HHS Public Access

Author manuscript

Eur J Pain. Author manuscript; available in PMC 2017 January 01.

Published in final edited form as:

Eur J Pain. 2016 January ; 20(1): 130–137. doi:10.1002/ejp.704.

Validity of Three Rating Scales for Measuring Pain Intensity in Youths with Physical Disabilities

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Abstract

Background—There is growing evidence confirming that youths with physical disabilities are at risk for chronic pain. Although many scales for assessing pain intensity exist, it is unclear whether they are all equally suitable for youths. The aim of this study was to address this knowledge gap by comparing the validity of the Numerical Rating Scale (NRS-11), the Wong Baker FACES Pain Rating Scale (FACES), and a 6-point categorical Verbal Rating Scale (VRS-6) for assessing pain intensity among youths (aged 8 to 20) with physical disabilities.

Methods—One hundred and thirteen youths (mean age= 14.19 years; SD = 2.9) were interviewed and asked to rate their current pain intensity and recalled (in the past week) worst, least, and average pain with the NRS-11 and the FACES. Participants were also asked to rate their average pain intensity during the past 4 weeks using a VRS-6, and were administered measures assessing pain interference, disability and psychological functioning.

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Conflicts of interest: nothing to be reported

Author contributions: All authors reviewed and provided comments on drafts and subsequent revisions of this article, and approved the final version for submission and publication. MPJ and JM participated in the design of the analyses, provided input in the data analysis plan. MPJ conducted the statistical analyses. JM prepared the first draft of the manuscript. MPJ, EC, RV, MR, ES, CT, and JME provided input into the data analysis plan and feedback on multiple drafts of the manuscript.

Results—Analyses showed that all of the pain intensity measures were associated positively with each other. Nevertheless, the NRS-11 appeared to out-perform both the VRS-6 and in particular the FACES scale with respect to: (1) the associations with the validity criterion (i.e., pain interference, disability and psychological functioning) and (2) a lack of any moderating effect of age on the association between the measure and the criterion variables.

Conclusions—The findings support the validity of the NRS-11 for assessing pain intensity in youths with physical disabilities between the ages of 8 and 20 years.

Keywords

Numerical Rating Scale; Wong-Baker FACES Pain Rating Scale; Verbal Rating Scale; pain intensity; measurement; validity; physical disabilities; youths

Introduction

Substantial gains have been made in the assessment and treatment of pain in youths over the last decade (McGrath *et al.*, 2013). However, youths with physical disabilities have been excluded from a significant amount of pain research (Bottos & Chambers, 2006; Breau & Burkitt, 2009). As a result, very few studies are available in this area, despite the fact that youths with disabilities are at a greater risk for chronic pain than the general population (Ehde *et al.*, 2003).

Advances in knowledge regarding the causes and treatment of disability-related pain in youths require the availability of valid and reliable pain measures. Self-report questionnaires are the most common method for collecting information about pain, and pain intensity is the most common domain assessed by clinicians and researchers (Jensen, 2011). Pain intensity measures that have been used in youths with physical disabilities include the Wong-Baker FACES Pain Rating Scale (FACES) (e.g., Ramchandren *et al.*, 2014; Tüzün *et al.*, 2010), the 0 – 10 Numerical Rating Scale (NRS-11) (e.g., Jóźwiak *et al.*, 2011; Suokas *et al.*, 2012; Tieleman *et al.*, 2011), and the Visual Analogue Scale (VAS) (e.g., Vles *et al.*, 2008; Wen *et al.*, 2013). Another straightforward option for assessing pain intensity is the (categorical) Verbal Rating Scale (VRS), which asks the respondent to select the word or phrase from a list (e.g., None, Mild, Moderate, Severe) that best represents his or her pain intensity level (Jensen & Karoly, 2011). However, to our knowledge, the validity of the VRS or the FACES has not yet been examined for assessing pain intensity in youths with physical disabilities, and no research has directly compared all four of these measures in the same sample of children with disabilities.

