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ORIGINAL ARTICLE

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Clinical signs and physical function in neck and upper extremities among elderly female computer users: the NEW study

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Abstract The aim of the study was to present the prevalence of clinical signs and symptoms among female computer users above 45 years, both in a group with self-reported neck/shoulder trouble (NS cases) and in a group without such trouble (NS controls). The hypothesis was that computer users with self-reported neck/shoulder trouble have more clinical findings than those not reporting trouble, and that a corresponding pattern holds true for physical function. In total 42 and 61 questionnaire-defined NS cases and NS controls participated and went through a clinical examination of the neck and upper extremities and five physical function tests: maximal voluntary contraction (MVC) of shoulder elevation, abduction, and handgrip, as well as endurance at 30% MVC shoulder elevation and a physical performance test. Based on clinical signs and symptoms, trapezius myalgia (38%), tension neck syndrome (17%) and cervicalgia (17%) were the most frequent diagnoses among NS cases, and were significantly more frequent among NS cases than NS controls. A total of 60% of the subjects with reported trouble had one or several of the diagnoses located in the neck/shoulder. Physical function of the shoulder was lower in subjects with self-reported trouble as well as in the subgroup of NS cases with clinical diagnoses. In conclusion, the present clinical diagnoses and physical function tests differed between NS cases and NS controls, and are therefore recommended to be included as quantitative objective measures in assessing musculoskeletal health. Physical function tests should be further developed in order to be able to detect pre-stages of work-related disorders for preventive strategies.

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Introduction

Epidemiological studies on work-related musculoskeletal trouble are often based on questionnaire surveys (e.g. Bernard 1997; Gerr et al. 2002; Jensen 2003; Palmer et al. 2001). In several studies the advantage of using clinical examinations in combination with questionnaires has been shown to provide more detailed information about the character and severity of the problems (Ohlsson et al. 1994a; Stål et al. 1997). In one study it was found that by using only questionnaires the risk was underestimated (Nordander et al. 1999), although most often the contrary has been reported (Gerr et al. 2002; Zetterberg et al. 1997). Clinical examinations are valuable when searching for morbidity contrasts, as they have a higher precision and they usually increase specificity, but on the other hand they decrease sensitivity. Also of note is that specific clinical signs may predict future symptoms, signs and sick leave (Toomingas et al. 1999; Viikari-Juntura et al. 2000).

Among computer workers, musculoskeletal trouble, defined as ache, pain or discomfort (Kuorinka et al. 1987) in the neck and upper extremities, has been investigated in a number of studies, including both questionnaires and clinical examinations (Andersen et al. 2003; Gerr et al. 2002; Kryger et al. 2003; Palmer et al. 2001). Generally, self-reported trouble and disability in especially the neck, shoulder and forearm has shown a higher prevalence among computer users than diagnoses from clinical examinations, though many clinical signs have been found. Consequently, there is a mismatch existing between self-reported trouble/disability and objective measures when clinical findings are identified only from classical diagnoses (Andersen et al. 2003). Even in studies where a new diagnosis has been introduced (forearm pain), the prevalence of this

diagnosis was low (Kryger et al. 2003). In order to describe the difference between subjects with and without self-reported trouble, classical diagnostic criteria in clinical examinations might therefore not be sufficient relevant measures and call for supplementary objective criteria (Punnett and Wegman 2004).

Some investigators have found a lower physical capacity (strength, endurance and physical performance tests) in workers with self-reported trouble compared with those without trouble, measured on a day without perceived trouble. With respect to muscle strength (maximum voluntary contraction, MVC), most of these differences (in shoulder elevation, abduction, external rotation and handgrip) have been found in work tasks where the external demands of force were relatively high, with many peaks and eccentric loadings, which might imply a higher risk for mechanical rupture, and thereby decreasing muscle strength. This was, for example, found in at least two studies of automobile workers (Kilbom 1988; Zetterberg et al. 1997). Reduced MVC at the wrist has further been found in several studies of subjects with different pain conditions in either the neck/shoulder region or elbow (Friedman 1998; Henriksson et al. 1996). Also, with respect to endurance time, a relation between a low endurance in the neck/shoulder muscles and a deterioration in neck and shoulder disorders was expected in a 1-year follow-up study of electronic workers, as the studied work included a static load in the neck/shoulder and arms (Kilbom 1988). The hypothesis was that exposure to static work would increase the risk of hypoxia and anaerobic conditions, and thereby reduce endurance time, but surprisingly, this relation was absent in the final analyses. Other studies, though, have found a lower endurance time (in shoulder flexion, shoulder abduction or repetitive gripping) in subjects with either trapezius myalgia, pain in neck/shoulder or tension neck (Hansson et al. 1992; Henriksson et al. 1996; Larsson et al. 2000a; Viikari-Juntura et al. 1988). Muscle pain or disability may constitute a direct inhibiting factor for muscle function (Lund et al. 1991) and mostly it also causes reduced activity level or prolonged inactivity, thereby reducing muscle mass and endurance.

