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Responsiveness of the QuickDASH and SF-12 in Workers with Neck or Upper Extremity Musculoskeletal Disorders: One-Year Follow-Up

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Abstract *Introduction* Questionnaires that measure functional status such as the Disability of the Arm, Shoulder and Hand (QuickDASH) and the Medical Outcomes Study 12-item Short-Form Health Survey (SF-12) can quantify the impact of health on performance. Little is known about whether these questionnaires can be used as a tool for measuring disabilities among workers. We compare the responsiveness of these two functional status questionnaires to changes in clinical outcomes of neck or upper extremity musculoskeletal disorders (UEMSD) among active workers in a longitudinal study. *Methods* We evaluated the effect size (ES) and standardized response means (SRM) of the QuickDASH and the SF-12 for 148 workers who were divided into four subgroups based on the diagnosis status change between baseline and 1-year visit. *Results* The ES and SRM for QuickDASH scores were 0.6/0.6 for the 50 subjects who became incident symptomatic neck or UEMSD cases, 1.3/1.0 for the 18 subjects who became incident clinical cases of neck or UEMSD, −1.0/−1.1 for the 46 subjects who recovered from having neck or UEMSD symptoms, and −1.1/−1.1 for the 34 subjects who recovered from being neck or UEMSD clinical cases. The correspondent ES/SRM for the QuickDASH work module were 0.4/0.3, 0.7/0.5, −0.6/−0.4, and −1.0/−0.8, respectively. The correspondent ES/SRM for the physical component scores of SF-12 (PCS12) for the four subgroups were 0.2/0.2, −0.9/−0.6, 0.3/0.2, and 0.3/0.3, respectively. *Conclusions* The QuickDASH scores were responsive to changes among active workers who were neck or UEMSD symptomatic or clinical case. PCS12 scores were sufficient only for use in clinical case status change.

Keywords Responsiveness · Neck or upper extremity musculoskeletal disorders · QuickDASH · SF-12

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Introduction

Work-related musculoskeletal disorders (WMSDs) are a significant occupational health problem, resulting in lost work days and a detrimental impact on workers' lives [1–4]. In Washington State, workers' compensation claims for upper extremity musculoskeletal disorders (UEMSDs) represent 27.1% of all claims, 36.1% of claims resulting in four or more lost work days, and more than $4.1 billion (42.6% of all costs) [5]. Although there has been progress in standardizing a core set of classification criteria in UEMSDs [6], major consensus on diagnosis of many upper extremity conditions is lacking. Self-reported outcome measures that assess functional status can quantify the impact of health on performance. Quantifying function may be useful in detecting mild to moderate disorders of the neck and upper extremity among workers, help early intervention with such disorders, and allow a quicker return to normal function. Instruments that have been identified as most relevant for epidemiological studies among workers with mild to moderate upper extremity conditions include the Nordic Musculoskeletal Questionnaire (127 items, [7]), the Upper Extremity Questionnaire (27 items, [8]), and the Neck and Upper Limb Instrument (20 items, [9]). There is a need to test other shorter functional measures that are relevant to active workers in the field studies.

The Disabilities of the Arm, Shoulder and Hand (DASH) is a questionnaire that is designed to assess single

or multiple upper extremity disabilities [10]. The DASH has been shown to be reliable and valid in different languages [11–14] and in patient or working populations with various upper extremity disorders [10, 15, 16]. The QuickDASH is an 11-item questionnaire that has similar reliability as DASH [17]. The QuickDASH also has a four-item optional work module that is scored separately to measure the ability of performing work tasks [17].

The widely used Short Form Health Survey (SF-36) is a multipurpose generic health status instrument that is used to assess physical and mental health functioning [18]. The SF-12, a shorter version (12-item) of SF-36, has been demonstrated to replicate SF-36 scores in differentiating the health status of persons with varying symptoms and acute conditions [19].

Previous research on the QuickDASH and SF-12 has provided initial evidence of the predictive, discriminate, concurrent validity and reliability of QuickDASH scores among workers [20]. Additional work, however, is needed to test how the QuickDASH and SF-12 would do in evaluating changes of diagnosis status over time. There were limited data published in patients with affected parts of the extremity using DASH or SF-12 [10, 21, 22]. Because most active workers are healthy, it's important to examine whether the questionnaires designed for clinical population can adequately address the changes of the neck and UEMSDs disabilities among these workers. Further, arranging access to these workers during work time can be logistically difficult, which makes the self-perceived short questionnaire more attractive.

The objective of this study is to evaluate the responsiveness of the QuickDASH and SF-12 to changes in various neck or UEMSDs diagnoses status of in a longitudinal study among actively employed workers. Responsiveness was described using effect size (ES) and standardized response means (SRM). We concurrently evaluated responsiveness for four subgroups of workers whose neck and UEMSD diagnosis status changed from baseline to 1-year visit to worse (incident cases) or better (recovered cases): (1) self-reported symptomatic incident neck and UEMSD cases, (2) clinically confirmed incident cases, (3) recovered self-reported symptomatic cases, and (4) recovered clinical cases. By definition, the directions for the QuickDASH (including QuickDASH and QuickDASH work module) and SF-12 (PCS-12 and MCS-12) scores are opposite, i.e., more disability was indicated by a higher value of QuickDASH but a lower value of SF-12, we therefore expect an increase in QuickDASH scores and a decrease in SF-12 scores among incident (symptomatic or clinical) cases and the reverse among the recovered (symptomatic or clinical) cases. The research questions posed was whether the ES and SRM of QuickDASH and SF-12 reflect the changes in neck or UEMSDs clinical status.

