The Symptom-Checklist-K-9 (SCL-K-9) Discriminates between Overweight/Obese Patients with and without Significant Binge Eating Pathology: Psychometric Properties of an Italian Version

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Abstract: A general personality and psychopathology evaluation is considered to be crucial part of the multidisciplinary assessment for weight-related problems. The Symptom Checklist-90-Revised (SCL-90-R) is commonly used to assess general psychopathology in both overweight and obese patients seeking weight-loss treatment. The main purpose of the present research was to investigate the psychometric properties of the brief form of the SCL-90-R (i.e., the SCL-K-9) in a clinical sample (N = 397) of patients seeking weight-loss treatment (i.e., bariatric surgery and a nutritional weight-loss program). The results of the confirmatory factor analysis supported a one-factor solution of the SCL-K-9, with all nine items loading significantly on the common latent factor (lambdas ≥ 0.587). The ordinal α (= 0.91), the inter-item mean indices of correlation (rii = 0.53), and the convergent validity were also satisfactory. A receiver operating characteristic curves procedure showed that both SCL-90-R and SCL-K-9 were able to classify patients with and without significant binge eating pathology according to the Binge Eating Scale (BES) total score. Overall, our results suggest that the SCL-K-9 has adequate psychometric properties and can be applied as a short screening tool to assess general psychopathology in overweight/obese individuals seeking weight-loss treatment and at follow-up interviews when time restraints preclude the use of the full-length form.

Keywords: binge eating; SCL-K-9; obesity; overweight; bariatric surgery candidates; obesity; psychopathology

1. Introduction

Obesity (i.e., body mass index (BMI) ≥ 30 kg/m²) and overweight (BMI ≥ 25 kg/m²) are serious prevalent health concerns [1] currently affecting over one-third of the world’s population [2]. Indeed, obesity, especially severe obesity (i.e., BMI ≥ 40), is strongly related to morbidity and mortality risk [3,4]. Moreover, weight-loss treatment-seeking individuals are often characterized by dysfunctional
eating patterns, especially binge eating [5–8], as well as high rates of psychopathology, particularly mood and anxiety disorders and body image concerns [6,9,10]. Therefore, a general personality and psychopathology evaluation is considered to be a crucial part of the multidisciplinary assessment for weight-related problems [11,12]. Although the association between psychopathology and the success of weight-loss treatments is controversial [6,13,14], it has often been reported [15–22] that mental health issues (e.g., binge eating disorder) are associated with several aspects of treatment outcomes (e.g., less weight loss, weight regain, and higher drop-out rates). In particular, binge eating disorder in bariatric surgery candidates may predict the development of problematic eating behaviors after surgery [23]. Therefore, brief screening tools to evaluate psychopathology could be extremely useful for clinicians as a first step of a more in-depth assessment procedure.

The Symptom Checklist-90-Revised (SCL-90-R) [24] is one of the most commonly used self-rating measures for assessing general psychopathology in patients seeking weight-loss treatment, such as bariatric surgery or a nutritional weight-loss program [11,12,25,26]. It comprises 90 items rated on a 5-point Likert scale (from “0” to “4”) investigating the severity of nine main psychopathological dimensions over the previous week, including somatic symptoms, interpersonal sensitivity, obsessive–compulsive behaviors, anxiety and depressive symptoms, hostility, phobic symptoms, paranoid tendencies, and psychoticism. Furthermore, this scale proposes a global severity index (GSI-90) as an index of overall psychological distress, with higher scores reflecting higher levels of psychopathological distress as well as a greater severity of self-reported symptoms [27].

Several short forms of the SCL-90-R have been proposed and validated since the 1980s in order to provide a more economical instrument [28]. Among these versions, the Symptom-Checklist-K-9 (SCL-K-9), composed of the nine items of the SCL-90-R (#24, #28, #31, #34, #43, #57, #58, #75, #77) that exhibit the highest item-total correlation, was proposed as an efficient and unidimensional screening tool representing all of the original symptom subscales of the SCL-90-R [29]. It was initially validated by a representative sample of German individuals (N = 2,057), where satisfactory internal reliability (Cronbach α = 0.87), as well as acceptable convergent validity with other measures of psychopathology (e.g., depression and anxiety), were demonstrated [29].

