Assessing Validity of the *Quick*DASH and SF-12 as Surveillance Tools among Workers with Neck or Upper Extremity Musculoskeletal Disorders

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ABSTRACT: The purpose of this article was to assess validity of the regional Disabilities of Arm, Shoulder, and Hand (*Quick*DASH) and Short-Form 12 (SF-12) for surveillance purpose. We compared the predictive, discriminate, and concurrent validity of the *Quick*-DASH and SF-12 among 231 workers with specific clinical diagnoses of neck or upper extremity musculoskeletal disorders (UEMSDs) and 175 workers with symptoms only. Compared to those with symptoms only, the odds of being any neck or UEMSD case were 1.45 (95% confidence interval [95% CI]: 1.24–1.70) and 0.66 (95% CI: 0.48–0.91) with every 10-point increase in *Quick*-DASH disability and physical component scale (PCS-12) scores, respectively. The clinical cases had significantly higher *Quick*DASH disability (23.0 vs. 14.3, $p < 0.0001$) and lower PCS-12 scores (44.8 vs. 47.3, $p = 0.0133$) than those with symptom only. The *Quick*-DASH disability scores were moderately correlated with the PCS-12 scores (rho = −0.40) among the clinical cases. Either *Quick*-DASH or PCS-12 can be used as a simple surveillance tool in an active working population.

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Musculoskeletal disorders remain the predominant occupational health problem in most industrialized countries.[1–5] These reported injuries and illnesses result in a tremendous amount of lost productivity and have a detrimental impact on both the working and nonworking lives of many people. U.S. Department of Labor, Bureau of Labor Statistics in 2004 reported that the national rate for all work-related musculoskeletal disorders cases resulting in days away from work was 141.3 per 10,000 and in Washington State, it was 302.7 per 10,000 full-time equivalent employees.[6] In Washington State, neck and upper extremity musculoskeletal disorders (UEMSDs) account for about 22% of all workers' compensation (WC) claims and up to 17% of all direct compensation costs. The average lost time per compensable claim of neck or UEMSD was 236 days.[7]

Although musculoskeletal complaints are among the most prevalent in workers, occupational medicine lacks evidence-based intervention measures for certain disorders, particularly in their early stages.[8] Studies of musculoskeletal disorders have used a wide variety of definitions that were based either on both symptoms and physical examination results (diagnosed clinical cases) or on symptoms alone. Prevalence of symptoms and clinical diagnosis in working populations has ranged 50–85% and 2–25%, respectively.[9–11] The lack of standardized diagnostic methods for assessment of UEMSD has been problematic in understanding the relationships between symptoms, clinical diagnoses, injury reporting, functional impairment, and disability. Validated instruments that evaluate the impact on functional ability can be used for surveillance purposes to 1) identify jobs requiring intervention and 2) assess worker status with respect to clinical course related to medical and job interventions. Improving surveillance instruments will increase the effectiveness of surveillance efforts by identifying workers at earlier stages of morbidity, thus allowing work sites to develop and implement interventions more effectively.

The Disabilities of the Arm, Shoulder, and Hand (DASH), a 30-item questionnaire, is a region-specific measure of health status designed to assess single or multiple upper extremity disabilities.[12] The DASH has been shown to be reliable and valid in different languages,[13–16] and in patient populations with various upper extremity disorders.[12,17,18] It has not

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been used for surveillance purposes. The *Quick*DASH is an 11-item questionnaire that has similar reliability as DASH.[19] The *Quick*DASH also has a four-item optional work module that is scored separately to measure the ability of performing work tasks.[19]

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.[20] The Short-Form 12 (SF-12), a shorter version of SF-36, has been demonstrated to replicate SF-36 scores in differentiating the health status of persons with varying symptoms and acute conditions.[21]

Health surveillance is characterized by systematic, ongoing, simple, reproducible data collection, analysis and reporting methods for groups of people over time. In the workplace, it can be used to assess the functioning of UEMSD prevention and control efforts.[22] Given the availability of clinically validated regional health status instruments such as the *Quick*DASH, it is appropriate to determine whether the *Quick*DASH is a useful health surveillance tool for active workers, particularly those with self-reported neck or upper extremity pain. Although SF-12 was not designed to measure outcomes of specific conditions, it is a generic health status measure that reflects the physical and mental health status of the workers.

The specific aims of this study are to compare predictive, discriminate, and concurrent validity of the *Quick*DASH and SF-12 in a group of actively employed workers with neck or UEMSD symptoms. The research questions posed were as follows: 1) Do the *Quick*DASH and SF-12 scores predict clinical cases of neck or UEMSDs? 2) Can the *Quick*DASH and SF-12 differentiate the symptoms between cases with different levels of body region affected, and between cases with different severity levels? And 3) Are the scores of the *Quick*DASH and the SF-12 correlated?

