RESEARCH ARTICLE

Editorial Process: Submission:10/31/2025 Acceptance:06/07/2026 Published:06/20/2026

Reliability and Validity Assessment of the General Medication Adherence Scale among Breast Cancer Patients in Pakistan

Daniya Noreen[1], Sadia Shakeel[2]*, Najia Rahim[2], Sana Shamim[3], Fakhsheena Anjum[2], Ale Zehra[2], Ghulam Haider[4], Ayesha Shakeel Ahmed[5]

Abstract

Background: Adherence rates to adjuvant therapy for breast cancer are often suboptimal, which raises the risk of recurrence, lowers survival rates, and increases healthcare expenses. The present study aimed to assess the validity and reliability of the General Medication Adherence Scale (GMAS) in identifying adherence to adjuvant cancer therapy (ACT) in breast cancer patients. **Method:** A prospective, cross-sectional study was conducted on breast cancer patients using the Urdu version of the GMAS. Reliability was assessed using Cronbach's alpha (α) and inter-item correlations. The instrument was subjected to principal component factor analysis (PCFA) with varimax rotation. Exploratory factor analysis (EFA) and PCFA were performed using IBM SPSS version 23, while confirmatory factor analysis (CFA) was carried out using IBM AMOS version 25. **Results:** Cronbach's alpha of the GMAS was found to be 0.882, confirming that the scale has good reliability. The mean score was significantly different among items ensuring the significance of each item in the GMAS scale (Tukey's test $p< 0.0001$; Chi-square=38.825, $p< 0.0001$). A total of 204 female responses were recorded; the mean age was 41.2±9.5 years. It was observed that n=95 (46.5%) of patients showed partial adherence whereas n=76 (37.2%) patients were highly adherent to ACT. The probability of patients' adhering to their therapy was greater among those who were employed [OR = 1.95, 95% CI (1.27, 2.62)] and have higher level of education [OR = 2.93, 95% CI (1.39, 4.46)]. The potential reasons for non-adherence were the cost of treatment n=44 (21.5%), adverse effects n=33 (16.1%), depression and emotional stress n=32 (15.6%). **Conclusions:** The Urdu version of GMAS, validated with good internal reliability, proved to be a feasible and accurate tool for measuring adherence among breast cancer patients.

Keywords: Breast cancer patients- Medication adherence- Adjuvant therapy- GMAS- Pakistan

Asian Pac J Cancer Prev, **27 (6)**, 2225-2234

Introduction

Cancer is one of the leading causes of mortality worldwide, with more than 29 million people expected to be diagnosed with cancer by 2040 [1]. Breast cancer has a high incidence and fatality rate in women, affecting one in 20 globally and upto one in eight in developed countries [2]. In 2020, more than 685,000 women died from breast cancer, with the majority of these deaths occurring in developing countries [3, 4]. Among Asian nations, Pakistan has one of the highest risks, with 1 in every 9 women likely to develop the disease [5]. About 34,066 new cases of breast cancer have been reported in Pakistan [6]. The increased burden of disease in developing countries is due to a lack of health resources, inadequate access to cancer screening and preventive programs. Access to timely diagnosis and prompt management are essential to limit mortality rates. According to an estimation, 30% of breast cancer cases are due to modifiable risk factors including physical inactivity, increased body weight and alcohol consumption [2].

Surgery is often a primary treatment for breast cancer, followed by adjuvant cancer therapies (ACT) such as chemotherapy, hormone therapy, or radiation, depending on cancer stage and biological profile [7]. ACT reduces recurrence risk and improves survival outcomes, particularly with hormone receptor–positive disease where tamoxifen or aromatase inhibitors decrease recurrence and increase overall survival [8]. However, adherence to ACT is often suboptimal due to several factors, including