Satisfactory psychometric properties, including a one-factor structure, adequate internal consistency, and convergent validity with psychopathology were also detected in Ukrainian [30] and German [31] general populations. For example, Petrowski et al. [31] recently documented the fit of a one-factor model (Confirmatory Fit Index (CFI) = 0.949; Tucker Lewis Index (TLI) = 0.932; Root Mean Square Error of Approximation (RMSEA) = 0.053). Results of invariance across gender and age groups, satisfactory internal consistency, and strong associations with both somatic (r = 0.60) and depressive symptoms (r = 0.71) were also reported [31].

These findings suggest that the SCL-K-9 is an adequate and valid assessment tool that can be used when time restraints preclude the use of the full-length form, such as in large epidemiological cohort surveys and at follow-up interviews [28–32]. However, as observed by Petrowski and coworkers [31], the investigation of the psychometric properties of SCL-K-9 in clinical samples is still an underdeveloped research area. Furthermore, to the best of our knowledge, no previous studies have investigated the psychometric properties and clinical utility of this measure in overweight/obese treatment-seeking sample populations. The use of validated psychological questionnaires to evaluate general psychopathology is recommend as part of the wider multidisciplinary assessment for weight-related problems [11,12].

Thus, the purposes of the current research were to propose an Italian adaptation of the SCL-K-9 and to explore its dimensionality and psychometric properties in a clinical sample of obese and overweight patients seeking weight-loss treatment (i.e., bariatric surgery and nutritional weight-loss programs). Another aim was to investigate whether, by using a receiver operating characteristic (ROC) curve procedure, the SCL-K-9 could be able to categorize patients with and without significant binge eating pathology according to the Binge Eating Scale (BES) total score[33] compared to the original SCL-90-R.

2. Material and Methods
2.1. Participants

The present data were extracted from a database used in a previous study by our research team [34]. Briefly, the study participants were 397 overweight and obese patients (291 women and 106 men) who were referred to a medical center in Rome (Italy) specializing in nutritional weight-loss treatment (N=122) or to the center for Bariatric Surgery Unit at the University of Rome “Tor Vergata” (N = 275). All study participants were examined at the time of study entry; inclusion/exclusion criteria are described elsewhere [34]. This research was approved by the ethics committee of the University of Rome “Tor Vergata”, in line with the Helsinki declaration standards.

2.2. Self-report measures

After enrolment, the Italian version of the Binge Eating Scale (BES) [8] and the SCL-90-R [35] were administered to all patients. Sociodemographic and clinical data were detected from medical records.

The BES [33] is a 16-item self-report questionnaire widely used to assess binge eating pathology (i.e., behavioral and cognitive/emotional symptoms). The total score ranges from 0 to 46 (with higher scores reflecting more severe binge eating pathology), and three different levels of severity were proposed [36,37]: (1) No significant binge eating (i.e., BES total score ≤17), (2) moderate binge eating (i.e., total score ranging from 18 to 26), and (3) severe binge eating (i.e., BES total score ≥27). Satisfactory psychometric properties (e.g., good internal consistency and factorial structure) have been widely reported in both surgical and nonsurgical patients [8,38–40]. The internal consistency in the present study was $\alpha = 0.90$.

The SCL-90-R [24] is a 90-item self-report measure used to assess general psychopathology and overall psychological distress. In the present sample, the internal consistency was $\alpha = 0.94$ for the GSI-90. According to previous studies [29,30], the SCL-9-K was obtained on the basis of SCL-90-R items. The GSI-K-9 is the total score of the SCL-9-K.

2.3. Statistical analyses

The SPSS 18.0 statistical package for the social sciences (IBM, Chicago, USA) was used to perform all of the analyses. Compared to our previous study [34], 6 participants were excluded due to missing items on the SCL-K-9.

