cannot even approximately be derived by a straight forward time weighting of task exposures.

Job exposures differed statistically significantly ($p<0.05$) between left and right wrists (see appendix III for left side TEMs and JEMS) .For flexion/extension and ulnar/radial deviation, both men and women had a higher median velocity and MPF on the right side; the same was present for median velocity of shoulder elevation.

***Table 6**. Task exposure matrix for postures and movements of the head and right upper arm for each sex. Data is displayed for the 7 tasks that constitute the work. Additionally, data is shown for total work and pause. For flexion/extension, positive angles denote flexion and negative angles extension. [SD=standard deviation].*
Continues beneath.

			Levelling		Sanding (hand)		Painting (brush)		Painting (roll)		Covering	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Head inclination												
Percentile (°)	1st	Men	-46	12	-39	14	-45	13	-53	12	-26	22
		Women	-40	6	-40	17	-45	14	-53	15	-23	15
	50th	Men	18	14	24	8	16	16	8	13	25	16
		Women	16	5	18	11	15	11	7	22	27	12
	90th	Men	64	11	54	6	54	15	50	12	52	17
		Women	55	8	55	11	53	14	54	12	54	12
Right upper arm elevation												
99th percentile (°)		Men	136	11	123	12	123	12	121	23	89	27
		Women	131	14	124	30	127	18	126	21	95	22
>90° (% time)		Men	15	8	6	2	12	9	8	7	2	2
		Women	9	4	11	6	12	8	11	7	3	4
Within-minute variation (°)[a]		Men	75	18	62	2	68	15	65	17	42	10
		Women	73	16	75	21	70	20	68	16	47	11
Between-minute variation (°)[a]		Men	29	5	29	6	28	6	26	9	18	8
		Women	31	5	26	12	29	7	27	7	19	8
Median velocity (°/s)		Men	51.6	16	59.9	13	47.0	17	52.5	19	47.0	24
		Women	59.9	20	66.4	25	43.2	14	50.8	13	48.4	25
Number of recordings		Men	5	-	6	-	17	-	14	-	12	-
		Women	7	-	8	-	17	-	15	-	16	-
Mean recording duration (minutes)		Men	88	-	95	-	158	-	130	-	52	-
		Women	158	-	51	-	149	-	102	-	55	-

[a]The measures of variation were calculated from the 5th-95th interpercentile range for each minute

***Table 6**. **Continued.** Task exposure matrix for postures and movements of the head and right upper arm for each sex. Data is displayed for the 7 tasks that constitute the work. Additionally, data is shown for total work and pause. For flexion/extension, positive angles denote flexion and negative angles extension. [SD=standard deviation]*

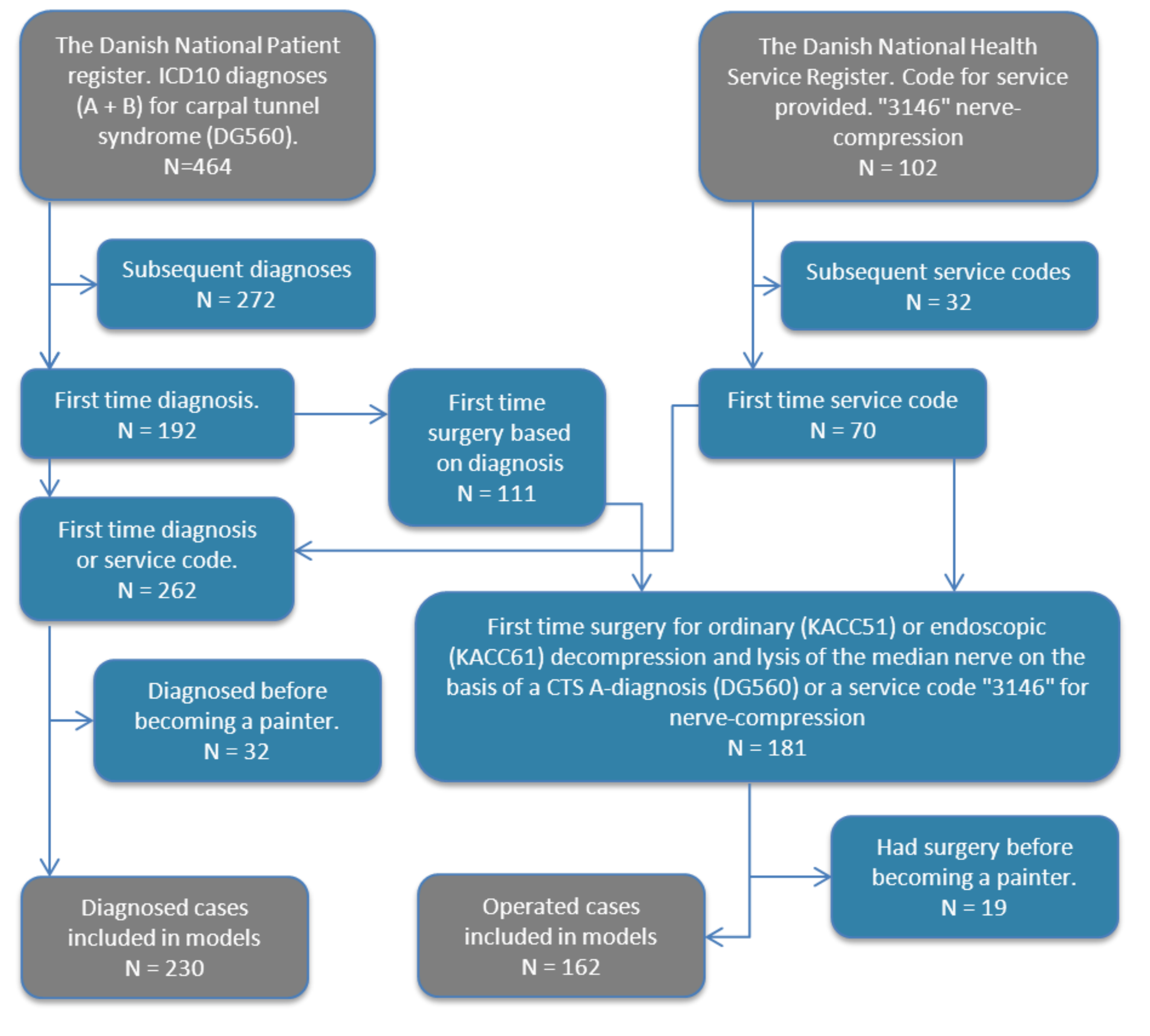
			Driving		Other		Total work		Pause	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
Head inclination										
Percentile (°)	1st	Men	-16	10	-38	13	-45	14	-22	14
		Women	-18	4	-40	12	-47	12	-21	14
	50th	Men	15	14	19	15	17	14	16	13
		Women	13	9	17	11	17	8	13	12
	90th	Men	44	14	51	14	52	13	43	15
		Women	40	11	51	11	53	10	36	14
Right upper arm elevation										
99th percentile (°)		Men	90	17	121	25	127	13	90	27
		Women	94	23	126	15	128	15	84	23
>90° (% time)		Men	4	8	6	5	9	4	2	3
		Women	3	6	10	11	9	5	1	1
Within-minute variation (°)[a]		Men	39	11	59	20	62	10	32	11
		Women	46	16	62	13	62	11	30	15
Between-minute variation (°)[a]		Men	18	6	28	6	31	5	20	7
		Women	19	3	30	5	32	6	22	7
Median velocity (°/s)		Men	33.6	12	38.5	18	42.9	12	17.0	19
		Women	29.4	11	43.9	18	43.7	13	10.1	9
Number of recordings		Men	9	-	10	-	25	-	24	-
		Women	8	-	15	-	25	-	25	-
Mean recording duration (minutes)		Men	51	-	124	-	313	-	52	-
		Women	41	-	78	-	318	-	61	-

[a]The measures of variation were calculated from the 5th-95th interpercentile range for each minute

7.8 CTS cases (Paper III)

From the DNPR and the NHSR, cases of CTS outcomes of first time diagnoses and first time CTS-surgery respectively were identified for use in the analyses (Figure 7).

***Figure 7**. Flow chart of CTS diagnoses (1994-2011) and CTS-surgery (1996-2011) in the painters cohort (N=9364)*



7.9 CTS prevalence and incidence rate in cohort (Paper III)

In the total population the female/male prevalence ratios of CTS diagnoses and surgery were 2.6 and 2.8 respectively, and the corresponding incidence rate ratios were 3.6 and 4.0 (Table 7).

Table 7. *Study population characteristics based on register information. Total and for questionnaire responders.*

	Diagnoses of carpal tunnel syndrome*				Surgery for carpal tunnel syndrome*			
	Number of cases	Risk Time (years)	Incidence rate per 10.000 years	Study period preva-lence (%)	Number of cases	Risk Time (years)	Incidence rate per 10.000 years	Study period preva-lence (%)
Total (n=9364)	230	104308	22.05	2.5	162	104792	15.46	1.7
Men (n=6236)	101	76694	13.17	1.6	66	76969	8.57	1.1
Women (n=3128)	129	27614	46.72	4.1	96	27823	34.50	3.1
Questionnaire re-sponders (n=4957)	162	60993	26.56	3.3	116	61332	18.91	2.3
Men (n=3124)	71	43310	16.39	2.3	48	43509	11.03	1.5
Women (n=1833)	91	17683	51.46	5.0	68	17823	38.15	3.7

*Records from the Danish National Patient Register and the Danish National Health Register during the study period 1994-2011.

7.10 Exposure response relationship (Paper III)

7.10.1 Median velocity for flexion extension of the wrist

Table 8 shows the results of survival analyses from models with the wrist velocity as the measure of exposure intensity and work duration in the previous year, sex, age, BMI, fractures near the wrist, comorbidity and questionnaire response status as the other explaining factors. We omitted seniority as a covariate due to a high correlation with age (see below). Owing to missing values among questionnaire responders, mainly to the task distribution question, the analysis of questionnaire responders (model 2) is based on 4198 observations (44.8% of the total material). Crude incidence rate ratios (IRR) were similar to the IRR's in the models with mutual adjustment except for sex and age. However, when these two covariates were mutually adjusted, their IRRs became similar to those of the other models. This pattern was expected and reflects the composition of the material with men being older and having less CTS than women.

Increasing median velocity was associated with a statistically significantly higher IRR for both CTS diagnoses and surgery. The IRR estimates were quite stable across models, approximately 1.30 per 1 °/s, with the exception of model 2a (men only) where it was a little lower (1.22) and not statistically significant. Work proportion in the previous year had no significant effects.

The effect of sex was highly statistically significant with IRR estimates for women versus men ranging from 4.6-4.9 for CTS diagnoses and 6.0-6.1 for CTS operations. The IRR increased significantly with increasing age. The IRR estimates increased with BMI, wrist fractures and co-morbidity. The estimates of BMI effects were of similar size and statistically significant for men and women and for the two CTS outcomes. The IRR estimates of wrist fractures and comorbidity were less stable with scattered statistically significant effects. There seemed to be different effects of wrist-near fractures and comorbidity for men and women (models 2a and 2b).

The IRR estimates for questionnaire responders were higher than for non-responders (model 1 and model 3).

The IRR estimates of work proportion, sex and age were similar for the total material (model 3) and for questionnaire responders (model 2).