*[1]Dow Institute of Medical Technology, Dow University of Health Sciences, Karachi, Pakistan. [2]Department of Pharmacy Practice, Faculty of Pharmaceutical Sciences, Dow College of Pharmacy, Dow University of Health Sciences, Karachi, Pakistan. [3]Department of Pharmaceutical Chemistry, Faculty of Pharmaceutical Sciences, Dow College of Pharmacy, Dow University of Health Sciences, Karachi, Pakistan. [4]Department of Clinical Oncology, Jinnah Postgraduate Medical Centre, Karachi, Pakistan. [5]Institute of Medical Technology, Jinnah Sindh Medical University, Karachi, Pakistan. *For Correspondence: sadia.shakeel@duhs.edu.pk*

adverse drug reactions, patients' perception of disease and medication, patient-provider communication, and financial problems. ACT may cause an increased risk of infection, bone loss, anemia, hot flashes, cognitive impairment, musculoskeletal complaints, weight gain, sexual dysfunction, depression and exhaustion depending on the particular therapy employed [5, 6]. There is strong evidence that these chronic adverse effects significantly lower patients' quality of life and compliance with therapy [9]. Improving adherence requires patient education, shared decision-making, management of adverse effects and regular evaluation of treatment compliance [10]. Patient non-adherence can negatively impact treatment goals and increase the likelihood of adverse outcomes, leading to more hospital admissions and higher costs for both patients and the healthcare system [11].

Adherence can be defined as the extent to which an individual's medication use, dietary habits, and/or adoption of lifestyle modifications align with the healthcare professional recommendations [12]. Assessing adherence can determine the needs of the individual patient care and guide the practitioner to enhance the patient's compliance and promote treatment satisfaction. There are several direct and indirect ways to measure patient medication adherence [7]. Direct approaches include laboratory measurements of serum drug levels or patient observation by a medical professional. Asking the pharmacist about a patient's prescriptions is an indirect way, but it is not a reliable indicator of how the patient takes their medications at home. Patients who take multiple pills may forget or skip a dose, but they may still refill their prescriptions on the designated day. Using validated questionnaires is a rather simple and affordable indirect way to measure patient medication adherence [9].

The General Medication Adherence Scale (GMAS) offers a novel approach by measuring medication adherence across three domains: patient behavior, comorbidity/pill burden, and financial constraints. GMAS has been translated and validated for use in different languages [13, 14]. GMAS is particularly pertinent in Pakistan's resource-constrained environment because, in contrast to other adherence measures used globally in oncology, it accounts for financial barriers in addition to behavioral and comorbidity-related factors. The Urdu version has been validated for the general Pakistani population; [15] however, it has not yet been used for patients with breast cancer. Given the extended duration and self-administered nature of oral hormonal therapy, assessing adherence in this population is clinically important, as sustained adherence is critical for therapeutic effectiveness and long-term outcomes. Hence, this study aimed to assess the validity and reliability of GMAS in identifying the adherence of ACT in breast cancer patients, thereby extending its applicability to an important yet under-researched patient group.

Materials and Methods

Study design and setting

A prospective, cross-sectional study was conducted on the breast cancer patients who visited the outpatient department (OPD) of Dow University Hospital from May'24 to Oct'24. Dow University Hospital is a renowned medical facility attached to Dow University of Health Sciences in Karachi, Pakistan. It offers a variety of medical services, such as cutting-edge surgical, therapeutic, and diagnostic procedures.

Sample size calculation

A sample size was calculated by using OpenEpi with a precision of ±5% and a confidence interval of 95% [16]. The previously reported breast cancer prevalence (14.5%) in Pakistan was used [17]. Based on this, the sample size of n=191 breast cancer patients was desirable for the study. The convenience sampling technique was used for the recruitment of study subjects.

The inclusion criteria were: all the confirmed patients diagnosed with early to locally advanced disease (stages I–III) of breast cancer based on ICD-11-CM Diagnosis Code C50 [18] and were on ACT (oral hormonal therapy) for at least 6 months, the patients being ≥ 18 years old and patients who provided the consent to contribute in the study. Patients who were pregnant or lactating and who were not willing of completing the survey were excluded. Moreover, patients receiving intravenous chemotherapy were excluded.

Data collection procedure

The recruitment was carried out on weekdays, Monday through Friday, by a researcher in the OPD. All breast cancer patients who fulfilled the inclusion criteria were contacted and the survey was administered online using the Google Forms® platform. Patients were made aware of the study, and those who were interested were given a tablet with the survey link open or a link on WhatsApp®. Before beginning the survey, patients had to indicate whether they were willing to participate and sign the informed consent. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [19].