Methods

Study Design

This study analyzed the data collected in a prospective cohort study of risk factors for developing work-related neck or UEMSD in fulltime employees in twelve different manufacturing and health care facilities in the State of Washington from 2001 to 2005 [23]. A workplace walk-through was conducted by study ergonomists to roughly categorize jobs into two levels of hand force (low, high) and three levels of hand activity (low, medium, high repetition) using the threshold limit values for hand activity level of the American Conference of Governmental Industrial Hygienists [24]. Facilities with at least three out of six exposure categories (high force-low repetition, high force-medium repetition, etc.) were eligible for inclusion. Only permanent employees who worked full time were eligible for recruiting. Those willing to participate (64.5% of eligible) completed the informed consent form approved by the Washington State Institutional Review Board (IRB). The form was also approved by the participating health care facilities' IRBs.

Health Assessment

Health assessment included a structured questionnaire interview conducted by trained interviewers and standardized physical examination performed by trained health team staff (physician, physical therapist, registered nurse):

1. Questionnaire interview contents were translated into multiple languages with interpreters available. They included:
   a. Demographics: age, gender, ethnicity, education, children or adults in the home requiring care, high force or repetitive sports and hobbies, and driving time. Relevant health history: diabetes, gout, hypertension, thyroid disease, rheumatoid or degenerative arthritis, acute traumatic injuries, smoking, medications, and treatment for musculoskeletal disorders.
   b. Work history: duration of employment with company, job, and similar work prior to current job, shift and hours, overtime, and second job.
   c. Body map for recording areas of pain or discomfort in the previous year lasting more than 1 week or occurring more than three times in the previous year. For those meeting these criteria, more detailed information regarding duration, frequency, onset, type and intensity of symptoms was sought.
2. Physical examination [25] was conducted bilaterally, blinded to the interview, on all subjects after the interview. They included:

a. Passive, active and resisted motions of the neck and upper extremity.
b. Maximum power and pinch grips in standardized postures.
c. Measured height and weight to calculate body mass index (BMI) as weight in kilograms divided by height squared measured in meters.

3. Nerve conduction velocity (NCV) studies [26] were performed on the dominant hand by registered nurses using standard techniques of supramaximal percutaneous nerve stimulation and surface recording. Anatomic landmarks and standardized stimulation to recording electrode distances were used. If the subject had abnormal findings on the dominant hand or symptoms in the non-dominant hand, the non-dominant hand was also tested, in which case the test was not blinded.
4. Detailed *case definitions* of symptoms and physical findings of tension neck syndrome (TNS), rotator cuff syndrome (RCS), lateral epicondylitis (LE), wrist tendinitis (WT), and carpal tunnel syndrome (CTS) were presented in Appendix.

Symptoms and physical findings in seven body regions were evaluated for every subject. *Self-reported symptomatic cases* were defined as pain, numbness, tingling, aching, stiffness, or burning in the neck, left or right shoulder, left or right elbow/forearm, or left or right hand/wrist within 7 days of the assessment; *AND* the symptoms lasted for more than 1 week or occurred more than three times in the previous 12 months; *and there was* no history of previous acute traumatic injury to the symptomatic body region.

Because we considered multiple body regions with potentially multiple symptomatic or clinical cases of neck and upper extremity for each subject, the subgroups of workers whose case status changed as to better or to worse became complicated. For the purpose of detecting changes in diagnosis status at both baseline and 1-year follow-up visits, we selected four subgroups of workers. The results are based on whether the QuickDASH or SF-12 could detect changes of a healthy worker who had come symptomatic or developed an upper extremity condition rather than the more difficult task, to detect various degrees of improvement of worsening based on persistent of symptoms.

1. Incident symptomatic cases:
   - Non-symptomatic at baseline; AND
   - Developed neck, shoulder, elbow/forearm, or hand/wrist symptoms at 1-year visit; AND
   - NO relevant physical finding.
2. Incident clinical cases:
   - Non-symptomatic at baseline; AND
   - Developed neck, shoulder, elbow/forearm, or hand/wrist symptoms at 1-year visit; AND
3. At least one physical finding in the relevant area. Recovered symptomatic cases:
   - Self-reported symptomatic cases in at least one body region at baseline; AND
   - Non-symptomatic at 1-year visit
4. Recovered clinical cases:
   - Clinical cases in at least one body regions at baseline; AND
   - Non-symptomatic at 1-year visit

Symptom Severity Scores

Symptom severity during the 7 days prior to the assessment was collected for each participant for each of the seven body regions using a four-point scale: mild, moderate, severe, and very severe. Due to the lack of very severe symptomatic cases, we combined the scales of severe or very severe and grouped severity scores into three categories. A summary severity score was then calculated for each participant as the sum of severity for all seven body regions. One subject, therefore, has a maximum of seven body regions affected and a maximum of 21 in severity score. Because our case definition considered both symptoms in the past 7 days and the duration or frequency of the symptoms, a few subjects who did not meet the positive case definition as symptomatic but still reported symptom severity scores of 1 (mild) or 2 (moderate), rather than 0 (none), during the past 7 days. The change scores of symptom severity for the seven body regions were the difference between baseline and 1-year visit.

