Int Arch Occup Environ Health
DOI 10.1007/s00420-012-0809-x

ORIGINAL ARTICLE

Concurrent validity of questions on arm, shoulder and neck symptoms of the RSI QuickScan

Marco J. M. Hoozemans · Erwin M. Speklé · Jaap H. van Dieën

Received: 6 December 2011 / Accepted: 1 August 2012

Abstract
Purpose The objective was to determine the concurrent validity of questions on arm, shoulder and neck symptoms of an Internet-based questionnaire. In addition, the inter-observer reliability of physical examinations by occupational physicians was investigated.
Methods A total of 160 employees of a Dutch occupational health service were approached, of which 106 participated. Right after the assessment of arm, shoulder and neck symptoms using a self-administered questionnaire, each participant was examined by two occupational physicians. The presence of symptoms in the past 7 days was compared to the physical examinations. The participation of two occupational physicians allowed us to study also the inter-observer reliability.
Results Overall, the concurrent validity of the symptom questions of the questionnaire can be defined as poor to moderate with κ values between 0.16 and 0.53. Detecting the presence of symptoms (p_{pos}) could be considered as moderately valid with values below 0.60, but the p_{neg} shows that the concurrent validity for detecting the absence of arm, shoulder or neck symptoms can be considered sufficient with values above 0.69. The agreement between occupational physicians can, with a few exceptions, be considered as moderate with κ values below 0.60. The agreement was sufficient for detecting the absence of symptoms ($p_{neg} > 0.7$).
Conclusions The agreement between the symptom questions of the questionnaire and physical examinations of occupational physicians can be considered as poor to moderate. The results are comparable to what is generally reported in the literature. Future studies should be aimed at gaining more fundamental knowledge about the possible conceptual differences between self-reported symptoms and symptoms assessed using physical examinations. Moreover, it is advisable to improve the inter-observer reliability of physical examinations as applied in the present study.

Keywords Questionnaire · Physical examination · Repetitive strain injury · Upper extremity disorders · Computer work · Occupational physicians

Introduction

A large number of people use a computer at work daily. This number as well as the number of hours per day working with a computer has increased over the years (Gerr et al. 2004; Wahlstrom 2005; Buckle 2005). Computer work has been recognized as a potential risk factor for arm, shoulder and neck symptoms (Brandt et al. 2004; Buckle 2005; Ekman et al. 2000; Palmer et al. 2001; Punnett and Bergqvist 1999; Wahlstrom 2005). Although the scientific evidence for a causal relationship is still controversial (IJmker et al. 2007; Waersted et al. 2010), in

M. J. M. Hoozemans (✉) · E. M. Speklé · J. H. van Dieën
Faculty of Human Movement Sciences, Research Institute MOVE, VU University Amsterdam, Van der Boechorststraat 9, 1081 BT Amsterdam, The Netherlands
e-mail: m.j.m.hoozemans@vu.nl

M. J. M. Hoozemans · E. M. Speklé · J. H. van Dieën
Body@Work, Research Centre on Physical Activity, Work and Health, EMGO Institute, VU University Medical Center, Van der Boechorststraat 7, 1081 BT Amsterdam, The Netherlands

E. M. Speklé
Arbo Unie OHS, Daltonlaan 500, 3584 BK Utrecht, The Netherlands

Published online: 07 September 2012

practice many computer workers visit their occupational physician in the Netherlands because of these symptoms. It is estimated that 2.5 % of the computer workers in the Netherlands, which is 2 % of the total working population, contact their occupational physician for arm, shoulder or neck symptoms (Klein Hesselink et al. 2009; Bakhuys Roozeboom et al. 2007; Bongers 2003).

Arm, shoulder and neck symptoms of workers are costly in terms of lost production, staff sickness, compensation and insurance costs, recruiting and training of new staff and the effect of discomfort or poor health on the quality of work. In the Netherlands, the total yearly costs of arm, shoulder and neck symptoms due to decreased productivity, sick leave, chronic disability and medical costs have been estimated to be 2.1 billion Euros (Blatter et al. 2005). To reduce these costs, employers monitor the prevalence of arm, shoulder and neck symptoms and potential risk factors for arm, shoulder and neck symptoms among their employees. In the Netherlands, 75 % of organizations with 500 or more employees implement specific interventions aimed at reducing the exposure to the potential risk factors. Recently, an Internet-based questionnaire (RSI QuickScan) was developed by an occupational health service in the Netherlands to assess the prevalence of potential risk factors and arm, shoulder or neck symptoms (Speklé et al. 2009, 2010). The internal consistency, reliability and concurrent validity of questions on work-related exposure were found to be acceptable (Speklé et al. 2009). The symptom-related questions of the RSI QuickScan still need to be validated by comparing outcomes with physical examinations by occupational physicians (Ohlsson et al. 1994; Zetterberg et al. 1997; Nordander et al. 1999; Toomingas et al. 1995; Bjorksten et al. 1999; Salerno et al. 2000; Stål et al. 1997; Akesson et al. 1999; Kaergaard et al. 2000; Juul-Kristensen et al. 2006), usually recognized as more objective than questionnaires (Perreault et al. 2008). Therefore, the main objective of the present study was to determine the concurrent validity of the symptom-related questions of the RSI QuickScan by assessing the agreement between the results of these self-administered questions and the physical examination by occupational physicians on the presence of arm, shoulder or neck symptoms in computer workers with and without arm, shoulder or neck symptoms.

In the present study, the results of the self-administered questions were compared to the physical examinations of two occupational physicians. In the course of the analyses, it was noticed that the inter-observer agreement between the two occupational physicians was not optimal. Therefore, an additional objective of the present study was to explore the inter-observer reliability of the physical examinations of the occupational physicians when applying a standardized physical examination for arm, shoulder or neck symptoms.