Research instrument

The survey collected patients' demographic characteristics, disease and medication history, and medication adherence elements. Adherence was measured using the Urdu version of GMAS [14]. Prior permission was obtained as the GMAS is available to use only after getting the permission from the scale developer. The scale consists of 3 components having a total of eleven multiple choice questions. The first component assessed adherence by examining patient behavior, and the second component considered comorbidities and pill burden. The third component used cost as a parameter to assess medication adherence. Every item is assigned a score between 0 and 3. Cumulative adherence for a patient was classified as high, good, partial and low if the total score was between 30–33, 27–29, 17–26 and 11–16 respectively. The poor adherence was considered if the total score was ≤10 [14].

As the GMAS has not been previously used and validated in breast cancer patients; therefore, face and content validity were conducted to ensures that items seem appropriate from the perspective of the target population.

(Figure 1) Particular consideration was given to important phrases related to technical and linguistic equivalence. Five subject-matter specialists from Dow University of Health Sciences evaluated the scale for making sure that every component of the construct intended to measure is covered in the questionnaire. Before initiating the full study, GMAS was piloted on 30 breast cancer patients to identify any questions that was unclear, confusing, or irrelevant and to evaluate the scale's practicality in the breast cancer patients. The validation of the study instrument followed the Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) recommendations [20].

Data analysis

The patients' demographic characteristics were assessed by employing descriptive statistics. The numeric variables were presented as mean ± SD whereas categorical variables as percentages and frequencies. Self-reported responses about non-adherence (GMAS scale; maximum score = 33) were taken into consideration while performing multiple logistic regression analyses. Patients' age, education, marital status, residence, duration of illness, comorbidities, number of medications, family history of cancer and insurance status were among the independent variables. Multiple logistic regression was conducted to identify significant associations, computing 95% confidence intervals, with statistical significance set at $p < 0.05$. The factor structure of the scale was examined using Principal Component Factor Analysis (PCFA) with varimax rotation. Before the analysis, the suitability of the data was assessed through the Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity. Exploratory Factor Analysis (EFA) and PCFA were performed using IBM SPSS version 23, while Confirmatory Factor Analysis (CFA) was conducted using IBM AMOS version 25. Internal reliability of the GMAS was evaluated using Cronbach's alpha.

Ethical approval

The study approval was obtained from the Institutional Review Board of the DUHS with reference no: IRB-3385/DUHS/Approval/2024/107. Before the study, the objectives of the study were explained to the patients and they were informed that their participation was voluntary. Besides, they were also assured that their responses would be kept confidential.

Results

Face and content validity

The GMAS demonstrated strong face and content validity. The content validity of the instrument was confirmed with a Content Validity Index (CVI) of 0.85, indicating strong alignment with the construct.

Reliability analysis

Cronbach's alpha assessed the internal reliability and found to be 0.882 showing good reliability of the tool [21]. The mean items score was significantly different among items ensuring the significance of each item in the GMAS scale (Tukey's test $p< 0.0001$; Chi-square=38.825, $p< 0.0001$). The reliability of three subscales were 0.829, 0.769, and 0.766 which validate the reasonable reliability of the tool (Table 1).

Factor analysis

Factor structure was analyzed using PCFA with varimax rotation. The KMO measure of sample adequacy and Bartlett's test of sphericity was reported as 0.844 and 909.05 with a significant result (p-value < 0.0001). A 3-factor model solution with eigenvalues above 1.0 is represented in Figure 2. Factor analysis was completed on 11 items of GMAS. Then parallel analysis was adopted to choose a final number of factors for factor analysis and factor loading greater than 0.4 was extracted. The range of factor loading ranged from 0.631-0.777. The average factor loading for 11 items was 0.711. The three components of the scales have eigenvalues of: component 1, 5.08; component 2, 1.174; and component 3, 1.05. The total variance defined by each component was found to be 46.17% (component 1), 10.67% (component 2) and 8.75 % (component 3). These factors were provided names as per their characteristics of loaded items on the same