Disability Measures Using QuickDASH

For those respondents who reported upper extremity symptoms in the last week, they were continued to administer the QuickDASH questionnaire by trained interviewers. Four questions were asked separately for neck, shoulder, elbow/forearm, and hand/wrist: "In the past 12 months, have you had neck problems (pain, stiffness, spasm, unable to move your head, burning, numbness or tingling) *at least 3 times OR lasting a week or longer*. Workers rated their ability to perform different physical functions *in the last week* using the 11-item QuickDASH questionnaire and their ability to perform work tasks using the four-item optional work module of the QuickDASH. Each item was rated on a five-point scale. The QuickDASH and QuickDASH work module scores were calculated

separately according to published guidelines [27] and yielded global scores ranging from 0 to 100, with higher scores reflecting increased disability.

General Health Using SF-12

The SF-12 questionnaire was self-administered right after the completion of the interview. The SF-12 includes dichotomous items, and three, five to six point scales. The SF-12 scores were transformed for the physical component scores (PCS-12) and mental component scores (MCS-12) [19]. Each subscale is scored from 0 to 100, with higher scores representing better function. In the general US population, the mean score of PCS-12 and MCS-12 is 50 (standard deviation 10, [19]).

Statistical Analyses

Characteristics of the Study Subjects

We used descriptive statistics (mean, standard deviations, and frequency) to describe participants in this study in terms of their demographic characteristics, self-reported symptoms, and limitations in work or outside work activities.

Responsiveness to Change

Responsiveness is the ability of any instrument to accurately detect change when it has occurred [28, 29]. In this study, we considered the change for both self-perceived symptoms and clinically confirmed physical findings. These diagnostic criteria became our indicators on whether a change had occurred. For this reason, the subjects who had the same diagnosis status at both baseline and 1-year visit were excluded from the study (Fig. 1). This analysis included four subgroups of the participants who experienced a change based on their diagnosis status either for the worse or for the better. Changes for the worse included those who were non-symptomatic at baseline and developed self-reported symptoms at 1-year visit. If confirmed with a physical finding in the symptomatic area, it is an *incident clinical case*. Without a physical finding, it is an *incident symptomatic case*. Changes for the better included those who were fully recovered at 1-year visit from either a clinical case (*recovered clinical case*) or a symptomatic case (*recovered symptomatic case*) at baseline. We expect an increase in QuickDASH scores and a decrease in SF-12 scores among incident cases and the reverse among the recovered cases.

Responsiveness of each questionnaire was evaluated by calculating the ES [30–32] and the SRM [33]. For ES, we used pooled standard deviations (SD) which was defined as the root mean square of the two SDs from initial and follow-up groups of workers by assuming that the two calculated SDs are estimates of the same population value [34].

$$\mathrm{ES} = \frac{\text{Mean change}(\text{follow-up scores} - \text{initial scores})}{\text{Pooled SD}}$$

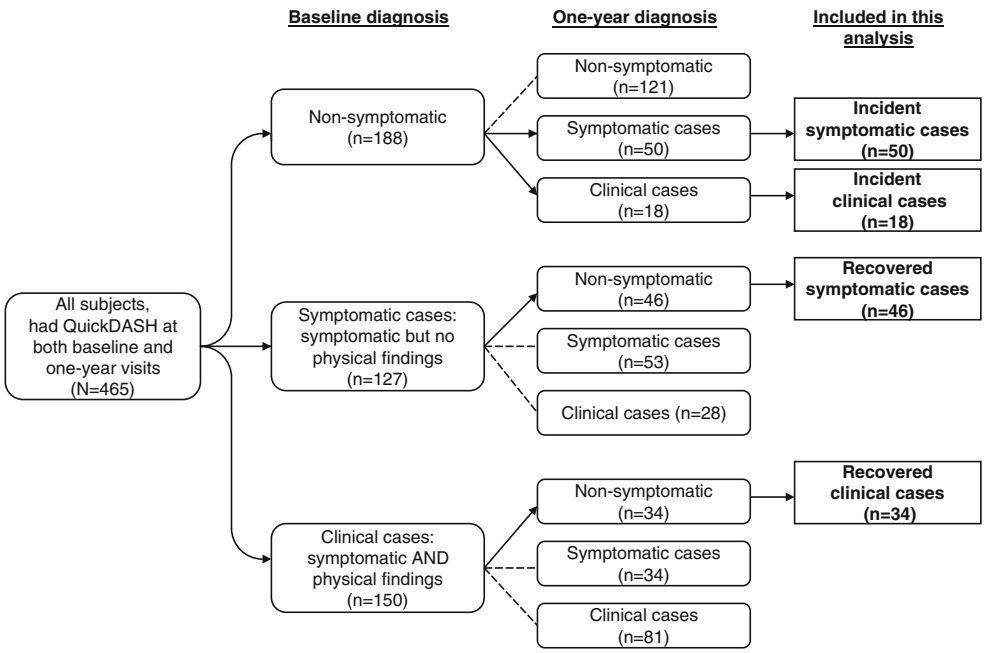

Fig. 1 Study population by diagnosis status of upper extremity musculoskeletal disorders among active workers. Seven body regions evaluated: neck, dominant or non-dominant shoulder, dominant or non-dominant elbow/forearm, and dominant or non-dominant hand/wrist

$$\text{SRM} = \frac{\text{Mean change(follow-up scores} - \text{initial scores)}}{\text{SD of the change scores}}$$