A critical issue with respect to the selection of measures for assessing pain intensity concerns the number of response options available on the measures. Measures with fewer response options, for example 4-point categorical scales and the FACES (which can be viewed as having only 4 response options because the first three faces appear to reflect different levels of mood rather than different levels of pain intensity; Tomlinson *et al.*, 2010), are often preferred by children, are easier to respond to, and may be more valid in children who are at lower levels of cognitive development (Champion et al., 1998). However, fewer response options limit a measure's potential sensitivity, and therefore are

potentially less valid than measures with more response options (Jensen & Karoly, 2011). Having an empirical understanding regarding the relative validity of measures with varying response options would allow clinicians and researchers to select the measure that might be most preferred or easiest to understand (i.e., measures with fewer response options) that also retain adequate levels of validity.

At this point in time, it is not clear which one among the available scales and measures that have been or could be used would be the best option -- or whether they are all equally suitable -- for assessing pain intensity in youths with a physical disability. The aim of this study was to address this knowledge gap by evaluating the relative validity of three measures in the same sample of youths with physical disabilities, namely, the NRS-11 the FACES, and a 6-point categorical Verbal Rating Scale (VRS-6). Based on previous research evaluating such pain intensity measures in youths who do not have physical disabilities (Jensen & Karoly, 2011), we hypothesized that all three scales would evidence validity. We also hypothesized that age would not moderate the strength of the validity coefficients. However, given the limited response options offered by the FACES (Tomlinson *et al.*, 2010), if any differences in validity coefficients were found between scales, we anticipated that the NRS-11 and the VRS-6 would evidence stronger validity than the FACES.

Methods

Participants

The participants for the analyses reported in this paper came from a convenience sample of 113 youths aged 8 to 20 years who had participated in a survey designed to study pain and its impact in youths with physical disabilities. Inclusion criteria for the primary study included: (1) having a diagnosis of cerebral palsy, neuromuscular disease, spina bifida, limb deficiency, or spinal cord injury; (2) being 8 to 20 chronological years old; (3) being able to speak English with or without the assistance of an augmentative communication device; and (4) no more than mild cognitive impairment, as assessed by obtaining a passing score (of 17/25 if administered in person or 15/22 if administered over the telephone, given that the phone interview version did not include a 3-point item requiring observation of the response) on a modified version of the Mini-Mental Status Examination (MMSE; (Folstein *et al.*, 1975). Ouvrier and colleagues (Ouvrier *et al.*, 1993) modified the MMSE for use with pediatric populations, and demonstrated to be valid and reliable with children as young as four years old. We used a modified version of the MMSE that included eight items from the youth version that yields a total score of up to 22 points if administered on the phone and 25 if administered in-person (the reduced possible total score for the telephone version is due to the omission of items that require in-person interaction). As in previous studies (Engel *et al.*, 2013), cut off scores of 15/22 and 17/25 were used to preserve the percentage of 24/30 recommended by the authors of the original adult version (Folstein *et al.*, 1975). None of the participants had even a mild cognitive impairment. In addition, in order to participate in the current analyses, participants from the original survey study must have reported that they had experienced a bothersome pain sometime in the three months prior to the interview, other than that associated with an acute injury (e.g., toe stub), acute illness (e.g., flu), or menstrual cramps, and were experiencing pain at the time of the interview. They were also

required to have provided response to both (1) one or more of the pain intensity measures to be examined and (2) one or more of the study validity criterion measures. Although a number of articles have been published using data from this survey study (Wilson *et al.*, 2006; Engel *et al.*, 2009, 2012, 2013), none have addressed questions regarding the validity of the pain intensity measures administered.

Procedures

Potential participants were recruited from a number of sources using a variety of strategies, including mailings from clinics at the local children's hospital, public postings, word of mouth, and a local summer camp sponsored by the Muscular Dystrophy Association. The study procedures were approved by the Children's Hospital and Regional Medical Center's Institutional Review Board (Seattle, WA; USA). All youth participants less than 18 years old and their parents or guardians gave written informed assent or consent to participate. Participants who were 18 to 20 years old provide their own assent or consent. All study participants were interviewed in person (by JME or a research staff member trained and supervised by JME) when possible, and by telephone when an in-person interview was not possible or practical. Data collection occurred on three different occasions. The FACES scales were administered only during the first wave of data collection (in order to reduce assessment burden), so responses to this scale are available only for n = 53 study participants. However, all participants provided NRS-11 and VRS-6 ratings, as well as responses to the measures of pain interference, psychological functioning, and disability.