Table 1. Results of Internal Consistency and Reliability Analysis

GMAS Items	Components	Cronbach's Alpha	Corrected Item-Total Correlation	Squared Multiple Correlation
Item 1	1 (Patient behavior domain)	0.829	0.631	0.434
Item 2			0.706	0.539
Item 3			0.585	0.478
Item 4			0.589	0.47
Item 5			0.594	0.495
Item 6	2 (Co morbidity and pill burden domain)	0.769	0.519	0.407
Item 7			0.654	0.49
Item 8			0.53	0.467
Item 9			0.579	0.566
Item 10	3 (Cost-related domain)	0.766	0.637	0.57
Item 11			0.527	0.399
Total reliability score		0.882		

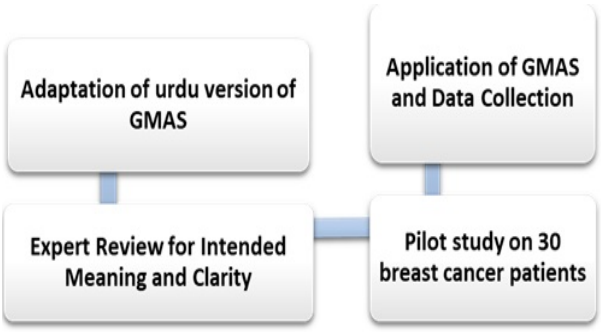

Figure 1. Study Design and Validation Process

Table 2. Results of Factor Analysis

GMAS items	Component		
	1	2	3
Item 1	0.608		
Item 2	0.593		
Item 3	0.783		
Item 4	0.671		
Item 5	0.685		
Item 6		0.814	
Item 7		0.61	
Item 8		0.798	
Item 9		0.788	
Item 10			0.638
Item 11			0.66

factor as reported in early researches [22]. There were five items in component 1, four in component 2, and two in component 3 (Table 2).

Based on the three-factor solution identified through EFA, a CFA was subsequently conducted to test the adequacy of this model. The CFA results supported the factor structure obtained from EFA, demonstrating acceptable model fit indices (χ^2/df = 2.33, CFI = 0.93, TLI = 0.91, RMSEA = 0.053, SRMR = 0.045).

Correlation Matrix

Values above 0.6 were found to a have high correlation considering p<0.01[23]. Correlation between items and items with total results was found significant (p=0.0001), while n is the total number of patients i.e. 204. It was concluded that correlation between items and total score was found significant, with r2 values calculated in the range of 0.631-0.769.

Item-item correlation matrix demonstrated a variety of correlation. Item 1 (difficulty remembering) has strong positive correlations with Item 2 (forgetting due to a busy schedule) at 0.518, moderate positive correlations with Item 5 (discontinue without informing the doctor) at 0.418, and Item 10 (discontinuing due to cost domain) at 0.435. Item 2 also shows a high correlation with Item 7 (treatment complexity) at 0.518, indicating that those who forget to take ACT medications due to external factors often struggle with complex ACT regimens. Item 4 (discontinue due to adverse effects) correlates strongly with Item 5 (discontinue without informing the doctor) at 0.615, suggesting that individuals who stop ACT medications due

Table 3. Detailed Patients' Characteristics

Age (mean±SD)	41.2±9.5
Patients' Characteristics	n (%)
Socioeconomic Status	
Lower Class	80 (39.2)
Lower Middle Class	97 (47.5)
Upper Class	2 (0.9)
Upper Middle Class	25 (12.3)
Employment Status	
Employed	8 (3.9)
Household	161 (78.2)
Retired	9 (4.4)
Self-employed	10 (4.9)
Unemployed	16 (7.8)
Marital Status	
Divorced	10 (4.9)
Married	125 (61.2)
Unmarried	26 (12.7)
Widow	43 (21.1)
Education	
No formal Education	6 (2.9)
Intermediate	155 (76)
Graduation	43 (21.1)
Residence	
Urban	115 (56.3)
Rural	89 (43.6)
Duration of Illness	
Less than 1 year	15 (7.3)
Between 1-3 years	71 (34.8)
Between 3-5 years	107 (52.5)
Between 5-10 years	11 (5.4)
Number of medicines prescribed	
Between 2-4	34 (16.6)
Between 5-6	141 (69.1)
Between 7-9	20 (9.8)
More than 9	9 (4.4)
Had at least 1 co-morbidity	
Yes	51 (25)
No	153 (75)
Insurance status	
Full insurance	37 (18.1)
No insurance	112 (54.9)
Partial insurance	55 (27)
Family history of cancer	
Yes	17 (8.3)
No	83 (40.6)
May Be	104 (51)

