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RESEARCH PAPER

Validity and reliability of the G8 screening test in older non-cancer patients

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Abstract

Purpose A comprehensive geriatric assessment (CGA) is a time-consuming approach that requires a special team and a screening test, whereas the G8 screening test is a practical and validated test for screening cancer patients. This study aimed to evaluate the validity and reliability of the G8 test in older patients without cancer and to investigate its concordance with CGA in an outpatient clinic.

Methods Two hundred older patients were included in the study. CGA and G8 tests were performed, and the concordance between them was evaluated for scale validity using Spearman correlation coefficients (r) and kappa analyses. Patients who obtained scores lower than the predefined cutoff values in at least one of the CGA tests were considered to have an abnormal CGA. Inter-rater and intra-rater concordance were assessed for reliability.

Results Of the 200 patients, 57.4% were female, and the median age was 73 (63–93) years. There was a strong concordance between the CGA and G8 screening test (kappa: 0.630; $p < 0.001$). Inter-rater and intra-rater concordance in the reliability assessments were high (kappa: 0.886; kappa: 875; $p < 0.001$, respectively), and inter- and intra-clinician assessments of the G8 scores revealed significant correlations ($r = 0.962$ and $r = 0.976$, respectively; $p < 0.001$).

Conclusion The G8 screening test is a valid and reliable tool for older adults without malignancy. It is a quick and practical test for physicians who frequently admit older patients.

Keywords G8 test · Geriatric assessment · Validation · Older adults

Introduction

Older adults are increasing worldwide. While older people accounted for only 8% of the world's population in the 1950s, this ratio increased to 11% in 2012. According to the data provided by the Turkish Statistical Institute, the proportion of the population aged 65 years and older in Turkey increased from 5.1% in 2000 to 9.1% in 2019, and is estimated to rise to 12.9% in 2030. Although the life expectancy of older adults in the European Union was 80.9 years in 2017, in Turkey, it was 71 years in 2000 and reached 78.4 years in 2019. This indicates that Turkey has a younger population than the countries in the European Union [1]. High disease prevalence, impaired functionality, increased rates of dependency, more hospital and emergency department admissions, and increased morbidity and mortality in older individuals indicate the need to develop a special assessment and health plan for the older population. This view forms the grounds for comprehensive geriatric assessment (CGA) [2, 3]. Although a variety of approaches are used at different centers, CGA determines the levels of functioning and dependency of the individual; grades cognitive functions, emotional states, and nutrition and physical capacity; and identifies comorbidities and geriatric syndromes such as risk of falls, delirium, incontinence, dementia, malnutrition, polypharmacy, dependence, and frailty; thereby, enabling the physician to develop a treatment plan that will provide maximum benefits [2–4].

The CGA-based approach requires a team comprising specialists in geriatrics as well as trained staff. Moreover,

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it is a time-consuming approach [5], as proper conduction of CGA generally takes 1–2 h [6, 7]. An interdisciplinary team is required to perform CGA. The composition of this team may vary as per the clinic and may consist of non-physician healthcare professionals, including nurses, dietitians, psychologists, physiotherapists, and social workers [7]. Although CGA is routinely performed in geriatric outpatient clinics, it is challenging to conduct in other outpatient clinics, primary health care centers, and family medicine centers. Therefore, in centers where performing CGA routinely is not feasible, easy-to-administer screening tests are needed to identify patients who will benefit from CGA. Screening instruments provide information about the patient's condition, but their specificity and sensitivity are low in predicting functional decline or quality of life [8]. It is crucial that the G8 test is associated with determining the geriatric risk profile and the decline in functionality [9, 10]. According to International Society of Geriatric Oncology (SIOG) although no screening tool can replace CGA, the sensitivity of the G8 test is high and the number of studies in the literature is quite high [11]. The G8 test was developed using content from the long form of the Mini-Nutritional Assessment for identifying cancer patients who may benefit from CGA [12]. Subsequently, investigations showed a significant relationship between the CGA test and the G8 screening test [13–16], Geriatricians may not be readily present in most centers; therefore, it is not possible to routinely conduct CGA in outpatient clinics. As the G8 screening test contributes to the efficient use of the workforce and resources in healthcare services [12], it could prove beneficial in such facilities.

Our study aimed to demonstrate that the G8 screening test, which was originally developed for use in the oncological population, can be used to screen older non-cancer patients. Moreover, our study aimed to determine the validity and reliability of the G8 screening test in the general population by comparing it with CGA.