Study population and methods

Study population

The study was part of a large longitudinal study in which 2,000 employees of a Dutch occupational health service (Arbo Unie) were invited in 2005 to fill in an Internet-based questionnaire, the RSI QuickScan (Speklé et al. 2009). From this population, a sample of 160 employees was randomly drawn to ensure that the sample of the study population of the present study was representative of the large population and that it included employees without symptoms, moderate symptoms and severe symptoms. The definitions of no symptoms, moderate symptoms and severe symptoms were based on the total symptom score for arm, shoulder and neck symptoms that was assessed using the questionnaire. In total, 106 (66 %) employees (19 men with a mean age of 46 (SD 9) years and 87 women with a mean age of 38 (SD 10) years) decided to participate, including 64 participants with no symptoms, 32 participants with moderate symptoms and 10 participants with severe symptoms.

The Ethics Committee of the Faculty of Human Movements Sciences of the VU University Amsterdam approved the study design, protocols, procedures and informed consent form.

Procedure

Each of the 106 employees, who decided to participate, was invited to see two occupational physicians of the occupational health service. Prior to this study, both occupational physicians were trained in the procedures of physical examination concerning arm, shoulder and neck symptoms. Just before seeing the first occupational physician, the participants signed the informed consent and filled in the fourteen symptom questions of the RSI QuickScan again. The occupational physicians were allowed neither to see or hear the answers to the questions before their physical examination, nor to discuss the participant with each other before returning the forms of the study to the researchers. After filling in the questionnaire, the participant was physically examined successively by both occupational physicians in separate rooms and according to the guideline on arm, shoulder or neck symptoms of the Netherlands Society of Occupational Medicine (Verbeek et al. 2003). The sequence of the occupational physicians, that is, being the first or second occupational physician to examine a participant, was systematically varied to ensure that the occupational physician had almost the same number of first and second examinations.

Questionnaire

The RSI QuickScan was developed to assess the presence or absence of arm, shoulder or neck symptoms and potential risk factors for these symptoms for the establishment of risk profiles related to arm, shoulder and neck symptoms in computer workers (Speklé et al. 2009) (A description of the actual questions studied can be found in Appendix 1 and at: https://www.rsiquickscan.com/research/questionnaire.pdf). The prevalence of arm, shoulder and neck symptoms was assessed using questions based on the 'Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms' published by Kuorinka et al. (1987) and on the Dutch Musculoskeletal Questionnaire by Hildebrandt et al. (2001). It specifies seven areas in the upper extremity region (neck, upper back, shoulder, elbow, forearm, wrist and hand), as suggested by Sluiter et al. (2001). The participants were asked whether they had experienced symptoms in these regions in the past 12 months and in the past 7 days separately using a four-point scale (never, once or twice, regular, long-lasting; 0–3 points). For each of the participants, the presence of arm, shoulder or neck symptoms was defined as reporting regular or long-lasting symptoms in one or more of the seven regions.

Physical examination

Each participant was physically examined twice according to the practice guideline for occupational physicians on the management of employees with complaints of arm, shoulder or neck of the Netherlands Society of Occupational Medicine (Verbeek et al. 2003). The occupational physicians were specifically trained in the physical examinations prior to the study. Implementation of the developed guidelines is a key issue in the quality process in daily professional practice. To support implementation, in addition to every guideline, a package of implementation-supporting aids is developed: checklists, knowledge tests, case descriptions, short versions for employers and employees, and PowerPoint presentations about the background and the content of the guideline. Furthermore, educational material is developed in conjunction with the schools of occupational medicine. (http://nvab.artsennet.nl/English/Guidelines.htm). The guideline is based on information from relevant systematic reviews, original studies and the Saltsa report on guidelines to determine upper extremity symptoms (Sluiter et al. 2001). Results of the physical examination were reported using a form (see Appendix 2) in which the absence or presence of specific and non-specific symptoms for four regions (neck, shoulder, elbow, forearm/wrist/hand) could be indicated. For each specific and non-specific symptom, it was determined whether the diagnosis was negative or positive. With respect to the specific symptoms, the occupational physicians had the following options: cervical radicular syndrome, specific shoulder symptoms, lateral and medial epicondylitis, tenosynovitis/peritendinitis or carpal tunnel syndrome.

Statistical analyses

Firstly, it was descriptively explored whether the answers (yes (regular or long-lasting symptoms) or no (symptoms never or once or twice)) reported by the participants themselves for each of the participants, for each of the four regions (neck, shoulder, elbow, forearm/wrist/hand), on the RSI QuickScan questionnaire, for both symptoms in the previous 7 days and previous 12 months, were comparable to the findings of the occupational physicians (in terms of positive or negative regarding the presence of symptoms) reported on the forms. For these descriptions, specific and non-specific symptoms were not distinguished.

Secondly, the scores of the participants on questions concerning the presence of symptoms in the past 7 days were compared to the observations of the two occupational physicians (in terms of positive or negative). Concurrent validity was determined irrespective of body region (total) and for the neck, shoulder, elbow and forearm/wrist/hand regions separately. The proportion of observed agreement (p_O) and Cohen's Kappa (κ) were calculated as measures of concurrent validity. Since p_O and κ show no insight into the agreement between the positive and negative answers and because the κ statistic is considered unstable as it is strongly influenced by the observed proportions of individuals who fall in each category of classification (Speklé et al. 2009; Perreault et al. 2008; Juul-Kristensen et al. 2006; Salerno et al. 2000; Feinstein and Cicchetti 1990), $p_{positive}$ (p_{pos}) and $p_{negative}$ (p_{neg}) were also calculated as extra means of assessing the agreement (Speklé et al. 2009; Feinstein and Cicchetti 1990; Cicchetti and Feinstein 1990). According to Cicchetti and Feinstein (Cicchetti and Feinstein 1990), the observed proportion of positive agreement (p_{pos}) can be calculated as the ratio of the actual number of subjects that the questionnaire and the occupational physician agree on having symptoms over the average number of subjects with symptoms that were identified by the questionnaire and the occupational physician $((cases_{questionnaire} + cases_{occupational\ physician})/2)$. Cicchetti and Feinstein (Cicchetti and Feinstein 1990) state that since this average value shows how many decisions were made, a correction for chance agreement seems less necessary than for the proportion of observed agreement.