Table 4. Results of Description Analysis

	GMAS Item description	Always	Mostly	Sometimes	Never	Mean	SD
Item 1	Difficulty remembering	0	30 (14.7)	81 (39.7)	93 (45.5)	2.3	0.713
Item 2	Forgetting due to busy schedule	11 (5.4)	32 (15.7)	61 (29.9)	100 (49)	2.22	0.906
Item 3	Discontinue when feel well	10 (4.9)	14 (6.9)	63 (30.9)	117 (57.4)	2.41	0.822
Item 4	Discontinue due to adverse effects	9 (4.4)	18 (8.8)	62 (30.4)	115 (56.3)	2.38	0.83
Item 5	Discontinue without informing doctor	4 (1.9)	20 (9.8)	58 (28.4)	122 (59.8)	2.48	0.72
Item 6	Polypharmacy	7 (3.4)	16 (7.8)	64 (31.4)	116 (56.9)	2.42	0.781
Item 7	Treatment Complexity	11 (5.3)	14 (6.9)	68 (33.3)	111 (54.4)	2.38	0.818
Item 8	Progression of disease	5 (2.5)	13 (6.4)	57 (27.9)	129 (63.2)	2.52	0.727
Item 9	Self-modification	6 (2.9)	14 (6.9)	62 (30.4)	122 (59.8)	2.47	0.752
Item10	Overpriced	12(5.9)	14(6.9)	67(32.8)	111(54.4)	2.35	0.852
Item11	Affordability	5(2.5)	23(11.3)	61(29.9)	115(56.3)	2.38	0.792

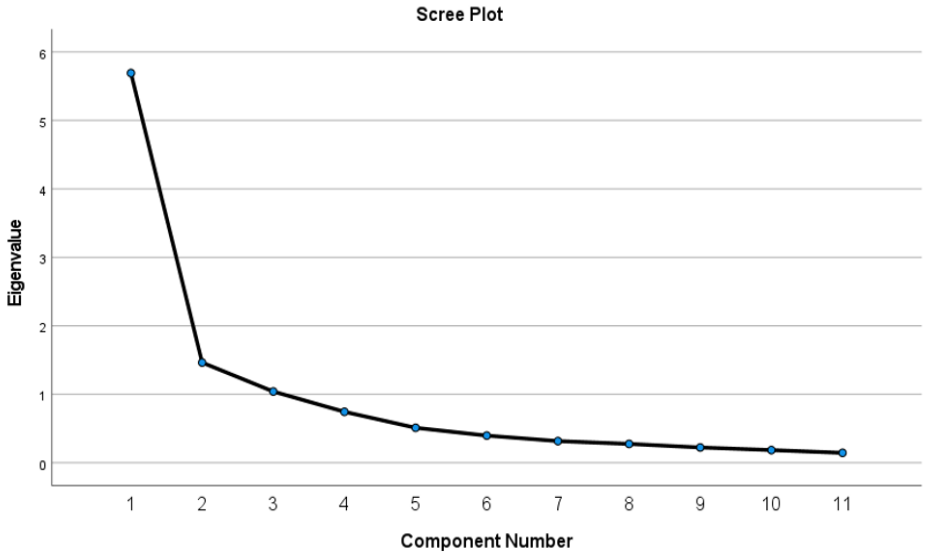

Figure 2. Scree Plot

to adverse effects are also likely to discontinue without consulting their doctor or due to additional medications. Item 7 has a strong correlation with Item 8 (progression of the disease) at 0.541, pointing to a relationship between the complexity of the ACT regimen and the tendency to alter the regimen. Additionally, Item 10 (discontinuing due to cost domain) shows moderate correlations with Item 1 (0.435), Item 5 (0.363), and shows strong correlations with Item 9 (0.585), indicating that ACT medication adherence is greatly impacted by financial concerns, often alongside issues like memory or changes in the ACT regimen.

