Ψ **Psychology Press**
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Reliability and validity of the Geriatric Depression Scale in detection of poststroke minor depression

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Objective: The aim of this study was to assess the validity and reliability of the 30-item Geriatric Depression Scale (GDS) as a screening tool for minor depression in poststroke patients. *Method*: Literate patients older than 18 years of age, diagnosed to have stroke, were eligible for the study. Standardized Mini Mental Status Examination (S-MMSE) and GDS were applied to all patients. The GDS was readministered 7 days later for retest reliability. *Results*: A total of 85 participants—49 nondepressed and 36 with minor depression—were eligible for the study. Cronbach's alpha coefficient was .89 in internal consistency analysis. The GDS scores were significantly higher ($p < .001$) in the depressed participants reflecting a high discriminant validity. The highest sum of sensitivity and specificity values of 1.44 (sensitivity = .69, specificity = .75) and 1.45 (sensitivity = .66, specificity = .79) were obtained for cutoff scores of 10/11 and 11/12, respectively. The area under receiver operating characteristics curve was .82. The test–retest reliability analysis revealed a high Pearson correlation coefficient ($r = .75$). *Conclusion*: Our findings suggest that the 30-item GDS has high discriminant validity, internal consistency, and test–retest reliability and reasonably useful cutoff scores; thus it can be used as a screening tool for minor depression in the poststroke population.

Keywords: Depression; Geriatric Depression Scale; Poststroke depression; Stroke; Reliability; Validity; Minor depression.

INTRODUCTION

Stroke due to cerebrovascular disorders often leads to significant physical impairment and psychological problems. Depression is among the most encountered psychiatric disorders after stroke. As reviewed by Hackett (Hackett, Yapa, Parag, & Anderson, 2005), at least one third of stroke survivors experience significant depressive symptoms at some time after the event. Using population attributable fractions, it is estimated that 8% of depression was deemed attributable to stroke, independent from other cardiovascular risk factors (Almeida et al., 2007). Poststroke depression has a detrimental effect on functionality after stroke. It is reported that depression is significantly and independently associated with poststroke disability one year after the event (Lo et al., 2008).

The frequency of poststroke minor depression depends on multiple factors such as the investigation setting, time elapsed since stroke, and diagnostic

criteria used to assess depression and thus changes from 5% to 44% (Hackett et al., 2005). Despite its detrimental effect on functionality, depression is not readily diagnosed in stroke victims. Because depressive symptoms are often considered as a part of stroke-related somatic symptoms, depression may remain underdiagnosed (Ramasubbu & Kennedy, 1994). More recently, Williams showed that only 41% of patients exceeding the cutoff on the Geriatric Depression Scale (GDS) were found to be either treated for or diagnosed as having depression, leaving almost 60% undiagnosed and untreated (Williams, Rittman, Boylstein, Faircloth, & Haijing, 2005). On the other hand, patients may suffer from insomnia and loss of appetite as a direct consequence of stroke, which may lead to a false increase in depression scores. Therefore, somatic items used to detect depression are less valid than nonsomatic items in stroke patients (Fedoroff, Starkstein, Parikh, Price, & Robinson, 1991; Stein, Sliwinski, Gordon, & Hibbard, 1996). This fact emphasizes the necessity of a screening tool for depression that does not include items related to somatic symptoms of depression. However, self- or clinician-rated screening tools like Beck Depression Inventory and Hamilton Depression Rating Scale include significant number of somatic items, which may potentially bias the diagnosis of depression in this population (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961; Hamilton, 1960).

