Clinical stress assessment using a visual analogue scale

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Background
Clinicians increasingly require short, efficient methods for assessing distress, both in applied research and clinical settings. Most of the available questionnaires are unsuitable for busy clinical settings. The visual analogue scale (VAS) is widely but empirically used to assess perceived stress.

Aims
To provide evidence on two of the psychometric properties of the VAS: its discriminative sensitivity (capacity to highlight a difference between groups) and its interconcept validity (the relationship between VAS stress assessment and the assessment of different, but similar concepts).

Methods
Employees attending occupational health centres were randomly selected and completed the VAS and also either the Perceived Stress Scale (PSS) or the Hospital Anxiety and Depression Scale (HADS). Analyses of variance were performed to study group effects (age, sex, marital status, parental status, occupational status) on stress scores (PSS and VAS).

Results
In total, 763 employees participated of whom 501 completed the PSS and 262 the HADS. P-values obtained for the effects of sex, age and occupational status were lower with the VAS than with the PSS. Correlations between the VAS and the anxiety subscale, depression subscale and total score of the HADS were 0.66, 0.45 and 0.65, respectively. Other tools used to assess aspects of psychological distress are known to have similar correlations.

Conclusions
Our findings provide evidence that the VAS is at least as discriminating as a questionnaire when it comes to highlighting differences in stress levels between two groups, and the observed correlations with related constructs support its construct validity.

Keywords
Occupational mental health; stress; validation; well-being; work stress.

Introduction

The assessment of stress is an important component of medical assessments, particularly in occupational or clinical medicine and areas such as oncology or chronic disease management. One way of assessing stress is to administer a questionnaire, which has the benefit of allowing a rapid quantitative assessment, which is particularly useful both in clinical and research settings.

A number of questionnaires are currently available for assessing stress, such as Cohen’s Perceived Stress Scale (PSS). However, these are often too long and complicated to use in routine clinical practice.

Mitchell recommends the utilization of a single question which asks participants to rate their perceived stress on a 10-point scale designed for use in both clinical and research settings, such as the visual analogue scale (VAS) [1]. This scale is particularly well suited for the clinical assessment of self-reported stress. Numerous recent studies (we identified 28 since 2008 in the Medline and PsycInfo databases) have used the VAS to assess perceived psychological stress.

Several subjective qualities favour the use of the VAS. First of all, it offers a quick and simple means of assessment of perceived stress within doctor–patient consultations, enabling patients to express their distress without using an impersonal questionnaire. Furthermore, it avoids misunderstandings that may occur during questionnaire-based assessments due to difficulty in communication (e.g. literacy or language problems).
Regardless of the qualitative properties of the VAS, it is vital to assess its psychometric properties. Several employee-based surveys have indicated some interesting psychometric properties, such as satisfactory stability and high inter-rater reliability [2–4]. Moreover, there are good correlations between the stress VAS and other tools used to assess stress, such as the 14-item PSS (Lin’s concordance correlation coefficient = 0.66) [2,5].

Experimental studies have also pointed to good sensitivity for acutely distressing events, and significant relationships with cardiovascular parameters (heart rate, blood pressure) [6] and salivary cortisol levels [7].

However, numerous parameters still need to be evaluated in order to assess the limitations of the VAS and its efficiency in assessing stress. The aim of this study was therefore to provide evidence of its discriminative sensitivity (i.e. the capacity to highlight a difference in stress between two groups) and its interconcept validity (the relationship between VAS assessments of stress and assessments of different but similar concepts such as anxiety or depression).

**Methods**

We randomly selected employees attending five occupational health centres in the Champagne-Ardenne, Haute-Normandie, and Ile-de-France départements in Northern France in 2010. In France, every employee must undergo a thorough medical examination either annually or biennially. On their arrival at the centre and before their actual examination, participants were told about the aim of the study and asked by the authors to take part on a voluntary and anonymous basis. They were assured that they could withdraw at any time. Both oral and written instructions were given to ensure informed participation, and participants were guaranteed confidentiality. Under prevailing French legislation, the study design did not require ethics committee approval since the participants were not patients.