The ES and SRM are point estimates of the effect measured: 0.2 indicating small, 0.5 indicating moderate and greater than 0.8 large change [32]. In this study, ES and SRM were calculated for the following four subscales: QuickDASH, QuickDASH work module, PCS-12, and MCS-12. The ES and SRM scores were then contrasted for four subgroups of workers based on their diagnosis status. We hypothesized that (1) a responsive measure would have at least a moderate (0.5) ES or SRM in those who changed diagnosis status; (2) those who experienced changes to the worse (incident cases) would have increased scores of QuickDASH or QuickDASH work module, therefore, the ES or SRM would be positive. Likewise, for those who experienced changes to the better (recovered cases), the ES or SRM of QuickDASH or QuickDASH work module would be negative. Since the directions for the QuickDASH (including QuickDASH and QuickDASH work module) and SF-12 (PCS-12 and MCS-12) scores are opposite, i.e., more disability was indicated by a higher value of QuickDASH but a lower value of SF-12, the opposite of ES or SRM would be expected for SF-12.

Results

Description of the Study Population

Of the 733 participants at baseline, 467 (63.7%) were available for follow up at 1-year visit, and 465 had self-assessed QuickDASH and SF-12 scores at both visits. Because we define changes in diagnosis status as both self-reported symptoms and clinical cases, we excluded the subjects who had no change in their diagnosis status: 121 non-symptomatic (ES/SRM of QuickDASH −0.09/−0.13), 53 persistent symptomatic cases (ES/SRM of QuickDASH 0.03/0.03), and 81 persistent clinical cases (ES/SRM of QuickDASH −0.09/−0.08). The results indicated that neither QuickDASH nor SF-12 could detect various degrees of improvement or worsening based on persistent of symptoms, we therefore excluded those whose diagnosis status changed between symptomatic to clinical cases: 28 subjects changed from symptomatic to clinical cases (ES/SRM of QuickDASH 0.05/0.06) and 34 subjects changed from clinical cases to symptomatic (ES/SRM of QuickDASH −0.10/−0.10). We evaluated the responsiveness of the QuickDASH, the QuickDASH work module, PCS-12, and MCS-12 scores for 148 workers who were divided into four subgroups based on the changes in their diagnosis status: 50 (26.6%) incident symptomatic cases, 18 (9.6%) incident clinical cases, 46 (36.2%) recovered symptomatic cases, and 34 (22.7%) recovered clinical cases (Fig. 1). Among the 18 incident clinical cases, three subjects were TNS, two were RCS, five were LE, one was WT, and seven subjects had two or three positive diagnoses of the above at 1 year visit. Among the 34 recovered clinical cases, five were TNS, six were RCS, seven were LE, four were WT, and 12 subjects had two to four positive diagnoses of the above at baseline.

At baseline, compared with self-reported incident symptomatic cases, incident clinical cases were 7 years older (Table 1). The recovered clinical cases were 6 years older, heavier (4 units higher in BMI), and had higher proportion of co-morbidity compared with self-reported recovered symptomatic cases. The subjects were comparable on gender, race, education, and time at current work. Even though the potential severity scores could be up to 21, the maximum symptom severity score was 5 and were expectedly low at baseline for the incident cases and at 1-year for the recovered cases. There were a maximum of five body regions affected.

Responsiveness to Change

The change scores of QuickDASH and QuickDASH work module reveal the changes in diagnosis status in the expected direction. For incident cases, the scores of QuickDASH and QuickDASH work module increased with increased disability, while for recovered cases, the reverse is observed, as expected. For both subgroups of incident and recovered cases, the mean score changes in QuickDASH for clinical cases were two-times more than that of symptomatic cases, with $\geq$12 points difference between baseline and 1-year visit (Table 2). The ES and SRM for QuickDASH were >0.8, reflecting a large change among the subjects in all but the subgroup of self-reported symptomatic incident cases where moderate ES and SRM were observed. The score changes for QuickDASH work module were not as big, except for the subgroup of recovered clinical cases where the mean score dropped 12 points. The ES and SRM were >0.8 for this subgroup of subjects.

The scores of PCS-12 decreased, as expected, for the subgroup of incident clinical cases where a large change as reflected by ES and a moderate change as reflected by SRM were observed (Table 2). For other subgroups, the ES and SRM of PCS-12 or MCS-12 were either too small (ES or SRM $<$ 0.2) or the changes were not in the expected directions.