The GDS is a self-rating screening tool for depression developed to be used in geriatric populations (Yesavage et al., 1982). Validity, reliability, and factor structure of different language versions (Black & Auerbach, 1995; Bourke & Blanchard, 1990; Cialdella et al., 1992; Dunn & Sacco, 1989; Izal & Montorio, 1993; Kohli, Banerjee, & Verma, 1991; Mui, 1996; Niino, Imaizumi, & Kawakami, 1991), including a Turkish version (T. Ertan & Eker, 2000), has been studied. The Turkish version has also been shown to be a reliable and valid instrument in detecting depression in Parkinson's disease (F. S. Ertan, Ertan, Kiziltan, & Uyucgil, 2005). As reviewed by Montorio and Wanchata (Montorio & Izal, 1996; Wancata, Alexandrowicz, Marquart, Weiss, & Friedrich, 2006), the validity of the GDS has been investigated in different settings (outpatients, inpatients, primary care) and populations (geriatric populations, patients with general medical conditions). Its use in poststroke patients has also been documented in several studies (Salbach, Mayo, Hanley, Richards, & Wood-Dauphinee, 2006; Williams et al., 2005). The psychometric properties of the scale has been investigated in poststroke patient samples with only major depression and with both major and minor depression (Williams et al., 2005). However, some authors consider minor depression occurring after stroke as a distinct category from poststroke major depression (Morris, Shields, Hopwood, Robinson, & Raphael, 1994; Paradiso & Robinson, 1999). Patients with poststroke minor depression have been found to be more disabled in both physical activities and language functioning than nondepressed poststroke patients (Parikh et al., 1990).

The GDS includes 30 yes/no type items and is designed to exclude somatic symptoms that are frequently seen in the nondepressed geriatric population. It has a shorter version (GDS-SF) that includes only 15 items (Sheikh & Yesevage, 1986). A study comparing these two versions in a previous poststroke sample concluded that although GDS-SF was an acceptable instrument in the detection of poststroke depression, the 30-item version had stronger psychometric characteristics in this population (Chau, Martin, Thompson, Chang, & Woo, 2006). Its worldwide use suggests that the GDS might be a potentially useful tool for screening depression in poststroke patients. To our knowledge, the validity of the GDS has not been assessed in a poststroke population with only minor depression. The aim of this study was to assess the validity and reliability of the 30-item GDS as a screening tool for minor depression in poststroke patients.

METHOD

The study sample was composed of patients recruited from four university hospital departments, three of them being rehabilitation centers and one an outpatient stroke unit.

Literate patients older than 18 years of age, diagnosed by a neurologist to have stroke, were eligible for the study. Since the assessment tools to be used in the study required the ability to read and write, participants who were premorbidly illiterate and those with aphasia were excluded. Participants with any other cerebral disorders besides stroke (Parkinson's disease, dementia, etc.), with any Axis I disorder defined by the DSM-IV-TR (*Diagnostic and Statistical Manual of Mental Disorders–Fourth Edition, Text Revision*; American Psychiatric Association, 2000) except depressive disorder, or with a history of any antidepressant treatment or any depressive episode before the occurrence of stroke were excluded from the study. All patients gave informed consent to participate, and the study was approved by the ethical committee.

Psychiatric clinical assessments were performed by psychiatrists in each center. Participants were evaluated according to DSM-IV-TR criteria for the

diagnosis of minor depression. Patients fulfilling the DSM-IV-TR diagnostic criteria for dementia or any other Axis I disorder as assessed by clinical evaluation were excluded from the study. Participants with a diagnosis of minor depression were included in the study only if their condition was found to be related to stroke based on clinical judgment.

Sociodemographic information was recorded, and the Turkish version of the Standardized Mini Mental Status Examination (S-MMSE; Gungen, Ertan, Eker, Yasar, & Engin, 2002) was applied to all patients.

All participants received the 30-item GDS at the end of the session. Thus, the interviewers were blind to the GDS scores while performing the diagnostic interview. The GDS was readministered 7 days later for retest reliability in a subgroup of patients who were available for reassessment.

