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Psychometric Properties of the Modified 5-D Itch Scale in a Burn Model System Sample of People With Burn Injury

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Abstract

The aim of this study is to evaluate the psychometric properties of the 4-dimension (4-D) itch scale, a modified version of the 5-dimension itch scale, in a sample of individuals with severe burn injury and/or burn injuries to hands, face, and/or feet. Four of the five domains of the 5-dimension itch scale (4-D) were administered to individuals who reported itching (N = 173) in the Burn Injury Model System Centers Program longitudinal study at either 5 or 10 years after injury. Analyses of the scale included evaluation of dimensionality, internal consistency, associations with other symptoms or quality of life measures, and an examination of floor and ceiling effects. Fit values from a one-factor confirmatory factor analysis were acceptable, supporting unidimensionality. Cronbach's α was 0.82, indicating good internal consistency. One item had a corrected item–total score correlation of less than 0.40. Associations between the 4-D and other measures were in the expected direction and magnitude. A negligible number of participants (no more than two) selected the lowest category for all items (ie, minimal floor effect) or the highest category for all items (ie, minimal ceiling effect). 4-D had acceptable psychometric properties in a sample of adult burn injury survivors; however, the scale could be improved by removing the item with a low correlation with the total score. (J Burn Care Res 2017;38:e402–e408)

Itching, or pruritus, is a very common and unpleasant symptom after a major burn injury. It affects quality of life of burn survivors,[1] including sleep quality, concentration, and participation in major life activities.[2] Severe itching can also increase stress experienced from the burn injury and affect the healing process.[3] Prevalence of itch in people after a major burn injury varies according to the severity of the injury, time since injury, and how itch is measured, but it has been reported as low as 16% and as high as 87%[2,4–6] in studies with follow-up length ranging from postdischarge to 2 years postinjury. Holavanahalli et al[7]

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found that itching was reported by 72% of participants at an average of 17 years after injury and 44% of participants more than 30 years after burn. A study by Carrougher at al[6] found that itch was also reported by a large portion of burn survivors at 5 and 10 years after injury.

The association between itch and health outcomes is an important area of research. Published studies report negative correlations between pruritus and different aspects of health in people with burn injuries and with other conditions.[3,6,8–10] Several studies found a significant relationship between pain and pruritus.[6,11–13] Carrougher et al reported a correlation between pain and itch of 0.5.[10,12]

In addition to pain, sleep problems are common during burn recovery[14] and appear to be associated with pruritus. Carrougher et al[6] (whose study also used some data from the Burn Model System [BMS] database) found that itch negatively affected sleep in a majority of burn survivors 4 to 10 years after injury (59%) and reported that people with itch also reported more sleep problems. This connection between sleep quality and pruritus has also been reported in a number of conditions other than burn recovery.[15–17] For instance, in patients with systemic sclerosis, pruritus was significantly correlated with sleep disturbance score, and after controlling for demographic variables and other symptoms, pruritus significantly predicted sleep quality.[15]

Itch also affects mood. Although there is a dearth of research on the relationship between pruritus and depression in people with burn injury, researchers have reported an association between depression and itch in other conditions. For instance, pruritus severity was associated with depression in patients with psoriasis, atopic dermatitis, and chronic idiopathic urticarial.[18]

Assessment of itch is important in clinical practice for making treatment decisions and to identify who is at risk for long-term problems with itching. Research assessing itch is essential for better understanding of the trajectory of itching over time and of the variables that predict future problems with itching. The availability of standardized instruments for measuring itch validated in people with burn injury is essential for comparative effectiveness studies and studies of strategies for itch treatment or management. However, few instruments are available to assess itching in burn survivors. Burn-related pruritus is typically measured using one of three single items aimed at measurement of itch severity. These include the Visual Analog Scale (a 0 to 10 scale on which respondents make a mark on a line representing the level of itch), the Numerical Rating Scale, a Likert scale with seven response options, or one itch item from the Burn Specific Health Scale (BSHS).[19] Although these instruments are short and relatively easy to administer, none of them evaluate the multidimensional nature of pruritus or its impact on quality of life. The 5-dimension (5-D) itch scale[20] was specifically developed to address these shortcomings and was designed for use in clinical trials. It was also designed to be brief, applicable to multiple diseases or conditions, and capable of detecting change over time.[20] Although the original development sample included 51 individuals with burns (22% of the total sample), no studies to date have evaluated the psychometric performance of the 5-D itch scale specifically in adults with severe burns. In addition, the original 5-D itch scale development study suggested that the performance of the 5-D itch scale may be different in burns than in the other included

conditions (primary dermatological disease, HIV, hepatobiliary disease, or chronic kidney disease) because the scores of people with burn on 5-D itch scale were lower than those of people with other conditions because of itching only at the site of the burn. In this study, we examined how a 4-dimension (4-D) functioned in people with burn injury to provide guidance to burn researchers and clinicians on the use of this version for measuring itch in burn survivors.