Measures

Pain intensity—The survey included a total of 9 rating scales assessing pain intensity: four 0 – 10 Numerical Rating Scales (NRSs), four Wong-Baker FACES Pain Rating scales (FACES), and a single 6-point categorical Verbal Rating Scale (VRS). The NRS-11 asked participants to rate their current pain intensity and recalled (in the past week) worst, least, and average pain by selecting the one number between 0 (“No pain”) and 10 (“Pain as bad as could be”) that represents the intensity of each of these four pain domains. The NRS-11 has been found to be valid and reliable (Miró *et al.*, 2009; Jensen & Karoly, 2011) even when used with children as young as 6 years of age (Castarlenas *et al.*, 2013). The FACES scale presents six line drawings of faces that are meant to represent six different levels of pain, from a smiling face (scored as 0, “Very happy because she/he does not hurt at all”) to a face that appears very upset and is crying (scored as 10, “…hurts as much as you can imagine, although you do not have to be crying to feel this bad”) (Wong & Baker, 1998). The FACES was administered only during face-to-face interviews. Participants were asked to rate their current pain intensity and recalled (in the past week) worst, least, and average pain by selecting the face from the scale that best represented the intensity of each domain. The FACES scale is frequently used to assess pain intensity in children and young adults, and has demonstrated adequate reliability and validity (Tomlinson *et al.*, 2010). Finally, the participants were asked to respond to a subset of items from the Child Health Questionnaire including an item assessing the intensity of bodily pain they experienced during the past four weeks with a 6-point VRS that includes the following descriptors: None, Very mild, Mild, Moderate, Severe, Very severe (Landgraf *et al.*, 1996).

Validity criterion—In addition to the pain intensity measures, the study participants were asked to respond to survey questionnaires assessing psychological functioning, pain interference, and disability.

Psychological functioning was assessed using the 16 items of the Mental Health scale from the Child Health Questionnaire (CHQ-CF87; Landgraf *et al.*, 1996). These items were designed to assess anxiety, depression and positive affect by asking about the frequency of positive and negative states. Respondents are asked to report how often, during the past 4 weeks, they experienced specific feelings on a 5-point scale from 1 = "*All of the time*" to 5 "*None of the time*." In the current sample, the internal consistency (Cronbach's alpha) of the scale was 0.88, indicating good to excellent reliability.

Pain interference was assessed using the Pain Interference scale of the Brief Pain Inventory (BPI) (Cleeland, 2009; Cleeland & Ryan, 1994), modified for individuals with disability. The modifications included changing the interference with walking item to an item assessing interference with "Mobility (ability to get around)" to make it possible for participants who could not ambulate independently because of their disability to respond to this item, as well as by adding items to assess three additional activity domains important to individuals with disabilities, but which were not included in the original 7-item BPI Interference scale; that is, interference with "Self-care (taking care of your daily needs)", "Recreational activities" and "Social activities". In the current sample, the 10-item modified BPI demonstrated excellent reliability, with a Cronbach's alpha of 0.90.

Disability was assessed using the 15-item Functional Disability Inventory (FDI; Claar & Walker, 2006), which asks respondents to rate how difficult it was for them to engage in regular activities in the last few days on a 1 ("*No trouble*") to 5 ("*Impossible*") scale (Walker & Greene, 1991). It was developed specifically to assess disability in children, and has demonstrated excellent reliability and validity properties (Claar & Walker, 2006; Kashikar-Zuck *et al.*, 2011). In the current sample, the internal consistency (Cronbach's alpha) of the disability score was 0.83, indicating good reliability.

Pain interference (i.e., the extent to which pain interferes with function) has some overlapping content with disability (i.e., the extent to which an individual is disabled due to a number of factors, including but not limited to pain). However, they are also distinct, as the former is more pain-specific. Furthermore, the BPI has been modified for individuals with disability, while the FDI is a specific instrument developed to assess disability in children but has not been validated for this specific patient population. Thus, the two measures provide related but also somewhat different information, and therefore provide a more complete information on the impact of pain in this understudied population.