Analyses to compare demographic data between the minor depression and nondepressed groups were carried out by using Student's *t* test for numeric variables (i.e., age, days since last stroke, S-MMSE total score) after the assessment of homogeneity of variances by Levene's test and chi-square test for categorical variables (i.e., percentage of participants over 65 years of age, gender, distribution of educational levels). Discriminant validity was tested by comparing total GDS scores of nondepressed and minor depression groups using Student's *t* test. Cronbach's alpha and Pearson correlation coefficients were calculated for internal consistency and test–retest reliability, respectively. Sensitivity, specificity, and positive and negative predictive values (PPV, NPV) were calculated for different cutoff scores. Cutoff scores were also assessed by the receiver operating characteristics (ROC) curve.

RESULTS

A total of 85 patients were included in the study.

The mean age of the sample was 60.1 ± 14 years (range 25–87 years), and 53 (62.4%) were female. A total of 12 participants (14.2%) were literate without schooling, while 38 (44.7%) graduated from primary school (i.e., 5 years of education), 22 (25.9%) from secondary school (i.e., 6–11 years of education), and 13 (15.3%) graduated from university (i.e., above 11 years of education). The mean duration since last stroke of the whole sample was 237 ± 231 (17–704) days. The number of participants assessed at 0–3 months, 4–6 months, 6–12 months, and >12 months after the stroke were 34 (40%), 12 (14%), 10 (12%), and 29 (34%), respectively. The mean S-MMSE score was 24.5 ± 4 (13–30). A total of 26 (31%) patients scored under 23 points on S-MMSE. A total of 70 (82.4%) participants had had their first stroke. Out of 85 participants, 36 (57.6%) were diagnosed to have minor depression, and 49 (42.4%) were found to be nondepressed.

Characteristics of the participants are summarized in Table 1. Comparison of gender, duration since last stroke, and S-MMSE scores did not reveal any significant difference between depressed and

TABLE 1
Sociodemographic and clinical characteristics of participants

	Minor depression (n = 36)		Nondepressed (n = 49)		Statistics
	Mean (± SD)	n (%)	Mean (± SD)	n (%)	
Age	57.3 ± 14		62.9 ± 9		$t(83) = 1.99, p = .05$ 95% CI: (–0.01; 11.15)
Females		21 (58)		32 (65)	$\chi^2(1) = 0.43, p = .51$
Days since last stroke	250 ± 240		229 ± 226		$t(83) = 0.40, p = .68$ 95% CI: (–123; 81)
Months since last stroke					
0–3		13 (36)		21 (43)	$\chi^2(3) = 2.5, p = .474$
4–6		7 (19)		5 (10)	$\chi^2(3) = 2.5, p = .474$
6–12		5 (14)		5 (10)	$\chi^2(3) = 2.5, p = .474$
>12		11 (31)		18 (37)	$\chi^2(3) = 2.5, p = .474$
Education					
No schooling		4 (11)		8 (16)	$\chi^2(3) = 5.29, p = .15$
Primary school		21 (58)		17 (35)	$\chi^2(3) = 5.29, p = .15$
Secondary school		8 (22)		14 (28)	$\chi^2(3) 5.29, p = .15$
University		3 (8)		10 (20)	$\chi^2(3) 5.29, p = .15$
S-MMSE score	23.9 ± 5		24.9 ± 4		$t(83) = 1.04, p = .29$ 95% CI: (–0.92; 2.98)
S-MMSE score <23		12 (33)		14 (29)	$\chi^2(1) = 0.22, p = .63$

Note. S-MMSE = Standardized Mini Mental Status Examination.

nondepressed groups. The nondepressed group was slightly older, but this difference was not statistically significant. Comparison of the distribution of duration since last stroke was not statistically different between the depressed and nondepressed groups.