During the medical consultation, a practitioner assessed the stress of all participants with the VAS. The French version of the PSS-14 was used to assess perceived stress during the previous month [8]. Items are rated on a 5-point Likert scale (0 = never, 1 = almost never, 2 = once in a while, 3 = often and 4 = very often). The scores of Items 4, 5, 6, 7, 9, 10 and 13 are reversed (4 = never, 3 = almost never, 2 = once in a while, 1 = often, 0 = very often). A total score can be obtained by summing the scores for the 14 items, following the guidelines set out by the original authors, and scores therefore range from 0 to 56. The higher the score, the higher the level of stress. We also calculated the PSS-10 (Items 1, 2, 3, 6, 7, 8, 9, 10, and 11; range [0–40]) and PSS-4 (Items 2, 6, 7 and 14; range [0–16]) scores. Each score (PSS-14, 10, 4) was converted to a 0–10 scale.

The PSS is a unidimensional scale that assesses perceived stress by asking respondents to report whether their lives seem to be unpredictable or uncontrollable, or if they feel overburdened. This questionnaire is based on Lazarus’ transactional model of stress. It assesses the cognitively mediated emotional response to an objective event, rather than the objective event itself, as a checklist of stressful events would do. This scale is used worldwide, and it has satisfactory psychometric properties.

We used the French version of the HADS to assess depression and anxiety [9,10]. The HADS is a 14-item self-report measure that was specifically developed to assess anxiety and depression. It is considered to be an effective means of screening for anxiety and depression and is widely used [11]. It has two subscales, one assessing anxiety (HAD-A) and the other assessing depression (HAD-D). The scores for each subscale range from 0 to 21.

We chose this scale for two reasons. Firstly, the HADS is a rapid and widely used scale, measuring a different concept from stress. Secondly, the literature contains several recent validation studies (since 2006) comparing different stress assessment methods with the HADS (i.e. interconcept validity). These methods are the PSS [13,14], the Psychological Distress Scale (PDS) [15] and the Distress Thermometer (DT) [16]. We could therefore compare the relationship between the VAS and the HADS with these different tools.

The Stress VAS consists of a small, unmarked 100 mm ruler with endpoints labelled ‘none’ and ‘as bad as it could be’.

The scale was introduced to participants by the practitioner during the consultation, with the following instruction: ‘Indicate how stressed you feel on the small ruler’. The scale therefore yielded a single subjective stress score between 0 and 100.

Analyses of variance (ANOVA) were performed to analyse the main effects of the different variables (age, sex, marital status, parental status, occupational status) on stress scores (PSS scales and Stress VAS).

We compared the discriminative sensitivity of the VAS and the PSS-14, 10 and 4 with the following formula, where M is the mean stress score of the participants, and s² its variance. M<sub>women</sub> and M<sub>men</sub> are the average stress scores for women and men, respectively, and Δ is the difference between M<sub>women</sub> and M<sub>men</sub>. The number n of women and men (n = n<sub>women</sub> = n<sub>men</sub>) needed to highlight a statistical difference in stress levels between the women and men is indicated by the formula:

\[
    n = 2 \left( \frac{s^2}{\Delta^2} \right) \Phi^2
\]

Φ is a constant.
The comparison of two different methods (here, the PSS and the VAS) allows a mathematical simplification:

\[
\left( \Phi = Z_{\alpha/2} - Z_{1-\beta} \right)
\]

We compared the capacity of the PSS and the VAS to highlight the statistical difference in stress according to sex. The ratio \( n_{\text{PSS}}/n_{\text{VAS}} \) was computed for each version of the PSS (14, 10 and 4 items). Interconcept validity was tested using two types of statistical analysis: Pearson’s correlation coefficient and analysis of variance (ANOVA). Pearson correlations between the VAS and HADS scores (HAD-A, HAD-D and total score) were computed. This type of analysis does not require a large sample to provide reliable correlations. We estimated that half of our sample would be enough and therefore aimed to include 250 participants.