Materials and methods

Study sample and design

This study was carried out with patients who were 65 years and older, admitted to the geriatric outpatient clinic of Gazi University Hospital. Our clinic in Ankara, the capital of Turkey, is a referral clinic for patients across the country. Of 303 patients, 44 had been previously admitted and had undergone a CGA. Since we compared G8 and CGA in our study, it was crucial to enroll only patients who were admitted to the clinic for the first time because those who were previously admitted might recall the geometric shapes of the Mini-Mental State Examination Scale (MMSE) or other tests specifications. To eliminate this bias, re-admitted patients were excluded. Fourteen dementia patients who had impairment about decision-making ability were also excluded from the study. Furthermore, nine patients with cancer were excluded because ours was a validation study for non-cancer patients. Thirteen patients with acute disease, such as pneumonia and urinary tract infection were also excluded. Furthermore, we also excluded 11 patients for hearing loss and six patients for vision loss. Six patients did not agree to participate in the study. The study was conducted on the remaining 200 patients. The G8 test and CGA were administered to the participants by the same geriatrician during face-to-face interviews in a separate room.

The sociodemographic characteristics, educational status, number of chronic diseases, number of drugs used, urinary incontinence and history of falls in the last year of the participants were recorded. First, the G8 screening test was performed followed by the CGA in our study that included the Katz Basic Activities of Daily Living Scale (BADL), Lawton-Brody instrumental activities of daily living scale (IADL), Mini-Mental State Examination Scale (MMSE), Geriatric Depression Scale-15 (GDS-15), and Mini-Nutritional Assessment Short-Form (MNA-SF). We accepted the results of the CGA as abnormal when the patient obtained scores lower than the predefined cutoff values in at least one of the CGA tests (BADL score ≤ 5; IADL score ≤ 7, MNA-SF score ≤ 11, MMSE score ≤ 23, and GDS-15 score ≥ 6).

Tests included in the comprehensive geriatric assessment

Katz Basic Activities of Daily Living Scale

The BADL scores the daily life activities of an individual over six items: bathing, dressing, toileting, transferring inside the home, continence, and feeding. The validation and reliability of the BADL, in the Turkish population, have been published previously. The score that can be obtained from the BADL ranges from 0 to 6 points [17, 18]. The CGA was considered abnormal when the patient was identified to have disabilities in the BADL items.

Lawton–Brody Instrumental Activities of Daily Living Scale

The IADL comprises eight categories, including the ability to use the telephone, the ability for shopping, food preparation, housekeeping, laundry, using transportation, the responsibility for medications, and the ability to handle finances. Each of these eight categories comprises questions for scoring the respective activities. The total test score can range from 0 to 8 points. The patient was considered to have an abnormal result from the CGA when any disability was identified in the IADl [19].

Mini-Mental State Examination Scale

The MMSE is commonly used to evaluate a patient's cognition. It consists of several categories to score the individual's temporal and spatial orientation, attention and calculation, registration, recall, language, repetition, and responses to complex orders. The total score that can be obtained from the test ranges from 0 to 30 points. A score of less than 24 suggests cognitive impairment in the patient. It takes about 10 min to complete the test [20]. The validity and reliability of the Turkish version of the test have been published previously [21]. In our study, patients scoring 23 points or less were evaluated to have abnormal CGA results.

Mini-Nutritional Assessment Short-Form

The MNA-SF test has a strong validity for screening the nutritional status of outpatients. The test is composed of questions regarding the difficulty of food intake, weight loss, mobility, neuropsychological status, body mass index (BMI), and acute illnesses. The test scores range from 0 to 14, with scores of ≤ 11 points indicating impairment [22]. The validity of this test in the Turkish population has been established [23]. Patients who scored ≤ 11 points were considered to have abnormal results from the CGA.

Geriatric Depression Scale-15

The GDS-15 is used to assess patients' moods. The test consists of 15 questions. Scores of 6 points or more suggest depression. The questions are answered with a "yes" or "no" response [24]. The patient had an abnormal result from the CGA when impairment was found according to the test scores. The validity and reliability of the test in the Turkish population have been published previously [25].

Clock drawing test

The clock drawing test evaluates visual–spatial skills. This simple scoring system, based on a clock drawing, was developed by Shua et al. and is an easy-to-use and valid test. A score of 0 indicates the inability to draw, while a score of 6 corresponds to a complete clock drawing with the minute hand placed close to nine and the hour hand placed close to 3 [26].