Baseline characteristics of study population

A total of 204 females' responses were recorded; the mean age was 41.2±9.5 years. The patients n=97 (47.5%) belonged to the lower middle class. The majority of the

Table 5. Results of Multiple Logistic Regression

Patients' characteristics	F value	p value	OR; 95% CI
Socioeconomic Status		0.19	
Employment Status	F = 32.5	<0.0001	1.95; 95% CI 1.27-2.62
Marital Status		0.704	
Education	F = 25.49	0.0001	2.93; 95% CI 1.39- 4.46
Residence		0.416	
Duration of illness		0.513	
Number of medicines prescribed		0.07	
Had at least 1 co-morbidity		< 0.05	
Insurance status	F = 12.16	<0.0001	1.79; 95% CI 0.77 - 2.80
Family history of cancer		0.52	

patients n=161 (78.2%) were housewives and n=125 (61.2%) were married. More than half of the patients n=115 (56.3%) were living in urban settings and the duration of illness of n=107 (52.5%) patients was between 3-5 years. No other co-morbidity was reported by 75% of the respondents. More than half n=104 (51%) did not know about the family history of cancer (Table 3).

Adherence score of respondents

Table 4 depicts the results of the GMAS item description. The mean adherence score was 26.3±8.7. High adherence was observed in n=76 (37.2%) patients, whereas n=20 (9.8%) demonstrated good adherence and n=95 (46.5%) showed partial adherence. When the patients were inquired about the potential reasons for non-adherence with ACT; the major responses were the cost of treatment n=44 (21.5%), fear and anxiety of the associated adverse effects n=33 (16.1%) and depression and emotional stress n=32 (15.6%).

Multiple logistic correlation

The variables including employment status, education, duration of illness, and insurance status were shown to be statistically correlated with most of the items of GMAS. (Table 5) The likelihood of breast cancer patients adhering to their ACT was higher for those who were employed [OR = 1.95, 95% CI (1.27, 2.62)]. The probability of patients adhering to ACT was around 2.93 times higher for those with a higher level of education [OR = 2.93, 95% CI (1.39, 4.46)]. The cancer patients with full insurance were 1.79 times more likely to adhere to the therapy than those with no insurance [OR = 1.79, 95% CI (0.77, 2.80)]. Additionally, treatment adherence was not significantly predicted for cancer patients with socioeconomic status ($p = 0.19$), marital status ($p = 0.704$), duration of illness ($p=0.513$), residence ($p =0.416$), number of medications ($p=0.07$), comorbidities ($p< 0.05$), and family history ($p =0.52$).

Discussion

The outcomes of the current study revealed that the GMAS was validated with good internal reliability. It was found to be a feasible and accurate tool to measure ACT adherence among breast cancer patients. In Pakistan, the issues of medication non-adherence and its effects are complicated due to the patients' situational, cultural, and healthcare system-related barriers and are not well understood. The GMAS was first developed for use in patients who spoke Urdu and had chronic illnesses [14]. GMAS offered a thorough way to evaluate the prevalence and contributing factors of non-adherence among patients. A number of self-reporting adherence instruments had already been developed [24, 25]. Nevertheless, research has shown that there isn't a scale that can be used as a benchmark to monitor adherence. Furthermore, none of the scales assess non-adherence related to costs [24]. The absence of cost-related non-adherence assessment might be due to the reason that the commonly used adherence scales were developed in industrialized nations, where the majority of patients are exempt from paying for their own medical care.

In the current study, GMAS was found validated for internal reliability (Cronbach's alpha = 0.882) [21]. The Moroccan study reported that the three constructs had a Cronbach's α of 0.804 [26], the Saudi study (Arabic version) had a value of 0.865 [13] and the Sudanese study had a value of 0.834 [27]. Nguyen et al., found Vietnamese GMAS as a reliable and valid tool showing good internal consistency (Cronbach's $\alpha = 0.817$) and strong test–retest reliability (Spearman's $r = 0.879$) [28]. Furthermore, the values reported in different investigations regarding the translation and validation in Pakistani patients ranged between 0.797 and 0.84 [14, 15]. These differences could be explained by factors such as the country's socioeconomic condition, cultural context and the characteristics of the target population. Even though all of these values were greater than 0.7 (acceptable limit) [23]. This demonstrated that there was good consistency between the Urdu and other versions of the GMAS scale.