**Results**

A total of 501 participants completed the PSS-14, and 262 completed the Hospital Anxiety and Depression Scale (HADS), giving 763 participants in total. The mean age of those completing the PSS was 40.4 years (95% confidence interval [39.4, 41.4]) (Table 1). There were 249 women and 252 men. As a large number of occupations were represented in this sample, they were divided into four categories, according to the French occupational status index.

We analysed the response rate for the first 100 participants. Only five workers declined to participate, the main reason being illiteracy. Given the high response rate (95%), we stopped collecting data for non-respondents.

All the scales showed significant differences in stress according to age and parental status. The effect of sex was only statistically significant for the 10-item version of the PSS and for the VAS (\( P < 0.05 \) and \( P < 0.01 \), respectively).

There were no differences in stress levels according to marital and occupational status. The \( P \)-values obtained for the effects of sex, age and occupational status were lower with the VAS than with the PSS.

Results showed that the ratios of numbers (assuming that numbers were equal in both groups) required to obtain a significant difference in stress levels according to sex, for each PSS version versus the VAS (\( n_{\text{PSS14}}/n_{\text{VAS}}, n_{\text{PSS10}}/n_{\text{VAS}} \) and \( n_{\text{PSS4}}/n_{\text{VAS}} \) ) were 3.9, 2.26 and 6.7 for the PSS-14, 10 and 4, respectively. For the most efficient version of the PSS (10 items), the sample size needed to be twice as high (2.26) as that of the VAS to highlight a significant difference in stress levels according to sex. We chose the sex effect to compute the numbers required to yield a significant stress difference for three reasons. First, the calculation required two categories and consequently could not be done with age or occupational status. Second, the difference in stress responses between women and men is well documented in the literature. Third and the last, the numbers in each group have to be equal (\( n_1 = n_2 \)).

The Pearson correlations between the VAS, HAD-A, HAD-D and HADS were \( r = 0.66, 0.45, \) and 0.65, respectively. These interconcept correlations were very close to those found with the PSS, the ODS and the DT (Table 2). Two recent studies reported similar correlations between the PSS and the HADS [13,14], while Grassi found a similar relationship between the DT (used in an oncology setting) and the HADS [15]. Lastly, Dolbeaut found the same relationship between the PDS and the HADS [16].

The ANOVA was run on the VAS scores after the anxiety and depression scores had been categorized as low, average or high. The cut-offs were determined using the lower third, middle third, and upper third of the normative distribution of each score from this sample. Results showed significant differences in stress levels (\( P \)-values < 0.001) according to anxiety and depression levels.

**Discussion**

This study showed that the VAS is at least as discriminating as the PSS. Moreover, the links with other related variables showed that the VAS does indeed measure what it is intended to measure, namely perceived stress, as we found similar links to those reported in the literature.

More specifically, we found that the size of the sample required to yield a statistical difference in stress according to sex was twice as high for the PSS-10 as it was for the VAS. This finding can be explained firstly by the fact that questionnaires are intrinsically designed to have a parametric distribution and a low variance. This kind of distribution allows for parametric statistical tests, and low confidence intervals. In this sense, questionnaires can be considered to be a statistically adequate measure of a concept.

However, low variance does not necessarily equate with a powerful method, and while the confidence interval will be lower, the scale will not be any more powerful as a result.

A weak variance of observations within a group leads to a low difference between two subgroups (e.g. male and female). We explained in the methods section that the discriminative sensibility of a scale is related to the \( \sqrt{\text{VA}} \) ratio. This ratio was lower with the VAS than with the PSS for all subgroups except parental status (the \( P \)-value is another expression of this ratio). We believe that this finding can be interpreted as indicating the
greater discriminative sensibility of the VAS. The VAS highlighted a difference in stress levels with half as many participants as the PSS. This finding must, however, be interpreted with caution. This was a univariate analysis, and some other factors may have intervened, such as age, occupational stress and parental status. The sole purpose of this analysis was thus to indicate the impact of discriminative sensitivity for clinical research.

The results of our study showed that the VAS is a relatively efficient tool for assessing stress. However, it is not a case-finding tool for anxiety or depression. Stress is not a mood disorder; high chronic stress levels are certainly a major risk factor, and can be a primary marker of a mood disorder, but they do not constitute pathology. There is, nonetheless, a clear relationship between stress, anxiety and depression, which we found to be similar to that reported for other tools used to assess different aspects of psychological distress.