Thus, following Cicchetti and Feinstein (Cicchetti and Feinstein 1990), in a fourfold table of the form:

$$\begin{Bmatrix} a & b \\ c & d \end{Bmatrix},$$

the observed proportion of positive agreement (p_{pos}) would be:

$$p_{pos} = \frac{a}{\left(\frac{(a+b)+(a+c)}{2}\right)}$$

Analogous to the proportion of positive agreement, the proportion of negative agreement (p_{neg}) can be calculated for the subjects identified as being without symptoms:

$$p_{neg} = \frac{d}{\left(\frac{(b+d)+(c+d)}{2}\right)}$$

In addition to the concurrent validity, the inter-observer reliability was studied by comparing the results of the two occupational physicians. For the inter-observer reliability, again the p_O, κ, p_{pos} and p_{neg} were calculated for each of the four body regions, that is, neck, shoulder, elbow and forearm/wrist/hand, separately for non-specific and specific symptoms.

Results

Prevalence of symptoms

Of the study population of 106 participants, 69 and 44 % reported to have had neck, shoulder or arm symptoms in the previous 12 months and 7 days, respectively (Fig. 1), of which the 12-month prevalence was comparable to the prevalence observed by the occupational physicians. Also for (only) neck symptoms, the occupational physicians observed prevalences close to the 12-month prevalence assessed by the RSI QuickScan. The occupational physicians observed very different numbers of participants with shoulder symptoms, which was also not comparable to what was reported by the participants themselves. In contrast, for elbow symptoms, the prevalences assessed by questionnaire and reported by the occupational physicians were comparable. Finally, for the forearm/wrist/hand symptoms, one occupational physician observed a prevalence close to the 12-month prevalence, while the other observed a prevalence close to the 7-day prevalence.

Concurrent validity

For the concurrent validity of the RSI QuickScan, the scores of 106 participants on questions concerning the presence of symptoms in the past 7 days were compared to the observations of two occupational physicians, which both observed each participant. Irrespective of body region, the proportion of observed agreement (p_O) between the questionnaire and the occupational physicians was 0.57 and 0.61 for occupational physicians 1 and 2, respectively (Fig. 2). For the neck, shoulder and forearm/wrist/hand regions, the p_O ranged from 0.61 to 0.76. The highest values of p_O were observed for the elbow (0.88–0.89). In terms of kappa coefficients (κ), a similar pattern could be observed, although κ values were low and were between 0.16 and 0.53 with highest values again observed for the elbow region. For the observed proportion of positive agreement (p_{pos}), that is, the agreement on the presence of symptoms, there were no large differences between the different body regions. Highest values of p_{pos} were 0.61 and 0.68 for the presence of symptoms irrespective of body region (total) for occupational physicians 1 and 2, respectively. As was already described for the p_O and κ, also the observed proportion of negative agreement (p_{neg}), that is,

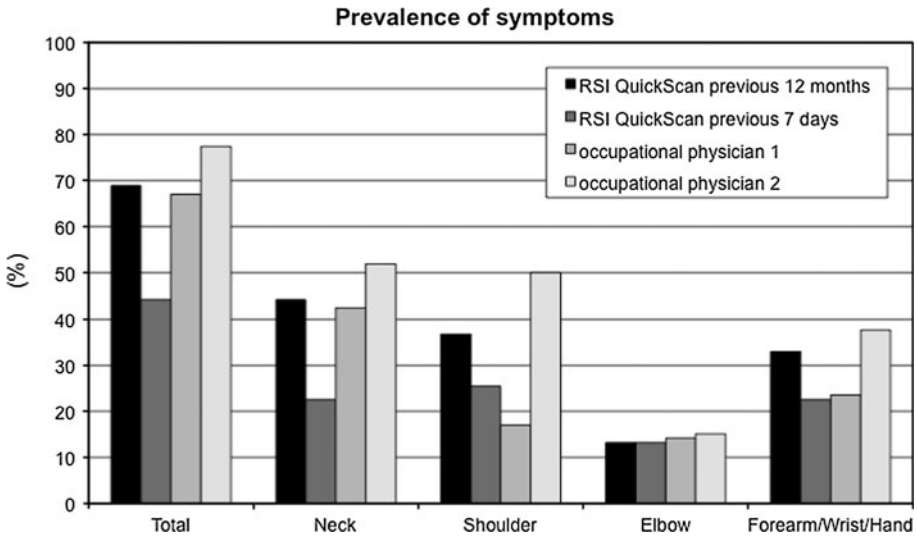

Fig. 1 The 12-month and 7-day prevalences of neck, shoulder and arm symptoms—separately and all together (total)—assessed by the RSI QuickScan and prevalences observed by two occupational physicians