The mean score of all items in the GMAS scale was significantly different (Tukey's test $p< 0.0001$; Chi-square=38.825, $p< 0.0001$) [29]. The tool has three components with good reliability for each sub-scale as reported by Naqvi et al., in the development and validation of GMAS[14]. PCA with varimax rotation results declared that the GMAS showed a 3-factor model with eigenvalues over 1.0. Eleven GMAS elements were subjected to factor analysis and factor loading was within the acceptable limit [23]. The factor loading for the three constructs in the GMAS tool used in Pakistan had values that were 0.70, 0.73, and 0.76, respectively [15]. The Moroccan version of GMAS tool found an average factor of 0.749 [26]. Nonetheless, the factor loading of the GMAS in Arabic was 0.725 for all structures in Saudi Arabia [13], while the English GMAS versions utilized there were 0.75, 0.70, and 0.72 for the three constructs, respectively [30]. In the current study, the average factor loading was within the acceptable range and were comparable to the original GMAS values [14]. The reason for any differences might be the study population as cancer patients have different psychological and financial concerns in contrast with the chronic illness as in the original article [14]. The item-total correlation coefficient (r2) was determined to be significant, with r2 values for 11 components falling between 0.631 and 0.769. The initial GMAS also has an item-total correlation in a similar range [14]. Items #4 and #5 were highly correlated as the patients were asked about the discontinuation due to adverse effects (item#4) and without informing the doctor (item#5). However, items #6 and #11 were least correlated as the patients were asked about non-adherence due to comorbidities (item#6) and cost-related issues (item#11). The validation of the present results was close to the English version of GMAS results with internal reliability of 0.819, and correlation coefficients ranging from 0.779–0.854 indicating high internal consistency [30]. Therefore, this study effectively showed that it has cross-cultural validity in addition to being internally consistent. It was found to be a helpful tool for examining ACT medication non-adherence in breast cancer patients in Pakistan.

In developing countries, medicine use and safety have

received comparatively less attention due to competing priorities and disparities in basic healthcare provision [31]. Research shows that, in the treatment of breast cancer patients, both poor medication adherence and lack of persistence remain serious challenges [32]. Numerous studies assessing the non-adherence among breast cancer reported the range of approximately 07-59% and found its association with different factors [33-35]. Adverse effects, forgetfulness, treatment cost, ignorance, and fear of progression or recurrence are some of the factors that contribute to non-adherence [36]. Pakistan is a low-income country with a hybrid healthcare system that combines government and private healthcare providers. The financial, cultural, and religious backgrounds of patients have an impact on the usage of medications. Though, the financial barriers are often prominent in local context, psychological factors also play a major role in medication adherence. Patients' beliefs about medicines, fears of side effects, cultural perceptions of illness, and trust in the healthcare system can significantly affect their willingness to take medications as prescribed. These influences are partly reflected in the behavioral domain of the GMAS in current study. Addressing them through patient counseling, culturally sensitive education, and strengthening physician–patient communication may help improve adherence in the local context [37].

Cancer treatment can cause adverse effects that may reduce patient compliance. Moreover, it places a higher financial burden on patients, which may contribute to medication non-adherence. Failure to comply with recommended therapies, follow-up appointments, and lifestyle recommendations may increase the risk of recurrence, reduce survival rates, increase drug resistance and make disease management even more difficult [32]. Noncompliance may prevent achievement of the treatment outcomes, which may worsen the prognosis, cause the cancer to spread, and lower overall survival rates [31]. A study conducted in Saudi Arabia reported that the median score for medication adherence was 28 among the chronic disease patients. The majority of the patients (42.6%) showed high adherence whereas (19.1%) showed good adherence. Low and poor adherence was observed only in (4.3%) and (1.4%) patients respectively [15]. Wang et al., translated the GMAS from English into Chinese to evaluate its validity and reliability in Chinese patients with chronic illnesses and that the validity and reliability of the GMAS was satisfactory [38]. Compared to these studies, our findings revealed relatively lower adherence scores (mean score = 26.3), which may be attributed to differences in patient support networks, cultural attitudes toward medical treatment, and the healthcare infrastructure in Pakistan. Furthermore, adherence varied significantly with patients' education, employment status, and insurance coverage. Forgetfulness in taking medications and difficulties in purchasing them were strongly correlated, as both factors are linked to patients' cognitive ability. Consistent with this, another study reported that women receiving ACT for breast cancer experienced problems with memory and concentration [39].