METHODS

Participants

The federally funded multicenter national research study BMS has maintained a longitudinal database on outcomes after burn injury since 1993. The goal of the BMS program is to study health outcomes of people with more severe injuries and/or injuries to the critical locations of hands, face, and/or feet; thus, enrolled participants are required to have received surgery for their burn injuries. In addition to burn-related surgery, current BMS database enrollment criteria for adult participants include meeting one of the following criteria: 1) greater than 10% TBSA burned and ≥65 years of age; 2) greater than 20% TBSA burned and 18 to 64 years of age; 3) electrical high voltage/lightning injury; or 4) burn injury to the hand, face, or feet. Database structure, enrollment, follow-up strategies, and data verification processes have been previously described in detail[21]; however, the 4-D itch scale was only administered in a supplemental pilot project. Patient and injury characteristics, as well as functional and psychosocial outcomes used in this study, were collected at discharge and 5 and 10 years after injury between 2009 and 2012 using in-person and phone interviews and mailed paper surveys. Originally participants agreed to data collection up to 2 years after injury and had to be reconsented for 5- and 10-year follow-up. Of the 1287 participants originally enrolled and eligible for the supplemental study, 389 (30%) agreed to participate in the 5- and 10-year follow-up. The sample used in this study consisted of those who completed the surveys at 5 or 10 years after injury and who reported postburn itching (n = 173) in response to the following yes/no screening question, “During the last 2 weeks, have you had any itching in the area of the burns, skin grafts, or donor sites?” To better understand the differences between the group with and without itching, we used *t*-tests and χ^2 tests to compare their injury and demographic characteristics.

Instruments

Itch Scale.—The 5-D itch scale has been recommended as an outcome measure for itch in clinical trials.[20] The 5-D itch scale includes the domains of itch duration, degree, direction, disability, and distribution. Three domains (duration, degree, and direction) are made up of one item, and the disability domain includes four items that assess the impact of itching on daily activities. The highest score on any one of the four items from the disability domain is used as the overall disability domain score. The distribution domain includes a checklist of potentially affected body parts, and the score corresponds to the number of body parts affected by itching. To minimize respondent burden (the complete survey included 109 items without the itch items), only four domains were assessed in this study, and the fifth domain (distribution) was not administered. This was supported by the evidence in the original study that the burn sample had lower scores in the distribution section of the measure because

burn injury itching is wound and graft site specific.[20] Because the distribution domain was not included in this study, we will use the term 4-D (instead of 5-D itch scale) to refer to the modified 5-D itch scale version. Because of this nonstandard administration, two ways of calculating scores were used. Scoring method I used the scoring suggested by Elman et al,[20] ie, adding the item scores from duration, degree, and direction domains and the highest score of the four items from the disability domain. Scoring method I was used to examine floor and ceiling effects and the associations between itching and other symptoms and health-related quality of life (HR-QOL). Scoring method II calculated the total score of the 4-D by adding the raw scores of individual items (ie, the single-item scores from duration, degree, and direction domains and four items from the disability domain). Because the scoring method I does not provide a summed score based on the raw score of each item, the scoring method II was used to examine the corrected-item total score correlation.

Symptoms and Health-Related Quality of Life Measures.—At 5 and 10 years, the BMS collected data to measure physical and mental health (SF-12©[22]), health and disability (World Health Organization Disability Assessment Scale [WHODAS][23]), depression (Patient Health Questionnaire 9[24]), insomnia intensity and interference (Insomnia Severity Index[25]), and burn-specific health (BSHS-Brief[26]). One pain interference item (during the past 4 weeks, how much did pain interfere with your normal work [including both work outside the home and housework]) was administered. The SF-12© physical component score and mental component score measure HR-QOL. Scores range from 0 to 100; the population norm is 50, and higher scores indicate better functioning. The WHODAS measures health and disability. This study utilized the WHODAS 32-item simple scoring version of the measure, where scores range from 32 to 160, with higher scores indicating more severe disability. The Patient Health Questionnaire 9 measures depression with a total score that ranges from 0 to 27, with higher scores indicating more depression and scores of 20 and higher indicating severe depression. The Insomnia Severity Index measures insomnia using seven items with a range of possible scores from 0 to 28, with higher scores indicating more severe insomnia. The BSHS-Brief is a 40-item measure that assesses several areas of functioning of the burn survivor using several sub-scales, where each subscale score is calculated using the mean of all items in that subscale. These sub-scales include heat sensitivity, affect, hand function, treatment regimens, work, sexuality, interpersonal relationships, simple abilities, and body image, and higher scores indicate better functioning.