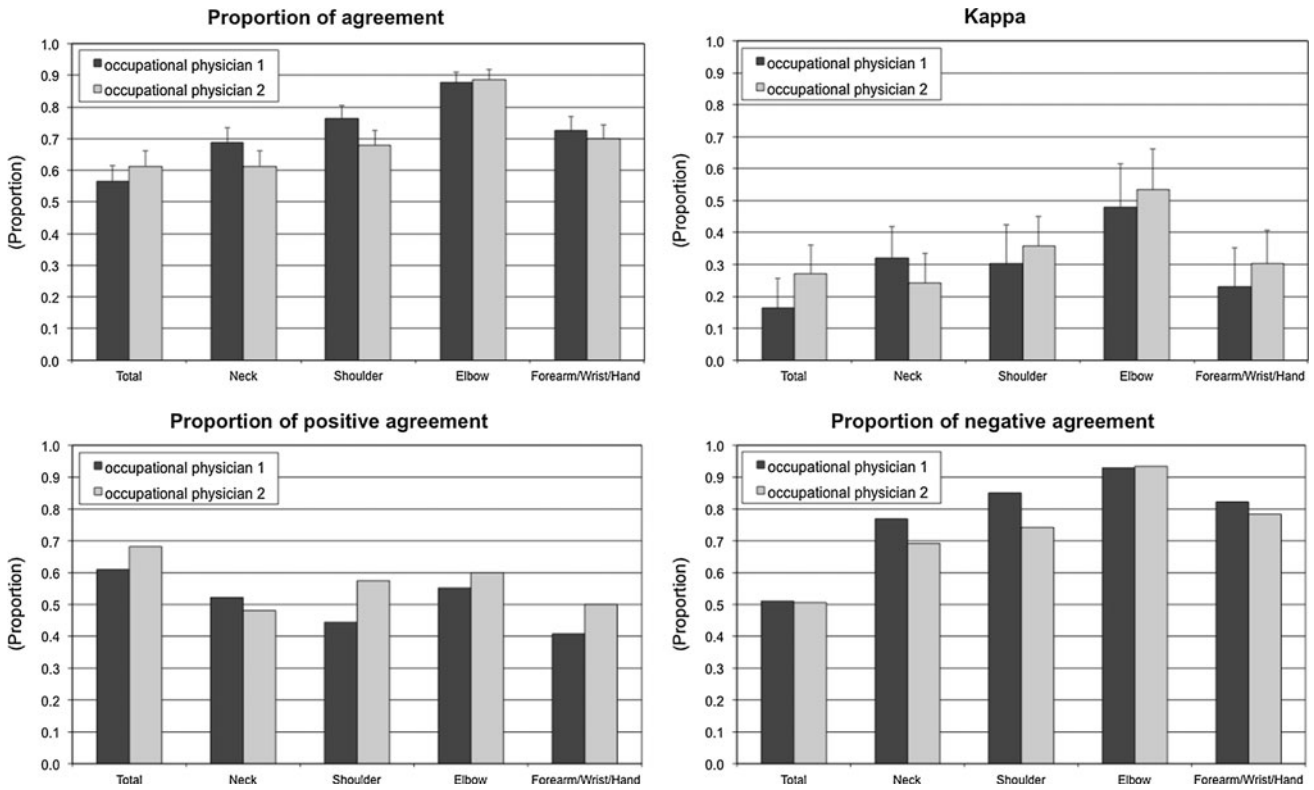

Fig. 2 Concurrent validity of the RSI QuickScan in terms of proportion of agreement, kappa coefficient, proportion of positive agreement and proportion of negative agreement. The scores of 106 participants on questions concerning the presence of symptoms in the past 7 days were compared to the observations of two occupational physicians. *Error bars* represent one standard error

the agreement on the absence of symptoms, showed the lowest values for the body regions taken together (0.51) and the highest values for the elbow region (0.93). Values of p_{neg} were mostly higher than p_{pos}.

Inter-observer reliability

Parameters concerning the concurrent validity generally showed minor differences between the two occupational physicians. Whether the occupational physicians actually agree on a participant is described in Fig. 3, presenting the inter-observer reliability for specific and non-specific neck, shoulders and arms symptoms separately. For the 106 participants, the occupational physicians generally showed high proportions of agreement for specific symptoms (0.89–0.99) and somewhat lower proportions of agreement for non-specific symptoms (0.67–0.89), with lowest values observed for non-specific neck (0.73) and shoulder (0.67) symptoms. Only one participant was observed to have specific neck symptoms by one occupational physician, which resulted in a κ and p_{pos} of zero. Other values of κ were between 0.54 and 0.63 for specific symptoms and between 0.05 and 0.45 for the non-specific symptoms. Furthermore, agreement on the presence of symptoms between the two occupational physicians (p_{pos}) was generally lower than the agreement on the absence of symptoms (p_{neg}). Exceptionally low proportions of agreement were found for the presence of non-specific shoulder symptoms and the presence of (specific or non-specific) elbow and forearm/wrist/hand symptoms. The observed p_{neg} values were all above 0.70.

Discussion

In the present study, the concurrent validity of the RSI QuickScan was determined by assessing the agreement between the results of questions on the presence of arm, shoulder or neck symptoms and physical examinations by occupational physicians. Results show that overall the concurrent validity of the symptom questions of the RSI QuickScan can be defined as poor to moderate when considering the κ (which was well below 0.60) (Altman 1991), but, when considering the p_{neg}, that the concurrent validity for detecting the absence of arm, shoulder or neck symptoms can be considered sufficient.