METHODS

Study Design and Health Data Collection

A cross-sectional data analysis was conducted from a study of 733 workers of 12 manufacturing and service work sites in Washington State.[23] The multidisciplinary study was designed to evaluate the risk factors for developing work-related neck or UEMSD. A workplace walkthrough 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 work 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 data were collected at the work sites during working hours, including a structured interview on personal characteristics (age, gender, race, education level, hand dominant, etc.), medical history (diabetes, hypertension, gout, thyroid, etc.), and working history. Measured weight and height were obtained for all subjects for calculating the body mass index (BMI). The subjects were screened for symptoms of any pain or discomfort in the previous 12 months and in the past seven days. A body map was used to ascertain more precise location of symptoms. Information on symptom onset, duration, frequency, severity, traumatic injury, and whether the symptoms interfered with work pace or quality of work, as well as the number of lost workdays due to symptoms were obtained. Symptom severity in seven days before the assessment was collected for each participant at the following body regions: neck, left or right shoulder, left or right elbow/forearm, and left or right hand/wrist using a four-point scale: mild, moderate, severe, and very severe. Due to the lack of very severe symptom cases, we combined the scales of severe or very severe and grouped severity scores into three categories: mild, moderate, and severe. An examiner (a physician, a registered nurse, or a physical therapist) who was blinded to the interview completed a brief physical examination on the neck, shoulder, elbow/forearm, and hand/wrist for all subjects. The standardized upper extremity physical examination on passive, active, and resisted motions of the neck and upper extremity was conducted bilaterally.[25] For the diagnosis of carpal tunnel syndrome, electrodiagnostic testing of the median and ulnar nerves at the wrist were done on the dominant hand unless symptomatic on the nondominant side.[26]

Case Definitions

All subjects in this analysis met the criteria of having positive symptoms of neck or upper extremity, defined as pain, numbness, tingling, aching, stiffness, or burning in the neck, shoulder, elbow/forearm, or hand/wrist in seven days before the assessment; *and* the symptoms lasted for more than one week or occurred more than three times in the previous 12 months; *and* no previous acute traumatic injury to the symptomatic body region.

The subjects were divided into two groups based on the clinical diagnoses:

1. *Clinical cases*: neck, shoulder, elbow/forearm, or hand/wrist symptoms *and* at least one physical

finding in the symptomatic area. The clinical cases included tension neck syndrome, rotator cuff tendinitis, lateral or medial epicondylitis, carpal tunnel syndrome, and flexor/extensor tendinitis of the hand/wrist, etc. The specific diagnoses of the clinical cases were aggregated by body regions of neck, dominant and nondominant side of shoulder, elbow/forearm, and hand/wrist. Case definitions were ascertained by physical examination and symptoms consistent with that reported by Sluiter et al.[25]

2. *Symptoms only*: neck, shoulder, elbow/forearm, or hand/wrist symptoms *but* no physical findings in the symptomatic body region.

In analysis, because neither *Quick*DASH nor SF-12 asked side-specific questions by body region, each participant was evaluated for a maximum of four body regions: neck, shoulder, elbow/forearm, and hand/wrist. For example, if one person had shoulder symptoms on either left or right side, or on both sides, the person was considered as having symptoms on one body region. One person, therefore, has a maximum of four body regions. For symptom severity on shoulder, elbow/forearm, and hand/wrist, if one side was more severe than the other side at the same body region, the category of more severe was chosen for that specific body region.

Study Population

Of the 733 participants, 453 (61.8%) had self-assessed nontraumatic symptoms of neck or UEMSD in one or more body regions. Among them, 238 (32.5% of 733) were confirmed as clinical cases of neck or UEMSD. After excluding those with missing data, we evaluated the *Quick*DASH and the SF-12 scores among 231 clinical cases of neck or UEMSD and 175 workers with upper extremity symptoms only (Figure 1).

Questionnaires on *Quick*DASH and SF-12

The *Quick*DASH questionnaire was administered by trained interviewers. Workers rated their ability to perform different physical functions using the 11-item *Quick*DASH disability questionnaire and their ability to perform work tasks using the four-item *Quick*DASH work questionnaire. Each item was rated on a five-point scale. The *Quick*DASH disability and work scores were calculated separately according to published guidelines[27] and yielded global scores ranging from 0 to 100, with higher scores reflecting increased disability.

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 scale (PCS-12) and mental component scores (MCS-12).[21] Each subscale is scored from 0 to 100, with higher scores representing better function.

Statistical Analyses

Characteristics of the Study Subjects

Student's t-test or chi-square test was used for comparison of demographic characteristics and the *Quick*DASH and SF-12 scores between the two groups of study subjects.

Group Prediction and Odds Ratios

Logistic regression was conducted to assess whether the *Quick*DASH or the SF-12 scores predicted clinical cases of neck or UEMSD. The odds of being a clinical case of neck or UEMSD with every 10-point increase of the *Quick*DASH and the SF-12 scores was estimated, with 95% confidence interval (95% CI). The odds ratio was considered significant if the 95% CI did not contain 1. Individual factors of age, gender, BMI, and comorbidity of hypertension, diabetes, gout, or thyroid were adjusted simultaneously in the multivariate logistic regression modeling.

Group Differences for Assessing Discriminate Validity

Two two-factor analyses of variance (ANOVAs) were used to test the differences between cases with clinical versus symptom as measured with the *Quick*DASH and SF-12 scores separated out 1) by cases with different numbers of body areas involved (neck, shoulder, elbow/forearm, and hand/wrist) and 2) by cases with different levels of severity (mild, moderate, and severe). The main effect on the differences between the two groups, the region/severity differences and the interaction of the two were evaluated. A third two-factor ANOVA was also used to test the level of perceived interference of symptoms with work activities for the two groups of study subjects.