In order to cover a broad range of disabilities, the static strength and endurance tests have recently been supplemented with more functional and daily activity-like tests, as for example the dynamic test of trunk strength and lifting capacity, recommended especially for measuring patient progress in rehabilitation programs for spinal disorders (Mayer et al. 1988). One of these lifting tests, the cervical/upper lifting test, the PILE (progressive isoinertial lifting evaluation) test (Mayer et al. 1988) had a satisfactory ability in discriminating between patients with either back or neck trouble and healthy controls (Ljungquist et al. 1999). The upper PILE test was further found to have satisfactory construct validity in detecting impairment and activity limitations in patients with spinal neck trouble and a sick leave of 1–6 months (Ljungquist et al. 2003).

For a work characterized by extensive low-force static contractions, particularly in the neck/shoulder region, such as computer work, supplementary methods such as clinical examinations and tests still remain to be established and validated to objectively identify findings among subjects with self-reported trouble. The aim of the present study was to present the prevalence of clinical signs and symptoms in female computer users, both in healthy subjects and in subjects with neck/shoulder trouble. The hypothesis was that computer users with self-reported neck/shoulder trouble have more clinical findings and a lower physical function (muscle strength, endurance and physical performance) than those not reporting trouble.

Methods

Subjects

General inclusion criteria were work for at least 20 h per week, predominantly at the computer, experience of at least 5 years with the same or similar computer work tasks, and being at least 45 years old. Based on a questionnaire survey using a modified version of the Nordic questionnaire (Kuorinka et al. 1987) a neck/shoulder case (NS case) was defined as a subject reporting trouble (ache, pain or discomfort) for more than 30 days within the last 12 months in either the neck or the shoulder or both (treated as one region), and reporting a maximum of two other areas with more than 30 days of trouble within the last 12 months. A neck/shoulder control (NS control) was defined as reporting a maximum of 7 days of trouble in both the neck and the two shoulders within the last 12 months, and a maximum of three areas in total with more than 30 days of trouble within the last 12 months. The present study group is a subgroup of the NEW (neuromuscular assessment in elderly workers) study population (Sjøgaard et al. 2004), representing only those subjects who also participated in a clinical examination of the neck and upper extremities, comprising a total of 50 subjects from Denmark and 53 from Sweden. In total, 42 NS cases and 61 NS controls from four workplaces, representing both public and private organizations, were included.

Procedures

On the basis of a questionnaire survey, the subjects were categorized as either NS cases or NS controls as specified above, and those not fulfilling these criteria were excluded from the present study. Eleven subjects did not want to participate. Included subjects were then met at their work place in the morning on a pre-fixed date. All subjects returned an extended screening questionnaire, and then a clinical examination of the neck and upper extremities as well as physical function tests were performed on each included subject in a semi-randomized order. In total, 21

subjects with additional severe health troubles (nine subjects) or increased blood pressure (BP) (12 subjects) (i.e. systolic BP above 110 mmHg + age, minimum 145 mmHg, or diastolic BP above 100 mmHg, or in medical treatment for increased BP) were excluded from most of the physical function tests. The physical function tests included MVCs measured for shoulder elevation and handgrip (Denmark and Sweden) and shoulder abduction tests (Denmark), endurance of shoulder elevation (Denmark and Sweden), and a physical performance test, upper PILE (Denmark).

Clinical examinations

Clinical experts (physiotherapists, physician) from three different centers [Departments of Occupational and Environmental Medicine at the university hospitals in Gothenburg and Lund, and the Department of Physiology at the National Institute of Occupational Health (NIOH), Copenhagen] performed the clinical examinations on the neck and upper extremities according to a standardized protocol (Larsson et al. 2000b; Ohlsson et al. 1994a; Ranney et al. 1995; Viikari-Juntura 1983). All examiners were carefully trained in performing the clinical examinations before the study. Diagnoses were computer calculated, based on carefully defined criteria (Ohlsson et al. 1994a). In short, the standardized clinical examination protocol on neck and upper extremities consisted of questions on pain, tiredness and stiffness on the day of examination, tests including range of motion (ROM) and tight muscles, provocation of pain, sensitivity, strength and palpation of tender points. Additionally, the original diagnoses (Ohlsson et al. 1994a) were extended by K. Ohlsson and C. Nordander (personal communication) with the following two diagnoses: (1) cervicalgia, with the criteria neck pain and limited mobility of the neck, and (2) trapezius myalgia, with the criteria neck pain, tightness of the trapezius muscle, and palpable tender points in the trapezius muscle. Finally, the total number of persons having positive regional findings and the mean number of findings in the neck, shoulder, elbow and hand per person were calculated. The total number of diagnoses searched for in the neck/shoulder region were: tension neck syndrome, cervicalgia, cervical syndrome, trapezius myalgia, thoracic outlet syndrome, frozen shoulder, supraspinatus tendinitis, infraspinatus tendinitis, bicipital tendinitis, acromioclavicular syndrome; in the elbow/hand region: lateral epicondylitis, medial epicondylitis, pronator syndrome, radial tunnel syndrome, cubital syndrome, peritendinitis, carpal tunnel syndrome, ulnar nerve entrapment at the wrist, overused hand syndrome and deQuervain's disease. All diagnoses, except for tension neck and cervicalgia, were searched for in both right and left sides.