__Table 8__. Incidence rate ratios (IRR) of CTS diagnoses and CTS surgery. Models with median velocity of flexion/extension of the right wrist, work proportion, sex, age, BMI, fractures near the wrist, comorbidity and questionnaire response as explaining factors, de-

	Median velocity of flexion/ extension of the wrist (Per 1 °/s)	Work proportion previous year	Sex (women/ men)	Age (per 10 years)	Body mass index (per 5 units)	Fracture near the wrist (yes/no)	Co-morbidity (yes/no)	Question-naire response (yes/no)
Model 1. Crude associations (n=4420)								
CTS diagnosis								
IRR	1.35[1]	0.75[2]	3.55[2]	0.99[2]	1,25[1]	1.47[1]	1.37[1]	1.69[2]
95 % CI	1.10-1.64	0.54-1.05	2.73-4.60	0.90-1.09	1.09-1.43	0.97-2.24	0.96-1.96	1.27-2.25
P-value	**0.0035**	**0.049**	**<0.0001-**	0.89	**0.0012**	0.070	0.083	**0.0003**
CTS surgery								
IRR	1.39	0.75	4.02	1.02	1.29	1.22	1.45	1,79
95 % CI	1.10-1.76	0.50-1.11	2.94-5,50	0.91-1.14	1.11-1.50	0.72-2.07	0.96-2.20	1.27-2.51
P-value	**0.0051**	0.15	**<0.0001**	0.79	**0.0009**	0.56	0.079	**0.0009**
Model 2. Mutually adjusted associations. All questionnaire responders (n=4198)								
CTS diagnosis								
IRR	1.29	.80	4.64	1.25	1.27	1.57	1.40	-
95 % CI	1.07-1.56	0.52-1.22	3.21-6.71	1.08-1.44	1.12-1.45	1.03-2.40	0.97-2.03	-
P-value	**0.0085**	0.29	**<0.0001**	**0.0030**	**0.0002**	**0.035**	0.075	-
CTS surgery								
IRR	1.32	0.86	6.03	1.41	1.32	1.33	1.42	-
95 % CI	1.06-1.65	0.52-1.41	3.89-9.34	1.18-1.67	1.14-1.52	0.78-2.25	0.92-2.19	-
P-value	**0.014**	0.55	**<0.0001**	**0.0001**	**0.0002**	0.30	0.11	-
Model 2a. Mutually adjusted associations. Male questionnaire responders (n=2596)								
CTS diagnosis								
IRR	1.22	0.72	-	1.13	1.25	2.12	1.21	-
95 % CI	0.86-1.72	0.39-1.33	-	0.91-1.41	1.01-1.55	1.21-3.70	0.72-2.04	-
P-value	0.27	0.29	-	0.26	**0.0394**	**0.0085**	0.48	-
CTS surgery								
IRR	1.30	0.80	-	1.33	1.33	1.47	1.10	-
95 % CI	0.85-1.99	0.38-1.68	-	1.00-1.76	1.06-1.66	0.69-3.13	0.58-2.08	-
P-value	0.23	0.56	-	**0.048**	**0.015**	0.33	0.77	-
Model 2b. Mutually adjusted associations. Female questionnaire responders (n=1602)								
CTS diagnosis								
IRR	1.32	0.80	-	1.34	1.30	1.13	1.60	-
95 % CI	1.05-1.64	0.44-1.46	-	1.11-1.62	1.11-1.53	0.58-2.17	0.96-2.69	-
P-value	**0.016**	0.47	-	**0.0026**	**0.0015**	0.73	0.073	-
CTS surgery								
IRR	1.32	0.85	-	1.45	1.31	1.22	1.78	-
95 % CI	1.02-1.71	0.43-1.71	-	1.16-1.80	1.09-1.58	0.58-2.55	1.003-3.16	-
P-value	**0.037**	0.65	-	**0.0010**	**0.0041**	0.60	**0.049**	-
Model 3. Mutually adjusted associations. Total cohort (n=9364)								
CTS diagnosis								
IRR	-	0.84	4.63	1.25	-	-	-	1.44
95 % CI	-	0.59-1.20	3.41-6.29	1.11-1.41	-	-	-	1.08-1.92
P-value	-	0.34	**<0.0001**	**0.0002**	-	-	-	0.0013
CTS surgery								
IRR	-	0.86	5.71	1.34	-	-	-	1.47
95 % CI	-	0.57-1.38	3.95-8.24	1.16-1.54	-	-	-	1.04-2.09
P-value	-	0.87	**<0.0001**	**<0.0001**	-	-	-	0.028

Bold highlights statistically significant IRRs ($p<0.05$). 1. Questionnaire responders (n=4420 for wrist velocity, n=4773 for BMI, n=4825 for fractures near the wrist, n=4787 for co-morbidity). 2. Total material (n=9364)

7.10.2 Mean power frequency

Table 9 shows the results from the models with the other two exposure intensity variables (MPF and non-neutral postures), analysed in the same models as in Table 8. In Table 9 the results for the other covariates were omitted justified by a high similarity to the results presented in Table 8. Increasing MPF was associated with statistically significantly higher IRR estimates for both CTS outcomes. An increase in MPF by 0.01 Hz resulted in IRRs ranging from 1.30 to 1.40. The effect was statistically significant in all models except model 2a (male questionnaire responders).

7.10.3 Non-neutral postures

Combined non-neutral postures did not have any statistically significant effects, either on CTS diagnoses or operations.

Table 9*. Incidence rate ratios of CTS diagnoses and CTS surgery. Models with mean power frequency and non-neutral postures for the right wrist, work proportion, sex, age, BMI, fractures near the wrist, comorbidity and questionnaire response as explaining factors, depending on the model. Same models as in Table 8. The results for explaining factors other than the two exposure intensity measures were similar to those of Table 8 and therefore omitted from this table.*

	Mean power frequency (Hz) (per units of 0.010 Hz*)	Non-neutral wrist postures (% time)
Model 1. Crude associations (n=4420)		
CTS diagnosis		
IRR	1.38	.98
95 % CI	1.12-1.70	0.88-1.08
P-value	**0.0026**	0.67
CTS surgery		
IRR	1.33	0.97
95 % CI	1.04-1.71	0.86-1.10
P-value	**0.025**	0.62
Model 2. Mutually adjusted associations. All questionnaire responders (n=4198)		
CTS diagnosis		
IRR	1.39	0.98
95 % CI	1.13-1.71	0.88-1.08
P-value	**0.0022**	0.66
CTS surgery		
IRR	1.34	0.97
95 % CI	1.04-1.72	0.86-1.09
P-value	**0.023**	0.59
Model 2a. Mutually adjusted associations. Male questionnaire responders (n=2596)		
CTS diagnosis		
IRR	1.33	1.07
95 % CI	0.57-3.13	0.94-1.21
P-value	0.51	0.31
CTS surgery		
IRR	1.30	1.02
95 % CI	0.46-3.66	0.87-1.20
P-value	0.62	0.80
Model 2b. Mutually adjusted associations. Female questionnaire responders (n=1602)		
CTS diagnosis		
IRR	1.40	0.86
95 % CI	1.13-1.74	0.74-1.002
P-value	**0.0024**	0.053
CTS surgery		
IRR	1.35	0.91
95 % CI	1.04-1.75	0.77-1.08
P-value	**0.025**	0.28

* Almost equal to the interquartile range.
Bold highlights statistically significant IRRs ($p<0.05$)

All of the models presented in Table 8 and Table 9 were also examined using work proportions accumulated over two and five years instead of only the previous year. The results of these analyses showed very similar effect estimates and confidence limits as the analyses with work proportion in the previous year only.

There were no statistically significant interaction terms between exposure intensity or duration variables and sex. Neither were the interaction terms between the variables of exposure intensity and duration.

Seniority was not included in the models (Tables 8 and 9) since it had a very high correlation (0.83) with age. The correlations were similar among men (0.82) and women (0.77). When seniority was included in the models instead of age, the effects of seniority were insignificant and the estimates were close to 1. When age and seniority were included in the same model, the effect was statistically significant for age but not for seniority in all models except model 3 for wrist velocity diagnoses (P=0.04). The estimates increased for age and decreased for seniority when both variables were included in the models.

Sensitivity analyses were applied, limiting the outcome to diagnoses and surgery listed only in the DNPR, slightly increased the IRRs and level of significance (data not shown).

8 Discussion

This thesis aims to establish a precise exposure assessment examining sex differences in load, force, task distributions, postures and movements of the upper extremity using a systematic approach. Also, it explores whether an exposure-response relationship is present between exposures of the wrist and CTS, and to what degree this will be influenced by sex. The first study showed that the relative muscular load was significantly higher in women compared to men and these objectively measured differences corresponded well to subjective ratings of physical exertion. Minimal sex differences were found in exerted force, with men using more force than women. In the second study, self-reported task distributions only showed minor sex differences and no significant differences were found between the sexes in upper extremity postures and movements. The third study found an exposure-response relationship between median wrist velocity and CTS, and MPF and CTS, but not between non-neutral postures and CTS. There was no significant effect of work proportion accumulated over 1, 2 or 5 years prior to a CTS event. These results imply that un-accumulated median velocity and MPF may be work related risk factors of CTS.

The risk of CTS was significantly different between men and women with comparable exposures. However, the effect of the exposure was not modified by sex.

8.1 Methodological considerations

Using the term sex as a common denominator for all properties concerning men and women has not been widely accepted. However, at a recent symposium on gender work and health (OBEL Summer School, Montreal, Canada) there was widespread agreement among international researchers working within the field of WMSDs and sex/gender for the need of an overall term incorporating both sex and gender, since aspects of one or the other are usually mutually influenced. Until such a term has been agreed upon, it should be recommended to clearly define the preconception.

EMG has been used extensively to assess intrinsic exposure in work settings. The quantification of muscular load has traditionally been performed using $\%EMG_{max}$ (173;180-183). However, this measure of relative muscular load does not express the exerted forces being applied during work. For this reason we applied an EMG-to-force calibration comparing a certain level of relative muscular load to absolute forces. It has been argued that the relationship between EMG and forces only can be assumed to be linear in the first 30% of the MVC (184). This did not cause a problem in the present study since the vast majority of monitored tasks did not exceed 30% of EMG_{max} (Paper I). The reported forces in Newtons should be interpreted with caution since the actual forces exerted in a task are composed of more elements than the muscle we measured. It should, however, be considered valid for use when comparing men and women doing identical tasks.

Among questionnaire responders men had higher age and seniority compared to women. Hence different trends of task composition in certain time periods could potentially introduce bias between men and women. To control for this we stratified by age, which also diminished the risk of bias as a result of age difference between responders and non-responders. The retrospective nature of a questionnaire will always per se introduce a potential risk of recall bias. It is well described how demanding tasks are often overestimated in self-reports, especially in combination with complaints (143;147;149;150). We assumed that any potential recall bias would be equal among sexes in the respective age groups, which would still allow for valid sex comparisons of task distributions (Paper II). Constructing the questionnaire we were aware not to use suggestive phrases indicating our interest in CTS, since this can influence symptomatic participants (148).

The methods applied for the technical measurements in this thesis have been shown to be both valid and reliable (156-159;174-176).
The tasks performed during the field measurements were completely random. Because of the relatively few individuals in each group (25 males and 25 females) this resulted in some tasks having less than the recommended minimum of five recordings (174). These tasks were pooled together in the task "other". The optimal strategy would have been to keep doing measurements until the desired number had been acquired, but that was beyond the re-

sources of the study. Duration and occurrence of tasks in the measurements were self-reported using a log book, a method which has been criticised for being imprecise (185). In order to adjust for potential overflow we trimmed the measurements of each task by two minutes at each end. Only minor changes occurred as a consequence of this, indicating an overall precise reporting.

Both the technical measurements and CTS case definitions were assessed using recommended valid methods, the resulting data in the TEMs and JEMs, as well as the CTS diagnoses, can be considered generic, which enables comparisons with others studies evaluating the potential effect of postures and movements on CTS using the same or equally valid and reliable methods. The need for similar designs is highlighted by several authors, arguing that this will allow a more valid pooling of data (100;186;187).

The scope of the study was to have an individually assessed task distribution (Paper II) as a prerequisite for being included in the exposure response analyses (Paper III). For these reasons only current members of the PUD, who we could contact, were included in the cohort. This introduces the possibility of a potential healthy worker bias if individuals that are more susceptible to CTS have left the profession as a result of their disorder. However, the prevalence and incidence rates reported in our study resemble those reported by others (80;88;91;138;188). This indicates that many have continued working as house painters despite CTS. Unfortunately we had no information on profession changes due to CTS. Atroshi et al. (61) reported a CTS incidence rate of 18.2 for men and 42.8 for women (per 10.000 person years) in the general population. In comparison, we found 16.4 in men and 51.5 in women. These results could indicate healthy worker bias at least for men. Painters with CTS who had left the profession before our investigation will contribute to an attenuation of prevalence and incidence rates, and potentially bias effect estimates toward unity.

There is a large variation in the quality of studies that have investigated CTS. Many studies are restricted by design using cross sectional or case control methodology. Even though some studies have used a prospective design (9;62;94;100;103;113;122;127;133) van Rijn et al. (79) demonstrated in a review that the quality of studies had not improved over two decades. Out of

37 studies included in a meta-analysis investigating the association between exposures in the work place and CTS, Barcenilla et al. (92) reported 28 cross-sectional studies, 5 case-control studies and 4 cohort studies. Even though exposure was assessed retrospectively in our design, regarding outcome we followed the cohort in the Danish registers which are of high quality and generally thought of as valid. Therefore the registration of CTS incidences was prospective.

A potential limitation of our study is that cases had had their outcome before rating their task distribution which is the basis for the individual exposure assessment. This enables the risk of differential misclassification, since it is well established that persons with complaints have higher reporting of demanding tasks (143;147;149). However, comparing the task distribution of CTS cases with that of the remaining responders did not show a consistent increasing pattern in the most demanding tasks (Paper III). Also, it is unlikely that questionnaire responders would be able to know which tasks had been measured to be the most demanding in terms of wrist velocity, MPF and non-neutral postures and, finally, the cases in the cohort were scattered over the entire study period which meant that the majority of cases would most likely have been symptom free at the time of the questionnaire.

The drawback of this study is that it has been very costly both in terms of time and money. This dilemma has been the focus of some researchers who compared expenditures of exposure assessments using inclinometry or direct observation in data collection and data analyses, respectively. Inclinometers performed consistently better than observation in both data steps, but inclinometry is an expensive way of collecting data (189-191). Novel biomechanical systems that can be applied to the participants, who then wear it for a period of time and return it by postal mail, may revolutionise physical exposure assessments if used as a common inclinometry and goniometry set-up (192-194).