Correlation for Assessing Concurrent Validity

Spearman rank correlation coefficients were calculated between the *Quick*DASH and the SF-12 scores for all clinical cases. Specifically, the correlations between scores of the *Quick*DASH disability and work, and between the PCS-12 and the MCS-12 were examined first for any neck or UEMSD clinical cases, followed by the body-region specific clinical cases. The correlation among the *Quick*DASH disability scores, the *Quick*DASH work scores, the PCS-12, and the MCS-12 were also examined for all clinical cases and the body-region specific clinical cases. Because a higher *Quick*DASH score indicates higher

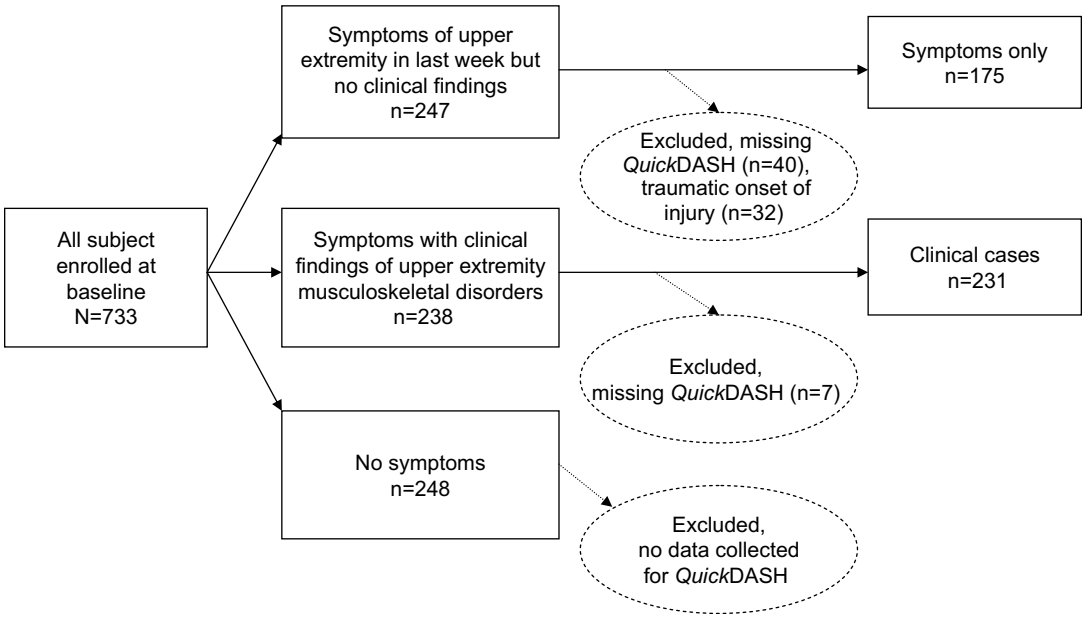

FIGURE 1. *Selection of the study population.*

disability and a lower PCS-12 (or MCS-12) score indicate better health, the *Quick*DASH and PCS-12 (or MCS-12) scores are negatively correlated. Poor correlation was indicated by values of $|\text{rho}| < 0.40$, moderate correlation of $0.40 \leq |\text{rho}| < 0.75$, and high correlation of $|\text{rho}| \geq 0.75$.[28]

All analyses were conducted using SAS (version 9.1) statistical software.[29] Statistical inferences were based on a significance level of p (two-sided) <0.05.

RESULTS

Characteristics of the Study Subjects

Table 1 presents the demographic characteristics of the study population. The 231 neck or UEMSD clinical cases were older, had higher BMI, worked more years in the current job, and were more likely to have comorbidities of hypertension, diabetes, gout, or thyroid than those with symptoms only ($p < 0.05$, Table 1). The two groups of participants were comparable in gender, race, and education ($p > 0.05$). More clinical cases of neck or UEMSD reported filing any WC claims than those with symptoms only ($p < 0.05$, Table 1). The 231 clinical cases had significantly higher *Quick*DASH disability and work scores (23.0 vs. 14.3 and 16.2 vs. 9.4, respectively, $p < 0.001$), and lower PCS-12 (44.8 vs. 47.3, $p = 0.013$) than that of 175 participants with symptom only. There were no differences in MCS-12 scores between the two groups ($p > 0.05$). The *Quick*DASH and PCS-12 outcomes were compatible but the increased disability is expressed as increasing *Quick*DASH score and decreasing PCS-12 score.

Group Prediction and Odds Ratios

Logistic regression using subjects with symptoms only as the referent group indicated that the odds of having any neck or UEMSD clinical cases were 1.45 (95% CI: 1.24−1.70) with every 10-point increase in *Quick*DASH disability scores, 1.26 (95% CI: 1.11−1.44) with every 10-point increase in *Quick*DASH work scores, and 0.66 (95% CI: 0.48−0.91) with every 10-point increase in PCS-12 scores (Table 2). By body region, higher *Quick*DASH disability scores significantly increased the odds of being a shoulder, elbow/forearm, or hand/wrist clinical case. Higher *Quick*DASH work scores increased the odds of being an elbow/forearm or hand/wrist clinical case, but the scores did not increase the odds of being a neck or shoulder case. The PCS-12 or the MCS-12 scores did not predict body-region specific diagnostic membership.