Correlations Between Itch and HR-QOL.—On the basis of the published literature discussed earlier, we hypothesized that higher itch scores would be associated with lower quality of life as measured with the SF-12, higher levels of pain, and higher scores for sleep disturbance and insomnia. We also expected a moderate positive correlation between the itch and depression scores in people with burn injury.

Analyses

Evaluation of Unidimensionality.—To examine whether there is support for a summary score for the 4-D and whether the data meet the assumptions of item response theory (IRT), a one-factor confirmatory factor analysis (CFA) with weighted least squares mean- and

variance-adjusted estimation was modeled using Mplus software 6.1.[27] Goodness of fit was evaluated using χ^2 test, comparative fit index (CFI),[28] Tucker-Lewis index (TLI),[29] and root mean square error of approximation (RMSEA).[30,31] CFI and TLI values greater than 0.95 are preferred,[32] and a RMSEA value of less than 0.08 indicates adequate fit.[33] Although the fit of the model is always of general interest, here the purpose of the analyses was to establish sufficient unidimensionality. Research has shown CFI to be the most sensitive to potential multidimensionality, whereas RMSEA is the least sensitive.[34]

Internal Consistency.—Internal consistency is used to examine whether items measure the same underlying construct. We computed Cronbach's α and corrected item–total score correlations. According to Streiner and Norman,[35] an acceptable range of Cronbach's α indicating internal consistency is between 0.7 and 0.9, values greater than 0.9 imply possible item redundancy, and values less than 0.7 mean the items do not correlate well with one another. The corrected item–total score correlation is calculated using the correlation between each item and the summed score based on all other items (six items) in the scale, except for the specific item being examined. Spearman's rank order correlations were calculated for the corrected item–total score correlations using the raw total scores of the 4-D (ie, scoring method II). Corrected item–total score correlations greater than 0.40 are typically regarded as evidence of interitem reliability.[36]

Floor and Ceiling Effects.—Finally, floor and ceiling effects were assessed by calculating the percentage of individuals with either the lowest possible or highest possible scores on the 4-D total score. Floor and ceiling effects occur when participants choose either the lowest (floor) or the highest (ceiling) response for all items in the scale. They are problematic because they limit the range of measurement and can result in suboptimal assessment of participants. A floor or ceiling effect greater than 15% is considered too high.[37,38] Mplus software 6.1 was used to evaluate unidimesionality, and SAS version 9.3 was used for all other analyses.

RESULTS

Participants

As shown in Table 1, of the 389 burn survivors who responded to the long-term follow-up surveys, 44% (n = 173) reported itching and were included in the analyses. Of these, 64% (n = 111) were men and 62% (n = 108) were non-Hispanic whites. The average age at the time of burn injury was 34 years (SD = 17). The average TBSA burned was 28% (SD = 20), and 67% (n = 116) of the injuries were caused by fire. The average TBSA grafted was 19% (SD = 17), and 94% of participants required an autograft (n = 162; two participants had no grafting and nine participants did not respond). Table 2 shows the distribution of responses to each 4-D item. Approximately 40% (n = 69) of participants reported at least a moderate level of intensity in their itch symptoms in the past 2 weeks (on a scale including "not present," "mild," "moderate," "severe," and "unbearable").

The study participants reported on average lower mental and physical health than the U.S. general public by about 5 points (1/2 SD), low depressive symptoms, and subclinical insomnia symptoms. These and additional scores are presented in Table 1.

Of the people who responded to 4-D in the supplemental study (n = 389), 45% (n = 173) reported itching at 5 and/or 10 years after injury and were included in our data set. When examining the similarities and differences between those who reported itching and those who did not, we found no significant differences in age at the time of burn ($P = .42$), TBSA burned ($P = .19$), or sex ($P = .39$).

