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DEBATE

HOW SHOULD WE USE THE VISUAL ANALOGUE SCALE (VAS) IN REHABILITATION OUTCOMES? IV: REPLY ON "HOW SHOULD WE USE THE VISUAL ANALOGUE SCALE (VAS) IN REHABILITATION OUTCOMES?"

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We would like to respond to the commentaries given (1–3) to our review on Visual Analogue Scales (VAS), which concluded that there is sufficient evidence that VAS data are ordinal and that the VAS should be analysed appropriately from a statistical perspective by using non-parametric statistics (4). The three commentaries raise a number of important points and somewhat different perspectives. Franchignoni et al. (1) comment that, from a practical point of view, the VAS is harder to understand and that patients take longer to score it than a Likert scale (5); that the VAS has lower compliance rates (6); that it takes longer for the clinician to obtain the data (measuring by the clinician) and that there are possibilities of clinician measurement error. This concurs with previous findings that the VAS is difficult for some people (7) and has low test-retest reliability as a consequence (8). By contrast, Price et al. (2) contend that the VAS is easy to use, although they also agree that for some people it is not. They further say that the literature suggests the VAS has better psychometric properties than the Numeric Rating Scale (NRS). Harms-Ringdahl makes the point about the variability of the anchors, which may be used, and raises important issues about sample size, distribution and the relationship between pain and physical functioning (3).

We think it important to differentiate the question of the similarity (or lack) of the NRS and VAS, and various operational matters with respect to the ease of use and other practical matters associated with the VAS, from the primary question we tried to address, which was that of the scaling property of the VAS. In this respect, Price et al. (2) argue that the VAS has ratio properties because 'separate judgments of ratios or proportions of pain intensity are in quantitative agreement with VAS ratings of pain' and that studies 'directed toward *both* experimental and clinical pain shows reliable stimulus-response power functions and a zero point for the VAS scale' (9–13). In addition, they claim that if VAS has ratio properties it must also have interval properties. This is much the same point made by Harms-Ringdahl who refers to findings from her experimental pain study in which pain was measured on the VAS and the Borg Category Ratio scale (14). She states that in this study 'pain intensity levels on both scales followed each either nicely' and that 'the non linear but logarithmic increase per se in pain intensity' seems to be an invalid reason for our recommendation not to use VAS assessments as interval data. She further indicates that we have failed to describe experimental studies where VAS has been found to allow measurements not only with interval but with ratio properties (3).

We would raise a number of points with respect to these assertions. Primarily, we would argue that the samples used in these studies, and the methods adopted do not allow for an assessment of ratio or, indeed, interval properties. In the original studies by Price et al. pain patients were subjected to noxious thermal stimuli to the forearm (11–13). As the power functions between VAS scores and the temperatures were predictive of estimated ratios of sensation or affect produced by pairs of standard temperatures (e.g. 47°C and 49°C), they concluded that this was evidence for ratio scaling properties of VAS.

We would suggest there are a number of issues with respect to this interpretation. Degree centigrade has only an arbitrary zero and is not a ratio scale in the first place. Only degree Kelvin can be said to be so. Thus deriving a ratio scale property using the measurement of degree centigrade cannot be undertaken (unless presumably the anchor for the VAS was –273 °C or their 'reliable' zero point is consistent with zero degree Kelvin). However, this does not preclude concluding that the scale is at the interval level, which itself is a necessary but not sufficient condition for ratio scaling.

Our primary concern relates to the fallacy of extrapolation from a narrow range, as typically undertaken in the studies reported by both Price et al. (2) and Harms-Ringdahl (3). The range of temperature extrapolation, from a few degrees to the whole, as in the Price et al. studies (11–13), represents a classical error. In part, this danger is recognised by the later findings of Myles et al. (9, 10). These studies asked patients with pain to score their pain and once it was halved (by means of pain relief) to score the VAS again and when they considered pain relief was satisfactory, the VAS was scored a third time (9). Similarly, patients were asked to consider what their pain might be like if it were twice as bad and score this on a VAS (10). The important point from this study is that the authors remind the reader that the sample had only mild-to-moderate pain and they explicitly state that the VAS may be non-linear at the margins. Thus they recognise the potential error of extrapolation from a narrow band in the centre.

In fact, the findings from these studies are quite consistent with information derived from Rasch analysis of the VAS, given the extremely limited range of stimuli presented to their subjects.

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We would remind readers that the Rasch model is consistent with a probabilistic form of the theory of additive conjoint measurement, which is how data from ordinal scales can be tested for quantitative structure and interval scaling (15, 16). In their study, Price et. al. (11) appear to have used a VAS of 150 mm in length, although they report that 100 is equal to the most intense sensation imaginable. Given a presumed rescaling to 0–100, they report the mean intensity values of pain at the 'minimum', 'usual' and 'maximal' levels during the previous week were 20.0, 49.3 and 72.3 ˚C, and 3 matching noxious temperatures as direct matches to their chronic pain at 43.1, 46.2 and 48.8 ˚C, respectively. Given their reported VAS scores were largely operating over the middle region of the scale, the empirical Rasch-based evidence does suggests that VAS will operate linearly (17). Outside of the middle range we have shown the VAS to be increasingly non-linear, such that points at the margins represent several magnitudes greater than a point in the middle region of the trait being measured (17). This was in fact the second such test of VAS data against the Rasch model, following an early analysis by Thomee et al. (18). In addition, traditional psychometric studies have also demonstrated that the VAS does not behave linearly (19–21).

Thus, in conclusion we would contend that the findings of the early experimental studies do not support interval scaling for the VAS and that, from first principles, given the experimental validation was based upon extrapolation from a narrow range of temperature, it cannot support the supposition of either an interval or ratio scale. Consequently we disagree with Price et al. (2) that there is insufficient evidence that the VAS is ordinal. They state strongly that our assertions of ordinality contain faulty assertions that could have destructive consequences for pain measurement. Rather, we would contend that holding on to the belief that the VAS is interval risks misinference, and could lead to flawed and inappropriate conclusions of trials, particularly where the levels of pain are outside the central portion of the VAS scale. Consequently, based on our review and research discussed above we maintain that parametric statistics should not be used for VAS rating data because the VAS only has ordinal scale properties. If Price and others wish to reject this evidence, they should refute Luce and Tukey's theory, and the mathematical proofs that the Rasch model is consistent with that theory in a probabilistic manner (16, 22). Otherwise the empirical evidence is unequivocal; VAS is ordinal.

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