In order to assess the psychometric properties of the SCL-K-9 at the item level, we reported corrected item-total correlations and descriptive statistics (means, standard deviations, skewness, and kurtosis). As a measure of reliability, we reported the ordinal $\alpha$ [41] and the inter-item mean correlation ($r_{ii}$). The convergent validity values of the BES, GSI-90, and SCL-90-R subscales were assessed using Pearson’s $r$ correlation coefficients. Furthermore, associations with age and BMI were investigated. Sex differences were also evaluated using a $t$-test for independent samples.

Data were submitted to a confirmatory factor analysis (CFA) using Mplus 6.0 (Los Angeles, CA, USA) [42] and a Weighted Least Square Mean and Variance Adjusted (WLSMV) estimator with a polychoric correlation matrix after calculating Mardia’s multivariate asymmetry skewness and kurtosis statistics [43]. The model fit was assessed using the following indices: (1) the RMSEA, as index of absolute fit, with values between 0.05 and 0.08 suggesting good adequacy of the model and values below 0.05 demonstrating strong evidence of absolute fit [44]; (2) the Weighted Root Mean Square Residual (WRMR), where values less than 1.0 indicated good model fit [45,46]; (3) the chi-squared ($\chi^2$) test, where p-values greater than 0.05 indicated that the model was adequate for the data; and (4) TLI as a measure of a relative model-fit compared to the “null” model, where values > 0.950 were recommended for a good model fit [46].

Lastly, in order to assess the performance of the SCL-K-9 in classifying patients according to their current binge eating severity, we performed a ROC test procedure [47]. A ROC curve is a two dimensional depiction of test performance [48], with the main outcome variable being the area under the ROC curve (AUC), which reflects the probability that a randomly sampled respondent would be
correctly categorized [49]. The AUC directly represents the overall accuracy of the instrument in categorizing a sample where values of ≥ 0.70 are considered to be satisfactory [50]. The Youden Index [51] was calculated in order to detect the maximum thresholds of both sensitivity (i.e., the proportion of subjects who have the target condition and exhibit positive test results) and specificity (i.e., the proportion of subjects without the target condition and exhibit negative test results).

3. Results

The patients had an average age of 43.40 years (SD = 12.02; range: 18–73) and the mean BMI was 40.32 kg/m² (SD = 9.39; range: 25.04–53.40). According to the standard BMI cut-off [52], there were 68 (17.1%) overweight patients and 329 obese patients (82.9%), mostly with severe obesity (49.9%). A total of 126 patients (31.7%) had a BES total score of ≥ 18 (i.e., moderate-to-severe binge eating), and 51 (12.8%) had a BES total score of ≥ 27 (i.e., severe binge eating). Detailed descriptive statistics of the study participants are reported in Table 1.

Table 1. Descriptive statistics of the sample.