A pilot reliability study regarding the clinical examinations was conducted on two groups of subjects (mostly computer users). First, one examiner from each of the three centers clinically examined a group of ten subjects [nine female, one male, mean age 41.5 (7.5) years], including one NS case, four NS controls, four intermediates (neither a NS case nor a NS control according to the inclusion criteria), one with more than three other regions of trouble (according to the questionnaire based NS case definitions above). Secondly, two Danish examiners from NIOH examined 15 subjects [nine females, six males, mean age 42.8 (10.1) years], including four NS cases, seven NS controls, three intermediates, one with more than three other regions of trouble. The statistics used were "percentage of agreement" and "intraclass correlation coefficients" (ICC) in a two-way mixed effects model, single-rater ICC values.

The pilot reliability study with the three examiners showed total agreement for all subjects in 34 of the 38 studied diagnoses, and total agreement for 80% and 90% of the subjects in the remaining four diagnoses (left biceps tendinitis, left and right trapezius myalgia, left acromioclavicular syndrome). In this group of subjects only five positive diagnoses were found. On the specific tests ICC values were 0.76 for palpation tests, 0.26 for ROM tests and 0.45 for pain-provocation tests. The reliability study with the two examiners showed a total agreement on all subjects in 36 out of the 38 studied diagnoses, a total agreement on 93% of the subjects in the remaining two diagnoses (right frozen shoulder, right overused hand syndrome). In this group of subjects only ten positive diagnoses were found. On the specific tests ICC values were 0.64 for palpation tests, 0.50 for ROM tests, 0.66 for pain-provocation tests and 0.21 for strength tests. Reliability of the clinical examination was found to be satisfactory in both the pilot reliability studies regarding percentage of agreement compared with studies in the literature. Reliability may vary between the studied groups and especially among keyboard operators where kappa values have been reported to be low. This is mainly due to a low prevalence of positive findings and "the mild nature of musculoskeletal disorders in keyboard operators", but still the overall agreement was excellent, which is in line with results from other studies (Salerno et al. 2000).

Another measure of reliability is to group the specific tests, which showed the reliability of all the palpation and all the pain provocation tests to be satisfactory in the present studies for the three and two examiners with respect to ICC values (0.76 and 0.45; 0.64 and 0.66). In a similar reliability study with three examiners, the agreement on palpation scores in the infraspinatus and trapezius muscles was tested and found to be moderate (multi-rater kappa value 0.45–0.57) (Andersen et al. 2002). Previous studies have found reliability of clinical signs in the upper extremities in general to be from good to excellent (kappa 0.66–1.00) (Palmer et al. 2000), but while prediction of individual scores was poor, the scores on a group level were satisfactory (Kramer et al. 2001).

Physical function tests

MVC (shoulder elevation, handgrip and shoulder abduction)

All MVC tests were performed according to a standardized procedure (Essendrop et al. 2001). For the shoulder tests the subject was sitting in a height-adjustable chair with no feet contact to the ground and with the subject's arms hanging vertically without support. For shoulder elevation, two Bofors dynamometers were placed bilaterally 1 cm medial to the medial edge of the acromion (Jensen et al. 1993; Søgaard et al. 1996) and the distance from the dynamometers to the sternoclavicular joints was measured for calculation of the torque. The same equipment was used in the entire Danish study and in part of the Swedish study. In the rest of the Swedish study, a similar but not identical piece of equipment was used for measuring shoulder elevation, with a smaller modification (Mathiassen 1993). Care was taken to standardize fully the experimental situation presented to the subjects from a biomechanical point of view. For the handgrip strength both the dominant and the non-dominant side were measured with the elbow flexed 90 deg with a Jamar dynamometer used with the best-fit sized span of the dynamometer (Bäckman et al. 1995). The shoulder abduction was measured with the elbows flexed 90 deg (only for the Danish group). With two Bofors dynamometers placed bilaterally 1 cm proximal from the elbow joints, the subject was instructed to perform a bilateral maximal shoulder abduction and the highest value was registered for each side (Bäckman et al. 1995). The distance from each of the two dynamometers to the same side of the acromion was measured, and a subtraction of 5 cm was used to estimate the lever arm for calculation of shoulder abduction torque (Plagenhoef 1971).

During the MVC tests the measurements on each muscle group were performed at least three times with a minimum of 30 s rest. If the third registration was more than 5% higher than the previous two registrations, a fourth test was performed, and a maximum of five tests were performed. The subject was instructed to build up the force over 5 s, then to keep the pressure for about 2 s and finally to lower the force to zero. The highest value obtained during a one second period was used, and verbal encouragement was given.