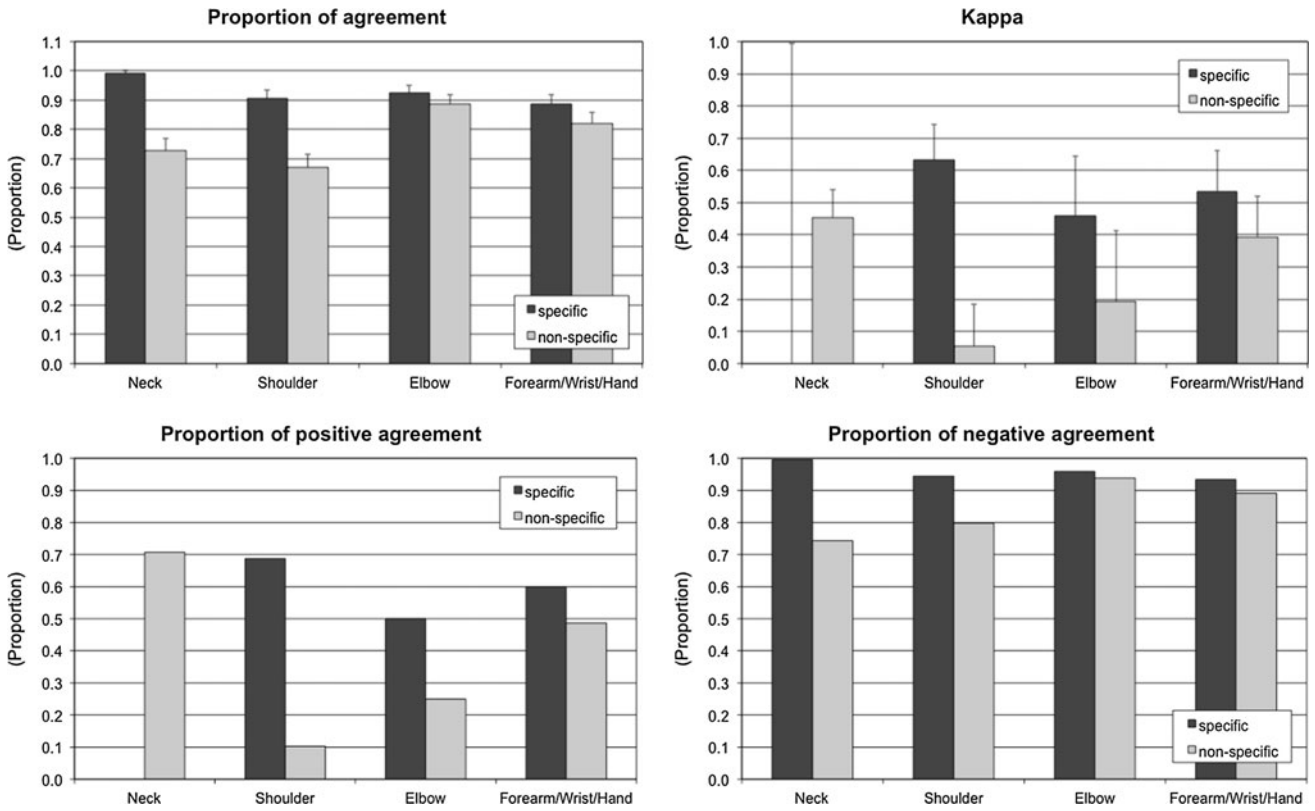

Fig. 3 The inter-observer reliability of the physical examination using the guideline of the Netherlands Society of Occupational Medicine in terms of proportion of agreement, kappa coefficient, proportion of positive agreement and proportion of negative agreement. Results are based on 106 participants, each observed by (the same) two occupational physicians, and for specific and non-specific symptoms of the neck, shoulders or arms. *Error bars* represent one standard error

In course of the analyses of the concurrent validity, it appeared that the inter-observer reliability was questionable. Therefore, as an additional part of this study, also the inter-observer reliability of the physical examinations was investigated. Although the analyses of the inter-observer reliability of the physical examinations generally resulted in relatively high levels of agreement, values of κ, p_{pos} and p_{neg} showed that the occupational physicians agreed sufficiently only on the presence of non-specific neck symptoms, specific shoulder and elbow symptoms and on the absence of non-specific and specific arm, shoulder or neck symptoms.

Validity of using questionnaires for assessment of musculoskeletal symptoms

To assess the prevalence of musculoskeletal symptoms in working populations, questionnaires are frequently used in occupational health care as well as in epidemiological studies. However, the validity of questionnaires compared to more objective methods of assessment, such as physical examinations, has been questioned in the following papers. In a population of 165 female workers, 94 workers (57 %) reported symptoms in a questionnaire and were given diagnoses in physical examinations (Ohlsson et al. 1994). The sensitivity for the diagnoses was 66–92 %, while the specificity was 64–88 %. The prevalence of symptoms or positive signs observed during the physical examinations was higher than the prevalence of symptoms assessed using the questionnaire. This is in contrast to several other studies that reported higher prevalences for questionnaires compared to physical examinations (Zetterberg et al. 1997; Nordander et al. 1999; Toomingas et al. 1995; Bjorksten et al. 1999; Salerno et al. 2000). Other studies report sensitivities of 52–60 % (Stål et al. 1997), 97 % for the neck and shoulders (Bjorksten et al. 1999) and 50–89 % (Akesson et al. 1999), and specificities of 86–98, 41 and 55–89 %, respectively. Although not reported in the results section, these values are comparable to values found in the present study with sensitivity ranging 33–70 % and specificity ranging 75–94 %. Akesson et al. (1999) found the sensitivity for the neck/shoulder to be higher than for the elbows/hands/wrists, but this could not be confirmed by the data of the present study. A high correlation between self-reported neck/shoulder symptoms and clinical signs of a neck/shoulder disorder was observed in a cohort of 243

female sewing operators (Kaergaard et al. 2000). Among female computer users over 45 years who reported musculoskeletal symptoms in the neck/shoulder using a questionnaire, 60 % was identified by physical examination with a specific diagnosis (Juul-Kristensen et al. 2006). However, in the control group that did not report musculoskeletal symptoms, 7 % was diagnosed. In the present study, 37–85 % of the subjects who reported to have had neck and/or shoulder symptoms in the past 7 days were diagnosed by physical examination and 10–44 % of the subjects who did not report to have had symptoms were diagnosed. Finally, for a population of 187 VDU users, Perreault et al. (2008) observed a p_O of 0.72 and a κ of 0.44 for the neck/shoulder region, values that are comparable to those observed in the present study.