Discussion

We evaluated the responsiveness of two self-perceived functional status questionnaires, QuickDASH for disability and SF-12 for general health function, among active

Table 1 Characteristics of the study participants

	Incident cases		Recovered cases		Excluded ($n = 317$)
	Self-reported symptomatic cases ($n = 50$)	Clinically confirmed cases ($n = 18$)	Self-reported symptomatic cases ($n = 46$)	Clinically confirmed cases ($n = 34$)	
Demographics, at baseline					
Age (years), mean ± SD	35.3 ± 10.2	42.6 ± 10.9	35.5 ± 10.2	41.9 ± 11.3	41.1 ± 10.7
Male, *n*(%)	26 (52.0)	13 (72.2)	26 (56.5)	14 (41.2)	147 (46.5)
BMI, mean ± SD	26.0 ± 4.7	27.6 ± 5.6	26.5 ± 4.5	30.9 ± 6.3	27.1 ± 5.7
White race, *n*(%)	25 (50.0)	10 (55.6)	28 (60.9)	21 (61.7)	189 (59.8)
High school or more education, *n*(%)	42 (84.0)	14 (77.8)	42 (91.3)	28 (82.4)	261 (82.6)
Co-morbidity*, *n*(%)	4 (8.0)	3 (16.7)	7 (15.2)	12 (35.3)	70 (22.1)
Years at current work, median (Q1–Q3)	2.5 (0.6–4.0)	3.8 (2.3–7.6)	2.6 (0.6–4.6)	2.6 (0.7–6.6)	2.4 (0.7–6.0)
Symptom severity**					
At baseline visit					
Range	0–2	0–1	1–7	1–8	
Median (Q1, Q3)	0 (0,0)	0 (0,0)	2 (1,3)	2 (2,4)	
At 1-year visit					
Range	1–12	1–7	0–2	0–3	
Median (Q1, Q3)	1 (1,3)	2 (2,4)	0 (0,0)	0 (0,0)	
Number of body regions affected					
At baseline visit (N/A for incident cases)					
Range	–	–	1–5	1–3	
Median (Q1, Q3)	–	–	1 (1,2)	2 (1,2)	
At 1-year visit (N/A for recovered cases)					
Range	1–5	1–3	–	–	
Median (Q1, Q3)	1 (1,2)	2 (1,2)	–	–	

* Having hypertension, diabetes, gout or thyroid

** A few subjects who reported symptoms in the past seven days but were not symptomatic cases because they did not meet the criteria of the case definition on duration or frequency of the symptoms

workers. We made direct comparisons between changes in health outcomes over time and the functional status measures. In our study, QuickDASH detected clinical changes for the four subgroups of workers whose clinical outcomes of neck and UEMSD changed directions, either to worse (a healthy worker became symptomatic) or to better (a symptomatic worker became a healthy worker). Responsiveness was also present for QuickDASH work module and PCS-12 for incident and recovered clinical cases, though less than that found with QuickDASH. Responsiveness for the subgroups of incident and recovered clinical cases were larger than that found in the symptomatic subgroups.

In a separate analysis of baseline data for the same study population of 231 workers with specific clinical diagnoses of neck or UEMSD and 175 workers with symptoms only, the QuickDASH was suggested as a good outcome measure for workers with musculoskeletal upper limb disorders [20]. Findings from the present study revealed that QuickDASH is also responsive to changes in clinical diagnosis status among workers with neck or UEMSD. Less responsiveness was observed for the QuickDASH work module and PCS-12, while no responsiveness was seen for MCS-12. This observed lack of responsiveness to the QuickDASH work module may be related to worker concern about job security if their employer found out that their job performance was hindered by their symptoms, even though they were informed that all study information was confidential. Alternatively, workers may perceive a greater burden of neck or upper extremity problems with social activities than with work because the pain was not limiting their work.

Our QuickDASH change scores data were comparable to previous reports of the DASH scores, although a direct comparison of the QuickDASH score is lacking and the raw scores of the QuickDASH were smaller than those in patient populations [10, 35, 36]. The smaller QuickDASH raw scores may be an indication of relatively healthier

Table 2 Effect size (ES) and standardized response means (SRM) of QuickDASH and the SF-12 by changes of diagnosis status in 1 year follow up

	Self-reported symptomatic cases ($n = 50$)					Clinically confirmed cases ($n = 18$)				
	Mean (SD) at baseline	Mean (SD) at 1-year	Mean difference (95% CI)	ES	SRM	Mean (SD) at baseline	Mean (SD) at 1-year	Mean difference (95% CI)	ES	SRM
Incident cases										
QuickDASH	3.5 (7.0)	9.7 (12.5)	6.2 (−14.9, 27.3)	0.6	0.6	0.9 (2.2)	13.1 (13.1)	12.2 (−12.9, 37.3)	1.3	1.0
Work module of QuickDASH	1.9 (5.8)	4.4 (7.5)	2.5 (−14.6, 19.6)	0.4	0.3	1.4 (4.6)	7.6 (12.0)	6.3 (−20.0, 32.5)	0.7	0.5
PCS-12	47.8 (5.3)	48.7 (5.7)	1.0 (−9.8, 11.7)	0.2	0.2	49.6 (6.3)	43.8 (7.3)	−5.9 (−26.3, 14.5)	−0.9	−0.6
MCS-12	51.7 (6.3)	47.9 (10.5)	−3.8 (−22.8, 15.2)	−0.6	−0.4	46.5 (10.0)	50.0 (9.5)	3.5 (−18.1, 25.1)	0.4	0.3
	Self-reported symptomatic cases ($n = 46$)					Clinically confirmed cases ($n = 34$)				
	Mean (SD) at baseline	Mean (SD) at 1-year	Mean difference (95% CI)	ES	SRM	Mean (SD) at baseline	Mean (SD) at 1-year	Mean difference (95% CI)	ES	SRM
Recovered cases										
QuickDASH	8.6 (8.3)	1.7 (5.1)	−6.9 (−19.3, 5.6)	−1.0	−1.1	16.1 (12.8)	3.0 (10.0)	−13.1 (−37.4,11.2)	−1.1	−1.1
Work module of QuickDASH	4.6 (9.4)	0.5 (2.9)	−4.1 (−23.1, 14.9)	−0.6	−0.4	13.2 (17.4)	0.6 (2.4)	−12.7 (−45.2,19.9)	−1.0	−0.8
PCS-12	48.0 (6.5)	49.8 (5.1)	1.8 (−13.7, 17.3)	0.3	0.2	47.2 (6.2)	50.2 (6.6)	2.5 (−16.1,21.1)	0.3	0.3
MCS-12	50.1 (10.5)	49.7 (9.5)	−0.4 (−26.2, 25.4)	0.0	0.0	50.2 (7.6)	48.6 (10.9)	−1.7 (−24.2,20.9)	−0.2	−0.1