Group Differences and Discriminate Validity

Number of Body Regions

Figure 2 compared the *Quick*DASH and the SF-12 scores between cases with clinical versus symptoms by different numbers of body regions involved. There were 188 clinical cases and 106 symptoms-only cases at one body region. The number of clinical cases and symptom only cases were 31 and 48 at two body regions; and 12 and 21 at three or four body regions. The *Quick*DASH disability and work scores were higher, and the PCS-12 scores were lower among the neck or UEMSD clinical cases than those

TABLE 1. **Demographic Characteristics of the Study Population and the Scores of *Quick*DASH and SF-12**

	All Subjects (N = 733)	*Neck and UEMSD Clinical Cases (n = 231)*	*Symptom Only (n = 175)*	*p-Value**
Age (yr) mean ± SE	39.5 ± 0.5	43.2 ± 0.7	39.3 ± 0.8	<0.001
Gender (% male)	52.3	41.1	45.1	0.42
Race (%)				0.65
White	59.5	63.2	61.7	
Asian	18.0	17.8	18.9	
Hispanic	13.0	9.1	12.0	
Others	9.6	10.0	7.4	
Body mass index, mean ± SE	27.3 ± 0.3	28.7 ± 0.4	26.6 ± 0.5	0.001
Education (% more than high school)	83.5	84.0	87.4	0.33
Working in manufacturing (%)	86.5	87.0	80.6	0.08
Years at current job, mean ± SE	4.1 ± 0.3	5.1 ± 0.4	4.0 ± 0.4	0.048
Comorbidities† (%)	19.5	27.8	17.1	0.014
Right dominant hand (%)	90.5	90.8	89.8	0.88
Filing any workers' compensation claims (%)	13.5	23.8	11.4	0.002
*Quick*DASH disability scores, mean ± SE	—	23.0 ± 1.1	14.3 ± 1.0	<0.001
*Quick*DASH work scores, mean ± SE	—	16.2 ± 1.3	9.4 ± 1.1	<0.001
PCS-12, mean ± SE	47.1 ± 0.4	44.8 ± 0.6	47.3 ± 0.6	0.013
MCS-12, mean ± SE	49.8 ± 0.6	48.3 ± 0.7	49.1 ± 0.9	0.43

DASH = Disabilities of the Arm, Shoulder, and Hand; SF-12 = Short-Form 12; UEMSD = upper extremity musculoskeletal disorder; PCS-12 = physical component scale; MCS-12 = mental component score; SE = standard error.
*p-Value: Student's t-test or chi-square test.
†Comorbidities include self-reported hypertension, diabetes, gout, or thyroid.

with symptom only for each comparison depicted (Figures 2A–2C). As the number of neck or UEMSD clinical case status or symptoms increased, the *Quick*DASH disability and work scores increased, and the PCS-12 scores decreased. Among the neck or UEMSD clinical cases, the mean *Quick*DASH disability (Figure 2A) and work scores (Figure 2B) were about twofold higher for the subjects who were diagnosed at three or four body regions ($n = 12$) than that of one body region ($n = 188$) (*Quick*DASH disability scores of 39.8 vs. 21.0, *Quick*DASH work scores of 28.6 vs. 14.2, respectively, $p < 0.01$). Similarly, the *Quick*DASH disability and work scores were significantly higher for symptoms of upper extremity at three or four body regions ($n = 21$) relative to symptoms at one body region ($n = 106$) (the *Quick*DASH disability scores of 21.5 vs. 12.0, the *Quick*DASH work scores of 16.4 vs. 8.2, respectively, $p < 0.05$). The PCS-12 scores were significantly lower for the 27 participants with clinical cases of neck or UEMSD at two body regions than that of the 163 clinical cases of neck or UEMSD at one body region (40.5 vs. 45.7, $p = 0.002$). There were no differences in MCS-12 scores by diagnosis or by the count of the symptoms or clinical cases (Figure 2D).

Symptom Severity

Table 3a compared the *Quick*DASH and the SF-12 scores between cases with clinical versus symptoms by the level of symptom severity. For each body region, group differences between neck or UEMSD

TABLE 2. **The Odds Ratio and 95% Confidence Interval of Any Neck or UEMSD by the *Quick*DASH and the SF-12 Scores***

	QuickDASH		*SF-12*	
	Disability score	*Work score*	*PCS-12*	*MCS-12*
Any neck or UEMSD clinical cases ($n = 231$) vs. any neck or UEMSD symptoms ($n = 174$)	**1.45 (1.24–1.70)**	**1.26 (1.11–1.44)**	**0.66 (0.48–0.91)**	0.87 (0.69–1.09)
Neck clinical cases ($n = 40$) vs. neck symptoms only ($n = 53$)	1.16 (0.89–1.51)	1.15 (0.88–1.49)	0.79 (0.40–1.57)	1.00 (0.61–1.65)
Shoulder clinical cases ($n = 79$) vs. shoulder symptoms only ($n = 46$)	**1.35 (1.03–1.78)**	1.16 (0.92–1.45)	0.59 (0.31–1.10)	1.14 (0.74–1.76)
Elbow/forearm clinical cases ($n = 65$) vs. elbow/forearm symptoms only ($n = 36$)	**1.70 (1.20–2.41)**	**1.59 (1.15–2.19)**	0.51 (0.26–1.01)	0.77 (0.49–1.21)
Hand/wrist clinical cases ($n = 104$) vs. hand/wrist symptoms only ($n = 131$)	**1.45 (1.20–1.75)**	**1.26 (1.08–1.48)**	0.81 (0.53–1.22)	0.87 (0.65–1.15)

DASH = Disabilities of the Arm, Shoulder, and Hand; SF-12 = Short-Form 12; UEMSD = upper extremity musculoskeletal disorder; PCS-12 = physical component scale; MCS-12 = mental component score.
*Bolding of the value indicates statistically significant at $\alpha = 0.05$ level.