Clearly, the concurrent validity of the RSI QuickScan questionnaire is comparable to the validity of other questionnaires according to the scientific literature, but can it be considered sufficient? About 80 % of the subjects with self-reported symptoms are diagnosed in a physical examination, which can be evaluated as sufficient. It is often argued that physical examinations assess the more severe symptoms, which might explain this finding. However, the occupational physicians found a disorder in about 40 % of the subjects without self-reported symptoms. Subjects that were categorized as having no self-reported symptoms included subjects that reported to have had no symptoms at all or only once in the past 7 days (and not long-lasting or regularly). The sensitivity might be increased by categorizing having had symptoms once as having had symptoms or by extending the retrospective period to more than 7 days. Furthermore, it can be questioned whether self-reported symptoms and symptoms assessed by physical examination are conceptually equal. Self-reported symptoms may, for instance, also be affected by exposure to physical or psychosocial factors at work or at home and physical examination, although protocoled, may not be that objective and may be considered a mixture of objective and subjective observations (Waersted et al. 2010). This may result in misclassification for both the self-reported symptoms and the symptoms assessed by physical examination, but in different and non-systematic directions.

Inter-observer reliability

During the analyses, it was noticed that the inter-observer agreement between the two occupational physicians was not optimal, and, therefore, the validity of the physical examination could be questioned (Marx et al. 1999). Salerno et al. (2000) even stated that self-administered measures of upper extremity conditions, such as questionnaires, might be more reliable than physical examination in a population of active workers because results of the physical examination seem to depend on the job content of the study population. In a systematic review of the literature concerning the possible causal relationship between computer work and musculoskeletal symptoms of the neck and upper extremity, Waersted et al. (2010) state that finding limited evidence may be partly caused by the selection of only studies with some sort of physical examination performed by a physician, physiotherapist or another trained health professional. They observed that the examination protocols and the resulting diagnoses differed substantially between the included studies. Furthermore, they argue that some of the diagnoses are in a grey zone between subjective complaints and 'objective' clinical diagnoses.

The exploration of the inter-observer reliability in the present study showed that, although the proportions of agreement were relatively high, κ's and the p_{pos}'s were relatively low, with the exception of specific shoulder, elbow and forearm/writs/hand symptoms and non-specific neck symptoms. The, generally, higher κ's and the p_{pos}'s for specific symptoms are likely caused by the strictly described diagnostics in the guideline, whereas the non-specific symptoms are more likely to be based on symptoms reported in anamneses subjectively evaluated by the occupational physicians. Toomingas et al. (1995) reported κ values of 0.52 and 0.62 for tests of tenderness, range of motion, pain at isometric muscular contraction and of nerve entrapment, which are comparable values to those reported by Andersen et al. (2002) (κ's 0.45–0.57). In another study (Salerno et al. 2000), two experienced examiners physically examined 159 keyboard operators. Although the observed agreement was 96–100 %, the corresponding κ values were low and unstable, which the authors attributed to the low prevalence of complaints. The reliability of the Southampton examination schedule, which was developed according to similar criteria as the physical examination protocol that is used in the Netherlands and that was applied in the present study, was studied in patients and in the general population (Palmer et al. 2000; Walker-Bone et al. 2002). In a group of 43 patients, 23 of the 31 variables in their schedule showed κ's above 0.40 in the inter-observer reliability analyses (Palmer et al. 2000). In the general population, 18 of the 33 variables showed κ's above 0.40 (Walker-Bone et al. 2002). Juul-Kristensen et al. (2006) concluded that the reliability of physical examinations was satisfactory with ICC values for specific diagnostic tests varying between 0.21 and 0.76 among a population of elderly female computer users. These results generally indicate that examiners do not always agree on their diagnoses.

Limitations of the study

In the present study, the two occupational physicians disagreed in 12–35 % of the cases, even though they were

recently trained in the examination protocol. These results of the inter-observer reliability part of this study may not be generalized because of including only two highly trained occupational physicians, which may not be representative of skills of the occupational physicians in the Netherlands. An additional study was performed in which 11 employees participated who contacted the occupational health service because of arm, shoulder or neck symptoms. Each of these 11 employees was physically examined by two out of 15 occupational physicians, who had more experience in working as an occupational physician, but were not recently trained. However, also in this additional study, the different pairs of occupational physicians disagreed in 9–27 % of the cases. In practice, the consequences of misinterpretation/misclassification may be considerable in terms of sick leave, return to work, associated financial costs and personal emotional burden. In addition, it can be discussed which professionals are optimally qualified to perform physical examinations validly as occupational physicians, who did the examinations in the present study and who are the ones who perform the examination in the occupational setting in the Netherlands are trained in occupational health in general and not in musculoskeletal health specifically. In the literature, it was found that physical examinations are performed by (among others) physicians, occupational therapists, physiotherapist, research nurses, rheumatologists, occupational therapists and orthopaedic specialists. Although the scientific literature does not indicate one of these professions as preferable, it is advisable that professionals who daily encounter patients with musculoskeletal symptoms and are specifically trained in diagnostics and treatment perform the physical examinations, which could be the physiotherapists in the Netherlands.

Another limitation in the present study, besides the examiners, is the study population. The study population consisted of, mainly female, computer workers, for which the RSI QuickScan was designed. Although this sample can be considered as representative of many organizations with computer workers (Speklé et al. 2009), it should be noted that results may not be generalized to other (industrial) occupational populations in which arm, shoulder and neck symptoms occur frequently.

Indices of agreement

The κ values reported in the present study, both the study of the concurrent validity and the study of the inter-observer reliability, can be classified as poor to moderate according to Altman (1991). However, as already discussed in several papers (Speklé et al. 2009; Perreault et al. 2008; Juul-Kristensen et al. 2006; Salerno et al. 2000; Feinstein and Cicchetti 1990), the κ statistic is strongly influenced by the observed proportions of individuals who fall in each category of classification (i.e. prevalence) and is considered unstable. Therefore, the p_O and the κ were supplemented with the p_{pos} and p_{neg} as suggested by Cicchetti and Feinstein (1990), which are analogous to sensitivity and specificity but are aimed at concordance and not accuracy in an inter-observer reliability study. Generally, these indices show that there is sufficient agreement on the absence of arm, shoulder and neck symptoms between the RSI QuickScan questionnaire and the occupational physicians and between the occupational physicians. However, for the presence of symptoms, the agreement between the questionnaire and the occupational physicians can be considered moderate with values around 50 %.