Levene's test showed no difference in variance between the two groups' GDS total scores, and an independent samples t test showed significantly higher mean score in the depressed group than in nondepressed participants (17.2 ± 4 vs. 12.8 ± 2), $t(83) = 5.67$, $p = .000$, 95% CI (2.8–5.9), reflecting a high discriminant validity. A high Cronbach's alpha coefficient ($\alpha = .88$) was obtained in an internal consistency analysis. Highest sum of sensitivity and specificity values of 1.44 and 1.45 were obtained for cutoff scores of 10/11 and 11/12, respectively. Sensitivity, specificity, and positive and negative predictive values of cutoff scores between 4/5 and 16/17 are shown in Table 2. The ROC curve is also presented in Figure 1. Area under the curve value in ROC curve assessment was .82. The GDS was readministered to 53 participants (32 nondepressed, 21 with minor depression) 7 days after the first interview for test–retest reliability analysis, and a high Pearson correlation coefficient was obtained between the two mean GDS scores obtained from the first and second ratings of this subgroup. ($r = .75$, $p = .000$).

In order to investigate the influence of age on GDS scores we divided our sample into elderly (those older than or equal to 65 years of age) and nonelderly (those younger than 65 years of age) subgroups. Age and GDS score were not found to be significantly correlated in either elderly (Pearson correlation; $r = .21$, $p = .23$) or nonelderly subgroups ($r = -.27$, $p = .052$). On the other hand, those with minor depression had a significantly greater mean GDS score than that of nondepressed in both elderly (12.0 ± 6.44 vs. 6.29 ± 4.47, $p = .018$) and nonelderly (15.34 ± 6.00 vs. 6.29 ± 4.47) subgroups.

DISCUSSION

In this study, the validity and reliability of the GDS as a screening tool for minor depression has been assessed in a mixed-aged poststroke population.
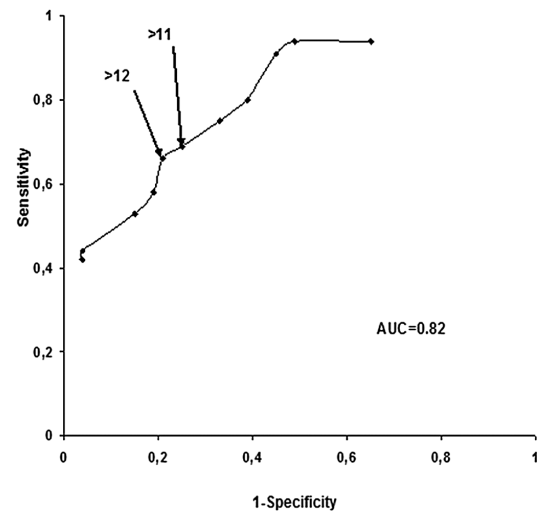
Figure 1. Receiver operating characteristics (ROC) curve for GDS in discriminating nondepressed subjects ($n = 49$) from those with minor depression ($n = 36$). AUC: area under curve.

Similar to the results obtained in depressed Turkish elderly (Cronbach's alpha = .91) and in general elderly populations in other cultures (Cronbach's alpha around .90), internal consistency of the GDS was high (Cronbach's alpha = .89; Cialdella et al., 1992; Dunn & Sacco, 1989; T. Ertan & Eker, 2000; Yesavage et al., 1982).

Two previous studies have reported that the characteristics of depression did not differ between stroke samples and elderly nonstroke rehabilitation patients/general medical populations (Cully et al., 2005; Mast, 2004). Thus they argue against the importance of our study. However, it must be noted that these studies were conducted among the elderly, and the incidence of silent brain infarcts significantly increases with age (Vermeer et al., 2003). Thus, some of their "non-stroke" patients may well have suffered from undetected stroke-related depression.

We excluded patients diagnosed with dementia according to the DSM-IV-TR criteria. Of our sample, 31% scored under 23 points on the S-MMSE, the cutoff score for detection of mild dementia in otherwise healthy elderly (Gungen et al., 2002), but the mean S-MMSE score of our sample was above 23. None of our participants was diagnosed to have

TABLE 2
Discrimination between depressed and nondepressed groups

Cutoff	4/5	5/6	6/7	7/8	8/9	9/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Sensitivity	.94	.94	.91	.80	.80	.75	.69	.66	.58	.53	.44	.42	.42
Specificity	.35	.51	.55	.61	.61	.67	.75	.79	.81	.85	.96	.96	.96
PPV	.51	.58	.60	.60	.60	.63	.67	.70	.70	.73	.88	.88	.88
NPV	.89	.89	.88	.81	.81	.78	.77	.76	.73	.71	.70	.69	.69