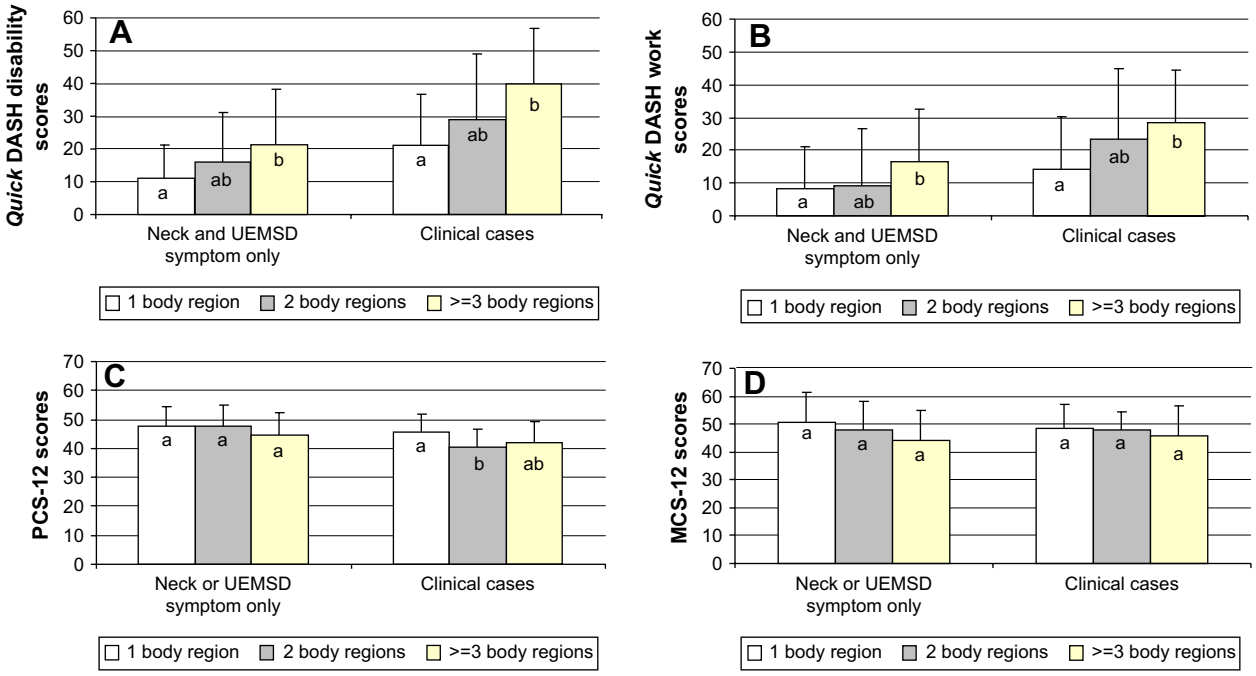

FIGURE 2. *Mean and standard deviations of QuickDASH disability (**A**), QuickDASH work (**B**), SF-12 physical (**C**), and SF-mental (**D**) scores by diagnosis group and number of body region. Different letters indicate significant different means ($p < 0.05$).*

clinical cases and symptoms were compared first. Among any neck or UEMSD cases, the *Quick*DASH disability and work scores were significantly higher at elbow/forearm and hand/wrist regions, and the PCS-12 scores significantly lower at elbow/forearm region, compared to the symptoms-only cases at the same body region ($p < 0.05$, Table 3a). The symptom severity within clinical cases or symptoms was further examined. Among the clinical cases, the *Quick*DASH disability and work scores were significantly higher, and the PCS-12 scores were significantly lower, when the severe symptoms were compared to the mild symptoms on all of the four body regions measured ($p < 0.05$, Table 3a). Among the symptoms-only cases, the *Quick*DASH disability and work scores were significantly higher for the severe symptoms relative to the mild symptoms at shoulder, elbow/forearm, and hand/wrist regions, whereas the PCS-12 scores were significantly lower at hand/wrist region (Table 3a). MCS-12 could not differentiate symptom severity in this analysis. There were no significant interactions detected between the groups (clinical cases or symptoms-only cases) and the symptom severity in this analysis.

Symptoms Interference with Work

The *Quick*DASH disability and work scores, and the PCS-12 were significantly different between the two diagnosis groups on reporting symptoms interference with work ($p < 0.05$, Table 3b). Among the 231 clinical cases, the *Quick*DASH disability and work scores were significantly higher, and PCS-12 scores significantly lower, if the neck or UEMSD symptoms interfered with activities outside of work, required light duty, or caused missing workdays, compared to the 175 symptom only cases (Table 3b). MCS-12 scores could not detect the difference between the clinical cases and the symptom only cases on the questions of whether the symptoms interfered with work.

Correlation between the Scores of *Quick*DASH and SF-12 and Concurrent Validity

Among all clinical cases, the *Quick*DASH disability scores were moderately correlated with the *Quick*DASH work scores and the PCS-12 scores ($\text{rho} = 0.63$ and $\text{rho} = -0.40$, respectively, Table 4). The *Quick*DASH work scores were poorly correlated with the PCS-12 and the MCS-12 scores ($\text{rho} = -0.35$ and $\text{rho} = -0.12$, respectively, Table 4). By body region, the *Quick*DASH disability scores were moderately correlated with the *Quick*DASH work scores ($0.58 \leq \text{rho} \leq 0.68$) at the four body regions measured and with the PCS-12 scores ($0.45 \leq |\text{rho}| \leq 0.64$) at shoulder, elbow/forearm, or hand/wrist regions (Table 4). The *Quick*DASH work scores were moderately correlated with the PCS-12 at elbow/forearm and hand/wrist regions ($|\text{rho}| > -0.44$, Table 4). The MCS-12 scores were in general poorly correlated with the *Quick*DASH disability, *Quick*DASH work scores, and the PCS-12 scores (Table 4).