Beforehand, a sample size calculation for the present study was not performed as, according to De Vet et al. (2011), sample size calculations for kappa values are difficult to perform. However, we expect the precision of the estimates of the parameters studied to be sufficient considering that De Vet et al. (2011) recommend about 50 patients to reasonably fill a 2×2 table to determine the kappa value and considering that lower kappa values would require a larger sample size to reach the same confidence interval.

Conclusions

In conclusion, the agreement between the symptom questions of the RSI QuickScan questionnaire and physical examinations of occupational physicians can be considered as poor to moderate with κ values between 0.16 and 0.53. Detecting the presence of symptoms (p_{pos}) could be considered as moderately valid with values below 0.60, but the p_{neg} shows that the concurrent validity for detecting the absence of arm, shoulder or neck symptoms can be considered sufficient with values above 0.69. During the study, it was noticed that the agreement between occupational physicians can, with a few exceptions, be considered as moderate with κ values below 0.60. But the agreement was sufficient for detecting the absence of symptoms ($p_{neg} > 0.7$). Future studies should be aimed at gaining more fundamental knowledge about the possible conceptual differences between self-reported symptoms and symptoms assessed using physical examinations. Moreover, it is advisable to improve the inter-observer reliability of physical examinations as currently applied in the present population of active computer workers.

Acknowledgments Floris Sielcken, Rolf Greeven and Sourena Shirzad are greatly acknowledged for the collection of the data of the present study.

Conflict of interest The authors declare that they have no conflict of interest.

Appendix 1

Actual questions used in the RSI QuickScan questionnaire to assess the prevalence of upper extremity symptoms in the present study.

Have you at any time during the last 12 months had trouble (ache, pain, discomfort) in:

Neck	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Upper back	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Shoulder	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Elbow	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Forearm	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Wrist	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Hand	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never

Have you at any time during the last 7 days had trouble (ache, pain, discomfort) in:

Neck	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Upper back	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Shoulder	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Elbow	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Forearm	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Wrist	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never
Hand	☐ yes, once or twice ☐ yes, regular ☐ yes, long-lasting ☐ no, never

Appendix 2

Form used to register upper extremity symptoms by the occupational physicians in the physical examinations.

Region	Diagnose	Negative	Positive: No pain No disabilities	Positive: Pain No disabilities	Positive: Pain Disabilities
Specific symptoms					
Neck	Cervical radicular syndrome				
Shoulder	Specific shoulder symptoms				
Elbow	Lateral epicondylitis				
	Medial epicondylitis				
Forearm wrist hand	Tenosynovitis/ peritendinitis				
	Carpal tunnel syndrome				
	Other				
Nonspecific symptoms					
Neck	Nonspecific symptoms				
Shoulder	Nonspecific symptoms				
Elbow	Nonspecific symptoms				
Forearm wrist hand	Nonspecific symptoms				

References

Akesson I, Johnsson B, Rylander L, Moritz U, Skerfving S (1999) Musculoskeletal disorders among female dental personnel–clinical examination and a 5-year follow-up study of symptoms. Int Arch Occup Environ Health 72(6):395–403

Altman DG (1991) Practical statistics for medical research, 1st edn. Chapman & Hall, London

Andersen JH, Kaergaard A, Frost P, Thomsen JF, Bonde JP, Fallentin N, Borg V, Mikkelsen S (2002) Physical, psychosocial, and individual risk factors for neck/shoulder pain with pressure tenderness in the muscles among workers performing monotonous, repetitive work. Spine (Phila Pa 1976) 27(6):660–667

Bakhuys Roozeboom M, de Vroome E, Smulders P, van den Bossche S (2007) TNO Arbeidssituatie survey 2000–2004. Trends in de arbeid in Nederland tussen 2000 en 2004. TNO Kwaliteit van Leven

Bjorksten MG, Boquist B, Talback M, Edling C (1999) The validity of reported musculoskeletal problems. A study of questionnaire answers in relation to diagnosed disorders and perception of pain. Appl Ergon 30(4):325–330

Blatter B, Houtman I, van den Bossche S, Kraan K, van den Heuvel S (2005) Gezondheidsschade en kosten als gevolg van RSI en psychosociale arbeidsbelasting in Nederland (Health effects and costs due to RSI and psychosocial workload in The Netherlands). Ministerie van Sociale Zaken en Werkgelegenheid, Den Haag

Bongers PM (2003) Maak werk van RSI. Inaugural speech, VU Medical Centre, Amsterdam

Brandt LP, Andersen JH, Lassen CF, Kryger A, Overgaard E, Vilstrup I, Mikkelsen S (2004) Neck and shoulder symptoms and disorders among Danish computer workers. Scand J Work Environ Health 30(5):399–409

Buckle P (2005) Ergonomics and musculoskeletal disorders: overview. Occup Med (Lond) 55(3):164–167

Cicchetti DV, Feinstein AR (1990) High agreement but low kappa: II. Resolving the paradoxes. J Clin Epidemiol 43(6):551–558

de Vet HCW, Terwee CB, Mokkink LB, Knol DL (2011) Measurement in medicine. A practical guide. Cambridge University Press, Cambridge

Ekman A, Andersson A, Hagberg M, Hjelm EW (2000) Gender differences in musculoskeletal health of computer and mouse users in the Swedish workforce. Occup Med (Lond) 50(8):608–613

Feinstein AR, Cicchetti DV (1990) High agreement but low kappa: I. The problems of two paradoxes. J Clin Epidemiol 43(6):543–549

Gerr F, Marcus M, Monteilh C (2004) Epidemiology of musculoskeletal disorders among computer users: lesson learned from the role of posture and keyboard use. J Electromyogr Kinesiol 14(1):25–31