G8 screening test

The G8 screening test was developed by Bellera et al. to identify oncology patients who would benefit from CGA. The G8 test consists of eight parameters: (1) food intake in the last 3 months; (2) weight loss in the last 3 months; (3) mobility; (4) neuropsychological problems; (5) BMI; (6) taking more than three medications; (7) self-rated health status, and (8) age. The possible total score of this Likert type is between 0 and 17 points. A G8 test score of 14 points or less indicates that the patient will benefit from CGA and that it should be performed [12].

Reliability

To evaluate inter-rater reliability, 18 patients were administered the G8 geriatric screening test. The test was subsequently repeated in another room by another geriatrician. To evaluate the intra-rater reliability, 20 patients underwent the G8 geriatric screening test 2 weeks later.

Translation into Turkish

The translation of the G8 screening test was performed by two independent translators using the methodology of forward and backward translation. The final translated versions were reviewed and compared by clinicians to evaluate both the item and semantic equivalence. Subsequently, the translated version was tested on a small group of patients to evaluate the comprehensibility of the test.

Statistical method

Categorical parameters were presented as numbers and percentages (n, %). The Chi-square test or Fisher's exact test was used for the comparison of categorical variables. The distribution of the numerical parameters was evaluated using histograms, coefficients of variation, and the Kolmogorov–Smirnov test. Normally distributed numerical parameters were presented as mean $\pm$ standard deviation. Non-normally distributed parameters were summarized as median (minimum–maximum) values. The data were not normally distributed; therefore, Spearman's test was used to evaluate the correlations between the total G8 screening test scores and the subscale scores, the number of chronic diseases, and the clock drawing test. Kappa analysis was performed to evaluate the agreement between the CGA results ("normal" or "abnormal") and the G8 screening test score (≤ 14 was considered an abnormal result). In order to evaluate the diagnostic performance of the G8 screening test, receiver operating curve (ROC) analysis was performed, accepting CGA as the gold standard. Subsequently, the area under the curve (AUC) was calculated, and the sensitivity and specificity values were determined. An AUC value close to 1 represented a perfectly accurate diagnostic test, whereas an AUC value of 0.5 represented an inaccurate test. Consequently, the Youden index was calculated to determine the optimal cutoff value. Kappa analysis was performed to test the inter-rater and intra-rater reliability. The data were non-normally distributed; therefore, Spearman's analysis

was used. To interpret the Spearman's rho (r) coefficient, we used the following benchmarks: 0–0.20, poor correlation; 0.21–0.40, fair correlation; 0.41–0.60, moderate correlation; 0.61–0.80, substantial/strong correlation; and 0.81–1.0, near-perfect correlation [27].

Results

The median age of the 200 enrolled patients was 73 years (65–93), and 57.4% were female. The median BMI was 27 kg/m^2 (19–43). No patients were living in nursing homes or residential care homes. While 11.5% of the study sample group lived alone, 44% lived with their spouses and 40% lived with relatives. Of the 200 patients, 72% were graduated at least primary school. At least one of the tests in the CGA revealed abnormal scores in 66% of the patients. The overall characteristics and CGA test results of the study population are shown in Table 1. Additionally, urinary incontinence was present in 37% of the patients, and 23% of patients reported that they had at least one fall in the past year.

For the validity assessment, the results of the CGA were grouped under two categories: "normal" and "abnormal". Subsequently, the agreement between these results and the G8 screening test results (≤ 14 abnormal) was examined. There was a strong concordance between the CGA and G8 screening test results (kappa: 0.630; $p < 0.001$). The inter-rater and intra-rater reliability values evaluated for the reliability of the test were notably high (kappa: 0.886, $p < 0.001$; kappa: 0.875, $p < 0.001$, respectively), and both the inter- and intra-clinician assessments of the G8 screening test scores showed a statistically significant high correlation ($r = 0.962$ and $r = 0.976$, respectively; $p < 0.001$). Furthermore, we examined the correlation of the G8 screening test scores with the CGA test scores, the number of chronic diseases, and the number of drugs used. We found a moderate correlation between the G8 screening test scores and the BADL, IADL, GDS, MMSE, and clock drawing test scores and a strong correlation between the G8 screening test scores and the MNA-SF scores. We identified a negative and weak correlation between the G8 screening test scores and the number of comorbid chronic diseases. There was also a negative and moderate correlation between the G8 screening test scores and the number of drugs used (Table 2).