subjects with mild to moderate UEMSD conditions. In our study, all subjects were currently working and were queried at the workplace. In a previous study of 172 patients with different UEMSD such as shoulder arthritis and carpal tunnel syndrome, the mean change in DASH score between baseline and 12-weeks after treatment was 13 (SD 17), the ES was 0.6 and the SRM 0.8 [10]. In another study of 109 patients having surgical treatment for a variety of upper-extremity conditions, the reported mean change in DASH score 6–21 months after the treatment was 15 (SD 13), ES 0.7 and SRM 1.2 [35]. Gummesson et al. [35] considered a 10-point difference in mean DASH score as a minimal important change. In our data from a field study of active workers, the mean changes in QuickDASH scores decreased 12 point for 18 incident clinical cases and increased 13 point for 34 recovered clinical cases, with ES/SRM 1.3/1.0 for incident clinical cases, and ES/SRM −1.1/−1.1 for recovered incident cases, respectively.

Slightly lower responses were expected for incident or recovered symptomatic cases relative to those of clinical cases in these data (Table 2). Yet a moderate to large QuickDASH responsiveness for the self-reported symptomatic suggested that functional status measures such as QuickDASH can detect the smaller changes in symptoms of neck and UEMSD among active workers. This reveals the potential importance of using the QuickDASH in at least secondary prevention efforts.

PCS-12 was largely responsive only to the incident clinical cases where a decreased general physical function was observed among these workers (Table 2). For the 46 recovered symptomatic cases and 34 clinical cases, the smaller ES and SRM suggested that workers' overall wellbeing did not improve, even though their clinical diagnosis status improved. SF-12 has been associated with psychosocial work characteristics such as decision latitude and effort-reward imbalance [37]. Although the present data did not suggest SF-12 to be a good measure for diagnosis status changes among workers, future studies that evaluate other factors associated with SF-12 may improve understanding of the impact of general health status on changes in clinical status.

An important strength of the present study is that the study design offers a unique opportunity for a fuller spectrum comparison on the responsiveness of the two questionnaires. We made concurrent comparisons on changes in clinical outcomes to better (recovered cases) or to worse (incident cases) and the functional status questionnaires of disability (QuickDASH) or wellbeing (SF-12). Further, we considered seven body regions. This means that the subject was evaluated on changes from single or multiple disorders in the upper limb and on any upper limb region. Short questionnaire such as QuickDASH means less respondent burden. QuickDASH measures functional disability which helps in understanding how potential work-related disorders affect the workers lives outside of work.

Several limitations in this study are worth noting. We had a small sample, especially for the incident clinical cases. Although we had a potentially large number of subjects to follow up, evaluating the clinical outcomes

became complicated when we consider both self-reported symptoms and physical findings. A larger sample size would allow further analysis of the responsiveness stratified by gender. This is especially important for the symptomatic cases, since men tend to be reluctant to report symptoms [38, 39]. Further, the clinical diagnosis included seven body regions which resulted in excluding more subjects who remained as unchanged, although they were either symptomatic or clinical cases, at either baseline or 1-year visit. Another limitation is that our follow-up time was 1 year, which might have missed capturing the information for short term changes on clinical outcomes. Although our study offers insights into the performance of the questionnaire in a working population, the above mentioned limitations prevent us from modeling the data. Further study with more workers in varying occupation is needed.

In summary, the results of this study highlight two important issues. First, the magnitude or size of the changes as reflected by ES and SRM suggested that QuickDASH helps in understanding changes in functional status among workers with neck or UEMSD. Second, this study supports the notion that QuickDASH could be a relevant supplement to the standard clinical diagnosis and thus offers a more complete picture of clinical meaning of health status changes for a working population of mainly healthy subjects. Of particular importance is that workers with mild or moderate symptoms may be detected earlier. These workers would have the opportunity to have reduced disability by change of work tasks and the possibility of early recovery.

Appendix

Case definitions of symptoms and physical findings of tension neck syndrome (TNS), rotator cuff syndrome (RCS), lateral epicondylitis (LE), wrist tendinitis (WT), and carpal tunnel syndrome (CTS).