Hildebrandt VH, Bongers PM, van Dijk FJ, Kemper HC, Dul J (2001) Dutch musculoskeletal questionnaire: description and basic qualities. Ergonomics 44(12):1038–1055

IJmker S, Huysmans MA, Blatter BM, van der Beek AJ, van Mechelen W, Bongers PM (2007) Should office workers spend fewer hours at their computer? A systematic review of the literature. Occup Environ Med 64(4):211–222

Juul-Kristensen B, Kadefors R, Hansen K, Bystrom P, Sandsjo L, Sjogaard G (2006) Clinical signs and physical function in neck and upper extremities among elderly female computer users: the NEW study. Eur J Appl Physiol 96(2):136–145

Kaergaard A, Andersen JH, Rasmussen K, Mikkelsen S (2000) Identification of neck-shoulder disorders in a 1 year follow-up study. Validation of a questionnaire-based method. Pain 86(3):305–310

Klein Hesselink J, Houtman I, Hooftman W, Bakhuys Roozeboom M (2009) Arbobalans 2009. Kwaliteit van de arbeid, effecten en maatregelen in Nederland. TNO Kwaliteit van Leven

Kuorinka IAA, Jonsson B, Kilbom è, Vinterberg H, Biering-Sorensen F, Andersson GBJ, Jorgensen K (1987) Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 18(3):233–237

Marx RG, Bombardier C, Wright JG (1999) What do we know about the reliability and validity of physical examination tests used to examine the upper extremity? J Hand Surg Am 24(1):185–193

Nordander C, Ohlsson K, Balogh I, Rylander L, Palsson B, Skerfving S (1999) Fish processing work: the impact of two sex dependent exposure profiles on musculoskeletal health. Occup Environ Med 56(4):256–264

Ohlsson K, Attewell RG, Johnsson B, Ahlm A, Skerfving S (1994) An assessment of neck and upper extremity disorders by questionnaire and clinical examination. Ergonomics 37(5):891–897

Palmer K, Walker-Bone K, Linaker C, Reading I, Kellingray S, Coggon D, Cooper C (2000) The Southampton examination schedule for the diagnosis of musculoskeletal disorders of the upper limb. Ann Rheum Dis 59(1):5–11

Palmer KT, Cooper C, Walker-Bone K, Syddall H, Coggon D (2001) Use of keyboards and symptoms in the neck and arm: evidence from a national survey. Occup Med (Lond) 51(6):392–395

Perreault N, Brisson C, Dionne CE, Montreuil S, Punnett L (2008) Agreement between a self-administered questionnaire on musculoskeletal disorders of the neck-shoulder region and a physical examination. BMC Musculoskelet Disord 9:34

Punnett L, Bergqvist U (1999) Musculoskeletal disorders in visual display unit work: gender and work demands. Occup Med 14(1):113–124

Salerno DF, Franzblau A, Werner RA, Chung KC, Schultz JS, Becker MP, Armstrong TJ (2000) Reliability of physical examination of the upper extremity among keyboard operators. Am J Ind Med 37(4):423–430

Sluiter JK, Rest KM, Frings-Dresen MH (2001) Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. Scand J Work Environ Health 27(Suppl 1):1–102

Speklé EM, Hoozemans MJ, van der Beek AJ, Blatter BM, Bongers PM, van Dieën JH (2009) Internal consistency, test-retest reliability and concurrent validity of a questionnaire on work-related exposure related to arm, shoulder and neck symptoms in computer workers. Ergonomics 52(9):1087–1103

Speklé EM, Hoozemans MJ, Blatter BM, Heinrich J, van der Beek AJ, Knol DL, Bongers PM, van Dieën JH (2010) Effectiveness of a questionnaire based intervention programme on the prevalence of arm, shoulder and neck symptoms, risk factors and sick leave in computer workers: a cluster randomised controlled trial in an occupational setting. BMC Musculoskelet Disord 11:99

Stål M, Moritz U, HJohnsson B, Pinzke S (1997) The natural course of musculoskeletal symptoms and clinical findings in upper extremities of female milkers. Int J Occup Environ Health 3:190–197

Toomingas A, Nemeth G, Alfredsson L (1995) Self-administered examination versus conventional medical examination of the musculoskeletal system in the neck, shoulders, and upper limbs. The Stockholm MUSIC I Study Group. J Clin Epidemiol 48(12):1473–1483

Verbeek JAHM, Broekkamp CW, van Cuilenburg LC, van Heijst AJP, Kramer E, Kremer EAJM, Rutten RGHM, Tellekamp JJ, Verhoeven ACLPJ (2003) Practice guideline for occupational physicians on the management of employees with complaints of arm, shoulder or neck. NVAB, Utrecht, The Netherlands. http://nvab.artsennet.nl/web/file?uuid=7870867f-9fde-4122-ae6b-d99811e5566a&owner=56486107-3665-4b31-91e4-b4b90e8c1963&contentid=55307

Waersted M, Hanvold TN, Veiersted KB (2010) Computer work and musculoskeletal disorders of the neck and upper extremity: a systematic review. BMC Musculoskelet Disord 11:79

Wahlstrom J (2005) Ergonomics, musculoskeletal disorders and computer work. Occup Med (Lond) 55(3):168–176

Walker-Bone K, Byng P, Linaker C, Reading I, Coggon D, Palmer KT, Cooper C (2002) Reliability of the Southampton examination schedule for the diagnosis of upper limb disorders in the general population. Ann Rheum Dis 61(12):1103–1106

Zetterberg C, Forsberg A, Hansson E, Johansson H, Nielsen P, Danielsson B, Inge G, Olsson BM (1997) Neck and upper extremity problems in car assembly workers. A comparison of subjective complaints, work satisfaction, physical examination and gender. Int J Ind Ergon 19(4):277–289