| Variables                        | Nonsurgical Patients (N = 122) | Surgical Candidates (N = 275) | Total (N = 397) |
|----------------------------------|-------------------------------|-------------------------------|-----------------|
| Age—M ± SD                       | 41.92 ± 13.53                 | 44.08 ± 11.23                 | 43.40 ± 12.02   |
| Females—N (%)                    | 90 (73.8)                     | 201 (73.1)                    | 291 (73.3)      |
| BMI—M ± SD                       | 31.72 ± 6.59                  | 44.15 ± 7.79                  | 40.33 ± 9.39    |
| BMI ≥ 25-29.9 kg/m²—N (%)        | 68 (55.7)                     | -                             | 68 (17.1)       |
| BMI ≥ 30-34.9 kg/m²—N (%)        | 18 (14.8)                     | 16 (5.8)                      | 34 (8.6)        |
| BMI ≥ 35-39.9 kg/m²—N (%)        | 22 (18.0)                     | 75 (27.3)                     | 97 (24.4)       |
| BMI ≥ 40 kg/m²—N (%)             | 14 (11.5)                     | 184 (66.9)                    | 198 (49.9)      |
| BES—M ± SD                       | 13.50 ± 9.30                  | 14.07 ± 10.28                 | 13.89 ± 9.39    |
| BES total score ≤ 17—N (%)       | 83 (68)                       | 188 (68.4)                    | 271 (68.3)      |
| BES total score ≥ 18—N (%)       | 39 (32)                       | 87 (31.6)                     | 126 (31.7)      |
| BES total score ≥ 27—N (%)       | 14 (11.5)                     | 37 (13.5)                     | 51 (12.8)       |
| GSI-90—M ± SD                    | 0.72 ± 0.59                   | 0.65 ± 0.55                   | 0.67 ± 0.57     |
| Somatization—M ± SD              | 0.83 ± 0.70                   | 0.97 ± 0.69                   | 0.93 ± 0.70     |
| Obsessive–compulsive symptoms—M ± SD | 0.89 ± 0.75                 | 0.66 ± 0.66                   | 0.73 ± 0.69     |
| Interpersonal sensitivity—M ± SD | 0.76 ± 0.78                   | 0.68 ± 0.70                   | 0.70 ± 0.73     |
| Depression—M ± SD                | 0.87 ± 0.78                   | 0.79 ± 0.74                   | 0.81 ± 0.76     |
| Anxiety—M ± SD                   | 0.70 ± 0.65                   | 0.56 ± 0.59                   | 0.60 ± 0.61     |
| Hostility—M ± SD                 | 0.65 ± 0.70                   | 0.44 ± 0.55                   | 0.50 ± 0.61     |
| Phobic anxiety—M ± SD            | 0.28 ± 0.52                   | 0.31 ± 0.51                   | 0.30 ± 0.52     |
| Paranoid ideation—M ± SD         | 0.74 ± 0.69                   | 0.59 ± 0.61                   | 0.64 ± 0.64     |
| Psychoticism—M ± SD              | 0.45 ± 0.56                   | 0.34 ± 0.49                   | 0.37 ± 0.52     |
3.1. Internal Consistency and Model Fit of the SCL-K-9

The ordinal $\alpha (= 0.91)$ and inter-item mean index of correlation ($r_i = 0.53$) values for the SCL-K-9 were satisfactory. The analysis of the items indicated that all the nine items had acceptable statistics (detailed items statistics are reported in Table 2). The results of the CFA supported a one-factor solution of the SCL-K-9, with all nine items loading significantly on the common latent factor ($\geq 0.587$). Detailed fit statistics and item loadings are reported in Table 3.
Table 2. Items statistics of the SCL-K-9.

| Item Number | Mean | SD  | Skewness | Kurtosis | Selectivity | Ordinal Alpha if Item is Dropped | Not at All (%) | A Little Bit (%) | Moderately (%) | Quite a Bit (%) | Extremely (%) |
|-------------|------|-----|----------|----------|-------------|---------------------------------|----------------|-----------------|----------------|----------------|---------------|
| #1          | 0.53 | 0.95| 1.96     | 3.26     | 0.69        | 0.90                            | 69.3           | 17.1            | 7.3            | 4.3            | 2.0           |
| #2          | 0.85 | 1.09| 1.23     | 0.77     | 0.71        | 0.90                            | 51.5           | 24.1            | 15.6           | 5.0            | 3.8           |
| #3          | 1.07 | 1.20| 0.97     | -0.06    | 0.72        | 0.90                            | 42.2           | 29.4            | 13.1           | 10.1           | 5.3           |
| #4          | 0.82 | 1.08| 1.28     | 0.83     | 0.77        | 0.90                            | 52.8           | 25.6            | 11.6           | 7.0            | 3.0           |
| #5          | 0.61 | 0.99| 1.72     | 2.31     | 0.72        | 0.90                            | 64.3           | 19.8            | 8.8            | 4.8            | 2.3           |
| #6          | 0.91 | 1.05| 1.03     | 0.32     | 0.76        | 0.90                            | 46.0           | 28.9            | 15.8           | 7.0            | 2.3           |
| #7          | 1.34 | 1.32| 0.68     | -0.75    | 0.55        | 0.91                            | 34.7           | 28.9            | 13.6           | 13.6           | 9.3           |
| #8          | 0.27 | 0.67| 2.82     | 8.04     | 0.62        | 0.91                            | 82.4           | 11.1            | 4.0            | 2.3            | .3            |
| #9          | 0.66 | 0.97| 1.52     | 1.69     | 0.72        | 0.90                            | 59.5           | 23.4            | 10.3           | 5.0            | 1.8           |
| Total       | 0.78 | 0.74| -        | -        | -           | -                               | -              | -               | -              | -              | -             |
Table 3. Model fit of the SCL-K-9.