Data Analyses

We first computed descriptive statistics to describe the sample. We then computed Pearson correlation coefficients among the nine intensity measures (four NRS-11 and four FACES scales assessing current, least, worst, and average pain, and 6-item VRS assessing bodily pain) to evaluate the relative validity of these scales with respect to their association with each other (i.e., other measures of the same construct). Next, we performed an exploratory

principal component analysis (PCA) of the three measures of usual or average pain (NRS-11 and FACES ratings of average pain and VRS-6 of bodily pain), paying particular attention to the loadings associated with each measure as an indication of that scale's validity. Pain intensity scales may be more or less valid for certain age stages. For example, although pain intensity reports provided with the NRS-11 have demonstrated to be valid when used with children as young as 7 years old (Castarlenas et al., 2013), it remains possible that the measure's scale scores may be less valid (i.e., yield lower validity coefficients) in children younger than 7 years old. This possibility can be tested using moderator analyses, with the lack of an age moderating effect indicating similar validity across different ages. Therefore, to test for possible age moderation effects, we computed Age X Intensity Measure interaction terms for each measure of usual or average pain, and regressed the three validity criterion measures (psychological functioning, functional disability, and pain interference) on age, pain intensity, and the Age X Intensity Measure interactions, with a plan to examine differences in validity coefficient in younger versus older participants if any of the interaction terms were significant. Finally, we computed Pearson correlation coefficients between the nine pain measures and the three validity criteria, to evaluate the relative criterion validity of each measure.

Criterion-related validity will be determined by positive correlations between the pain intensity scores with the measures of pain interference and disability, and negative correlations between the pain intensity scores with psychological functioning. Pain intensity has been suggested as an important predictor of chronic pain and related disability (e.g., Miró *et al.*, 2007) and therefore we used measures of disability as criterion variables for the current study. However, it is also important to note that although we use measures of disability as criterion variables here, this should not be taken as our suggesting that disability is *only* determined by pain intensity; disability is rather influenced by a number of biological environmental, social, and psychological factors, so while the associations between measures of pain intensity and disability would be expected to be positive (if the measure of pain intensity are valid), these associations are not necessarily expected to be strong (see Miró & Huguet, 2004, for a similar procedure).

Results

Description of the study sample

Demographic and descriptive information for the 113 study participants is presented in Table 1.[1]

Associations among the pain intensity measures

The Pearson correlation coefficients between the nine measures of pain intensity (four NRS-11 scales, four FACES scales, and one VRS-6) are presented in Table 2. As can be seen, all of the measures were associated positively with each other. The strongest associations to emerge were those related to the NRS-11 and the FACES worst pain ratings, which were not only strongly associated with one another (r = 0.79), but also strongly

[1]A table of the means and SDs of the study variables as a function of participant age is available from the first author.

associated with the VRS-6 of bodily pain (rs = 0.52 and 0.56). The six pairs of NRS-11 ratings were also strongly associated with one another. Contrary to our hypothesis, however, the measures did not all evidence consistently strong associations with each another. In particular, only one of the coefficients involving the FACES scale evidenced a strong association (i.e., $r \geq 0.50$) with the other measures of pain intensity.

Principal Component Analysis of the average pain ratings

The PCA of the NRS-11 average, FACES average, and VRS-6 bodily pain ratings yielded a single factor (eigenvalues = 1.78, 0.70, and 0.52), with loadings of 0.80, 0.80, and 0.70 for each scale, respectively.

Age moderating effects on the associations between average pain ratings and criterion measures

The series of nine regression analyses to test for possible age moderation effects in the associations between the three average pain ratings (NRS-11, FACES, and VRS-6) and the three criterion variables (pain interference, psychological functioning, and disability) yielded no significant Age X Measure interaction effects for the NRS-11 or the VRS-6, or for the FACES scale predicting pain interference and psychological functioning. However, a significant Age X FACES interaction effect emerged in the prediction of the FDI scale score (R^2 change = .09, F change (1,49) = 5.04, $p < .05$).