Likewise, substantial expenses were spent on the printing, postal distribution and scanning of the questionnaires. Online distribution of the questionnaire could have been a cost efficient alternative. This possibility was discussed with the PUD who advised against it, since it was their experience that only half of their members were confident internet users.

It has been argued that too many resources may be used compared to what may be gained (142;169), while others advocate for a precise task based exposure assessment as possible, due to a potentially high risk of misclassification when only using job titles (20).
Patil et al. (81) showed a higher CTS prevalence among dairy workers doing one kind of task compared to dairy workers doing other tasks. This illustrates the need for precise task based exposure assessments even within the same profession.
Some have suggested that increasing precision for exposures on a continuous scale leads to a decrease in observed sex differences in the workplace, insinuating that most observed sex differences in occupational settings are caused by an imprecise exposure assessment (93;141). In contrast to this belief we have, along with others (8), shown that sex differences in CTS persist in spite of a precise exposure assessment on a continuous scale.

Many studies have only reported exposures in hours per day or week, spent on the movements, postures or tasks in question, per profession (79). This methodology only gives an assessment of frequency and not intensity. Therefore, when applied to individuals working in different professions, with different tasks, or even with different techniques or strategies this may introduce a bias resulting in attenuation of estimates. Different thresholds of exposures between studies (i.e. > 1 hour, > 2 hours or > 3 hours) and reporting on a categorical scale adds to the inter-study heterogeneity and may contribute to some of the observed differences (36). To solve these challenges a common standard has been proposed by the ACGIH using the AL and TLV based on hand activity level and normalized peak force (94;98;122-124;195). However, studies using very wide categories or dichotomisation when analysing sex differences may also be at risk of interclass confounding, for example if there is an offset between women and men within a given exposure category (33).
As well as using subjectively assessed distributions of common tasks as a measure of frequency, we applied a precise biomechanical measurement for each of the tasks described, reported on a continuous scale (Paper II). Hence, a precise continuous measure of exposure intensity was included, adding to the overall precision of the exposure assessment.

As described earlier, CTS case definitions vary in epidemiologic research. Similar to other recent studies (61) the CTS cases included in our study were physician diagnosed. We did not have any data on whether or not cases had an electro diagnostic test (EDT) made, but every case had a clinical interview and a physical examination, sufficient for decision regarding treatment. In Denmark it is recommended that EDT is performed prior to treatment but in very obvious cases this might be omitted. Atroshi et al. (96) demonstrated differences in CTS prevalence in the general population depending on which diagnostic criteria were used. For symptoms and EDT measurement it was 4.9 %; physical examination and symptoms 3.8 %; and physical examination, symptoms and electro physical examination 2.7 %. Others have shown similar results (74;133). Some have hypothesised that symptoms and physical examinations may capture other aspects of CTS than EDT, due to different mechanisms (63;196;197). If the majority of our cases did not have an EDT this could potentially introduce an over-reporting of CTS, but in Paper III we found CTS prevalence and incidence rates comparable to those reported by others (61;74;80;88;91;96;133;138;188). This indicates we used precise diagnostic criteria. The use of symptoms and physical examination, complemented by a high quality EDT, is recommended in the literature also for epidemiological research (63;64;77;91).

Differences between CTS incidence rates and prevalence in different populations may, besides different case definitions and exposure measurements, partly reflect variations in underlying non-occupational risk factors i.e. comorbidities. A recent meta-analysis observed a significant heterogeneity among studies (92). In a meta-regression analysis they identified several significant determinants, such as study design, case definitions, risk of bias score and country.

In a review by van Rijn et al. (79) attention was directed to the discrepancy between the proportion of studies that had only used questionnaire data to estimate CTS (14 %) and studies that had only used questionnaires to assess the exposure (66 %). They argue that the heterogeneity between studies therefore should be higher for the exposure assessments than for the CTS ascertainment. This is supported by the meta-analysis of Barcenilla et al. (92) that showed a significant heterogeneity in exposure assessment methods between studies.

In the present study, several Danish registers were used to supply information on diagnoses of CTS, surgery for CTS, work proportion and pregnancies. Data reported to both the DNPR and NHSR is primarily used to settle payments with health care providers and may have limitations. An underreporting of 5 % was reported in a 2008 estimate of surgeries to the DNPR. In relation to our study this should be considered as non-differential misclassification which may attenuate findings using CTS surgery as outcome. The service code used for classifying CTS in the NHSR is not unique. We performed sensitivity analysis, excluding cases from the NHSR. This revealed higher estimates, indicating some misclassification. However, since the misclassification would be non-differential, the NHSR was kept in the model.

Most studies that have investigated occupational risk factors for CTS have not included sex specific analyses. Knowing that female sex is a well-established risk factor for CTS, sex should at least be included as a confounder.
It has, in recent years, been suggested to include sex stratification in the analyses of exposure response relationships instead of only adjusting for sex (37;198-200). However this recommendation may primarily be applicable in studies where there is uncertainty as to whether or not men and women are equally exposed or in studies where there are large sex differences in exposure. Comparable exposures between sexes assessed by objective and valid methods should, in most settings, allow for simple adjustment. On the other hand, it can be argued that estimates of potential covariates may be influenced in different ways depending on sex (123;141;201;202). This effect could be masked if only a multivariate model is used. Stratified analyses will potentially highlight differences which can be associated to specific physiological or psychosocial features of the sexes. We included sex-stratified analyses for exposure response relationship (Paper III), and these resulted in higher estimates in women for age and co-morbidities whereas men had higher estimates for fractures near the wrist. Multilevel and cluster analyses have also been suggested as suitable methods for comparing sex specific risks (203).

A Poisson log linear regression model was applied in the investigation of possible exposure response relations (Paper III). The Poisson model was chosen since it is recommended for regression analyses of time dependent continuous variables. Some have proposed to classify subjects in groups by anthropometry instead of sex (10;54). Won et al. (54) found stronger differences between anthropometric groups than sex. A possible way to test this hypothesis would be to apply a latent class analysis (204). This could potentially direct attention to the most influential effect modifiers.

Seniority was not included as a confounder in the final multivariate model (Paper III). It was initially included but it had a high correlation with age, was insignificant and changed direction after adjustment for age. Also, based on the literature, we did not find any indication to keep it in the model since seniority is not a well-established risk factor for CTS. This fits the reports of only recent exposure having an effect on CTS (78).
Household chores and leisure time activity have been hypothesized to influence the observed sex difference in prevalence of WMSD (4;8;199;205), although with some conflicting evidence regarding CTS (201). We did not include any variables regarding this issue. From our questionnaire data we learnt that the distributions of household tasks were very traditional among the house-painters with women doing more kitchen and cleaning chores and men doing more versatile tasks. In leisure time activities we did not find any systematic difference between men and women. In order to incorporate these aspects into the exposure assessments we would have needed precise biomechanical measurements of all the tasks in question. This would have proved too demanding in terms of time and finances.

8.2 Discussion of findings

Since the measurements of loads and forces were done in a laboratory setup, the concentrated nature could suggest that the values obtained might be higher than what would be expected in real world settings. Hence, in order to add this to the constructed JEMs and TEMs it would be necessary to weigh these measurements by potential differences between goniometry and inclinometry data obtained in the two settings.
The relative differences in muscular load could partly explain why women could be more vulnerable than men, doing identical tasks at the same extrinsic physical exposure. Nordander et al. (8) investigated sex differences in workers with identical tasks. They found similar postures and movements but higher relative muscular load in women compared to men, and a higher prevalence of MSDs in women. They suggested that the higher risk of MSD in women could

be partly explained by the higher relative muscular activity. Assuming that individuals are more susceptible to MSDs if a threshold of relative muscular load is exceeded this could be a reasonable explanation for sex differences in MSDs being caused by higher relative loads in women compared to men. Some have suggested that anthropometrics or the design of tools (which are usually designed to fit the average man) may be part of the explanation why MSDs are more prevalent among women than men (4;29;54;206). This hypothesis assumes that men and women exert different levels of force on the tools. In contrast, our results show that men and women apply the same degree of force when performing common house painter tasks, indicating that the tools are not causing the sex difference in MSDs.
We found a linear relationship between Borg CR10 ratings and relative muscular load (Paper I). The results in figure 5 indicate that the difference between sexes is more pronounced in the more strenuous tasks. We also found that women experience a higher relative load when applying the same absolute force in a given task. Therefore, if a task is considered high load, women will use a higher proportion of their EMG_{max} compared to men, and the higher the load, the bigger the difference in perceived exertion. Burt et al. (123)have showed that high peak work ratings on Borg CR10 were a risk factor of CTS and others too have used it for exposure assessment (36). This indicates that the Borg CR10 could be used as a subjective measure of differences in perceived physical exertion.

Though statistically significant, only minor sex differences were found in self-reported task distributions, and the age stratified patterns within each task were similar for men and women. This does not support the reports of women having a more strenuous task composition as a result of sex segregation, leading to the development of MSDs (6;8;20;24;25;199;207). If anything, we found the men do more of the strenuous tasks.

Our results in Paper III suggest that exposure intensity rather than exposure duration might have an impact on the development of WMSDs. However, since the individual measure of intensity is based on a lifetime estimate of task distributions, corresponding to a constant frequency of tasks, we cannot make any conclusions regarding limited periods of high intensity work leading up to a CTS incident. In practice this would require a prospective study design with regular registrations of task frequency. Some have used company data as a way to collect information on worker exposure (208;209). However, with the exception of some professions with clearly defined and monotonous tasks (i.e. truck drivers and baggage handlers), the level of detail in this data is often limited to work time (152) or other information comparable to what can be required from the Danish registers (210-213). Therefore they will primarily be a measure of the work duration. Among house painters, a substantial difference in task intensity would be expected between individuals working on a fixed scheme being paid by the hour, and workers doing piecework contracts. The latter usually work faster in order to earn more money, so having a higher proportion of these workers in a population will most likely increase exposure variables related to working speed. From our questionnaire data we know that approximately 20 % of the population was employed on piecework contracts most of the time. Since the data collection in this study was carried out during a period of recession, it was our experience that many workers had gone from piecework contracts to being paid by the hour. This may have influenced some respondents' composition of work tasks, but since they were asked about a typical week in their work life, we do not think this has influenced the data to a greater extent. However, the technical measurements were not done on any workers doing piecework contracts. This may have biased the results, primarily due to the different work pace. Hence the external validity may have been reduced, but sex differences in postures and movements should not be influenced since the potential bias must be assumed to be equal among men and women.

Multivariate analyses in Paper III showed a significant effect of exposure intensity but not duration in terms of work proportion. This led us to conclude that a potential decline in high risk exposure, as a preventive measure, could result in a decreased risk of CTS. Shiri et al. (78) supports this notion by only reporting a risk of CTS for exposure in the most recent job. In spite of having only 45% of the potential material available for the full analyses (Model 2 in Tables 8 and 9), very stable estimates of IRR were found when comparing the effects of the covariates (sex, age and work proportion) to the full cohort. Thus, we do not think that non-response would likely have introduced a selection bias.

Excessive extension was the main contributor to non-neutral postures in our measurements. The rationale for this is to position the hand so the flexor muscles can exert more power without being affected by active insufficiency. This wrist position has been shown to produce elevated carpal tunnel pressures which can potentially lead to CTS (214-216) but in contrast to some studies (36;217) we did not find any effect of non-neutral postures on CTS. This could possibly be explained by the definition of non-neutral postures (Paper II) where our limits for deviations were in the high end of what is reported in normative material (218). However, our findings are supported by other studies that found no relationship between non-neutral postures and increased risk of MSDs (38;42;92;126).
Another explanation could be the choice of exposure measure. Direct measurements are usually considered superior to self-reports (142) and Spielholz et al. (145) showed a substantial difference between self-reports and direct measurements of extreme posture duration. This discrepancy offers an explanation for the inconsistency in reported findings.

We did not conduct any specific investigation on the hypothesis of women having an overall lower threshold for reporting complaints. Nathan et al. (102) have postulated that CTS symptoms are perceived more finely by women than men but using the recommended diagnostic criteria for CTS as we did in our study, the effects of this should be very limited because of objective examinations. This is supported by Mondelli et al. (16) who found similar results for men and women in clinical and electro-physical severity of CTS.

No modifying effect of sex was found for the exposure intensity and exposure duration variables on CTS outcomes. This indicates that men and women are equally affected by the exposure. In a study of work related risk factors for musculoskeletal symptoms, Hooftman et al. (33) found a modifying effect of sex. Contrary to their own expectations they found a higher vulnerability to exposures in men. However, they could not offer any explanation for this finding and although the study was prospective, both the exposure and the outcome were subjectively assessed in a questionnaire.
The results of the Poisson regression are reported on a logarithmic IRR-scale. When back-transformed the incidence rate at zero exposure will determine the increase in incidence rates. Hence, as a result of higher incidence rates due

to the independent effect of sex, women will have steeper incidence rate curves than men. This corresponds with the observed incidence rates by tertiles, and similar patterns are found for both diagnoses and surgery for the exposure variables median velocity and MPF (figures 8 and 9). However, this sex difference in incidence rate curves is only observed, and supplementary analyses testing for statistical significance using additive models should be considered. The differences in exposure-response curves between men and women may be interpreted as a difference in vulnerability in response to effects of physical exposures on CTS. These results may, however, result from the nature of the multiplicative model we used and no firm conclusion can therefore be made.