| Model fit | $\chi^2$ | df | Sig. | RMSEA (0.00/0.05) | TLI | WRMR |
|-----------|---------|----|------|-------------------|-----|------|
|           | 34.87   | 27 | 0.14 | 0.027             | 0.996 | 0.50 |

| Items     | #1      | #2  | #3   | #4    | #5   | #6    | #7   | #8    | #9    |
|-----------|---------|-----|------|-------|------|-------|------|-------|-------|
| Loadings  | 0.728   | 0.743 | 0.775 | 0.819 | 0.764 | 0.797 | 0.587 | 0.683 | 0.763 |
| $R^2$     | 0.530   | 0.553 | 0.601 | 0.671 | 0.584 | 0.635 | 0.344 | 0.467 | 0.582 |

3.2. Psychometric properties of the SCL-K-9

The GSI-K-9 shared 90% of its variance with the original GSI-90 ($r = 0.95$; $p < 0.001$). The convergent validity of the SCL-K-9 was satisfactory. The GSI-K-9 was strongly correlated with the BES total score ($r = 0.53$; $p < 0.001$), as well as with all of the SCL-90-R subscales ($r > 0.68$; $p < 0.001$). No significant correlations were reported with either age ($r = 0.02$; $p = 0.64$) or BMI ($r = 0.06$; $p = 0.23$). However, compared to men, women reported higher scores in the both GSI ($0.55 \pm 0.53$ vs $0.71 \pm 0.58$ vs.; $t_{395} = -2.50$; $p = 0.013$) and GSI-K-9 ($0.62 \pm 0.64$ vs $0.85 \pm 0.77$; $t_{395} = -2.73$; $p = 0.007$).

A ROC curve procedure showed that both the GSI-K-9 (area under the ROC curve = 0.75, 95%; confidence interval [0.70, 0.81], SE = 0.03, $p < 0.001$) and the GSI-90 (area under the ROC curve = 0.78, 95%; confidence interval [0.73, 0.83], SE = 0.03, $p < 0.001$) classified patients with moderate-to-severe levels of binge eating (i.e., BES total score $\geq 18$; Figure 1A). Particularly, a score of 0.83 or higher on the GSI-9-K (Youden index = 0.36) categorized individuals with a sensitivity of 0.62 (62% of all the subjects with BES total score $\geq 18$ were correctly detected) and a specificity of 0.75 (25% of patients were incorrectly identified as having a moderate-to-severe level of binge eating). The ROC curve procedure also showed that both the GSI-K-9 (area under the ROC curve = 0.80, 95%; confidence interval [0.73, 0.87], SE = 0.04, $p < 0.001$) and the GSI-90 (area under the ROC curve = 0.81, 95%; confidence interval [0.75, 0.88], SE = 0.03, $p < 0.001$) classified patients with severe levels of binge eating (i.e., BES total score $\geq 27$; Figure 1B). Particularly, a score of 0.96 or higher on the GSI-K-9 (Youden index = 0.44) categorized individuals with a sensitivity of 0.71 (71% of all the subjects with BES total score $\geq 27$ were correctly detected) and a specificity of 0.73 (27% of patients were incorrectly identified as having a severe level of binge eating).
Figure 1. Panel A: ROC curve graph for the ability of the GSI-K-9 and GSI-90 to discriminate individuals with moderate-to-severe levels of binge eating (BES total score ≥ 18) from those without a significant level of binge eating symptoms (BES total score < 18). Panel B: ROC curve graph for the ability of the GSI-K-9 and GSI-90 to discriminate individuals with severe levels of binge eating (BES total score ≥ 27) from those without significant levels of binge eating symptoms (BES total score < 27).