Endurance shoulder elevation test

The 30% MVC was chosen in order to produce exhaustion within a few minutes for most subjects (Rohmert 1960), and the test was performed as a bilateral shoulder elevation test. Data from strain gauge dynamometers was sampled with 100 Hz and amplified on an Analyzer 10 electrical measuring bridge (PMH Electric 1999). With the same position as during the MVC measurements, two Bofors dynamometers were placed bilaterally 1 cm medial to the medial edge of the acromion, while feedback of force and target force was given to the subject for the right shoulder only. The endurance time and perceived local exertion, CR-10 rating scale (Borg 1990), was measured. The test was ended if the subject was able to keep the force for more than 360 s.

Upper PILE

The upper PILE test (Mayer et al. 1988; Ljungquist and Harms-Ringdahl 1999) was performed where the subject had to lift a load of 4 kg from a shelf placed 75 cm from the floor and place it on a shelf 137 cm from the floor and back again four times during 20 s. The weight of the load was increased by 2.5 kg every 20th second if the subject succeeded in carrying the weight and keeping the lifting frequency. During the test the heart rate of the subject was measured with a Polar heart rate (HR) watch. The test was terminated when one of the following conditions was fulfilled: (1) when the maximum permissible HR limit (190÷age) was reached, (2) when the weight limit [for subjects with body mass index (BMI) ≤ 32, 50% of the body mass; for subjects with BMI >32 (six subjects), 50% of the height in centimeters minus 100] was reached, (3) when the subject was not able to perform the pre-set lifting frequency, or (4) when the subject wanted to terminate the test herself. Before and after the test rated perceived exertion (RPE, 6–20) (Borg 1970) and pain rating on a scale from 0–10 were rated. The recorded variables were the maximum weight lifted at stop, the accumulated weight lifted, the accumulated lifting endurance time, the final HR as a percentage of the maximum permissible HR, total work (TW) in joules, calculated as accumulated weight x total lifting distance x lifting frequency, and total power (TP) in watts, calculated as TW/accumulated lifting endurance time.

Statistics

Non-parametric statistics were used. The differences between the questionnaire-based NS cases and NS controls in relation to number of persons with diagnoses, regional findings, mean number of findings per person, physical function tests, in addition to the difference between the two subgroups of the questionnaire-based NS cases and NS controls in relation to the physical function tests were tested with a non-parametric unpaired Mann–Whitney *U*-test (tested for normality). SPSS version 11.5 was used for calculation of the statistical values. P values <0.05 were used as the level of significance.

Results

The NS case group was <2 years younger than the NS control group (Table 1). Further, the NS cases had a larger mass and BMI than the NS controls, while there was no difference with respect to height. Regarding

Table 1 Demographic data [mean (SEM)] of subjects with self-reported musculoskeletal trouble. *NS* Neck/shoulder

	NS cases ($n=42$)	NS controls ($n=61$)
Age (years)	54.0 (0.7)	55.7 (0.7)*
Mass (kg)	71.9 (1.9)	66.8 (1.3)*
Height (cm)	164.4 (0.7)	165.5 (0.8)
Body mass index	26.7 (0.8)	24.3 (0.5)*
Experience in present job (years)	17.5 (1.9)	18.7 (1.6)
Weekly working time (h)	36.4 (0.8)	38.1 (0.8)

*Significant difference ($P<0.05$) between NS cases and NS controls

seniority, this study group had longer experience than requested, corresponding to a mean of 18.2 (1.2) years with computer work and a weekly working time of 37.4 (0.6) h. Trouble in various body regions is depicted in Fig. 1 for NS cases and NS controls. Further, it is worth mentioning that the NS cases could be classified as "cases" (more than 30 days of trouble) for other particular body regions: in 38% ($n=16$) regarding their upper back, 31% ($n=13$) regarding their lower back and 20% ($n=8$) regarding their elbows. Correspondingly, the NS controls could be classified as "cases" in 7% regarding their elbows ($n=4$), 7% regarding their knees ($n=4$) and 7% regarding their feet ($n=4$). The three body regions with the highest percentages of trouble are reported for the NS cases as well the NS controls.