***Figure 8**. Observed incidence rates of CTS-outcomes by tertiles of wrist velocity (grey and black columns) with estimated incidence rates overlaid. Estimates are based on crude associations (Model 1 in table 8)*

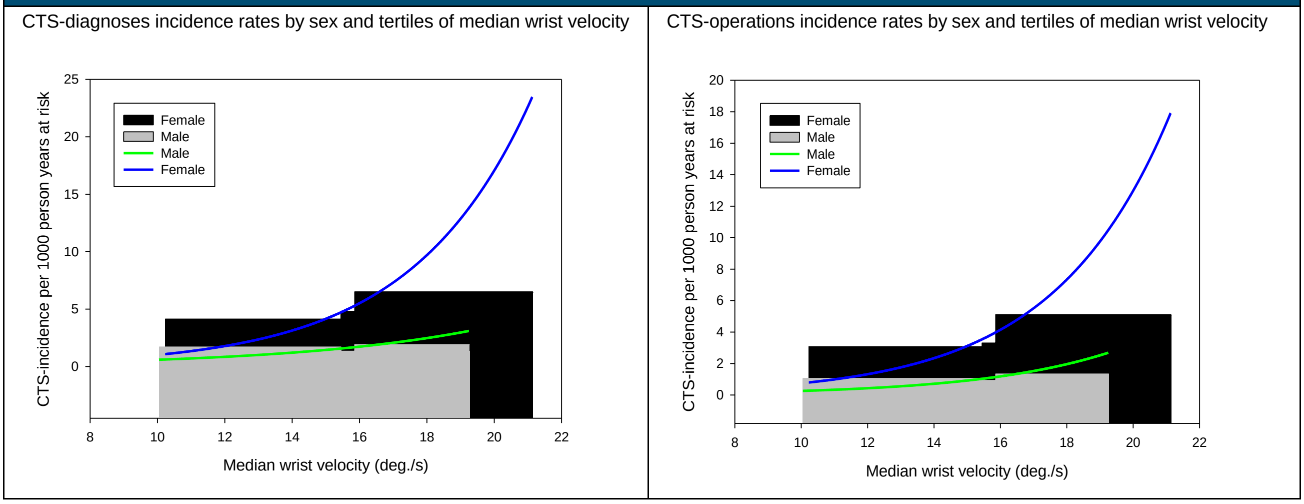
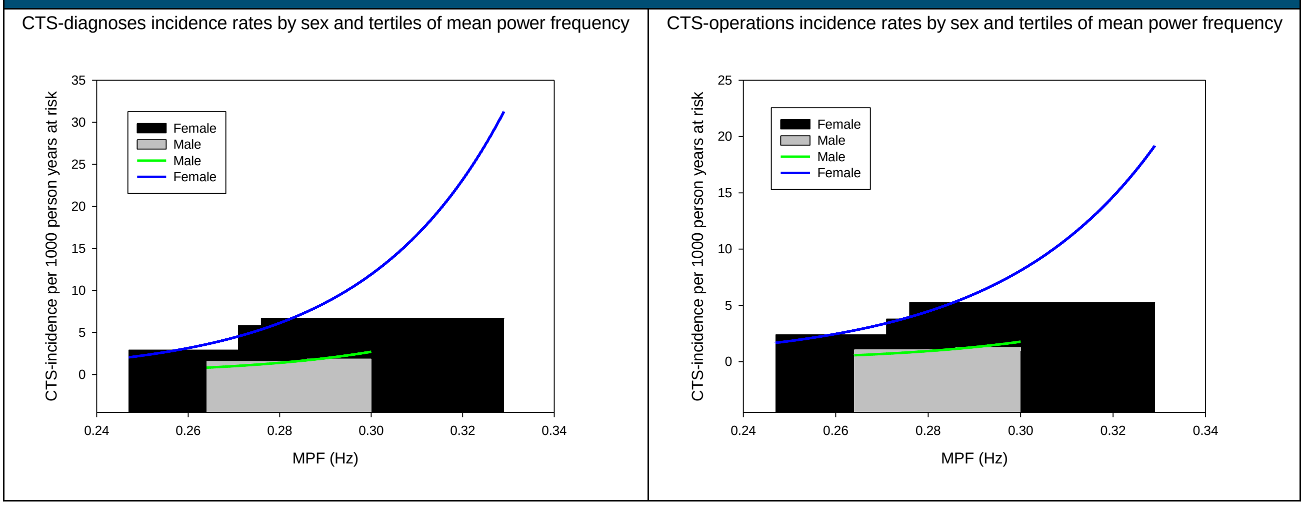


***Figure 9**. Observed incidence rates of CTS-outcomes by tertiles of MPF (grey and black columns) with estimated rates overlaid. Estimates are based on crude associations (Model 1 in Table9)*



Many studies have claimed that sex differences in WMSDs may be caused in part by uncontrolled sex differences in exposure (32;83;207;219). In contrast to this belief we have by means of a precise sex specific exposure assessment, shown that an increased risk of a common work-related upper extremity disorder in women compared to men persists, despite a comparable physical exposure.

Our main strength in this study is the use of a physician-diagnosed outcome reported independently from the technical assessed exposure.

Based on current results, individual or sex specific exposure assessment should be recommended in order to minimise misclassification caused by uncontrolled differences in tasks.

8.3 Clinical relevance of findings

Results obtained from a task-based exposure assessment may prove useful in developing preventive measures due to its ability to distinguish between the impacts of potential risk factors within a profession. Given that the absolute incidence rates for women increased at a steeper rate with increasing exposures than the incidence rates for men did, a larger potential for prevention would exist for women than for men.

Since our population was limited to Danish house painters, interpretations of results should be made with caution if applied to other professions.

9 Conclusions

Within the Danish house painting trade, women had a higher relative load than men, without exerting more force. Only minor sex differences were found in task distributions and postures and movements of the upper extremity. A systematic approach resulted in a precise assessment of physical exposure especially for intensity and duration and somewhat for frequency. Information on physician diagnosed CTS and surgery for CTS was obtained from valid Danish registers. The IRR estimates for CTS increased significantly for wrist velocity, and for repetitive use of the wrist, but not for non-neutral postures. Female sex had a significantly higher risk of CTS, but sex did not have any modifying effect on the exposure variables in the applied models. However, it is not clear to what extent these results reflect that women may be more vulnerable to these exposures than men and to what extent they reflect the basic assumptions of the statistical model used for the analyses.

10 Perspectives

When trying to reduce risk factors for CTS in the workplace, caution is given regarding reduction of one hazardous element of a task without paying attention to the interrelated elements that constitute that task. Instead the focus should be on reducing time spent on high risk tasks (8;220).

Due to a relatively low response proportion in the questionnaire, the use of covariates in the full models was limited to half of the potential population. This complete data analysis does not necessarily introduce bias if the data is assumed to be missing completely at random. However, the missing data reduces the potential power of the analysis. A common way to resolve this is to perform imputations. Imputation of missing data can be performed in several ways. A very basic method is to impute the missing values with the mean of the population or subsets thereof. More sophisticated methods can also be applied, for example multiple imputations by chained equations. In this method numerous multiple imputed datasets have a regression analysis performed and the estimates of these are then pooled, taking advantage of the variation that has been generated (221). This method could be tested on our data to see if some of the insignificant results would change if the statistical power was increased.

The extensive data collection we obtained on Danish house painters, will allow a similar study on shoulder disorders as the one performed on CTS. Svendsen et al. (170) have previously showed that there are significant differences in postures and movements of the upper arm between the tasks of Danish male house painters. A large exposure contrast between tasks will increase the possibility of detecting any sex difference in a TEM, assuming the same contrast is present among female house painters. Since shoulder disorders are the most commonly reported WMSD to the NBII by both male and female house painters this would be very relevant and sex specific risk factors could potentially be detected, allowing for prevention in both men and women.

As part of the SHARM-project we obtained full work day measurements of postures and movements in the upper extremity in several other professions believed to have either repetitive or strenuous tasks (Table 10). These measurements were made in collaboration with Annett Dalbøge from the Danish Ramazzini Centre, Department of Occupational Medicine, Aarhus University Hospital, Aarhus, Denmark.
As displayed in Table 10 we obtained measurements on both men and women in additional six professions. For all the professions listed we also have information on diagnoses and surgery from the DNPR. Therefore we will be able to investigate if sex differences in prevalence and incidence rates of CTS within these professions are comparable to those observed in Danish house painters. Prevalence and incidence rates should also be determined for the professions where we only have information on one of the sexes. However, we do not have any questionnaire information on these supplementary professions. Therefore we will have to rely on register information on job titles, age, sex, seniority and work proportions. Regarding the work day measurements for these additional professions we do not have detailed information on separate tasks performed. If testing for an exposure response relationship we would therefore be restricted to use a JEM instead of a TEM.

As recommended in the thesis tests for sex differences can only be perform if the task distribution can be assumed to be comparable between men and women. Therefor samples should be made testing for homogeneity in tasks.

Table 10. Listing of the number of individuals in each profession who have had whole day measurements made using goniometry and inclinometry.

	Women	Men	Total
House painter	25	25	50
Laundry worker	13	10	23
Car mechanic	-	11	11
Paper industry worker	10	10	20
Electronics worker	11	10	21
Truck driver	-	10	10
Construction worker	-	10	10
Storage worker	10	10	20
Postal worker	10	10	20
Kitchen assistant	10	-	10
Health care assistant	10	-	10
Scaffolder	-	10	10
Bank clerk	-	10	10
Dustman	-	11	11
Carpenter	-	10	10
Insulator	-	10	10
Plumber	-	11	11
Gardener	9	11	20
Smith	-	12	12
Nurse	10	-	10
Bricklayer	-	10	10
Wood industry worker	-	10	10
Farmer	-	10	10
Total number of full day measurements	**118**	**221**	**339**

Figures 10 and 11 illustrate the distribution of professions for the exposure variables median velocity and MPF. As we reported in Paper II it shows that male and female house painters have very similar exposures even compared to other professions. It would be very interesting to see if the effect of the exposure variables on CTS is consistent across professions.

Figure 10. *Median velocity (°/s) of the right wrist. Distribution of professions.*