Abbreviations: ROC—receiver operating characteristic; GSI-K-9—global severity index of the Symptom Checklist-K-9; BES—Binge Eating Scale; GSI-90—global severity index of the Symptom Checklist-90-Revised.

4. Discussion

The major purpose of the current research was to explore the dimensionality and psychometric properties of the SCL-K-9 in a clinical sample of obese and overweight patients seeking weight-loss treatments (i.e., bariatric surgery and nutritional weight-loss therapy). Consistent with previous studies in the general population [30,31], our data supported unidimensionality of the SCL-K-9, with satisfactory psychometric properties. Specifically, the internal consistency, correlations with the original indices of the SCL-90-R, and the convergent validity regarding binge eating severity were all satisfactory. This was in accordance with previous reports detecting the association between binge eating and psychopathology in overweight/obese patients [53–55]. Although causal relationships between investigated variables could not be established in our study, it has been proposed that a lack of control over eating could reflect dysfunctional coping strategies consistent with people attempting to self-medicate in response to a range of psychological symptoms and negative affective states [55–57]. In line with previous studies [29,31], our results also showed that, compared to men, women exhibited higher scores on the SCL-K-9, suggesting that, among individuals with obesity, psychopathology may be more strongly associated with women than men [10,58,59].

Our data also suggested that the SCL-K-9 could discriminate between patients with and without significant binge eating pathology according to different levels of severity. The ability of the GSI-K-9 to discriminate between individuals with different levels of binge eating was comparable with that of the original GSI-90. For example, a randomly chosen patient with severe binge eating (i.e., BES total score ≥ 27) had an 80% probability of having a higher score on the GSI-K-9 than a randomly chosen individual with a BES total score < 27. This performance was comparable to that observed using the full SCL-90-R (i.e., 81% probability).

Although the present data are interesting, some limits should be underlined and considered in order to guide future research. One limitation that must be considered is that the high female proportion of our sample limits the generalizability of these findings. Second, we did not investigate the stability of SCL-K-9 over time and its predictive validity on future weight-loss outcomes, such as drop-out rates. Lastly, we used only self-reported measures; in the future, the performance of the SCL-K-9 to classify patients with and without mental disorders should be analyzed using structured clinical interviews. Indeed, although the SCL-90-R is an adequate instrument to assess general psychopathology, it does not diagnose a mental disorder [60].

Despite these limitations, to the best of our knowledge, this is the first study investigating the dimensionality and psychometric properties of the SCL-K-9 in a clinical sample of obese and overweight patients seeking weight-loss treatment.

5. Conclusion

Overall, our data suggested that the SCL-K-9 possesses satisfactory psychometric properties and can be used as a short screening tool for the assessment of general psychopathology in overweight/obese patients seeking weight-loss treatment when time restraints preclude the use of the full-length form. As a time-saving instrument, the SCL-K-9 could be useful for clinicians as a first step of a more in-depth assessment procedure, as well as to measure outcomes of psychopathological symptoms associated with weight-loss treatment during follow-up assessment [31]. The ability of this brief version to discriminate between overweight/obese patients with and without significant binge
eating pathology may have important clinical implications. Considering that the presence of both pre- and post-operative binge eating negatively influences the long-term outcomes [17,61–63], this brief tool could help clinicians to promptly identify high-risk individuals. Accordingly, individuals presenting positive screening results could be addressed via a proper psychosocial intervention [64,65], and surgeons may select a more suitable type of intervention based on the patient’s eating disorder [66]. Finally, the SCL-K-9 could be useful for researchers as a brief psychopathological screening questionnaire in large epidemiological cohort studies.

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