TABLE 3A. **The *Quick*DASH and the SF-12 on Symptom Severity***

	Sample Size		*QuickDASH Disability Score*			*QuickDASH Work Score*			*PCS-12*			*MCS-12*		
	Clinical Cases	*Symptom Only*	*Clinical Cases*	*Symptom Only*	*p-Value*	*Clinical Cases*	*Symptom Only*	*p-Value*	*Clinical Cases*	*Symptom Only*	*p-Value*	*Clinical Cases*	*Symptom Only*	*p-Value*
Symptom severity in last seven days														
Neck	23	36	14.9[a]	15.3[a]	0.86	9.8[a]	7.3[a]	0.87	45.6[a]	47.1[a]	0.71	51.0[a]	53.1[a]	0.67
Mild	13	17	25.9[a]	19.1[a]		13.5[a]	15.4[ab]		48.1[a]	46.6[a]		45.7[ab]	50.0[a]	
Moderate	4	—	47.7[b]	—		45.3[b]	—		36.7[b]	—		37.4[b]	—	
Severe														
Shoulder	22	20	12.6[a]	17.8[a]	0.81	9.1[a]	7.1[a]	0.84	46.9[a]	46.7[a]	0.34	50.6[a]	49.1[a]	0.29
Mild	41	20	20.5[ab]	21.6[ab]		15.1[a]	13.8[a]		44.0[a]	46.3[a]		50.3[a]	48.2[a]	
Moderate	16	7	42.6[c]	36.0[c]		30.5[b]	28.6[b]		37.9[b]	43.0[a]		46.8[a]	41.6[a]	
Severe														
Elbow/forearm	21	20	17.4[a]	12.0[a]	0.010	9.2[a]	3.8[a]	0.005	45.4[a]	47.9[a]	0.010	47.3[a]	50.8[a]	0.89
Mild	31	11	26.1[b]	24.0[b]		22.4[b]	9.1[ab]		42.9[a]	45.5[a]		47.5[a]	47.9[a]	
Moderate	13	6	43.9[c]	35.9[c]		37.0[c]	17.7[b]		37.2[b]	41.7[a]		44.0[a]	47.8[a]	
Severe														
Hand/wrist	37	79	19.4[a]	12.1[a]	<0.001	11.9[a]	5.0[a]	0.005	46.6[a]	49.5[a]	0.19	48.0[a]	49.1[a]	0.79
Mild	45	38	27.8[b]	23.2[b]		18.5[b]	14.5[b]		44.8[ab]	46.1[ab]		48.7[a]	48.4[a]	
Moderate	21	15	40.7[c]	33.2[c]		31.3[c]	29.6[c]		41.0[b]	41.8[b]		46.0[a]	46.1[a]	
Severe														

DASH = Disabilities of the Arm, Shoulder, and Hand; SF-12 = Short-Form 12; UEMSD = upper extremity musculoskeletal disorder; PCS-12 = physical component scale; MCS-12 = mental component score.

*Two-factor analysis of variance with unequal cells. p-Value indicates the group differences between clinically positive and negative cases. Different letters indicate significant differences of severity or whether symptoms affect work activities ($p < 0.05$). Cell number <4 was listed as "—."

TABLE 3B. The *Quick*DASH and the SF-12 on Symptoms Interference with Work*

	Sample Size		*Quick*DASH Disability Score			*Quick*DASH Work Score			PCS-12			MCS-12		
	Clinical Cases (*n* = 231)	*Symptom Only* (*n* = 175)	*Clinical Cases*	*Symptom Only*	*p-Value*	*Clinical Cases*	*Symptom Only*	*p-Value*	*Clinical Cases*	*Symptom Only*	*p-Value*	*Clinical Cases*	*Symptom Only*	*p-Value*
Symptoms interfere with activities outside of work														
No	99	100	15.7[a]	10.2[a]	<0.001	10.3[a]	4.6[a]	<0.001	47.4[a]	50.1[a]	0.001	49.9[a]	49.4[a]	0.49
Yes	132	75	28.5[b]	19.8[b]		20.5[b]	15.8[b]		43.0[b]	43.6[b]		47.1[a]	48.4[a]	
Symptoms require light duty														
No	190	156	21.7[a]	13.8[a]	<0.001	14.7[a]	9.3[a]	<0.001	45.4[a]	48.8[a]	0.002	49.0[a]	47.6[a]	0.48
Yes	41	19	29.1[b]	18.3[a]		22.9[b]	10.5[a]		41.8[b]	49.9[a]		44.9[a]	44.1[a]	
Symptoms cause missing workdays														
No	193	158	21.1[a]	13.7[a]	<0.001	14.4[a]	8.8[a]	<0.001	45.6[a]	48.0[a]	0.002	48.5[a]	48.5[a]	0.49
Yes	38	17	32.5[b]	20.5[b]		25.0[b]	15.4[a]		40.4[b]	39.7[b]		46.6[a]	53.2[b]	

DASH = Disabilities of the Arm, Shoulder, and Hand; SF-12 = Short-Form 12; UEMSD = upper extremity musculoskeletal disorder; PCS-12 = physical component scale; MCS-12 = mental component score.

*Two-factor analysis of variance with unequal cells. p-Value indicates the group differences between clinically positive and negative cases. Different letters indicate significant differences of severity or whether symptoms affect work activities ($p < 0.05$).