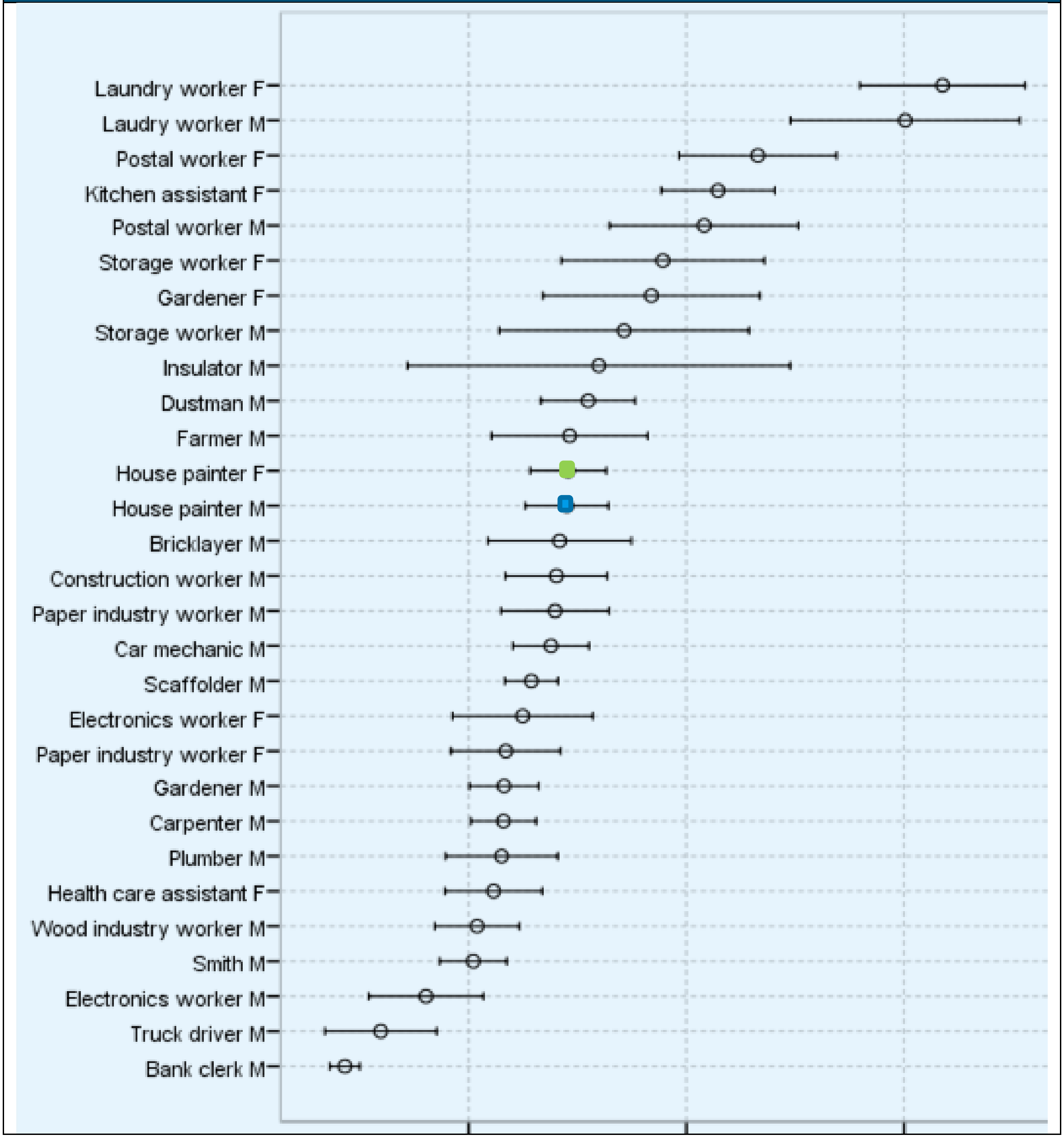
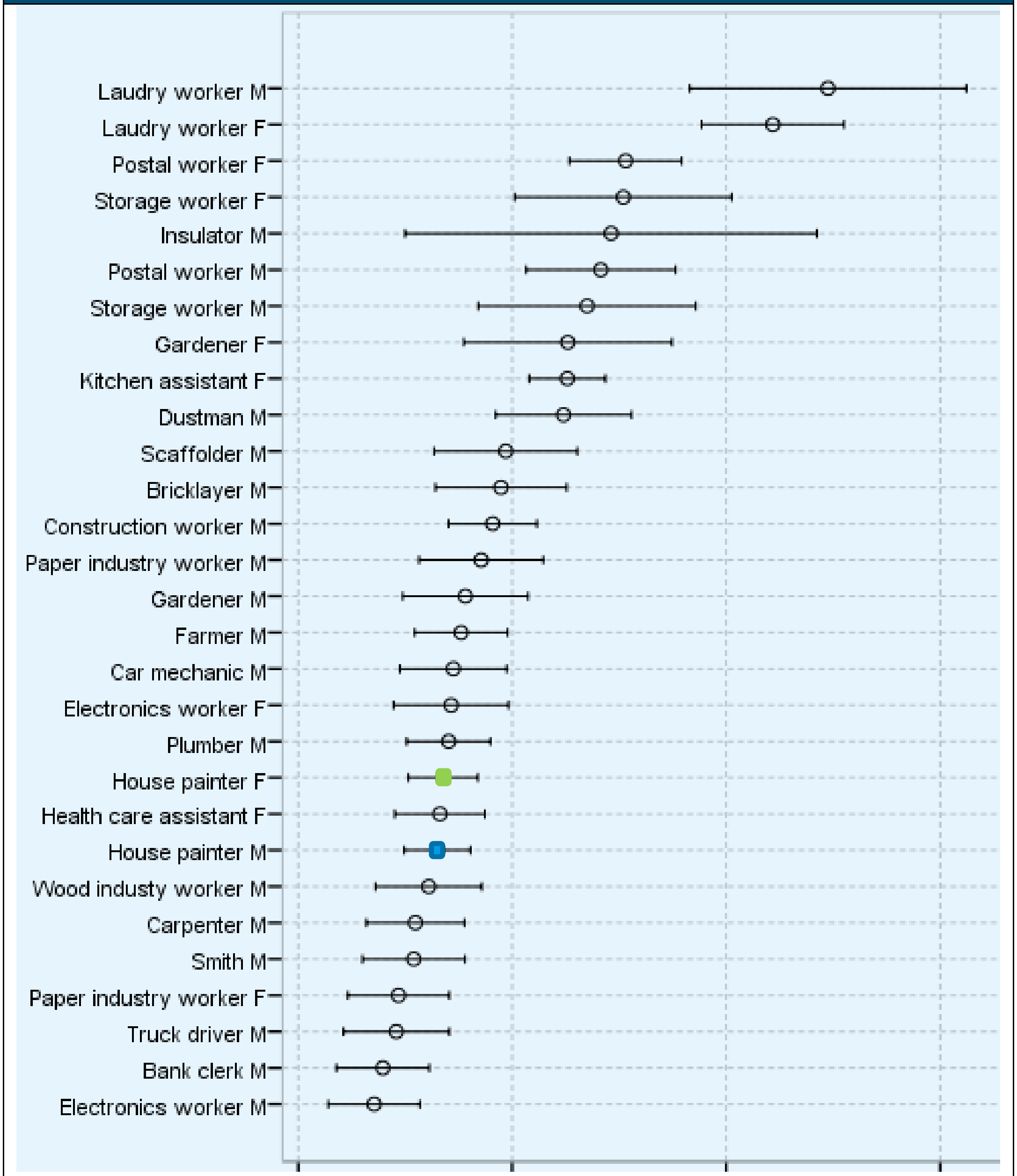


Figure 11. *MPF (Hz) of the right wrist. Distribution of exposure in professions .*



11 Summary

Many studies have showed a higher prevalence and incidence rate of work-related musculoskeletal disorders in women compared to men, especially in the upper extremity. However, many studies have relied on self-reported exposure and/or outcome and in many cases the exposure assessments have had several methodological deficiencies.

In this study a systematic approach was applied trying to establish a precise sex specific exposure assessment examining sex differences in relative muscular load, exerted forces, perceived exertion, task distributions and postures and movements of the upper extremity. For the data collection we used electromyography, Borg CR10 scale, questionnaires, Danish registers, goniometry and inclinometry. The Danish house painters profession was studied since it has a high proportion of women (one third) and a supposedly homogeneous task distribution.

Postures movements and task distributions were combined in a task exposure matrix which was used to explore the exposure response relationship between exposures of the wrist and physician diagnosed carpal tunnel syndrome (CTS) obtained from the Danish registers. This was tested for modification by sex. The relative muscular load was significantly higher in women compared to men and these objectively measured differences corresponded well to subjective ratings of physical exertion. Minimal sex differences were found in exerted force, by men using more force than women. Self-reported task distributions only showed minor sex differences and no significant differences were found between the sexes in upper extremity postures and movements. An exposure-response relationship was found between median wrist velocity and CTS, and mean power frequency and CTS, but not between non-neutral postures and CTS. There was no significant effect of work proportion accumulated over 1, 2 or 5 years prior to a CTS event. These results imply that un-accumulated median velocity and MPF may be work related risk factors of CTS.

The risk of CTS was significantly higher in women than in men with comparable exposures, but the effect of the exposure was not modified by sex.

However, it is not clear to what extent these results reflect that women may be more vulnerable to these exposures than men and to what extent they reflect the basic assumptions of the statistical model used for the analyses.

12 Dansk resumé (Danish summary)

Mange undersøgelser har vist en højere prævalens og incidensrate af arbejdsrelaterede sygdomme i det øvre bevægeapparat hos kvinder end hos mænd. Mange undersøgelser har anvendt selvrapporterede vurderinger af eksponering og/eller udfald, som har haft flere metodologiske mangler.

I denne undersøgelse blev en systematisk tilgang brugt til at etablere en præcis kønsspecifik eksponeringsvurdering til brug i analyserne af kønsforskelle i relativ muskulær belastning, anvendt styrke, subjektivt bedømt anstrengelse, opgave fordeling og arbejdsstillinger og bevægelser i overekstremiteterne. Til dataindsamlingen anvendtes elektromyografi, Borg CR10 skala, spørgeskema, danske registre, gonio- og inklinometri. Danske malere blev undersøgt, da de har en høj andel af kvinder og angiveligt en homogen opgavefordeling. Arbejdsstillinger, bevægelser og opgavesammensætninger blev kombineret i en opgave-eksponeringsmatrice, som blev brugt til at undersøge dosis-respons sammenhængen mellem eksponeringsvariable for håndleddet og læge diagnosticeret karpaltunnelsyndrom (KTS) rapporteret til de danske registre. Dette blev testet for modifikation af køn. Den relative muskulære belastning var signifikant højere hos kvinder end hos mænd, og dette korrelerede med subjektive vurderinger af fysisk anstrengelse. Der blev fundet minimale kønsforskelle i anvendt styrke, med højeste værdier hos mænd. Der blev kun fundet mindre kønsforskelle i opgavefordelingen, og der blev ikke fundet nogen signifikante forskelle mellem kønnene for arbejdsstillinger og bevægelser i det øvre bevægeapparat. Der blev fundet en dosis-respons sammenhæng mellem middelhastigheden for håndleddet og KTS, og et mål for repetivitet og KTS, men ikke mellem ikke-neutrale håndledsstillinger og KTS. Der var ingen signifikant effekt af kumuleret belastning mellem 1 og 5 år forud for et KTS tilfælde. Disse resultater antyder, at middelhastighed og repetivitet kan være arbejdsrelaterede risikofaktorer for KTS uden at være kumuleret over længere tid. Risikoen for KTS var signifikant højere hos kvinder end hos mænd med sammenlignelige eksponeringer, men effekten af eksponeringen blev ikke modificeret af køn.

Det er imidlertid ikke klart, i hvilket omfang disse resultater afspejler, at kvinder kan være mere sårbare over for disse eksponeringer end mænd, og i hvilket omfang de afspejler de grundlæggende antagelser i den statistiske model, der anvendes til analyserne.

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15 Appendices

Appendix I:	Borg CR-10 scale
Appendix II:	Log-book for biomechanical measurements
Appendix III:	Task- and job exposure matrices
Appendix IV:	SHARM questionnaire (in Danish)

15.1 Appendix I: Borg CR-10 scale

Borg CR10 scale.

Scale	Scale Rating	Perceived exertion	Note
0	Nothing at all		Subjects don´t feel any exertion whatsoever, e.g. no muscle fatigue, no breathlessness or difficulties breathing
0.3			
0.5	Extremely weak	Just noticeable	
0.7			
1	Very weak		Very light. As taking a short walk at your own pace.
1.5			
2	Weak	Light	
2.5			
3	Moderate		Is somewhat but not especially hard. It feels good and not difficult to go on.
4			
5	Strong	Heavy	The work is hard and tiring, but continuing not terribly difficult. The effort and exertion is about half as intense as 'Maximal'
6			
7	Very Strong		Is quite strenuous. Subject can go on, but really have to push himself/herself and are very tired.
8			
9			
10	Extreme strong	Maximal	An extremely strenuous level. For most subjects this is the most strenuous exertion they have ever experienced.

15.2 Appendix II: Log-book for biomechanical measurements

Measurement start time ______ Logbook for ______ Date ______

Driving	Pause	Covering, carrying materials and equipment. Cleaning.	Primary working height	Full leveling	Sanding (by hand)	Sanding (Giraffe drywall sander)	Painting (brush)	Painting (roll)	Hanging wallpaper, glass fibre tissue, glass felt.	Removing wallpaper, glass fibre tissue, glass felt.	Spraying	Other	Task end time
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	Ceiling☐ Wall☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

15.3 Appendix III: Task- and job exposure matrices for the left side

Exposure values for the postures and movements per task/gender, left wrist. Data are shown for the 7 tasks that constitute the work. Additionally data are shown for total work and pauses. For flexion/extension and ulnar/radial deviation positive angles denote flexion and ulnar deviation and negative angles extension and radial deviation. MPF = mean power frequency.