The NS cases had significantly more clinical diagnoses than the NS controls (Table 2). The following three diagnoses were the most common found in the NS case group: trapezius myalgia (38% in total and 21% double sided), tension neck syndrome (17%) and cervicalgia (17%). Acromioclavicular syndrome, biceps tendinitis, supraspinatus tendinitis and frozen shoulder were found in only 7, 7, 5 and 2% of NS cases, respectively. A total 60% of NS cases had at least one of the seven diagnoses (either right or left side), while 31, 19 and 14% of the NS cases had at least two, three or four of the seven diagnoses, respectively (Table 2). In the NS case group, most of the diagnoses were found in the right (dominant) side. In the NS control group, only trapezius myalgia (7%) and tension neck (2%) were found, and only 7% of the NS controls had at least one of the seven diagnoses. No diagnoses of cervical syndrome, thoracic outlet syndrome or infraspinatus tendinitis were found among either NS cases or NS controls. Although NS cases were selected on the criteria of neck/shoulder trouble additional diagnoses were found in the elbow and hand region (Table 2), and here medial epicondylitis was found in one subject with bilateral medial epicondylitis and one subject with overused hand syndrome (left side). No diagnoses of lateral epicondylitis, peritendinitis, pronator teres syndrome, radial tunnel syndrome, cubital syndrome, ulnar nerve entrapment at the wrist, carpal tunnel syndrome or deQuervain's disease were found. No diagnoses in the elbow and hand region were found for the NS controls.

Significantly more NS cases had positive findings in the neck/shoulder (Table 3), as 95 (right side) and 98% (left side) NS cases and 71 and 72% NS controls had at least one finding in the neck region, whereas 46 and 69% NS cases and 25 and 28% NS controls had positive findings in the shoulder region. The mean number of

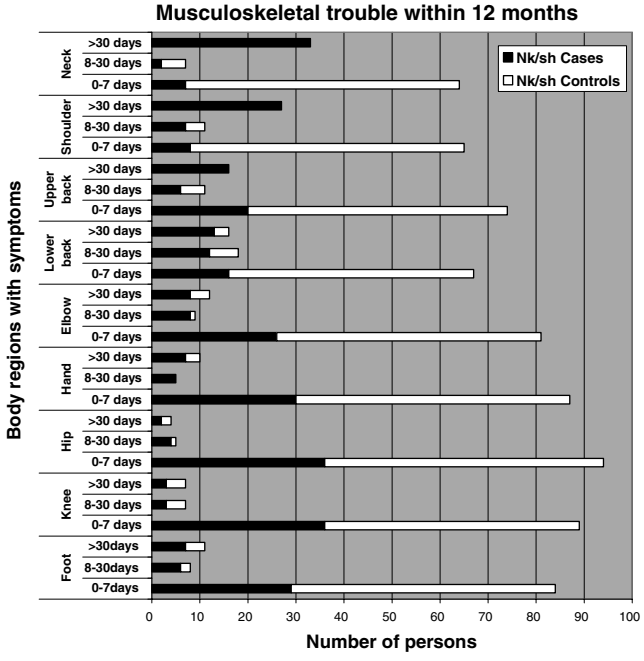

Fig. 1 Distribution of musculoskeletal trouble in different body regions for NS cases ($n=42$) and NS controls ($n=61$). For each body region the total response for the three categories (< 7 days, 8–30 days and > 30 days) sums up to 103 subjects. For each category the number of NS cases are presented first (*filled bars*) and the NS controls in continuation of these (*open bars*)

Table 2 Number of clinical diagnoses in neck, shoulder, elbow and hand regions among self-reported NS cases and NS controls versus total number of subjects

Diagnosis	NS cases		NS controls	
	Right	Left	Right	Left
Neck/shoulder				
1. Tension neck (no side)	7/42		1/61*	
2. Cervicalgia (no side)	7/42		0/61*	
3. Trapezius myalgia	16/42	12/42	4/61*	4/61*
4. Acromioclavicular syndrome	3/42	2/42	0/61*	0/61*
5. Frozen shoulder	0/41	1/41	0/60	0/60
6. Supraspinatus tendinitis	1/42	2/42	0/61	0/60*
7. Biceps tendinitis	3/42	3/42	0/61*	0/61*
≥One of diagnoses 1–7	25/42		4/61*	
≥Two of diagnoses 1–7	13/42		2/61*	
≥Three of diagnoses 1–7	8/42		1/61*	
≥Four of diagnoses 1–7	6/42		0/61*	
Elbow/hand				
8. Medial epicondylitis	1/42	1/42	0/61	0/61
9. Overused hand syndrome	0/42	1/42	0/61	0/61

*Significant difference ($P < 0.05$) between NS cases and NS controls

Table 3 Number of persons with clinical findings per region and mean number of findings per region for neck, shoulder, elbow and hand regions among self-reported NS cases and NS controls versus total number of subjects

Findings	NS cases		NS controls	
	Right	Left	Right	Left
Neck/shoulder				
No. with neck findings	40/42	41/42	41/58*	43/60*
No. with shoulder findings	29/42	19/41	17/61*	15/59*
Mean no. neck findings per person	7/40	6/40	3/60*	2/60*
Mean no. shoulder findings per person	3/40	2/40	1/60*	0/60*
Elbow/hand				
No with elbow findings	27/41	20/41	19/59*	14/59*
No. with hand findings	18/40	17/41	18/61	15/61*
Mean no. elbow findings per person	2/40	1/40	1/60*	1/60*
Mean no. hand findings per person	1/40	1/40	1/60*	0/60

*Significant difference ($P < 0.05$) between NS cases and NS controls

findings per person was significantly higher in the NS cases and highest for the neck/shoulder compared to the elbow/hand region. About 50% of the NS cases and about 30% of the NS controls had at least one positive finding in the elbow/hand. Further, when defining potential diagnoses as diagnoses where all but one criteria are present, potential trapezius myalgia, tension neck and cervicalgia constituted additional 31, 24 and 45% of the NS cases, but also 20, 8 and 11% of the NS controls. In the elbow/hand region potential diagnoses of medial epicondylitis and overused hand syndrome were only represented in the NS cases by 10 and 7%.