The G8 screening test scores were compared with the results obtained from the gold standard CGA (categorized as normal and abnormal), and the AUC value was calculated. The calculated AUC value was 0.880. Using the Youden index, a cutoff value of 14.5 was calculated as optimal, and the sensitivity and specificity of the test were found to be 81% and 90%, respectively. The ROC curve analysis is shown in Fig. 1. Table 3 summarizes the sensitivity and specificity values of the G8 test for the different cutoff values.

Table 1 General characteristics of the patients

	Patient ($n = 200$)
Age, years, median (min–max)	73 (63–93)
Number of drugs, number (min–max)	4 (0–21)
Number of chronic diseases, number, median (min–max)	2 (0–9)
BMI, kg/m^2, median (min–max)	27 (19–43)
BADL score, median (min–max)	6 (0–6)
IADL score, median (min–max)	8 (0–8)
MMSE score, median (min–max)	27 (8–30)
MNA-SF score, median (min–max)	12 (3–14)
GDS-15 score, median (min–max)	4 (0–14)
Clock drawing score, median (min–max)	5 (0–6)
G8 total score, median (min–max)	14 (3–17)

BMI body mass index, *BADL* Katz Basic Activities of Daily Living Scale, *IADL* Lawton-Brody Instrumental Activities of Daily Living Scale, *MMSE* Mini-Mental State Examination Scale, *MNA-SF* Mini-Nutritional Assessment Short-Form, *GDS-15* Geriatric Depression Scale-15

Discussion

Our study is the first to reveal the validity and reliability of the G8 screening test in non-cancer patients, as previous studies have only shown the applicability of the G8 screening test in oncological populations [12–15]. A high number of older patients are routinely admitted to family physicians' clinics, primary health care centers, and various outpatient clinics in hospitals, and a considerable number of these patients may benefit from CGA. Our results demonstrated

Table 2 Correlation between the G8 test score and scores of the CGA tests

	G8 Spearman's rho coefficient (r)	p value
BADL	0.575	< 0.001
IADL	0.591	< 0.001
MMSE	0.489	< 0.001
MNA-SF	0.682	< 0.001
GDS-15	− 0.541	< 0.001
Clock drawing test	0.402	< 0.001
Number of drugs used	− 0.420	< 0.001
Number of concomitant chronic diseases	− 0.382	< 0.001

BADL basic activities of daily living, *IADL* Lawton-Brody instrumental activities of daily living, *MMSE* Mini-Mental State Examination scale, *MNA-SF* Mini-Nutritional Assessment Short-Form, *GDS-15* Geriatric Depression Scale-15

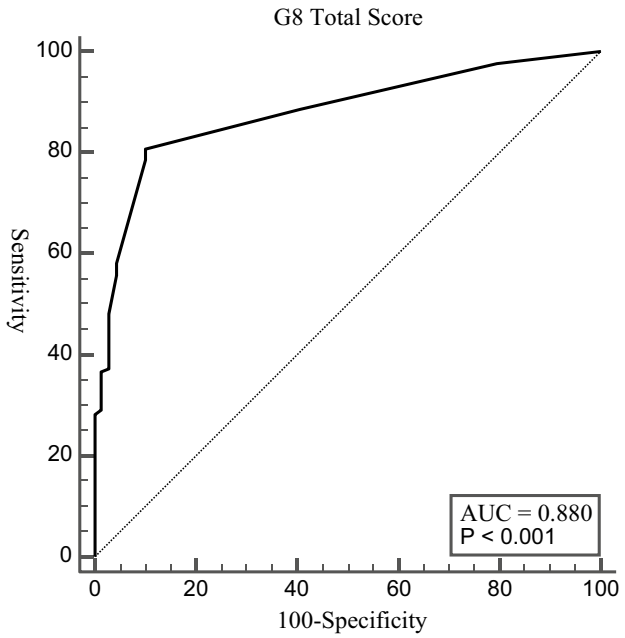

Fig. 1 Receiver operating characteristic curve analysis: performance of the G8 screening tool. *AUC* area under the curve