			Full leveling	Sanding (by hand)	Painting (brush)	Painting (roll)	Covering, carrying and cleaning	Driving	Other	Total work	Pause
Flexion/extension											
Percentile (°)	10th	Men	-47 (8)	-54 (10)	-50 (7)	-50 (14)	-42 (12)	-48 (10)	-50 (10)	-49 (8)	-45 (15)
		Women	-52 (15)	-60 (17)	-53 (13)	-52 (11)	-47 (13)	-48 (11)	-48 (9)	-51 (10)	-46 (8)
	50th	Men	-20 (7)	-21 (7)	-20 (8)	-17 (9)	-14 (8)	-22 (12)	-21 (9)	-18 (8)	-15 (10)
		Women	-21 (11)	-27 (14)	-23 (10)	-25 (11)	-19 (9)	-18 (10)	-21 (11)	-21 (10)	-18 (9)
	90th	Men	2 (9)	2 (11)	3 (12)	5 (11)	9 (9)	10 (13)	5 (12)	6 (11)	13 (16)
		Women	6 (9)	0 (14)	6 (13)	3 (14)	7 (9)	6 (9)	7 (11)	8 (11)	12 (14)
	95-5th	Men	64 (7)	76 (11)	70 (10)	70 (11)	74 (16)	73 (12)	70 (12)	74 (6)	73 (18)
		Women	77 (9)	76 (19)	77 (15)	72 (15)	70 (16)	72 (16)	75 (12)	77 (11)	74 (13)
Median velocity (°/s)		Men	11 (4)	10 (3)	10 (4)	12 (8)	10 (3)	9 (4)	9 (4)	9 (4)	6 (5)
		Women	11 (4)	15 (4)	8 (5)	12 (6)	12 (5)	8 (3)	10 (3)	10 (4)	4 (2)
Repetitiveness (MPF; Hz)		Men	.26 (.03)	.23 (.05)	.20 (.04)	.24 (.08)	.23 (.05)	.25 (.05)	.22 (.03)	.22 (.04)	.19 (.05)
		Women	.22 (.03)	.24 (.06)	.20 (.05)	.24 (.06)	.27 (.07)	.26 (.07)	.24 (.03)	.22 (.04)	.18 (.04)
Ulnar/radial deviation											
Percentile (°)	10th	Men	-12 (9)	-22 (5)	-21 (10)	-22 (9)	-16 (7)	-16 (7)	-17 (9)	-21 (9)	-21 (11)
		Women	-16 (7)	-21 (10)	-28 (11)	-22 (10)	-20 (11)	-19 (8)	-23 (9)	-22 (9)	-21 (9)
	50th	Men	0 (7)	-7 (5)	-5 (8)	-7 (8)	-4 (7)	-4 (8)	3 (8)	-5 (8)	-5 (9)
		Women	-2 (5)	-5 (9)	-7 (8)	-5 (8)	-3 (6)	-5 (7)	-4 (9)	-4 (7)	-5 (9)
	90th	Men	18 (5)	6 (5)	12 (10)	9 (10)	11 (8)	10 (9)	12 (8)	11 (9)	9 (9)
		Women	13 (4)	9 (9)	9 (8)	10 (8)	11 (6)	8 (6)	12 (7)	11 (7)	10 (9)
	95-5th	Men	38 (6)	37 (3)	43 (12)	39 (7)	36 (9)	32 (4)	36 (5)	42 (9)	39 (10)
		Women	39 (5)	42 (8)	48 (11)	42 (6)	42 (13)	35 (5)	43 (5)	43 (6)	39 (9)
Median velocity (°/s)		Men	7 (2)	6 (1)	5 (3)	7 (4)	6 (2)	5 (2)	5 (2)	5 (2)	3 (3)
		Women	6 (2)	10 (4)	5 (4)	8 (4)	7 (3)	5 (2)	6 (2)	6 (3)	2 (2)
Repetitiveness (MPF; Hz)		Men	.24 (.02)	.23 (.03)	.21 (.05)	.25 (.07)	.23 (.05)	.28 (.07)	.23 (.04)	.23 (.05)	.20 (.06)
		Women	.24 (.05)	.27 (.06)	.19 (.05)	.25 (.06)	.25 (.07)	.27 (.05)	.23 (.04)	.23 (.05)	.19 (.03)
Number of recordings		Men	5	5	14	13	12	8	10	25	23
		Women	7	8	17	15	16	8	15	25	25
Mean recording duration in minutes		Men	88	102	141	128	49	55	118	280	45
		Women	158	51	149	102	55	41	77	317	61
Left upper arm elevation											
99th percentile (°)		Men	125 (15)	102 (6)	115 (16)	118 (15)	88 (26)	96 (18)	120 (23)	120 (14)	86 (24)
		Women	110 (15)	120 (27)	113 (20)	120 (17)	94 (18)	97 (16)	111 (16)	116 (15)	80 (15)
>90° (% time)		Men	7.6 (5.4)	2.5 (1)	7.9 (7)	10.3 (12)	1.5 (2)	2.4 (3.1)	4.8 (3.5)	6.6 (5.4)	1.7 (3.2)
		Women	3.8 (2.8)	8 (5.9)	5.7 (4.7)	13.4 (13)	2.6 (3.8)	1.7 (1.4)	6.8 (12.3)	5.6 (3.9)	1.1 (2.2)
Within-minute variation (°)		Men	67 (17)	50 (3)	57 (12)	64 (18)	41 (11)	41 (12)	55 (12)	-	33 (15)
		Women	57 (14)	70 (20)	55 (14)	69 (18)	47 (13)	41 (4)	52 (10)	-	26 (9)
Between-minute variation (°)		Men	30 (2)	23 (3)	26 (4)	27 (5)	19 (7)	21 (11)	28 (7)	-	20 (8)
		Women	25 (3)	24 (10)	25 (6)	26 (6)	21 (6)	20 (4)	27 (5)	-	19 (5)
Median velocity (°/s)		Men	42 (12)	44 (10)	36 (15)	45 (21)	41 (19)	32 (13)	31 (12)	35 (11)	18 (19)
		Women	42 (12)	55 (19)	31 (11)	43 (15)	42 (15)	28 (11)	35 (11)	35 (11)	10 (8)

15.4 Appendix IV: SHARM questionnaire (in Danish)

Forord

Dette spørgeskema er en del af projektet SHARM (*shoulder, arm*), der har som formål at undersøge årsager til kønsforskelle i udvikling af bevægeapparatlidelser.

Projektet udføres af en projektgruppe under Arbejds- og miljømedicinsk afdeling på Bispebjerg Hospital. Projektet er finansieret af Arbejdsmiljøforskningsfonden, og gennemføres i samarbejde med Malerforbundet.

Alle oplysninger behandles strengt fortroligt og bruges kun til statistik. Du kan på et hvert tidspunkt trække dig ud af undersøgelsen og få slettet dine oplysninger.
Projektet er godkendt af Datatilsynet.

April 2011

Med venlig hilsen

Thomas Heilskov-Hansen
Cand.scient.san.
ph.d.-stud.

Jane Frølund Thomsen
Overlæge, ph.d.

Sigurd Mikkelsen
Overlæge, dr.med.

Udfyld skemaet med sort eller blå kuglepen

Vi vil bede dig om at udfylde alle spørgsmål og sende skemaet tilbage i vedlagte svarkuvert. Retur-adressen er påtrykt og portoen er betalt.
Der skal kun sættes et kryds i hvert spørgsmål, medmindre der bliver bedt om andet.

Vær venlig at udfylde skemaet tydeligt. Svarene bliver scannet ind på en maskine, så alle tal og kryds skal være nemme at tolke.
Ved eventuelle spørgsmål, kontakt Thomas Heilskov-Hansen på E-mail: than0207@bbh.regionh.dk

	Rigtigt	Forkert
Sæt et tydeligt **kryds**	☐ ☒	☐ ☐ √
Hvis et felt er udfyldt forkert, skraveres den pågældende kasse og krydset sættes i den rigtige kasse.	■ ☒	☒ → ☒
Tal skrives i felterne.	2	1
Tal rettes ved at sætte en streg igennem det forkerte tal og skrive det rigtige tal ovenover.	4	4

Erhvervsstatus og arbejde

1. Hvornår blev du udlært som maler? |__|__|__|__| *(Skriv årstal)*

2. Hvor mange år har du sammenlagt arbejdet som maler?(Inklusiv læretid)
Se bort fra længerevarende perioder med arbejdsløshed, sygdom el. lign. |__|__| *(Skriv antal år)*

Dette spørgsmål besvares kun, hvis du ikke aktuelt arbejder som maler.
3. Hvornår har du sidst arbejdet som maler? ca.|__|__| *(Måned)* |__|__|__|__| *(Årstal)*

4. Hvad er din erhvervsstatus lige nu?
(Sæt kun et kryds)

- ☐ I arbejde som maler ⇨ Gå til næste spørgsmål (Nr. 5)

- ☐ På barselsorlov/forældreorlov
- ☐ Sygemeldt
- ☐ Under revalidering/omskoling
- ☐ Arbejdsløs

⇨ Besvar de følgende spørgsmål ud fra forholdene på din sidste arbejdsplads som maler

- ☐ Folkepensionist
- ☐ Førtidspensionist
- ☐ Efterlønsmodtager
- ☐ Andet

⇨ Gå til spørgsmål nr. 27 side 6

5. Hvad er din normale ugentlige arbejdstid? |__|__| *(Skriv antal timer)*

6. Har du det seneste år haft bi-beskæftigelse som maler ved siden af dit normale arbejde?

Nej ☐

Ja *(skriv antal timer, pr. uge)* |__|__|

3

Samlet vurdering af dit arbejde

7. Hvor fysisk krævende synes du alt i alt dit arbejde er?

Særdeles krævende	Meget krævende	Ret krævende	Noget krævende	Ikke så krævende	Meget lidt krævende
☐	☐	☐	☐	☐	☐

8. Hvor psykisk krævende synes du alt i alt dit arbejde er?

Særdeles krævende	Meget krævende	Ret krævende	Noget krævende	Ikke så krævende	Meget lidt krævende
☐	☐	☐	☐	☐	☐

9. Hvor stor synes du din arbejdsbyrde er?

Særdeles stor	Meget stor	Ret stor	Moderat stor	Ikke så stor	Ret lille
☐	☐	☐	☐	☐	☐

10. Hvor stor indflydelse har du normalt på tilrettelæggelsen og udførelsen af dit arbejde?

Meget stor	Ret stor	Moderat stor	Ikke så stor	Ret lille	Meget lille
☐	☐	☐	☐	☐	☐

11. Hvor stor indflydelse har du normalt på fordelingen af arbejdsopgaver mellem kolleger?

Meget stor	Ret stor	Moderat stor	Ikke så stor	Ret lille	Meget lille
☐	☐	☐	☐	☐	☐

12. Er du alt i alt tilfreds med den måde din arbejdsplads ledes på?

I meget høj grad	I høj grad	I nogen grad	I mindre grad	I ringe grad	I meget ringe grad
☐	☐	☐	☐	☐	☐

13. Er dit arbejde stimulerende, udviklende og engagerende?

I meget høj grad	I høj grad	I nogen grad	I mindre grad	I ringe grad	I meget ringe grad
☐	☐	☐	☐	☐	☐

14. Hvordan er stemningen og det psykiske arbejdsklima på din arbejdsplads?

Meget god	Ret god	Nogenlunde god	Ikke så god	Ret dårlig	Meget dårlig
☐	☐	☐	☐	☐	☐

15. Synes du din arbejdsindsats bliver tilstrækkeligt værdsat?

I meget høj grad	I høj grad	I nogen grad	I mindre grad	I ringe grad	I meget ringe grad
☐	☐	☐	☐	☐	☐

16. Er dit normale daglige arbejde stressende på en ubehagelig måde?

Altid	Næsten altid	Som regel	Ofte	Af og til	Sjældent/aldrig
☐	☐	☐	☐	☐	☐

17. Hvor tilfreds er du alt i alt med dit arbejde?

Meget tilfreds	Ret tilfreds	Tilfreds	Lidt tilfreds	Ret utilfreds	Meget utilfreds
☐	☐	☐	☐	☐	☐

18. Hvor stor en del af din arbejdstid det sidste år har været akkord-arbejde?

Næsten hele tiden	Ca. ¾ af tiden	Ca. halvdelen	Ca. ¼ af tiden	Næsten ingen del af tiden
☐	☐	☐	☐	☐

19. Har du tilstrækkelig med tid og ressourcer til at løse dine arbejdsopgaver tilfredsstillende?

I meget høj grad	I høj grad	I nogen grad	I mindre grad	I ringe grad	I meget ringe grad
☐	☐	☐	☐	☐	☐

20. Hvor hårdt er dit arbejde fysisk, sammenlignet med dine <u>mandlige</u> kolleger?

Meget hårdere	Hårdere	Lige så hårdt	Mindre hårdt	Meget mindre hårdt	Har ingen mandlige kolleger
☐	☐	☐	☐	☐	☐

21. Hvor hårdt er dit arbejde fysisk, sammenlignet med dine <u>kvindelige</u> kolleger?

Meget hårdere	Hårdere	Lige så hårdt	Mindre hårdt	Meget mindre hårdt	Har ingen kvindelige kolleger
☐	☐	☐	☐	☐	☐

22. På en typisk arbejdsdag, hvor stor en del af din samlede arbejdstid arbejder du med en eller begge **<u>albuer</u>** løftet over skulderhøjde?

Under en ½ time	½ time til under 1 time	1 time til under 2 timer	2 timer til under 4 timer	Mindst 4 timer
☐	☐	☐	☐	☐

23. På en typisk arbejdsdag, hvor stor en del af din samlede arbejdstid udfører du de samme bevægelser med arme eller hænder flere gange i minuttet?