Analyses

Evaluation of Unidimensionality.—Fit statistics of the one-factor CFA for the 4-D were acceptable, supporting unidimensionality. CFI exceeded the recommended level of 0.95 (0.96), providing evidence for unidimensionality. TLI just missed the recommended level of 0.95 (0.94). RMSEA did not meet the recommended level (0.22 with a 90% confidence interval, 0.18–0.25], nor did χ^2 test (127.76 with 14 *df*, $P < .001$).

Internal Consistency. .—Cronbach's α was 0.82, indicating good internal consistency of the 4-D. One item (ie, over the past 2 weeks, has your itching gotten better or worse compared with the previous months?) had a corrected item–total score correlation of less than 0.40 (Table 3).

Association With HR-QOL Measures.—The correlations between the 4-D scores and scores on HR-QOL measures using the scoring method I were all in the expected direction and of at least a moderate magnitude, ranging from 0.36 to 0.55 (Table 4). All correlations were statistically significant at the .01 level. As hypothesized, a higher 4-D score was associated with lower scores on physical, mental, and burn-specific health, and with higher scores on depression, disability, pain interference, and insomnia.

Floor and Ceiling Effects

Only two participants (1%) selected the lowest category for every item based on the scoring method I (ie, four items from four domains; obtained the minimum score of 4) and one participant selected the highest category for every domains (ie, obtained the maximum score of 20).

DISCUSSION

The four domains of the 5-D itch scale administered to burn injury survivors in this study had acceptable psychometric properties. In particular, CFA results provided adequate support for the use of a summary score, and internal consistency was acceptable for all but one item that measures change in itching. The psychometric properties of the scale may be improved by removing this item, which does not contribute adequately to the summary score. Floor and ceiling effects were negligible. The relationships between the 4-D score and the score on other health domains supported the validity of the 4-D score. For example, the correlations between the SF-12 physical component score and mental component score, and the 4-D score in this study were similar to the previously reported results,[10] especially considering the use of different instruments. The correlation between insomnia and itch in our sample was a little higher, but similar to the previously reported correlation between itch intensity and sleep disturbance in systemic sclerosis. In our sample, we found a

higher positive correlation between itch and depression than those reported in people with dermatological conditions associated with itch. In our sample, the correlation between pain interference and itch measured by the 4-D was moderate (0.5). We were unable to find other published studies with independent samples that reported a correlation between pain and itch. In addition, published research with people with conditions associated with pruritus, such as psoriasis, often used condition-specific quality of life measures, so the effects of pruritus were difficult to compare across conditions or studies.[39–41]

The results of this study should be viewed within its limitations. First, the BMS database is not representative of the general population of people with burn injuries because of its inclusion criteria, which focus on patients with major burn injuries or injuries to the critical areas of hands, face, and/or feet. Second, only four domains of the 5-D itch scale were administered. In future research, the psychometric properties of the 5-D itch scale summary score in burn injury survivors should be examined. In addition, with a larger sample of participants, IRT analyses could be used to further examine the scale properties, including functioning of the response categories and potential bias (ie, differential item functioning) because of age, gender, severity, of injury or other variables. Third, some of our hypotheses were based on a previously published article that used the same database. As a result, we were unable to compare our results with previously published results on the relationship between pain and itch.

In summary, our results support the use of the 4-D scale for measuring itch in people with burn injury for both research and clinical practice. In particular, we found the four-item scale to be sufficiently unidimensional to support a summary score, to have adequate internal consistency and minimal floor and ceiling effects. Because the instrument is brief, it is suitable for administration in busy clinics and for inclusion in epidemiological research. Future research directions include analyses with larger samples that use IRT methods to examine functioning of response options and explore the impact of deleting of the item with the lowest correlation with the summary score. Longitudinal analyses would be useful to examine sensitivity to change, and further research is needed in samples that include people with less severe burn injuries. The 4-D itch scale could be used to better understand itching and its relationship with pain, depression, and sleep.

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Table 1.