It was not possible in this study to administer both the PSS and the HADS to the same participants, as this would have required too much time and effort both for them and for the occupational physicians. Hence, the correlations between the HADS and the PSS were extracted from the literature. It would have been better to base our assessment of the interconcept validity of the
VAS on our own data. This limitation provides further evidence that a comprehensive questionnaire battery is poorly suited to a busy clinical setting.

Although the present study had several limitations other earlier validity studies have also highlighted the psychometric properties of the VAS in stress assessment: its inter-rater reliability [3], its stability [4] and its good concordance (which is different from the Pearson correlation) [17] with the PSS (Lin’s concordance correlation coefficient = 0.66) [2].

Experimental studies of acute stress responses have highlighted the sensitivity of the VAS [6,18–20]. Unfortunately, to our knowledge, there are no published assessments of its reproducibility. Even if this is an important issue and constitutes a weakness in our study’s design, it would have been difficult to carry this out in the present study, or in a worker-based study. This is a possible focus for future studies.

Overall, numerous surveys have shown the psychometric properties of the VAS for the assessment of stress to be very satisfactory. Its main weakness is its simplicity. A short tool may be perceived as ineffective, by both patients and practitioners, with complex stress assessments or biological markers being perceived as a more effective way of measuring stress.

Mitchell claimed that no screening tool should be seen as an alternative to careful clinical assessment [12]. The particularity of the VAS is that it is a clinical tool used by clinicians during consultations. Hence, it is (and should be) only part of the clinical stress assessment, forming just the starting point of an interview. The VAS extends the doctor–patient relationship more than a questionnaire given in a waiting room would and is eminently suited to a busy clinical setting. This has been confirmed by our own personal experience, extending over several years, with patients spontaneously adding comments after their self-assessment on the VAS. Feedback from practitioners using the VAS on a daily basis is also very positive.

Clinicians are increasingly looking for efficient methods of assessing distress, both in applied research and clinical settings. Perceived stress measures are often administered on top of broader evaluations and medical examinations. Consequently, most questionnaires are not suitable for busy clinical settings. Clinicians, undertaking routine clinical work, clinical research, medical examinations or occupational health, may be interested in a very short clinical tool for the assessment of stress.

Numerous psychometricians consider that a psychological dimension cannot be measured with fewer than three items. We agree that a complex psychological dimension such as self-esteem cannot be assessed with a single question. Besides, when there are several items, specific statistical analyses can be conducted to assess internal validity, such as internal consistency and factor analysis. Putting aside ideological considerations, numerous studies of stress or distress assessment have shown that some concepts or feelings can be evaluated with a short tool. This was confirmed by a recent meta-analysis concerning short screening tools used for the assessment of cancer-related distress, which identified 45 short and ultra-short tools [12]. Very few of these tools have been validated, but the author concluded that ‘the overall accuracy of these single-item approaches seems comparable to that of the 14-item HADS (total score), whereas their efficiency is superior’.

**Key points**

- Clinicians undertaking routine clinical work, clinical research, medical examinations or occupational health, may value a very short clinical tool for the assessment of stress.
- The visual analogue scale is widely but empirically used to assess perceived stress.
- Our study suggests that the visual analogue scale is at least as discriminating as a questionnaire when it comes to highlighting differences in stress levels between two groups.

**Conflicts of interest**

None declared.

**References**


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<tr>
<th>HADS-Anxiety scale</th>
<th>Low anxiety</th>
<th>Average anxiety</th>
<th>High anxiety</th>
<th>P-value</th>
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<tbody>
<tr>
<td>VAS stress (mean (SD))</td>
<td>2.21 (1.59)</td>
<td>3.62 (1.82)</td>
<td>5.32 (2.32)</td>
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<tr>
<td>VAS stress (mean (SD))</td>
<td>2.63 (1.86)</td>
<td>3.42 (2.17)</td>
<td>5.13 (2.24)</td>
<td>&lt; 0.001</td>
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