Under en ½ time	½ time til under 1 time	1 time til under 2 timer	2 timer til under 4 timer	Mindst 4 timer
☐	☐	☐	☐	☐

6

24. Er følgende redskaber besværlige eller anstrengende for dig at arbejde med? *(Sæt et kryds i hver linje)*

	I meget høj grad	I høj grad	I nogen grad	I mindre grad	Slet ikke
Sprøjte	☐	☐	☐	☐	☐
Rulle	☐	☐	☐	☐	☐
Spartel til fuldspartling	☐	☐	☐	☐	☐
Girafsliber	☐	☐	☐	☐	☐
Håndholdt slibemaskine	☐	☐	☐	☐	☐
Tapet-stripper	☐	☐	☐	☐	☐

25. De følgende spørgsmål drejer sig om, hvordan et eventuelt arm-, skulder- eller håndproblem påvirker din arbejdsevne.
Marker venligst ud for den kategori der bedst beskriver din fysiske formåen i den forløbne uge. Havde du vanskeligt ved:
(Sæt et kryds i hver linje)

	Ikke vanskeligt	Lidt vanskeligt	Noget vanskeligt	Meget vanskeligt	Umuligt
At bruge din sædvanlige fremgangsmåde i dit arbejde?	☐	☐	☐	☐	☐
At udføre dit sædvanlige arbejde pga. smerter i din arm, skulder eller hånd?	☐	☐	☐	☐	☐
At udføre dit arbejde så godt, som du gerne ville?	☐	☐	☐	☐	☐
At bruge så megen tid på dit arbejde som du plejer?	☐	☐	☐	☐	☐

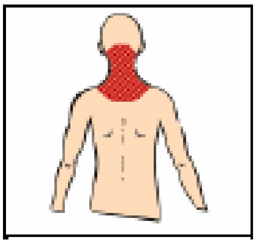
26. Tror du stadig du arbejder som maler om 10 år?*(Sæt gerne flere krydser)*

☐ Ja

☐ Nej, angiv hvilken grund →
- ☐ Efterløn, pension
- ☐ Arbejdet er for hårdt
- ☐ Behov for nye udfordringer
- ☐ Sygdom
- ☐ Andet

7

Dit helbred (Udfyldes både af nuværende og tidligere malere)



Nakken

27. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **nakken**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

28. Hvor længe har du sammenlagt haft smerter eller ubehag i **nakken** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

29. Hvor længe har du sammenlagt været sygemeldt inden for de sidste 12 måneder på grund af smerter eller ubehag i **nakken**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

30. Hvor meget har du alt i alt været generet af smerter eller ubehag i **nakken** inden for de sidste 12 måneder?

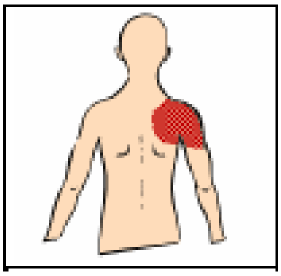
Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

31. Har du haft smerter eller ubehag i **nakken** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte



Højre skulder

32. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **højre skulder**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

33. Hvor længe har du sammenlagt haft smerter eller ubehag i **højre skulder** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

34. Hvor længe har du sammenlagt været sygemeldt inden for de sidste 12 måneder på grund af smerter eller ubehag i **højre skulder**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

35. Hvor meget har du alt i alt været generet af smerter eller ubehag i **højre skulder** inden for de sidste 12 måneder?

Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

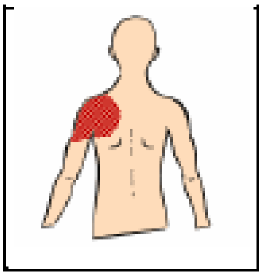
36. Har du haft smerter eller ubehag i **højre skulder** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte

9



Venstre skulder

37. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **venstre skulder**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

38. Hvor længe har du sammenlagt haft smerter eller ubehag i **venstre skulder** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

39. Hvor længe har du sammenlagt været sygemeldt inden for de sidste 12 måneder på grund af smerter eller ubehag i **venstre skulder**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

40. Hvor meget har du alt i alt været generet af smerter eller ubehag i **venstre skulder** inden for de sidste 12 måneder?

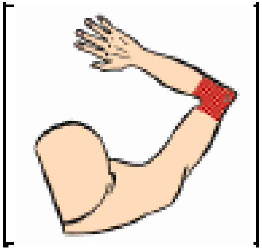
Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

41. Har du haft smerter eller ubehag i **venstre skulder** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte



Højre albue

42. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **højre albue**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

43. Hvor længe har du sammenlagt haft smerter eller ubehag i **højre albue** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

44. Hvor længe har du sammenlagt været sygemeldt inden for de sidste 12 måneder på grund af smerter eller ubehag i **højre albue**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

45. Hvor meget har du alt i alt været generet af smerter eller ubehag i **højre albue** inden for de sidste 12 måneder?

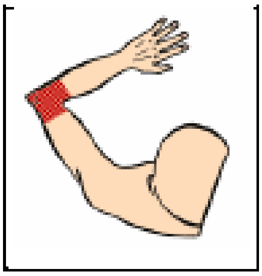
Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

46. Har du haft smerter eller ubehag i **højre albue** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte



Venstre albue

47. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **venstre albue**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

48. Hvor længe har du sammenlagt haft smerter eller ubehag i **venstre albue** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

49. Hvor længe har du sammenlagt været sygemeldt inden for de sidste 12 måneder på grund af smerter eller ubehag i **venstre albue**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

50. Hvor meget har du alt i alt været generet af smerter eller ubehag i **venstre albue** inden for de sidste 12 måneder?

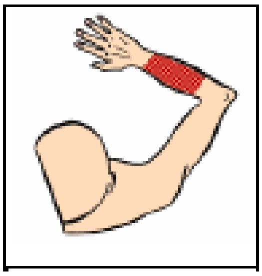
Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

51. Har du haft smerter eller ubehag i **venstre albue** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte



Højre underarm

52. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **højre underarm**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

53. Hvor længe har du sammenlagt haft smerter eller ubehag i **højre underarm** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

54. Hvor længe har du sammenlagt været sygemeldt inden for de sidste 12 måneder på grund af smerter eller ubehag i **højre underarm**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

55. Hvor meget har du alt i alt været generet af smerter eller ubehag i **højre underarm** inden for de sidste 12 måneder?

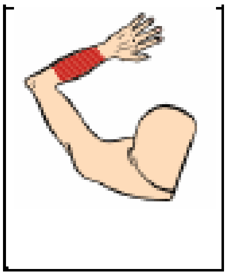
Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

56. Har du haft smerter eller ubehag i **højre underarm** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte



Venstre underarm

57. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **venstre underarm**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

58. Hvor længe har du sammenlagt haft smerter eller ubehag i **venstre underarm** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

59. Hvor længe har du sammenlagt været <u>sygemeldt</u> inden for de sidste 12 måneder på grund af smerter eller ubehag i **venstre underarm**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

60. Hvor meget har du alt i alt været generet af smerter eller ubehag i **venstre underarm** inden for de sidste 12 måneder?

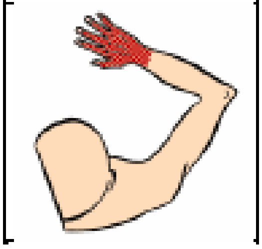
Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

61. Har du haft smerter eller ubehag i **venstre underarm** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte



Højre hånd

62. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **højre hånd**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

63. Hvor længe har du sammenlagt haft smerter eller ubehag i **højre hånd** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

64. Hvor længe har du sammenlagt været sygemeldt inden for de sidste 12 måneder på grund af smerter eller ubehag i **højre hånd**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

65. Hvor meget har du alt i alt været generet af smerter eller ubehag i **højre hånd** inden for de sidste 12 måneder?

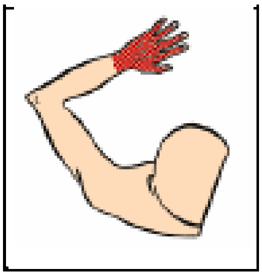
Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

66. Har du haft smerter eller ubehag i **højre hånd** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte



Venstre hånd

67. Har du på noget tidspunkt inden for de sidste 12 måneder haft smerter eller ubehag i **venstre hånd**?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Besvar nedenstående spørgsmål

68. Hvor længe har du sammenlagt haft smerter eller ubehag i **venstre hånd** inden for de sidste 12 måneder?

1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Hver dag
☐	☐	☐	☐	☐

69. Hvor længe har du sammenlagt været **sygemeldt** inden for de sidste 12 måneder på grund af smerter eller ubehag i **venstre hånd**?

0 dage	1-7 dage	8-30 dage	31-90 dage	Mere end 90 dage	Er ikke erhvervsaktiv
☐	☐	☐	☐	☐	☐

70. Hvor meget har du alt i alt været generet af smerter eller ubehag i **venstre hånd** inden for de sidste 12 måneder?

Meget lidt	Lidt	Noget	En hel del	Meget	Særdeles meget
☐	☐	☐	☐	☐	☐

71. Har du haft smerter eller ubehag i **venstre hånd** inden for de seneste 7 dage?

☐ Nej → Gå til spørgsmålene på næste side

☐ Ja → Angiv graden af smerten nedenfor *(Sæt kun ét kryds)*

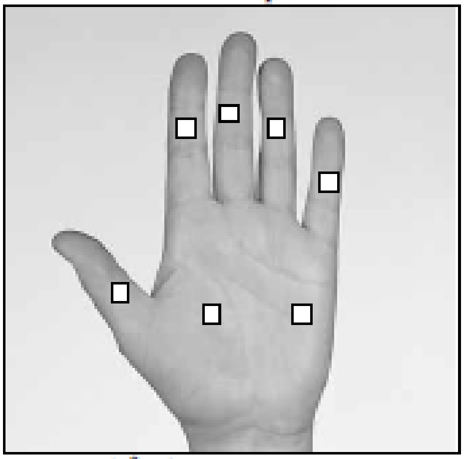
- ☐ 1 = Meget let smerte
- ☐ 2 = Let smerte
- ☐ 3 = Let til moderat smerte
- ☐ 4 = Moderat smerte
- ☐ 5 = Moderat til svær smerte
- ☐ 6 = Svær smerte
- ☐ 7 = Meget svær smerte

72. Har du indenfor de sidste 12 måneder haft snurrende eller prikkende fornemmelser i fingrene? Bortset fra, når du har siddet eller ligget forkert med armene.

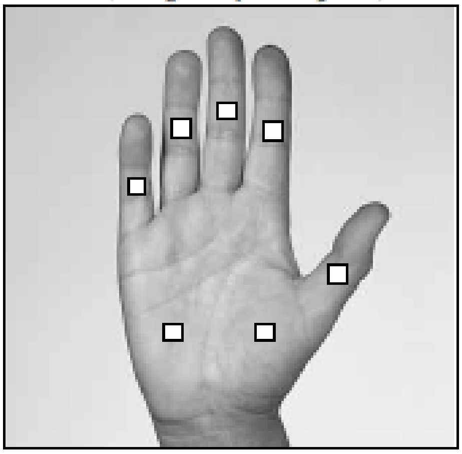
(Sæt et kryds ud for hver hånd)

	Venstre hånd	Højre hånd
Nej	☐	☐
Sjældent	☐	☐
Mindst 1 gang om måneden	☐	☐
Mindst 1 gang om ugen	☐	☐
Dagligt	☐	☐

73. Dette spørgsmål besvares kun, hvis du har haft snurrende eller prikkende fornemmelser i hænderne inden for de sidste 12 måneder? Sæt kryds i kasserne på figuren svarende til hvor du har oplevet snurrende eller prikkende fornemmelser *(Sæt gerne flere krydser)*



Venstre hånd



Højre hånd

74. Vurder venligst, hvordan din evne til at udføre følgende handlinger har været i den forløbne uge, ved at markere under det svar der passer bedst.

	Ikke vanskeligt	Lidt vanskeligt	Noget vanskeligt	Meget vanskeligt	Umuligt
1. Åbne et (marmelade)glas med stramt låg.	☐	☐	☐	☐	☐
2. Udføre tungt husarbejde (fx vaske vægge, vaske gulve).	☐	☐	☐	☐	☐
3. Bære en indkøbspose eller en mappe.	☐	☐	☐	☐	☐
4. Vaske dig selv på ryggen.	☐	☐	☐	☐	☐
5. Bruge en kniv til at skære mad ud.	☐	☐	☐	☐	☐
6. Fritidsaktiviteter, som sender en vis kraft eller stød gennem din arm, skulder eller hånd (f.eks. golf, slag med hammer, tennis, osv.)	☐	☐	☐	☐	☐

75. Hvor *vanskeligt* har det været for dig i den forløbne uge, at omgås familie, venner, naboer og grupper pga. din arm, skulder eller hånd?