Demographic, symptom, and quality of life characteristics of burn injury participants (n = 173)

Age at injury (yr)	34 ± 17
%TBSA burned	27.9 ± 19.8
%TBSA grafted (n = 162)	18.92 ± 17.24
SF-12 MCS (n = 166)	44.8 ± 12.1
SF-12 PCS (n = 166)	45.1 ± 10.1
PHQ-9 (n = 165)	7.3 ± 6.1
	(6% with a score of 20 or above)
ISI (n = 108)	13.4 ± 6.1
BSHS-B (n = 157)	118.5 ± 29.4
WHODAS (n = 158)	59.8 ± 23.5
Gender	
Male	111 (64.2)
Female	62 (35.8)
Ethnicity	
Non-Hispanic white	108 (62.4)
Others	64 (37.0)
Missing	1 (0.6)
Injury etiology	
Fire/flame	116 (67.2)
Grease	17 (9.8)
Electricity	14 (8.1)
Scald	11 (6.4)
Flash	7 (4.0)
Others	8 (4.6)

BSHS-B, Burn Specific Health Scale Brief; *ISI*, Insomnia Severity Index; *PHQ-9*, Patient Health Questionnaire 9; *SF-12 PCS*, SF-12 Physical Health Component Score; *SF-12 MCS*, SF-12 Mental Health Component Score; *WHODAS*, World Health Organization Disability Assessment Scale.

Data are represented as mean ± SD and n (%).

Table 2.

Distribution of 4-dimension itch scale responses in persons with severe burn injury (n = 173)

	n (%)
Duration: During the past 2 weeks how many hours a day have you been itching?	
Less than 6 h a day	134 (77.46)
6–12 h a day	20 (11.56)
12–18 h a day	11 (6.36)
18–23 h a day	2 (1.16)
All day	6 (3.47)
Degree: Please rate the intensity of your itching over the past 2 weeks?	
Not present	11 (6.36)
Mild	93 (53.76)
Moderate	49 (28.32)
Severe	18 (10.40)
Unbearable	2 (1.16)
Direction: Over the past 2 weeks, has your itching gotten better or worse compared with the previous month?	
Completely resolved	14 (8.09)
Much better, but still present	31 (17.92)
Little bit better, but still present	38 (21.97)
Unchanged	83 (47.98)
Getting worse	7 (4.05)
Disability: Rate the impact of your itching on the following activity over the last 2 weeks	
Sleep	
Never affects sleep	79 (45.66)
Occasionally delays falling asleep	47 (27.17)
Frequently delays falling asleep	16 (9.25)
Delays falling asleep and occasionally wakes me up at night	26 (15.03)
Delays falling asleep and frequently wakes me up at night	5 (2.89)
Leisure/social	
Never affects this activity	85 (49.13)
Rarely affects this activity	37 (21.39)
Occasionally affects this activity	41 (23.70)
Frequently affects this activity	8 (4.62)
Always affects this activity	2 (1.16)
Housework/errands	
Never affects this activity	92 (53.18)
Rarely affects this activity	32 (18.50)
Occasionally affects this activity	33 (19.08)
Frequently affects this activity	11 (6.36)
Always affects this activity	5 (2.89)
Work/school	
Never affects this activity	85 (49.13)

	n (%)
Rarely affects this activity	37 (21.39)
Occasionally affects this activity	31 (17.92)
Frequently affects this activity	13 (7.51)
Always affects this activity	6 (3.47)
Missing	1 (0.58)

Table 3.

Corrected item-total score correlation (Spearman) for each item

	Corrected Item–Total Score Correlation
Duration	
Correlation	0.41
P value	<.001
n	172
Degree	
Correlation	0.45
P value	<.001
n	172
Direction	
Correlation	0.28
P value	<.001
n	172
Disability—sleep	
Correlation	0.62
P value	<.001
n	172
Disability—leisure/social	
Correlation	0.72
P value	<.001
n	172
Disability—housework/errands	
Correlation	0.76
P value	<.001
n	172
Disability—work/school	
Correlation	0.68
P value	<.001
n	172

Table 4.

Spearman correlations between the 4-D total score and symptom and quality of life measures

4-D	SF-12 PCS	SF-12 MCS	BSHS-B	WHODAS	PHQ-9	Pain Interference (From SF-12)	ISI
Correlation	−0.42	−0.36	−0.55	0.49	0.49	0.49	0.40
P value	<.001	<.001	<.001	<.001	<.001	<.001	<.001
n	166	166	157	158	165	167	108

BSHS-B, Burn Specific Health Scale Brief; *ISI*, Insomnia Severity Index; *PHQ-9*, Patient Health Questionnaire 9; *SF-12 MCS*, SF-12 Mental Health Component Score; *SF-12 PCS*, SF-12 Physical Health Component Score; *WHODAS*, World Health Organization Disability Assessment Scale; *4-D*, 4-dimensional Itch Scale.

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