To better understand this interaction, we examined the correlation coefficients between the FACES measure of average pain intensity and the FDI scale score separately for 8-11 year olds (n = 14), 12-15 year olds (n = 17), and 16-20 year olds (n = 23). These coefficients were -.43 (i.e., more pain, less disability), .27 and .17, respectively. The negative correlation for the 8-11 year old group is an unusual finding, so we examined the scatter plot in order to better understand it. The scatter plot showed that all of the fourteen 8-11 year olds reported very little pain on the FACES: 5 selected the first face reporting no pain or a zero value (a happy face), 6 other participants selected the second face reporting almost no pain, and 1 participant selected the third face (this is a neutral face). The one participant who reported a neutral face also reported very low disability. So this single participant, in combination with the others who evidenced variable disability, made the average slope negative.

Association between the measures of average pain and validity criterion

Table 3 presents the validity coefficients for the NRS-11, the FACES, and the VRS-6. As can be seen, both the NRS-11 and VRS-6 evidenced similar validity (as indicated by similar validity coefficients) in the sample. However, and consistent with our hypothesis, the FACES evidenced lower levels of validity than either the NRS-11 or VRS-6 – in particular for predicting psychological functioning and disability.

Discussion

The findings from this study provide important new information regarding the validity of three measures of pain intensity in youths and young adults with disability. The validity of the pain measures examined here was supported via (1) strong associations with each other,

(2) strong loadings on a factor score representing global pain intensity, and (3) statistically significant negative associations with measures of psychological functioning, and positive associations with disability and pain interference. However, across all measures of validity, the NRS-11 appeared to out-perform both the VRS-6 and in particular the FACES. That is, the NRS appears to be more useful than the other measures on the basis of two related issues. First, it demonstrated a pattern of stronger associations with the criterion measures, and second on the direct comparisons of those statistics (see Sánchez-Rodríguez *et al.*, 2012, for a similar procedure).

In previous studies with chronic pain samples all three scales have shown adequate validity (Jensen & Karoly, 2011; Miró *et al.*, 2009; Tomlinson *et al.*, 2010). However, even though pain intensity scales are often strongly associated with one another, they do not always demonstrate strong agreement (e.g., (Sánchez-Rodríguez *et al.*, 2012). No single scale exists that is perfect for all purposes, all settings, and all populations. For example, some faces scales are preferred over other scales (e.g., Miró & Huguet, 2004). In fact, when selecting among face scales, a major concern is that of potential bias associated with faces that show emotional reactions, like smiling or crying faces, instead of neutral or pain faces. Chambers et al (1999), for example, in a study comparing children's ratings in five well know scales, including some with smiling faces, like the FACES, observed that children reported higher pain intensity scores when using faces scales that included a smiling face.

In our study, we also encountered an unusual finding in relation with the FACES scale. This may be associated with the fact that the first three levels (faces) appear to represent basically “no pain” levels; yet they represent the same range in levels (from 0 to 2) as that between the faces that represent markedly different levels of intensity (3 to 5). This limits the actual levels of pain intensity that can be reported on the FACES to four, which may limit the sensitivity – and therefore validity – of this measure.

There are a number of limitations that should be considered when interpreting the findings from this study. First, although the overall size of the study sample (N = 113) was adequate, it was made up of youths with 5 different disability diagnoses, and with a varying number of participants from each diagnostic group. Thus, the findings may or may not generalize to other children with these specific disabilities. Replication of the current findings in additional samples of youths with physical disabilities would help establish their reliability. Second, the presentation of the scales was not counterbalanced during the interviews; it is possible that order effects might have biased the results in some unknown way. However, in previous studies, we did not find any differences in patients' reports caused by the order in which the scales were presented (Miró *et al.*, 2009). Third, we did not assess analgesic use in this study. It is possible that analgesic use might have influenced how the participants responded to the different measures in some unknown way. Relatedly, we did not assess response to pain-producing or pain-relieving stimuli or assess observed pain behavior – two important additional validity criterion. Future research should examine the potential impact of analgesic use on the validity of the measures, and examine the relative ability of these measures to detect changes in pain and their associations with measures of pain behavior. Finally, we had planned to include participants in the current study only if they had, at most, mild cognitive impairment. However, none of the participants had even a mild cognitive

impairment. Given that children and adolescents with physical disabilities are also at risk for having intellectual disabilities (e.g., Beckung & Hagberg, 2000, 2002), the findings from this study would not necessarily generalize to children with physical disabilities who also have cognitive impairment. Research would be needed in these populations to determine which pain measures would be most valid in this special population.