Shoulder elevation strength was significantly lower in the NS case compared to the NS control group (Table 4). Including a subgroup of the NS cases, with only those with a clinical diagnosis of one or several of the seven diagnoses found in the neck/shoulder region, (see clinical examination for definition) the same significant difference was found for this NS case subgroup compared to a NS control group defined as NS controls without these clinical diagnoses. The difference was found in both sides. There was no difference within the NS case group, i.e. between the NS case group with and the NS case group without a clinical diagnosis, with respect to any of the physical function tests. No significant difference was found between NS cases and NS controls in shoulder abduction strength or shoulder elevation endurance time, since most of the subjects were able to hold the preset 6 min, corresponding to 59 subjects (71%) of the subjects who performed the shoulder elevation endurance test. Both NS case groups rated the local fatigue (CR-10 rating) significantly higher than their NS controls after the 6th minute of the endurance test. No significant difference was found in the upper PILE test, although the NS controls tended to lift more, to have a longer endurance time and to perform a larger total work (joules) and power (watts). However, the pain rating after the test was significantly higher in the NS case group with diagnoses compared to the NS control group without a diagnosis. With respect to handgrip strength no significant difference was found, neither between the questionnaire-based NS case/NS control group nor between a subgroup of the NS cases, in which only subjects with a clinical diagnosis in the elbow or hand region (see clinical examination for definition) was included, and the respective subgroup of the NS controls, in which subjects with diagnoses in the elbow/hand were excluded.

Discussion

The main finding of the present study was that trapezius myalgia, tension neck syndrome and cervicalgia, based on the present clinical examinations, are the most frequent diagnoses among computer users, and they are highly significant more frequent among NS cases than NS controls. Having one or more of the diagnoses located in the neck/shoulder constituted 60% of the subjects with self-reported trouble. Physical function of the shoulder was lower in subjects with self-reported trouble (NS cases) as

Table 4 Physical function tests [mean (SEM)] in relation to strength, endurance time (30% of maximum voluntary contraction) and upper progressive isoinertial lifting evaluation (*PILE*) test for NS cases and NS controls defined from the questionnaire, and a subgroup with and without one or several clinical diagnoses. *RPE* Rated perceived exertion of whole body fatigue, *CR-10* criterion rating scale of local fatigue,*HR* heart rate,*Final HR*measured as percentage maximum HR

	Questionnaire							
	NS cases		NS controls		NS cases (+ diagnoses)		NS controls (no diagnoses)	
	n	Mean	*n*	Mean	*n*	Mean	*n*	Mean
Shoulder elevation					Neck/shoulder diagnoses			
Strength, right (N)	34	379 (15)	53	423 (18)*	17	370 (19)	48	425 (19)*
Strength, left (N)	20	354 (19)	42	420 (22)*	8	344 (31)	40	425 (22)*
Endurance, right (s)	31	301 (18)	52	318 (11)	16	292 (28)	47	314 (12)
CR-10 after 6 min of endurance	9	6.9 (0.8)	28	4.5 (0.4)*	6	6.8 (1.2)	26	4.7 (0.4)*
Shoulder abduction								
Strength, right (N)	16	158 (10)	23	138 (7)	8	157 (16)	22	138 (7)
Strength, left (N)	16	145 (8)	23	137 (8)	6	143 (19)	22	137 (9)
Upper PILE								
Max weight at stop (kg)	16	11.2 (0.6)	23	11.5 (0.6)	9	11.5 (0.7)	22	11.4 (0.6)
Total lifted weight (kg)	16	30.3 (2.8)	23	32.6 (3.0)	9	31.8 (3.7)	22	32.1 (3.1)
Endurance time (s)	16	77.5 (4.4)	23	80.0 (4.9)	9	80.0 (5.8)	22	79.1 (5.0)
Final HR	16	87.4 (3.3)	23	91.5 (2.6)	9	86.9 (3.9)	22	91.1 (2.7)
Total work (J)	16	738 (68)	23	794 (74)	9	775 (90)	22	780 (76)
Total power (W)	16	9.2 (0.3)	23	9.4 (0.4)	9	9.4 (0.4)	22	9.4 (0.4)
Pain rating before the test (0–10)	15	0.8 (0.4)	22	0.3 (0.2)	9	1.3 (0.7)	21	0.3 (0.2)
Pain rating after the test (0–10)	15	1.0 (0.5)	23	0.2 (0.2)	8	1.6 (0.9)	22	0.2 (0.2)*
RPE before the test (6–20)	16	14.6 (0.3)	23	14.1 (0.5)	9	14.8 (0.5)	22	14.1 (0.5)
RPE after the test (6–20)	16	15.8 (0.4)	23	14.9 (0.6)	9	16.2 (0.4)	22	14.8 (0.7)
Handgrip					Elbow/hand diagnoses			
Strength, right (N)	27	289 (9)	46	306 (9)	1	334 (–)	45	307 (9)
Strength, left (N)	18	275 (15)	35	281 (9)	2	353 (59)	34	282 (9)

*Significant difference $P < 0.05$

well as in the subgroup of NS cases with clinical diagnoses compared to their respective NS control groups.