Slet ikke	Lidt	En del	Temmelig meget	Virkelig meget
☐	☐	☐	☐	☐

76. Har du i den forløbne uge været hæmmet i at udføre dit arbejde eller andre gøremål pga. din arm, skulder eller hånd?

Slet ikke hæmmet	Lidt hæmmet	En del hæmmet	Meget hæmmet	Ude af stand til
☐	☐	☐	☐	☐

77. Vær venlig at angive sværhedsgraden af følgende symptomer i den forløbne uge.

	Ingen	Lidt	En del	Svær	Ekstrem
Smerte i din arm, skulder eller hånd.	☐	☐	☐	☐	☐
Prikken i din arm, skulder eller hånd	☐	☐	☐	☐	☐

78. Hvor vanskeligt har det i den forløbne uge været for dig, at sove pga. smerter i din arm, skulder eller hånd?

Ikke vanskeligt	Lidt vanskeligt	Noget vanskeligt	Meget vanskeligt	Så vanskeligt at det forhindrer mig i at sove
☐	☐	☐	☐	☐

79. Har du indenfor de sidste 12 måneder modtaget behandling i nakke, skulder, arm eller hånd? (Fx kiropraktor, fysioterapeut eller massør)
(Sæt ét kryds i hver linje)

	Nej	Ja
Nakken	☐	☐
Højre skulder	☐	☐
Venstre skulder	☐	☐
Højre albue	☐	☐
Venstre albue	☐	☐
Højre underarm	☐	☐
Venstre underarm	☐	☐
Højre hånd/håndled	☐	☐
Venstre hånd/håndled	☐	☐

80. Har du nogen af disse sygdomme? *(Sæt ét kryds i hver linje)*

	Nej	Ja
For højt eller for lavt stofskifte (sygdom i skjoldbruskkirtlen)	☐	☐
Diabetes (sukkersyge)	☐	☐
Leddegigt	☐	☐
Urinsyregigt	☐	☐
Bindevævslidelse	☐	☐
Psoriasis	☐	☐
Håndeksem	☐	☐

Malerarbejde, baggrund og levevaner

81. Dette spørgsmål vedrører kun dit arbejde efter 1990.
Spørgsmålet er lidt svært. Prøv så godt som muligt at få timerne til at passe.
Du skal angive, hvor mange timer om ugen du i gennemsnit har arbejdet med forskellige arbejdsopgaver.
Start med at skrive "0" ud for de arbejdsfunktioner du ikke har haft.
Fordel så resten, så det svarer til det samlede antal timer på en typisk arbejdsuge.
(Du kan eventuelt regne timerne sammen på et stykke kladdepapir, inden du skriver dem ind i skemaet)

	Angiv antal hele timer per opgave, på en uge *(Under ½ time tæller som 0, over ½ time tæller som 1)* Gennemsnit per uge
Nedtagning af tapet	ca.|__|__| timer om ugen
Fuld-spartling	ca.|__|__| timer om ugen
Slibning (håndholdt værktøj – ikke giraf)	ca.|__|__| timer om ugen
Slibning (giraf)	ca.|__|__| timer om ugen
Malearbejde (pensel)	ca.|__|__| timer om ugen
Malearbejde (rulle)	ca.|__|__| timer om ugen
Sprøjtearbejde	ca.|__|__| timer om ugen
Opsætning af væv, filt eller tapet	ca.|__|__| timer om ugen
Afdækning, bæring af materialer og udstyr, samt oprydning og rengøring	ca.|__|__| timer om ugen
Pauser	ca.|__|__| timer om ugen
Kørsel	ca.|__|__| timer om ugen
Andet	ca.|__|__| timer om ugen
	I alt |__|__| timer om ugen

20

82. Tænk igen på dit arbejde som maler efter 1990. Hvor anstrengende har det generelt været for dine arme? Se først på de sproglige beskrivelser, og sæt derefter *et* kryds ud for det tal der passer bedst.

☐	0	Overhovedet ingen		→ "Overhovedet ingen" betyder at du ikke føler nogen som helst anstrengelse f.eks. ingen muskeltræthed, ingen forpustelse eller åndenød.
☐	0,3			
☐	0,5	Ekstremt svag	Knapt mærkbar	
☐	0,7			
☐	1	Meget svag		→ "Meget svag" er en meget let anstrengelse.
☐	1,5			
☐	2	Svag	Let	
☐	2,5			
☐	3	Moderat		→ "Moderat" er noget, men ikke særlig anstrengende. Det føles godt, og det er ikke svært at fortsætte.
☐	4			
☐	5	Stærk	Tung	→ "Stærk". Arbejdet er anstrengende og trættende, men du har ingen større vanskeligheder med at fortsætte. Anstrengelsen er cirka halvt så stærk som "Maksimal"
☐	6			
☐	7	Meget stærk		→ "Meget stærk" er en meget kraftig anstrengelse. Du er i stand til at fortsætte, men du må virkelig presse dig selv og føler dig meget træt.
☐	8			
☐	9			
☐	10	Ekstremt stærk	"Maksimal"	→ "Ekstremt stærk" – "Maksimal" er et ekstremt højt niveau. For de fleste mennesker er dette det mest anstrengende de nogensinde har oplevet i deres liv.
☐	11			
☐	•	Absolut maksimum	Højest mulige	

83. Hvor stor en del af dit arbejdsliv som maler efter 1990 har bestået af...
(Sæt et kryds i hver linje)

	Næsten hele tiden	Ca. ¾ af tiden	Ca. halvdelen	Ca. ¼ af tiden	Næsten ingen del af tiden
Nybyg?	☐	☐	☐	☐	☐
Reparation?	☐	☐	☐	☐	☐
Flyttelejligheder?	☐	☐	☐	☐	☐
Andet?	☐	☐	☐	☐	☐

84. Har du nogensinde været udsat for en sportsskade, en ulykke, slag eller fald, der har medført smerter i mere end tre måneder i …

(sæt ét kryds i hver linje)

	Nej/Ved ikke	Ja	Ca. årstal
Nakken?	☐	☐	|_|_|_|_|
Højre skulder?	☐	☐	|_|_|_|_|
Venstre skulder?	☐	☐	|_|_|_|_|
Højre albue?	☐	☐	|_|_|_|_|
Venstre albue?	☐	☐	|_|_|_|_|
Højre underarm?	☐	☐	|_|_|_|_|
Venstre underarm?	☐	☐	|_|_|_|_|
Højre hånd/håndled?	☐	☐	|_|_|_|_|
Venstre hånd/håndled?	☐	☐	|_|_|_|_|

85. Har du nogensinde vedvarende skiftet arbejde, arbejdsopgaver eller arbejdsmetoder på grund af problemer i …

(Sæt ét kryds i hver linje)

	Nej/Ved ikke	Ja	Ca. årstal
Nakken?	☐	☐	|_|_|_|_|
Højre skulder?	☐	☐	|_|_|_|_|
Venstre skulder?	☐	☐	|_|_|_|_|
Højre albue?	☐	☐	|_|_|_|_|
Venstre albue?	☐	☐	|_|_|_|_|
Højre underarm?	☐	☐	|_|_|_|_|
Venstre underarm?	☐	☐	|_|_|_|_|
Højre hånd/håndled?	☐	☐	|_|_|_|_|
Venstre hånd/håndled?	☐	☐	|_|_|_|_|

86. Hvordan synes du dit helbred er alt i alt? *(Sæt kun ét kryds)*

Fremragende	Vældig godt	Godt	Mindre godt	Dårligt
☐	☐	☐	☐	☐

87. Er du nogensinde blevet opereret for snurren og prikken i fingrene (karpaltunnelsyndrom)? *(Sæt gerne flere krydser)*

			Ca. årstal
☐ Nej			
☐ Ja →	☐ I højre hånd	→	|_|_|_|_|
	☐ I venstre hånd	→	|_|_|_|_|
	☐ I begge hænder	→	|_|_|_|_|

88. Er du nogensinde blevet opereret i …

(Sæt ét kryds i hver linje)

	Nej	Ja	Ca. årstal
Nakken?	☐	☐	|_|_|_|_|
Højre skulder?	☐	☐	|_|_|_|_|
Venstre skulder?	☐	☐	|_|_|_|_|
Højre albue?	☐	☐	|_|_|_|_|
Venstre albue?	☐	☐	|_|_|_|_|
Højre underarm?	☐	☐	|_|_|_|_|
Venstre underarm?	☐	☐	|_|_|_|_|
Højre hånd/håndled? *(Se bort fra operation for karpaltunnelsyndrom)*	☐	☐	|_|_|_|_|
Venstre hånd/håndled? *(Se bort fra operation for karpaltunnelsyndrom)*	☐	☐	|_|_|_|_|

89. Har du nogensinde haft knoglebrud ved håndleddet?

	Ca. årstal
☐ Nej	
☐ Ja, højre	|_|_|_|_|
☐ Ja, venstre	|_|_|_|_|

90. Højde, vægt, køn og alder:

Hvor høj er du (uden sko)?	|__|__|__| cm
Hvad vejer du (uden tøj)?	|__|__|__| kg.
Køn?	Kvinde ☐ Mand ☐
Hvornår er du født?	*(Dag)* |__|__| *(Måned)* |__|__| *(Årstal)* |__|__|__|__|

91. Er du venstre- eller højrehåndet?

☐ Venstre
☐ Højre
☐ Bruger begge hænder lige godt

92. Har du hjemmeboende børn?

	1	2	3	4 eller flere
☐ Nej				
☐ Ja, antal i alt →	☐	☐	☐	☐

93. Er du gift/samlevende?

☐ Nej
☐ Ja

94. Har du på noget tidspunkt taget/tager du hormonholdige piller f.eks. prævention (P-piller), hormonbehandling i forbindelse med menopausen, eller i forbindelse med kunstig befrugtning?

☐ Nej
☐ Ja, angiv antal hele år → \|__\|__\|

95. Har du inden for de sidste 4 uger taget smertestillende medicin på grund af smerter i nakke, skuldre, arme eller hænder?

☐ Nej
☐ Ja, angiv hyppighed →
- ☐ Dagligt
- ☐ Flere gange om ugen
- ☐ Flere gange om måneden
- ☐ En enkelt gang

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96. Ryger du?

☐ Nej, har aldrig røget

☐ Nej, men har tidligere røget. Angiv venligst ↘

☐ Ja, angiv venligst ↘

☐ Cigaretter	→ Antal om dagen	|_|_|	Antal år	|_|_|
☐ Cerutter	→ Antal om dagen	|_|_|	Antal år	|_|_|
☐ Cigarer	→ Antal om dagen	|_|_|	Antal år	|_|_|
☐ Pibe	→ Gram tobak om <u>ugen</u>	|_|_|	Antal år	|_|_|

97. Hvor mange timer <u>om ugen</u> bruger du på huslige gøremål?

(Antal timer pr. uge)

\|_\|_\|

98. Hvem udfører følgende opgaver i din husholdning?

(sæt ét kryds i hver linje)

	Altid mig	For det meste mig	Deler ligeligt med min samlever	For det meste min samlever	Altid min samlever	En tredje person	Udføres ikke
Laver mad	☐	☐	☐	☐	☐	☐	☐
Vasker tøj	☐	☐	☐	☐	☐	☐	☐
Foretager daglige indkøb	☐	☐	☐	☐	☐	☐	☐
Gør rent i boligen	☐	☐	☐	☐	☐	☐	☐
Bringer børn i institution	☐	☐	☐	☐	☐	☐	☐
Henter børn i institution	☐	☐	☐	☐	☐	☐	☐
Passer børn ved sygdom	☐	☐	☐	☐	☐	☐	☐
Vedligeholder bil, cykler osv.	☐	☐	☐	☐	☐	☐	☐
Laver havearbejde	☐	☐	☐	☐	☐	☐	☐
Laver små-reparationer hjemme	☐	☐	☐	☐	☐	☐	☐

Fritid

99. Anfør din fysiske aktivitet i fritiden indenfor det sidste år, herunder transport på cykel eller gå-ben til og fra arbejde.

- ☐ Næsten helt fysisk passiv eller let fysisk aktiv i mindre end 2 timer pr. uge
- ☐ Let fysisk aktivitet fra 2-4 timer pr. uge
- ☐ Let fysisk aktivitet i mere end 4 timer pr. uge eller mere anstrengende fysisk aktivitet i 2-4 timer pr. uge
- ☐ Mere anstrengende fysisk aktivitet i mere end 4 timer eller regelmæssig hård træning og evt. konkurrencer flere gange pr. uge

100. Har du dyrket en eller flere af nedenstående sportsgrene i mindst 2 timer om ugen?
(sæt ét kryds i hver linje, og skriv antal år, hvis ja)

	Nej	Ja		ca. antal år
Håndbold	☐	☐	→	_|_|_
Svømning	☐	☐	→	_|_|_
Badminton, tennis eller squash	☐	☐	→	_|_|_
Roning	☐	☐	→	_|_|_
Styrketræning, vægtløftning	☐	☐	→	_|_|_
Boksning	☐	☐	→	_|_|_
Anden skulder/armbelastende sportsgren	☐	☐	→	_|_|_
Hvis ja, hvilken: ____________________				

Spørgeskemaet lægges i den medfølgende svarkuvert og returneres. Portoen er betalt.

Tak fordi du ville medvirke i undersøgelsen.

16 Original papers

Paper I: Sex differences in muscular load among house painters performing identical work tasks.
(Eur J Appl Physiol 2014;1-11)

Paper II: Sex differences in task distribution and task exposures among Danish house painters: An observational study combining questionnaire data with biomechanical measurements.
(PLoS One. 2014 Nov 3;9(11):e110899)

Paper III: Exposure-response relationships between movements and postures of the wrist and carpal tunnel syndrome among male and female house painters: a retrospective cohort study.
(Occup Environ Med. 2016 Jun;73(6):401-8.)

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