



# Equipercentile linking of scales measuring functioning and symptoms: Examining the GAF, SOFAS, CGI-S, and PANSS



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## Abstract

The Global Assessment of Functioning (GAF) and the Social and Occupational Functioning Assessment Scale (SOFAS) are rating scales commonly used to assess the level of functioning in patients with schizophrenia. To understand the correspondence of scores between GAF and SOFAS, and what they mean from a clinical point of view, we examined the linkage of (a) GAF with SOFAS total scores, (b) GAF with Clinical Global Impressions Scale (CGI) and Positive and Negative Syndrome Scale (PANSS), and (c) SOFAS with CGI and PANSS. We used the equipercentile linking method to identify corresponding scores of simultaneous GAF, SOFAS, PANSS and CGI ratings in 1208 patients from a naturalistic European cohort study. Data were collected at baseline and at months 6, 12, 18 and 24. GAF and SOFAS total scores were found to be practically exchangeable. Both scales had strong negative correlations with CGI and PANSS; the linkage also suggested the presence of slight impairment in functioning even when patients are free from symptoms. These findings are important for the comparison of scores when different rating scales are used. We present a detailed conversion table in an online supplement.

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## 1. Introduction

The Global Assessment of Functioning (GAF) (Lehman, 1983) is a rating scale used to subjectively assess the social and occupational functioning as well as psychological symptoms of adults. The scale was first presented in the DSM-IV, Axis V (American Psychiatric Association, 1994). The most important disadvantage of the GAF scale is the inability to differentiate psychiatric symptoms from relational, social, and occupational functioning. The need for a specific assessment tool of global functioning, not directly affected by psychopathology, led to the development of the Social and Occupational Functioning Assessment Scale (SOFAS) (Goldman et al., 1992). The SOFAS rates the social and occupational functioning but not psychological symptoms. It also takes into account impairments due to a general medical condition and is usually used for the evaluation of the current time period. It was initially described by Goldman et al. in the paper 'Revising Axis V for DSM-IV: A review of measures of social functioning' and later included in the DSM-IV, section 'Criteria Sets and Axes Provided for Further Study' (Goldman et al., 1992). Both scales' scores are based on a continuum of functioning, with higher scores indicating better functioning.

The GAF and the SOFAS are both used today for the assessment of functioning. Nevertheless, many situations may require the transformation of scores obtained from one scale to equivalent scores of another one, e.g. when the results of GAF studies need to be compared with those of SOFAS studies, or when baseline functioning severity needs to be entered as a covariate in meta-analyses. While a linkage among the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987), the Brief Psychiatric Rating Scale (BPRS) (Overall and Gorham, 1962) and the Clinical Global Impression-Severity scale (CGI-S) (Guy, 1976) has been successfully applied in previous studies (Leucht et al., 2006, 2012, 2013b; Levine et al., 2008), the GAF and the SOFAS have not been thoroughly examined; to the best of our knowledge, only one report has addressed the link of the GAF to the PANSS and the CGI-S (Rabinowitz et al., 2010) and none the link of SOFAS to any of those scales. Thus, we aimed to examine the linkage of (a) GAF with SOFAS scores, (b) GAF with CGI-S and PANSS, replicating previous results, and (c) SOFAS with CGI-S and PANSS.

## 2. Experimental procedures

Individual patient data from the European Schizophrenia Cohort (EuroSC) (Bebbington et al., 2005) were used. EuroSC was a naturalistic two-year follow-up of 1208 patients, suffering from schizophrenia according to Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) criteria (American Psychiatric Association, 1994). The participants were selected in order to provide a representative sample of the patients treated in secondary psychiatric services in each area. There were 743 men and 465 women, with mean age  $40.9 \pm 10.9$  years, duration of illness  $13.7 \pm 10.3$  and mean PANSS score at baseline  $57.3 \pm 20.9$ . Details of the study have been presented elsewhere (Bebbington et al., 2005).

We used the GAF, SOFAS, CGI-S and PANSS scores of all 1208 participants. The GAF and the SOFAS range from 1 to 100 and are divided into 10-point intervals describing the level of functioning and symptoms. The anchor point of 1-10 describes the most severely ill (persistent inability) and the anchor point of 91-100

describes the healthiest (superior functioning) (eTable 1). The single PANSS items were rated on a 7-point scale (1=absent, 2=minimal, 3=mild, 4=moderate, 5=moderate severe, 6=severe, and 7=extreme), meaning that the total PANSS score could range from 30 to 210. The CGI-Severity (CGI-S) assesses the clinician's impression of the current state of the patient's illness using the following scores: 1=normal, not at all ill; 2=borderline mentally ill; 3=mildly ill; 4=moderately ill; 5=markedly ill; 6=severely ill; or 7=extremely ill. Assessments were performed at study enrollment, and then every 6 months up to 2 years except the CGI-S which was only assessed at enrollment and endpoint.

For correlations, we used Spearman's rank correlation coefficient. Statistical significance was also attached to correlations ( $P < 0.05$ ). For linking we used the equipercentile linking, a technique that identifies those scores on each scale that have the same percentile ranks. In brief, the percentile rank functions are calculated for both variables. Using the percentile rank function of one variable and the inverse percentile rank function of the other, one then finds for every score of one variable a score on the other variable that has the same percentile rank. This method has been extensively used in previous studies by other working groups (Choi et al., 2014; Huber et al., 2008; Montoya et al., 2011; Schennach-Wolff et al., 2010; Turkoz et al., 2013) as well as ours (Furukawa et al., 2009; Leucht et al., 2006, 2012, 2013a, 2013b; Levine and Leucht, 2013; Levine et al., 2008). More detailed descriptions of the method are available elsewhere (Kolen and Brennan, 2004).

## 3. Results

### 3.1. Correlations

The GAF and the SOFAS were strongly correlated with Spearman correlation coefficients ranging between 0.86 and 0.93 for the comparison of the total scores at baseline and at months 6, 12, 18 and 24 (all  $p$ -Values  $< 0.0001$ ).

The GAF and the CGI-S had a strong negative correlation of  $-0.63$  at baseline and  $-0.71$  at endpoint ( $p$ -Values  $< 0.0001$ ). Similarly, the GAF and the PANSS total score had a strong negative correlation of  $-0.57$  at both time points ( $p$ -Values  $< 0.0001$ ).

### 3.2. Linking the GAF total scores with the SOFAS total scores

A GAF total score of 1 on the average corresponded to a SOFAS total score of 5, a GAF of 10 to a SOFAS of 8, of 20 to 21, of 30 to 32, of 40 to 41, of 50 to 50, of 60 to 60, of 70 to 70, of 80 to 80, of 90 to 90 and of 100 to 98 (Fig. 1 and eTable 2). The analysis showed that the two scales are in an almost perfect linear linking and are practically exchangeable, especially between 15 and 98 points.

### 3.3. Linking of the GAF total scores with the CGI-S and the PANSS total scores

A CGI-S ranking of 1-'normal' corresponded to a GAF score of 64 (range, 60-68), of 2-'borderline' to 57 (range, 55-59), of 3-'mildly ill' to 53 (range, 52-54), of 4-'moderately ill' to 50 (range, 48-51), of 5-'markedly ill' to 46 (range, 45-47), of 6-'severely ill' to 42 (range, 40-44), and 7-'extremely ill' to 37 (range, 35-39) (Fig. 2). Each CGI-S severity rating increment corresponded to an average of 4.5 point decrement to the GAF total score.

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