Table 3 The G8 sensitivity and specificity for different cutoff values

Criterion	Sensitivity	95% CI	Specificity	95% CI
≤ 13	55.73	46.8–64.4	95.65	87.8–99.1
≤ 13.5	58.02	49.1–66.6	95.65	87.8–99.1
≤ 14	78.63	70.6–85.3	89.86	80.2–95.8
≤ 14.5[a]	80.92	73.1–87.3	89.86	80.2–95.8
≤ 15	88.55	81.8–93.4	59.42	46.9–71.1
≤ 16	97.71	93.5–99.5	20.29	11.6–31.7

CI confidence interval

[a]Cutoff value that corresponded to the highest Youden index in the receiver operating characteristic curve analysis

that there was a strong and positive correlation between the impairment found in the G8 screening test and the impairment found in the CGA. Moreover, the G8 screening test showed high inter-rater and intra-rater reliability. These findings suggest that the G8 screening test can be used among older individuals who do not have cancer.

Several scales related to CGA screening have been developed, such as the Identification of Seniors at Risk (ISAR) [28], PRISMA-7 [29], Clinic Frailty Score (CFS) [30], G8 test [12]. Each of these scales arise from a conceptual point of view that indicates that older adults need a distinctive approach. The purpose of the ISAR screening tool, developed by McCusker et al., is to identify those with high mortality and morbidity risk admitted to the emergency department [28]. However, Yao et al. stated that the ISAR alone was not highly successful in predicting adverse outcomes in patients admitted to the emergency department [31]. The PRISMA-7 is a frailty scale that determines disability in older adults [29]. Studies have shown that PRISMA-7 has high sensitivity and low specificity in diagnosing frailty. This increases the false positivity rate and decreases the diagnostic accuracy. This limits its screening test capability [32, 33]. CFS is a subjective frailty scale consisting of components such as mobility, cognition, and physical function, which are used to determine vulnerability. The fact that the CFS score varies according to the decision of the physician is one of the its limitations [34]. The G8 test is one of those with the best sensitivity in detecting older patients with cancer who can benefit from CGA compared to other screening tests [35]. Walree et al. showed that low G8 screening test scores may predict survival rates and treatment-related complications [10]. Considering that the G8 screening test could be applicable and beneficial in a wide range of older populations in addition to cancer patients, we included non-cancer patients in our study. Since CGA was considered superior to other screening tests [8.11.35], we compared G8 with CGA in our study.

CGA is a multi-faceted approach that evaluates the individual's physical, psychosocial, functional, and independence aspects. It contributes to the development of long-term plans for treatment and follow-up and includes detailed examinations to improve patients' quality of life and survival [3, 36]. A meta-analysis by Ellis et al. showed that CGA improved cognitive functions and functionality [37], while Pilotto et al. showed that CGA was beneficial in improving mortality, disability, and cognitive functions [38]. Various tests are used within the scope of CGA. The BADL and IADL are frequently used by geriatricians to evaluate an individual's independence in daily life [17, 19]. Functional limitations increase in older adults, which can negatively affect health [39]. Li et al. stated that as disability increases in ADL, the risk of death and cognitive impairment increases within 3 years [40]. In our study, the G8 screening tool was found to be moderately and significantly correlated with both the BADL and IADL. This correlation indicates that any impairment in the independence of the individual can affect the G8 screening test score. The G8 screening test also correlated with the scores of two cognitive tests: the MMSE and clock drawing test. The MMSE helps to detect memory problems and to diagnose Alzheimer's disease and mild cognitive impairment (MCI) [41, 42]. The clock drawing test assesses an individual's cognition, as well as their ability to coordinate, plan, use, and evaluate the level of visual perception, audiovisual coordination, and constructional praxis [43].

The incidence of depressive symptoms in this population varies from 5 to 10%. Depression negatively affects the quality of life, well-being, and daily life of older adults and

can increase the risk of suicide and suicidal thoughts. For these reasons, it is crucial to screen for and diagnose depression in older individuals [44]. Notably, depression is often misdiagnosed as dementia in older people, and a differential diagnosis may be difficult [45]. In our study, a significant negative correlation was observed between the results of the G8 screening test and the GDS-15 test, which demonstrates that the G8 test can assess mood. The MMSE, GDS-15, and the tests of activities of daily living (BADL and IADL) are used in combination to diagnose cognitive diseases such as Alzheimer's disease and MCI in older individuals. These tests are also useful in the differential diagnosis between dementia and pseudodementia [41, 42, 45]. Creavin et al. stated that it is better to use the MMSE with personality, behavior, and activities of daily living for detecting Alzheimer's [46]. The correlations between these tests and the G8 test may indicate that the G8 screening test is effective and able to evaluate the patient in more than one aspect.