Despite the limitations of this study, noted above, the findings advance our knowledge by providing specific information on the validity of three widely used scales to assess pain intensity in youths with physical disabilities. The findings have important implications for researchers and clinicians seeking to select pain intensity measures to use in their settings. First, even though the three scales are all easy to administer and score, they do not appear to have similar validity. Although additional research is needed to confirm our results, on the basis of these findings, the NRS-11 can be recommended over the others to assess pain intensity in youths with physical disabilities.

Acknowledgments

Funding sources: The work of Dr. Jordi Miró and ALGOS is supported by grants from the Government of Catalonia (AGAUR; 2009 SGR 434), Universitat Rovira i Virgili (PFR program), RecerCaixa, the Spanish Ministry of Economy and Competitiveness (MINECO; PSI2012-32471) , and the Institució Catalana de Recerca i Estudis Avançats. Support for the study upon which the findings reported here are based was provided by Grant P01 ND/NS 33988 from the National Institute of Child Health and Human Development and the National Institute of Neurological Disorders and Stroke, National Institutes of Health. RV is supported by a doctoral grant from MINECO. MR salary and travelling support was funded by The Earl Russell Chair in Pain Medicine, Western University, London, Ontario.

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What is already known about this topic?: Different pain intensity measures have been used in youths with physical disabilities.

What does this study add: This work helps to advance our knowledge by providing specific information on the validity of three widely used scales to assess pain intensity in youths with physical disabilities. On the basis of these findings, the NRS-11 can be recommended over the others to assess pain intensity in youths with physical disabilities.

Table 1

Description of study sample

Variable	N (%)	Mean (SD)	Range
Diagnosis			
Spinal cord injury	10 (9%)		
Cerebral palsy	39 (35%)		
Spina bifida	27 (24%)		
Limb deficiency	9 (8%)		
Neuromuscular disease	28 (25%)		
Age in years	113	14.19 (2.90)	8-20
Sex			
Males	64 (57%)		
Females	49 (43%)		

Table 2

Pearson correlation coefficients between nine measures of pain intensity

	NRS-11				FACES			
Measure	**Average**	**Worst**	**Least**	**Current**	**Average**	**Worst**	**Least**	**Current**
NRS-11								
Worst	.75***							
Least	.58***	.54***						
Current	.61***	.56***	.72***					
FACES								
Average	.48***	.50***	.33*	0.07				
Worst	.62***	.79***	.46**	.40*	.63***			
Least	.50***	.39**	.69***	.43**	0.24	.48***		
Current	.40**	.47***	.55***	.74***	0.27	.49***	.38**	
VRS-6	.33***	.52***	.39***	.32***	.32*	.56***	0.26	.39**

*** p < .001,

** p < .01,

* p < .05

Note: NRS = Numerical Rating Scale (0-10); VRS = Verbal Rating Scale (6 point: None, Very mild, Mild, Moderate, Severe, Very severe); FACES = Wong Baker FACES Pain Rating Scale (0-10)

Table 3

Pearson correlation coefficients between the measures of average pain intensity and validity criterion

	NRS-11	FACES	VRS-6
Pain Interference (BPI)	.62***	.54***	.48***
Psychological Functioning (CHQ)	-.46***	-.29**	-.51***
Disability (FDI)	.39***	0.22	.36***

*** $p < .001$,

** $p < .01$

Note: NRS-11 = Numerical Rating Scale (0-10); FACES = Wong Baker FACES Pain Rating Scale (0-10); VRS = Verbal Rating Scale (6 point: None, Very mild, Mild, Moderate, Severe, Very severe); BPI = Brief Pain Inventory; CHQ = Child Health Questionnaire; FDI = Functional Disability Inventory.