Current Neck Symptoms

Neck pain, stiffness, spasm, burning, numbness or tingling in the neck region in the last 7 days, AND occurring more than three times or lasting more than 1 week in the previous 12 months, AND no traumatic injury onset.

Tension Neck Syndrome (TNS)

Tension neck syndrome: current symptoms AND positive physical examination: pain in neck/trapezius area with resisted head rotation, neck extension/flexion, or lateral rotation.

Current Shoulder Symptoms

Pain, stiffness, spasm, unable to raise arms, burning, numbness, or tingling of the shoulder region in the last 7 days, AND occurring more than three times or lasting more than 1 week in the previous 12 months, AND no traumatic injury onset.

Rotator Cuff Syndrome (RCS)

Current shoulder symptoms, AND positive physical examination in the same shoulder: resisted shoulder abduction, external rotation, internal rotation (pain in respective tendon insertion area) OR "painful arc" (pain in rotator cuff area with active shoulder abduction typically at 60–120°).

Current Elbow Symptoms

Pain, aching, stiffness, burning, numbness, or tingling in the elbow or forearm region in the past 7 days, AND occurring more than 1 week or occurred more than three times in the previous 12 months; AND no previous accident or sudden injury at the elbow/forearm area.

Lateral Epicondylitis (LE)

Current elbow symptoms at the lateral side of the elbow or forearm; AND positive physical examination on the same elbow: pain at the lateral humeral epicondyle region on resisted wrist extension or tenderness on palpation of the lateral epicondyle.

Current Hand/Wrist Symptoms

Pain, aching, stiffness, burning, numbness, or tingling in the hand/wrist in the last 7 days, AND occurring more than three times or lasting more than 1 week in the previous 12 months, AND no traumatic injury onset.

Wrist Tendinitis (WT)

Current symptoms and positive physical examinations: resisted wrist extension or flexion with the elbow extended.

Current Carpal Tunnel Syndrome Symptoms

Symptoms of burning, or pain/numbness/tingling in the planar median nerve distribution of the hand in the last 7 days, AND lasting for more than 1 week OR occurred more than three times in the previous 12 months, AND no acute traumatic onset.

Carpal Tunnel Syndrome (CTS)

Current symptoms AND positive electrodiagnostic test (NCV) in the same hand *for distal median motor or sensory nerve* which meets A and B or meets A and C below.

Criteria	Description
A	Median motor latency 8 cm > 4.5 ms, median sensory latency D2-wrist 14 cm > 3.5 ms, or mid palmar latency 8 cm > 2.2 ms
B	Ulnar sensory latency 14 cm < 3.7 ms
C	Median sensory latency (14 cm) minus ulnar sensory latency >0.5 ms. or mid-palmar difference >0.3 ms

Criteria were adapted from the Washington State Department of Labor and Industries Medical Treatment Guidelines [26].