Note. Depressed group, $n = 36$; nondepressed group, $n = 49$. PPV = positive predictive value; NPV = negative predictive value.

dementia. It should be noted that although S-MMSE measures the cognitive level it is not a diagnostic tool. Patients may score under the cutoff but may not have dementia, yet some others scoring above the cutoff may very well have dementia. That is the main reason why we used DSM-IV-TR diagnostic criteria for dementia but not S-MMSE score.

Reliability and validity of the 15-item GDS have been previously assessed in geriatric poststroke populations (Tang et al., 2004a). Although it has been found to be a useful screening instrument showing satisfactory accuracy in detecting depression, the authors suggested using a more specific instrument to supplement the GDS due to its low PPV (Tang et al., 2004a). The only study assessing the efficacy of the 30-item GDS in a mixed-age stroke population has been performed by Johnson et al. (1995). Their primary aim was to compare the GDS with two other screening instruments in terms of validity and reliability. They did not report the internal consistency measure for the GDS but a cutoff score of 10/11 has been suggested as optimal for the discrimination of depression. This result is similar to ours, despite some methodological differences between the two studies. Johnson et al. have used DSM-III (*Diagnostic and Statistical Manual of Mental Disorders–Third Edition*; American Psychiatric Association, 1980) criteria for major depression and dysthymic disorder excluding the necessity of a 2-year symptom duration but requiring the presence of symptoms for 1 month, in order to define "mild or minor depression" (Johnson et al., 1995). Although these criteria have been used by other authors to define minor depression, they are not as specific as the minor depression criteria of DSM-IV-TR. Since DSM-III criteria do not necessitate at least one of the symptoms being depressive mood or anhedonia, the diagnosis based on DSM-III criteria include other forms of subclinical or subthreshold depression. While Johnson et al. have included patients up to 4 months after the stroke, we did not limit our inclusion criteria based on the time elapsed since last stroke or age, and this provided a broader range of patients available for our study. The prevalence of poststroke depression varies with time elapsed since stroke. It has been estimated to be up to 47% for depression and 20% for minor depression during the acute phase while it increases up to 58% and 44% at 2 to 4 months after stroke for overall depression and minor depression, respectively. The prevalence is even higher at 6 months and reaches 60% for overall depression (Aben et al., 2001). In a longitudinal follow-up study, the GDS score has been shown to increase from 3 months to 1 year after stroke (Lo et al., 2008). This indicates that the severity of depression may also vary according to time elapsed since stroke. In contrast, Saxena et al. (Saxena, Ng, Yong, Fong, & Koh, 2008) report contradicting evidence suggesting no change in the prevalence from acute phase to 6 months after stroke. However, their study included subclinical depression, which might include some forms of subthreshold depression other than minor depression. In order to cover a broader spectrum of poststroke patients, we did not limit our study to the acute phase. Patients at 3 months after stroke accounted for 40%, those at 4 to 12 months after stroke accounted for 26%, and those at more than 1 year after stroke accounted for the remaining 34% of our population.

Another study has compared the GDS, Visual Analogue Mood Scale, and Hospital Anxiety and Depression Scale in the detection of depression in a Chinese poststroke population (Tang, Ungvari, Chiu, & Sze, 2004b). Patients with major depression, dysthymic disorder, and adjustment disorder with depressed mood were included in this study. There were only 14 depressed participants (9 with major depression and 5 with adjustment disorder with depressed mood) and 46 cases without depression. The investigators have mentioned the weaknesses of their study as low number of participants and the recruitment site being a rehabilitation center, which does not reflect the entire range of poststroke patients (Tang et al., 2004b). Major differences of this study from ours were the use of the 15-item GDS, smaller sample size, and mean duration of time elapsed from stroke of 4 weeks. Their study population was older than ours (mean age 71.93 vs. 61.0 years). We believe our sample represents a wider range of poststroke patients referred from rehabilitation centers as well as from an outpatient stroke center.