DISCUSSION

We assessed the predictive, discriminate, and concurrent validity of the *Quick*DASH and the SF-12 scores among active workers with self-reported neck or UEMSD symptoms. The findings of this analysis suggest that the *Quick*DASH disability scores, the *Quick*DASH work scores, and the PCS-12 scores could predict whether subjects had any clinically diagnosed cases of neck or UEMSD. The *Quick*DASH disability or work scores could differentiate the severity of symptoms on shoulder, elbow/forearm, and hand/wrist regions, and the PCS-12 on hand/wrist region. A moderate correlation was observed between the *Quick*DASH disability and work scores or PCS-12 among neck or UEMSD clinical cases. Although both the *Quick*DASH disability/work scores and the PCS-12 scores could differentiate between the two groups of workers with any musculoskeletal symptoms, the *Quick*DASH disability/work scores appeared to be better than that of the PCS-12 in measuring body-region specific symptoms. This supports the use of the *Quick*DASH as an outcome measure for people with musculoskeletal upper-limb disorders, whereas PCS-12 as a more generic measure of health status. The MCS-12 in general did not appear useful in measuring at-work disability in this analysis.

The finding that the clinical cases were older than that of symptoms only was consistent with several previous studies.[30,31] The prevalence of self-reported neck and upper extremity symptoms in our study was 62%, close to that of a recent report with similar definitions in symptoms in two working populations,[32–34] but higher than that of another previous report.[35] Bernard (1994), using questionnaire only, reported that 41% of the 973 newspaper employees as having symptoms of UEMSDs. The criterion for the symptom severity in Bernard's study was at least "moderate," whereas ours included "mild" symptoms. The prevalence of UEMSD clinical cases in our study was 33%, compared to a 22% of the 518 telecommunication employees in Hales' study,[9] and 15% in women and 11% in men in a working population in France,[32] although Roquelaure's study counted six clinically diagnosed musculoskeletal disorders (MSDs) that did not include disorders on the neck.

Although higher *Quick*DASH scores and lower PCS-12 indicate decreased functional ability, the magnitude of odds ratio for predicting whether subjects had any neck or UEMSD clinical diagnosis was similar using the *Quick*DASH disability, the *Quick*DASH work scores, or the PCS-12 (Table 2). For every 10-point increase of the tested scores, the odds of being a clinical case increased 45% with the *Quick*DASH disability scores, 26% with the *Quick*DASH work scores, and decreased 34% with

TABLE 4. **Correlations between the *Quick*DASH and the SF-12 among 231 Neck or UEMSD Clinical Cases***

	QuickDASH		*SF-12*	
	Disability Score	*Work Score*	*PCS-12*	*MCS-12*
Any neck or UEMSD clinical cases ($n = 231$)				
Disability score	1.0			
Work score	0.63 (<0.001)	1.0		
PCS-12	−0.40 (<0.001)	−0.35 (<0.001)	1.0	
MCS-12	−0.19 (0.007)	−0.12 (0.09)	−0.18 (0.012)	1.0
Neck clinical cases ($n = 40$)				
Disability score	1.0			
Work score	0.58 (<0.001)	1.0		
PCS-12	−0.18 (0.28)	−0.38 (0.024)	1.0	
MCS-12	−0.40 (0.016)	−0.20 (0.24)	−0.01 (0.96)	1.0
Shoulder clinical cases ($n = 79$)				
Disability score	1.0			
Work score	0.62 (<0.001)	1.0		
PCS-12	−0.45 (<0.001)	−0.31 (0.009)	1.0	
MCS-12	−0.20 (0.007)	−0.23 (0.05)	−0.06 (0.60)	1.0
Elbow/forearm clinical cases ($n = 65$)				
Disability score	1.0			
Work score	0.67 (<0.001)	1.0		
PCS-12	−0.64 (<0.001)	−0.65 (<0.001)	1.0	
MCS-12	−0.16 (0.25)	−0.09 (0.49)	−0.03 (0.85)	1.0
Hand/wrist clinical cases ($n = 103$)				
Disability score	1.0			
Work score	0.68 (<0.001)	1.0		
PCS-12	−0.49 (<0.001)	−0.44 (<0.001)	1.0	
MCS-12	−0.10 (0.37)	−0.09 (0.41)	−0.32 (0.003)	1.0

DASH = Disabilities of the Arm, Shoulder, and Hand; SF-12 = Short-Form 12; UEMSD = upper extremity musculoskeletal disorder; PCS-12 = physical component scale; MCS-12 = mental component score.
*Spearman correlation coefficients (p-value).

the PCS-12 scores. These data suggest that the *Quick*DASH and the PCS-12 are comparable in measuring disability among workers with any neck or UEMSD. By body region, however, the *Quick*DASH disability or work scores were more useful in predicting clinical diagnosis than that of the PCS-12 (Table 2). The PCS-12 reflects the effect of physical disability including comorbidity. The significant association between any neck or UEMSD clinical cases and the PCS-12 as found in this analysis, even after adjusting for comorbidity (Table 2), implies that the impact of UEMSD among workers may not be limited to the upper extremity, but to an overall health function. Moreover, the PCS-12 could differentiate clinical cases of neck or UEMSD between one body region and those involved with multiple body regions. In Figure 2C, the PCS-12 scores were not significantly lower for those with neck or UEMSD clinical cases at three or four body regions ($n = 10$) than that of one body region. When two or more body regions were combined (sample size increased to $n = 37$) and were compared to those of neck or UEMSD clinical cases at one body region ($n = 163$), the PCS-12 scores were significantly lower (40.8 for those of neck or UEMSD at more than one body region vs. 45.7 for those at one body region, $p < 0.001$). It is actually somewhat surprising that the PCS-12 could differentiate upper extremity cases as well as it did because the questions on the PCS-12 would seemingly be more likely to identify back and perhaps shoulder disorders given that the questions address activities such as climbing stairs and vacuuming rather than specific distal upper extremity activities such as sewing, knitting, and washing dishes.