Additionally, malnutrition is a significant problem among the older adults and can lead to disability, sarcopenia, decreased quality of life, and mortality [47]. The MNA-SF not only detects malnutrition, but can also be used to follow-up on the nutritional status of a patient [22]. The results of the MNA-SF and the G8 screening tool were highly correlated. However, this result was anticipated, as the MNA-SF was utilized for developing the G8 screening tool [12].

Moreover, polypharmacy is increasing in the older adults. Although the adverse outcomes caused by polypharmacy are not fully known, polypharmacy may increase side effects, adverse drug reactions, depression, cognitive impairment, and delirium mortality [48]. Notably, the G8 screening test indicated issues with polypharmacy. Our results demonstrated that the test scores deteriorated as the number of drugs used by the individual increased. Multi-morbidity is defined as the coexistence of more than two diseases in the same person. It has been reported that increasing numbers of comorbid diseases are associated with a shortened life span [49]. Therefore, the assessment of an older individual should involve the evaluation of comorbid diseases. In our study, deterioration of the G8 screening test scores was observed as the number of comorbid diseases increased. The remarkable aspect of this finding is that the test results were correlated with the number of chronic diseases, although there are no questions regarding comorbid diseases in the G8 screening test.

A test that is administered to the general population should be reliable and yield consistent results. In our study, both time and rater differences were examined. It was found that both the inter- and intra-rater assessments were highly correlated. Furthermore, ROC analysis was performed in comparison to the CGA, which was the reference test. In the ROC analysis, the AUC value was calculated as 0.880, which is a considerably high value and indicates a high diagnostic power. In addition, the optimal cutoff value of the test was ≤ 14.5. At this cutoff point, the sensitivity and specificity of the test were 80.9% and 89.8%, respectively, which were considerably high and satisfactory. The first study to evaluate the G8 test reported a cutoff value of 14 with a sensitivity of 85% and a specificity of 65% [12]. In the ONCODAGE study, wherein impairment in one of the CGA tests was accepted as an abnormal result, the cutoff value of the G8 screening test was 14 in the ROC analysis, with a sensitivity and specificity of 76.5% and 64.4%, respectively [14]. In a study conducted by Bailer et al., the sensitivity, specificity, and cutoff values of the test were found to be 75%, 85%, and 12.5, respectively [15]. However, the test population in our study greatly differed from these studies since ours was the first to conduct the G8 test in a non-cancer population. Another reason for the difference could be the inclusion of different parameters in the CGA. In the study by Bellera et al., the Cumulative Illness Rating Scale-Geriatric and the "timed-up and go" test were included in the CGA in addition to the tests used in our study (BADL, IADL, MMSE, MNA-SF, and GDS) [12]. The ONCODAGE study used similar tests as Bellera et al. However, Bailer et al. also included the social support index and the long version of the GDS in the CGA [12, 14, 15].

There were several limitations to our study. First, this study comprised a small sample size. Second, this was a single-center study, and the results of a multicenter study could be more adaptable to the general population. Third, walking tests to measure physical performance could have been added. Moreover, the frailty scale was not used, and correlations between frailty and the G8 test remain to be determined. Lastly, different scales of CGA and multiple frailty indexes should have been used in non-cancer patients to validate the G8 screening test.

To the best of our knowledge, our study is the first to evaluate validity and reliability of G8 screening test in non-cancer patients. There is a need for screening tests to determine elderly patients who can benefit from CGA-based approach in primary health care centers. Results of our study suggest that G8 screening test developed for cancer patients, can reliably be used for non-cancer patients. Future studies across different populations are needed for the G8 test to be widely used.

Author contributions CC, RTD, and MCK equally contributed to the conception and design of the research; CC, II, FY, CO, and HC equally contributed to the acquisition and analysis of the data; CC, OD, MCK, SC, CO, and BG equally contributed to the interpretation of the data; and CC, OD, MCK, and BG drafted the manuscript. All authors critically revised the manuscript, agreed to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

Availability of data and materials Data are kept confidential.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethics approval The study was approved by Assessment and Evaluation Ethics Sub-Working Group of Gazi University Ethics Committee (24.10.2019-E.133043).

Consent to participate Written informed consent was obtained from all participants.

Consent for publication Permission to use and adapt the G8 screening test was obtained from the respective investigators (C. Bellera).

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