The primary aim in both of the above-mentioned studies was to compare screening instruments; thus they did not evaluate test–retest reliability of the GDS (Johnson et al., 1995; Tang et al., 2004b). When compared to our study, inclusion of patients with major depression was a major methodological difference of these studies. As emphasized by Paradiso and Robinson (1999), minor depression occurring after stroke may well be a distinct category than major depression. Although these two disorders are usually assumed to be a part of the same continuum and are usually put in the same general category of poststroke depression, research on the validity of the minor depression concept indicates that it may well be a distinct category. Participants with poststroke

minor depression are younger and have left cerebral hemisphere lesions more frequently than do nondepressed participants (Paradiso & Robinson, 1999). They are less likely to have a family history of affective disorders (Morris et al., 1994), have lower frequency of comorbid generalized anxiety disorder, and are less frequently diagnosed with a psychiatric disorder in the past than are participants with poststroke major depression (Paradiso & Robinson, 1999). Moreover, minor depression is also found to be associated with more posterior lesions than is poststroke major depression, which may indicate different etiological models for minor and major depression (Paradiso & Robinson, 1999). We believe these findings should be replicated in larger groups in order to establish the categorical difference between major and minor depression in poststroke patients. Nevertheless, we also believe that these results constitute an adequate basis of evidence to suggest that assessment tools should be validated separately for minor and major poststroke depression.

Alongside some methodological differences, Johnson et al. (1995) have found the sum of sensitivity and specificity as 1.5, and our study revealed a sum of 1.44 and 1.45. Our cutoff scores (10/11 and 11/12) had a higher specificity (.75–.79 vs. .66), but a lower sensitivity (.69–.66 vs. .84) than those reported by these investigators (Johnson et al., 1995). This may be due to the absence of participants with major depression in our study, which may have resulted in lower sensitivity scores, and inclusion of subclinical patients in Johnson's study as a result of the different diagnostic criteria employed, which may have lowered the specificity.

Our findings suggest 10/11 and 11/12 as cutoff scores with the highest sum of sensitivity and specificity (1.44 and 1.45, respectively). The specificity and sensitivity are not very strong. Including participants with major depression may have facilitated the detection of a more accurate cutoff score with higher sensitivity and specificity. On the other hand, a large overlap might exist between participants with minor depression and nondepressed participants in terms of severity of depressive symptoms, which may have decreased the specificity and sensitivity.

As expected, our study including minor depression cases only did not reveal highly sensitive and specific cutoff scores. However, it provides specificity and sensitivity data for various cutoff scores that may be used for first-step screening of minor depression in poststroke population. Cutoff scores to be used for screening or diagnosis of poststroke minor depression have not been previously reported.

We also aimed to evaluate the impact of age on GDS scores. Our analyses revealed that age and GDS scores were not correlated either in elderly or in nonelderly subgroups, and patients with minor depression had significantly greater GDS scores than did nondepressed both in elderly and in nonelderly participants. Based on these findings, we may suggest that the GDS has high discriminant validity in both elderly and nonelderly cohorts. However, it should be noted that our sample size precluded us to confirm this suggestion with further analysis, which may have revealed more robust findings. Thus we believe that this finding should be replicated in a larger study.

To our knowledge, this is the first study assessing the validity of an assessment tool in the detection of poststroke minor depression. We assessed the validity and reliability of the 30-item GDS in detecting depression in a poststroke population representing a wide range of poststroke patients in terms of time elapsed from last stroke and recruitment site, but with a homogenous diagnosis of minor depression. Internal consistency, test–retest reliability, and area under curve values demonstrated the usefulness of the 30-item GDS in detecting depression in our study population. Despite its low sensitivity and specificity values, the GDS can be used as a first-step screening tool of minor depression in an elderly as well as a younger poststroke population.

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