Computer work

The focus on a female population was due to many epidemiological studies having demonstrated the prevalence of musculoskeletal trouble to be higher in female than in male computer users (Karlqvist et al. 2003; Punnett and Bergqvist 1997). Explanations for this finding include differences in work tasks, working techniques, relative muscular workload and women tending to work longer hours with stereotype working tasks than men (Blangsted et al. 2003; Karlqvist et al. 2003; Lindegård et al. 2003; Wahlström et al. 2000). Computer work was chosen as representing light monotonous work in contrast to heavy monotonous work, which has previously been studied with respect to physical function and musculoskeletal trouble (Kilbom 1988; Larsson et al. 2000a; Zetterberg et al. 1997). The selection of computer work has additionally been supported as such work has increased dramatically during the last years, is expected to increase further in the future, and is assumed to have consequences related to musculoskeletal problems.

Inclusion criteria were female computer users above 45 years with at least 5 years experience, and a minimum of 20 h per week of work, predominantly with the computer. In reality, this study group had experience approximately three times larger and a weekly computer work exposure 1.5 times longer than the minimum criteria required for inclusion. The exposure to computer work in this study can therefore be described as relatively extensive from the self-reported statements. Of note is that the included subjects are still working, meaning that they do not have severe musculoskeletal disorders, seriously limiting their work ability.

While all seven diagnoses have a relation to the static and or repetitive work load found in many studies of computer work (Hagberg and Wegman 1987), the first two diagnoses (trapezius myalgia, tension neck) present the clinical signs in the muscle bulks, while the remaining diagnoses present the clinical signs around/in the insertions of the involved muscle tendons and the capsules of/in the involved joints. The prognosis of these disorders is usually good for a one-off incidence, provided that the exposure pattern is reduced, but the prognosis of repeated incidences is still unknown, with respect to whether it may lead to a persistent stage with reduced physical function.

Clinical pattern

In the neck/shoulder region trapezius myalgia (right and/or left side), cervicalgia, and tension neck showed significantly higher prevalence in the NS cases than in the NS controls in the present study. In addition to this, biceps tendinitis, supraspinatus tendinitis and frozen

shoulder were the second most frequent diagnoses among the NS cases, but absent in the NS controls. To this extent, the main part of the hypothesis of the study was confirmed. The lack of significant differences between the groups with respect to diagnoses in the elbow and hand is not surprising, since the inclusion criteria specifically focused on the neck/shoulder region. However, it should be kept in mind that an inclusion criterion in the study was trouble for a maximum of three body regions, in order to exclude those with generalized pain, fibromyalgia etc. (Wolfe et al. 1990). Of note is that among the three other regions with reported trouble during the last year, the upper back region was the most frequently reported region (38%). As it is the region lying anatomically closest to the neck/shoulder region, this indicates that it is difficult to distinguish this region from the neck/shoulder region for the subjects.

The type of diagnoses found were expected taking the present questionnaire-based definitions of NS cases and NS controls and previous studies of repetitive work tasks into consideration. However, it is important to underline that the present study group is not a representative sample of computer users in general, as contrast groups have been selected, i.e. NS cases and NS controls. By selecting morbidity contrast groups, other biological/physiological effects could be studied within the NEW project, e.g. physical function, muscle activity and other variables.

Studies of workers within slaughterhouses and fishing industries including clinical examinations have in general revealed a higher prevalence of diagnoses than studies within computer workers, although the prevalence of self-reported trouble has been at about the same level (Frost and Andersen 1999; Gerr et al. 2002; Kryger et al. 2003; Ohlsson et al. 1994b). In the present study, the most common diagnoses established in the neck/shoulder region, trapezius myalgia, tension neck and cervicalgia, showed modest prevalences of 38, 17 and 17%, respectively, among the NS cases defined from the questionnaire. In this study, though, the focus was on all those subjects with one or several of the present seven diagnoses, including 60% of the subjects with self-reported troubles, which reduces the discrepancy between self-reported and ''objective'' NS cases considerably. Even if slaughterhouse and fish-filleting work are both characterized as repetitive work, the clinical pattern may be different when comparing workers with light and heavy repetitive work, respectively. This may challenge the clinical examination technique when examining subjects from the light repetitive industry. In line with this, revision of the classical criteria for diagnoses might be required to better distinguish between NS cases having attracted specific peripheral tissue disorders compared with those suffering from generalized musculoskeletal complaints. This is pertinent for future improvement of prevention, treatment and prognosis of the highly prevalent musculoskeletal disorders reported in workplaces with light repetitive work. In fact, the difficulty in establishing reliable criteria that help to 'objectify' subjectively reported musculoskeletal trouble has given rise to some controversy, particularly in worker's compensation issues.