It is also interesting that the MCS-12 did not differentiate cases from noncases. This may be because the population was actively working, rather than being off work. Previous studies have found mental health compromised in those off work with, for example, carpal tunnel syndrome.[36]

The results of this analysis indicate that higher *Quick*DASH disability scores significantly increased the odds of being body-region specific UEMSD clinical cases, except for the neck (Table 2). The reason why there were no difference in *Quick*DASH disability scores between the clinical cases and symptoms-only subjects for neck in this analysis may be explained by 1) the *Quick*DASH instrument does not include neck specific question and therefore there is no clear way to assess neck disabilities using the *Quick*DASH and 2) physical exams in our study excluded palpation and focused only on range of

motion. It is likely that this exam was less sensitive than those using palpation in diagnostic criteria.[32]

The *Quick*DASH disability scores were generally higher than that of work scores at the same comparison level (Figures 2A and 2B and Table 3a). This is presumed to be due to the following: 1) workers' perceptions of symptoms affecting activities outside of work may differ than that of at work; 2) workers felt reluctant to admit to symptoms affecting their job performance, especially during the work hours when the interviews were conducted, and thus discount their at-work disability. The *Quick*DASH disability scores were lower in our study relative to patient population with a variety of upper extremity conditions,[37–39] reflecting a relatively healthier working population with less disability. The symptoms of neck or UEMSD, however, may require light duty and cause missing workdays and thus affect job performance and productivity, as indicated by the significantly higher *Quick*DASH disability and work scores, and lower PCS-12 scores (Table 3b), even for workers without discernible medical diagnoses.

We have not found previous studies on the correlation between the *Quick*DASH and the SF-12 for measures of disorders for all regions of upper extremity; this limited us from making a direct comparison. Atroshi et al.[13] reported stronger correlation between scores of the DASH and the PCS-12 (rho = 0.74) than that of the DASH and the MCS-12 (rho = 0.51) among 176 patients with upper extremity conditions. In our analysis of 231 workers with clinically diagnosed neck or UEMSD, the correlations between the *Quick*DASH disability scores and the PCS-12 or the MCS-12 scores were lower (Table 4). Our results on hand/wrist MSDs were compared to a previous study on wrist disorders.[40] Jain et al's study of 43 patients with ulnar wrist disorders,[40] using the DASH and the SF-36, reported the correlations between the DASH and the PCS-36 of 0.48 ($p = 0.001$), and the DASH and the MCS-36 of 0.23 ($p = 0.15$). Our study of 103 hand/wrist clinical cases, using the *Quick*DASH and the SF-12, indicated a moderate correlation between the *Quick*DASH disability and the PCS-12 $|\text{rho}| = 0.49$ ($p < 0.001$), and a poor correlation between the *Quick*DASH disability and the MCS-12 $|\text{rho}| = 0.10$ ($p = 0.37$) (Table 4).

This analysis was limited by its cross-sectional design. Further studies of the instruments' ability to detect change over time in a longitudinal analysis are needed. Cautions should be taken in interpretation of the results due to the smaller sample sizes in some categories by symptom severity (Table 3a).

The *Quick*DASH and SF-12 assess a different construct looking at the same issue through different lenses, one from the perspective of wellness or workers, one from the perspective of disability of workers. We concluded that either the region-specific measure of health status such as the *Quick*DASH or the generic measures such as the PCS-12 could be used as surveillance tools for at-work disability of any neck or UEMSD. The *Quick*DASH disability assessment could also be used to predict body region specific clinical cases of neck or UEMSD. The *Quick*DASH work scores did not provide superior results to the *Quick*DASH disability scores. It may be that workers would be more reluctant to indicate difficulty in performing their job because of fear of economic consequences. However, the work scores may still be useful for assessing workplace interventions. Using the *Quick*DASH disability and work scores as tools for neck or UEMSD surveillance in the workplace could lead to improved detection of neck or UEMSD symptoms and clinical cases, increase the ability to intervene along the causal pathway of disability and could improve the ability to assess interventions aimed at reducing neck or UEMSDs.

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#1. Approximately what % of all workers' compensation claims (in Washington) are UEMSDs
   a. 30-35
   b. 20-25
   c. 10-15
   d. 40-45

#2. The (Quick) DASH and the PCS-12 were
   a. equivalent
   b. not correlated
   c. positively correlated
   d. negatively correlated

#3. The results suggest that
   a. neither the (Quick) DASH, nor the PCS-12, nor the MSC-12 was able to differentiate the symptom severity
   b. the PCS-12 and the (Quick) DASH were very similar in their ability to differentiate the symptom severity
   c. the (Quick) DASH was better at differentiating the symptom severity than the MSC-12
   d. both the MSC-12 and the PCS-12 were better at differentiating the symptom severity than the (Quick) DASH

#4. The authors consider
   a. the (Quick) DASH and the PCS-12 tools to measure the same phenomena
   b. the (Quick) DASH a better outcome measure for UEMSDs and the PCS-12 a more generic measure of health status
   c. the MSC-12 the best outcome measure for UEMSDs
   d. neither the (Quick) DASH, nor the PCS-12, nor the MSC-12 valid tools for UEMSDs

#5. The authors consider both the PCS-12 and the (Quick) DASH as valid measurement tools for UEMSDs
   a. true
   b. false

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