References

1. Bongers PM, Kremer AM, ter Laak J. Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist? A review of the epidemiological literature. Am J Ind Med. 2002;41:315–42.
2. Aptel M, Aublet-Cuvelier A, Cnockaert JC. Work-related musculoskeletal disorders of the upper limb. Joint Bone Spine. 2002; 69:546–55.
3. Silverstein BA, Welp E, Nelson NA, Kalat J. Claims incidence of work related musculoskeletal disorders of the upper extremities: Washington State, 1987 through 1995. Am J Public Health. 1998; 88:1827–33.
4. Ashbury FD. Occupational repetitive strain injuries and gender in Ontario, 1986 to 1991. J Occup Environ Med. 1995;37:479–85.
5. Silverstein B, Adams D. Work-related musculoskeletal disorders of the neck, back and upper extremity in Washington State. Technical Report 40-11-2007. Washington State Department of Labor and Industries, Olympia Washington. 2007.
6. Katz JN, Stock SR, Rempel D, Franzblau A, Gray RH. Classification criteria and severity assessment in work-associated upper extremity disorders: methods matter. Am J Ind Med. 2000; 38:369–72.
7. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, Jørgensen K. Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18:233–7.
8. Franzblau A, Salerno DF, Armstrong TJ, Werner RA. Test-retest reliability of an upper-extremity discomfort questionnaire in an industrial population. Scand J Work Environ Health. 1997;23: 299–307.
9. Stock S, Streiner D, Tugwell P, Loisel P, Reardon R, Durand, MJ. 1996. Validation of the neck and upper limb index (NULI), a functional status instrument for work related musculoskeletal disorders. In 25ème Congrès annuel de la Commission internationale de santé au travail/CIST.
10. Beaton DE, Davis AM, Hudak P, McConnell S. The DASH (disabilities of the arm, shoulder and hand) outcome measure: what do we know about it now. Br J Hand Ther. 2001;6:109–18.
11. Atroshi I, Gummesson C, Andersson B, Dahlgren E, Johansson A. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire. Reliability and validity of the Swedish version evaluated in 176 patients. Acta Orthop Scand. 2000;71: 613–8.
12. Offenbaecher M, Ewert T, Sangha O, Stucki G. Validation of a German version of the disabilities of arm, shoulder, and hand questionnaire (DASH-G). J Rheumatol. 2002;29:401–2.
13. Padua R, Padua L, Ceccarelli E, Romanini E, Zanoli G, Amadio PC, Campi A. Italian version of the disability of the arm, shoulder and hand (DASH) questionnaire. Cross-cultural adaptation and validation. J Hand Surg [Br]. 2003;28:179–86.
14. Rosales RS, Delgado EB, De La Lastra-Bosch ID. Evaluation of the Spanish version of the DASH and carpal tunnel syndrome health-related quality-of-life instruments: cross-cultural adaptation process and reliability. J Hand Surg [Am]. 2002;27:334–43.
15. Bot SD, Terwee CB, van der Windt DA, Bouter LM, Dekker J, de Vet HC. Clinimetric evaluation of shoulder disability questionnaires: a systematic review of the literature. Ann Rheum Dis. 2004;63:335–41.
16. Turchin DC, Beaton DE, Richards RR. Validity of observer-based aggregate scoring systems as descriptors of elbow pain, function, and disability. J Bone Joint Surg. 1998;80:154–62.
17. Beaton DE, Wright JG, Katz JN. Development of the QuickDASH: comparison of three item-reduction approaches. J Bone Joint Surg Am. 2005;87:1038–46.
18. McHorney CA, Ware JE Jr. Construction and validation of an alternate form general mental health scale for the Medical Outcomes Study Short-Form 36-Item Health Survey. Med Care. 1995;33:15–28.
19. Ware JE, Wright JG, Katz JN. A 12-item short-form health survey. Construction of scales and preliminary tests of reliability and validity. Med Care. 1996;34:220–33.
20. Fan ZJ, Smith C, Silverstein BA. Assessing validity of the QuickDASH and SF-12 as surveillance tools among workers with neck or upper extremity musculoskeletal disorders. J Hand Ther. 2008;21:354–65.
21. Kirkley A, Griffin S, McLintock H, Ng L. The development and evaluation of a disease-specific quality of life measurement tool for shoulder instability. The Western Ontario Shoulder Instability Index (WOSI). Am J Sports Med. 1998;26:764–72.
22. MacDermid JC, Richards RS, Donner A, Bellamy N, Roth JH. Responsiveness of SF-36, DASH and PRWE and physical impairments in evaluating recovery after distal radius fracture. J Hand Surg [Am]. 2000;25:330–340.
23. Silverstein BA, Viikari-Juntura E, Fan ZJ, Bonauto DK, Bao S, Smith C. Natural course of nontraumatic rotator cuff tendinitis and shoulder symptoms in a working population. Scand J Work Environ Health. 2006;32:99–108.
24. ACGIH. Threshold limit values for chemical substances and physical agents and biological exposure indices. 2000.
25. Sluiter JK, Rest KM, Frings-Dresen MHW. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. Scand J Work Environ Health. 2001;27: 1–102.
26. Washington State Department of Labor and Industries. Diagnosis and treatment of work-related carpal tunnel syndrome. Med Treat Guidel. 2005;32–36.
27. The Institute for Work & Health and American Academy of Orthopaedic Surgeon. The QuickDASH outcome measure. 2006.
28. De Bruin AF, Diederiks PM, De Witte LP, Stevens FC, Philipsen H. Assessing the responsiveness of a functional status measure: the Sickness Impact Profile versus the SIP68. J Clin Epidemiol. 1997;50:529–540.
29. Terwee CB, Diederiks JP, Wiersinga WM, Prummel MF, Bossuyt PM. On assessing responsiveness of health-related quality of life

instruments: guidelines for instrument evaluation. Qual Life Res. 2003;12:349–362.
30. Kazis LE, Anderson JJ, Meenan RF. Effect sizes for interpreting changes in health status. Med Care. 1989;27:S178–89.
31. Olejnik S, Algina J. Measures of effect size for comparative studies: applications, interpretations and limitations. Contemp Educ Psychol. 2000;25:241–86.
32. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Lawrence Erlbaum Associates; 1988.
33. Liang MH, Fossel AH, Larson MG. Comparisons of five health status instruments for orthopedic evaluation. Med Care. 1990;28: 632–42.
34. Hedges LV, Olkin I. Statistical methods for meta-analysis. Orlando: Academic Press; 1985.
35. Gummesson C, Atroshi I, Ekdahl C. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: longitudinal construct validity and measuring self-rated health change after surgery. BMC Musculoskelet Disord. 2003;12:349–62.
36. Navsarikar A, Gladman DD, Husted JA, Cook RJ. Validity assessment of the disabilities of the arm, shoulder and hand questionnaire (DASH) for patients with psoriatic arthritis. J Rheumatol. 1999;26:2191–4.
37. Kudielka BM, Hanebuth D, von Kanel R, Gander ML, Grande G, Fischer JE. Health-related quality of life measured by the SF12 in working populations: associations with psychosocial work characteristics. J Occup Health Psychol. 2005;10:429–40.
38. Dahlberg R, Karlqvist L, Bildt C, Nykvist K. Do work technique and musculoskeletal symptoms differ between men and women performing the same type of work tasks? Appl Ergon. 2004;35: 521–9.
39. Silverstein B, Fan ZJ, Smith CK, Bao S, Howard N, Spielholz P, Bonauto D, Viikari-Juntura E. Gender adjustment or stratification in discerning upper extremity musculoskeletal disorder risk? Scand J Work Environ Health. 2009;35:113–26.