The present study is a contribution towards refining clinical examinations and specifications of diagnoses. Still there is a discrepancy between the self-reported trouble and objective diagnoses, and the clinically positive findings could be described alternatively, e.g. as number of positive findings or potential/possible diagnoses (diagnoses where all but one criteria are present). In the present study the mean number of neck/shoulder findings was between three and seven per person, significantly higher in the NS cases than in the NS controls. Taking potential diagnoses into consideration, the overlap between self-reported and clinically defined NS cases turned out to be larger, but smaller in the NS controls, meaning that sensitivity increased whereas specificity decreased. The presence of potential diagnoses in NS controls might be due to the selection criteria for NS controls (trouble for up to 7 days within the last 12 months), i.e. musculoskeletal trouble was not fully absent in this group. Further, in order to describe how seriously the subjects without diagnoses were affected, the number of persons with positive findings, the mean number of findings per person and the distribution of these findings may be relevant to present. In the future, trade offs should be considered regarding inclusion of the present clinically positive findings per se in addition to diagnoses.

Physical function

With respect to the physical function tests, shoulder elevation strength in both sides was significantly higher in NS controls compared to NS cases. As most of the diagnoses were found in the region corresponding to the distribution area of trapezius this could be expected, supporting the hypothesis that the most frequent diagnoses, tension neck, trapezius myalgia, and cervicalgia, might have induced a possible wearing effect in the muscles active during shoulder elevation, as also reported by previous studies (Kilbom 1988). An effect corresponding to a lower capacity of shoulder elevation endurance was expected in NS cases compared to NS controls, but only a tendency was found. This may be due to the test being terminated after 6 min, and more than 70% of the selected subjects sustained it for that period. The significantly higher perceived local fatigue rate just after the 6th min of the endurance test in the NS cases indicated a difference, although this measure was only performed in a smaller group.

In general the total number of subjects was small in three of the physical function tests, i.e. shoulder abduction strength, left handgrip strength and upper PILE. Regarding shoulder abduction strength, where the NS controls were not found to be significantly stronger than the NS cases, this could be due to the fact that very few diagnoses were found in the abductor muscles, i.e. only 2% and 5% among the NS cases had supraspinatus

tendinitis and 7% had biceps tendinitis. Although the remaining diagnoses were included in this subgroup of NS cases, they were not supposed to have a large influence on the capacity of shoulder abduction strength, as the affected muscles are not primarily involved in shoulder abduction. As subjects were also allowed to have reported trouble in the elbow/hand region, handgrip strength was chosen as the relevant physical function test for this region. There was a tendency to a larger handgrip strength in the questionnaire-defined NS controls, but no significant effect was seen. No conclusion on shoulder abduction and handgrip strength can be drawn. Regarding the upper PILE test there was no significant difference between NS cases and NS controls with regard to physical capacity, but a significantly lower pain rating after the test was found in the NS control group without a clinical diagnosis compared to the NS case group with a clinical diagnosis. There was a tendency, though, to a higher physical capacity and a lower local RPE after the test in the NS controls compared to NS cases. Although previous studies have shown this test to be able to distinguish well between healthy and subjects who had been sick-listed full or part-time because of neck disorders (Ljungquist et al. 1999; Ljungquist et al. 2003), the present group might not have disabilities sufficiently serious as to influence the capacity of performing this functional test. No conclusion on upper PILE can be drawn. Future studies might profit by a further development of specific physical function tests in order to be able to describe differences between NS cases and NS controls with respect to musculoskeletal trouble, disability and physical function.

Conclusion

The present study showed that the most common diagnoses in senior computer users reporting neck/shoulder trouble were trapezius myalgia, tension neck syndrome and cervicalgia. These diagnoses were found in 60% of the subjects reporting musculoskeletal trouble in the neck/shoulder area and were more common in this group than in subjects not reporting such trouble, and among whom diagnoses were found in only 7%. The physical function of the shoulder was lower in the subjects with self-reported trouble, as well as in the subgroup of those with clinical diagnoses compared with those with no self-reported trouble.

In order to objectively assess musculoskeletal health among those reporting trouble, supplementary outcome measures to classical diagnoses may be considered, e.g. number of regional clinical findings. Additionally, physical function tests found to differ between NS cases and NS controls, and between the subgroups of those with and without clinical diagnoses, are recommended to be included as supplementary quantitative objective measures. Further development of physical function tests is essential in detection of pre-stages to work-related disorders for preventive strategies.

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