It is reported that the progression of disease affects adherence, as patients may lose motivation or hope when their condition worsens, leading to reduced commitment to treatment [40]. A systemic review of twenty-six studies reported a mean rate of adherence at five years for the implementation phase was decreased by 25.5% from the first to fifth year [41]. In the current study, patients found difficulty in remembering medications due to complexity of the ACT regime and the patients who faced adverse effects often discontinued medications without informing their doctor. An Ethiopian study reported that 42.3% of patients were adherent to their treatment regimen. Significant predictors of chemotherapy adherence included having a family history of cancer [AOR = 3.58, 95% CI (2.22, 5.76)], being female [AOR = 2.17, 95% CI: (1.31, 3.60)], not having a history of comorbidity [AOR = 2.74, 95% CI (1.56, 4.81)], experiencing chemotherapy side effects [AOR = 3.50, 95% CI (1.55, 7.90)], and having social support [AOR = 1.52, 95% CI (1.21, 1.95)][42]. Patients with chronic myeloid leukemia in Taiwan often exhibit poor adherence, with the primary cause being a lack of comprehensive information about their medication and treatment [43]. Similar findings were documented in earlier research on cancer patients in Indian study [44]. Patients' history of adverse effects often resulted in treatment interruptions, driven by concerns about worsening symptoms [45], as observed in the current study. The probability of breast cancer patients adhering to ACT was higher for those with a higher level of education [OR = 2.93, 95% CI (1.39, 4.46)]. Unintentional non-adherence to breast cancer treatment reported by J.Brett, et al. was associated with employment status and the level of education of respondents [36] as reported in the current study.

Treatment cost is a major factor associated with the non-adherence among patients [36]. Another study showed that financial constraint was the major patient-related factor that influenced non-adherence to ACT, followed by ACT medication adverse effects and duration of treatment [46]. Cost-related medication underutilization are more common in low- and middle-income countries. Patients without insurance coverage often cannot afford treatment, leading to non-compliance and poorer outcomes [47]. A similar trend was observed in the present study: patients with full insurance and stable employment were more likely to adhere to therapy, likely due to better affordability of cancer treatment. Employment often provides access to healthcare funds or insurance coverage, thereby reducing the financial burden. In Pakistan, most cancer treatment expenses are borne directly by patients and their families, making cost a major barrier to adherence. Increasing awareness of the impact of non-adherence underscores the need to evaluate adherence in relation to treatment costs and to implement targeted strategies that improve adherence among cancer patients.

Hence, the measurement attributes of the GMAS were comprehensively evaluated among breast cancer patients in Pakistan. The findings demonstrated that the GMAS produced consistent results, confirming its suitability for this patient population. Validation of the scale indicates that it is a reliable tool and its use may be extended to other populations in future research. Moreover, the study highlighted cultural variations and context-specific

factors that may enhance the adaptability of the GMAS for broader application.

Limitations

Since this study was conducted among breast cancer patients in Karachi using convenience sampling, it may not fully capture the broader demographic, socioeconomic, or healthcare access variations across Pakistan. Therefore, the findings should be interpreted with caution when generalizing to national or global populations. A population-based nationwide survey is warranted to comprehensively assess medication adherence among breast cancer patients in Pakistan. Furthermore, to enhance the tool's acceptability and utility, additional validation studies involving patients with different types of cancer across the country are recommended.

In conclusion, the Urdu version of the GMAS was validated and demonstrated good internal reliability. The findings revealed that adherence to ACT was strongly correlated with sociodemographic characteristics. These results underscore the importance of regularly monitoring medication adherence to mitigate the adverse health consequences of non-adherence in breast cancer treatment. Moreover, integrating adherence-enhancing interventions into health policy is essential to improve adherence, not only at the individual level but also across the healthcare system.

Author Contribution Statement

DN and SS: Conception, study design, data collection, data interpretation, and manuscript writing. NR, FA, and AZ: Data collection, data analysis, and interpretation. SSh: Methodology development, data analysis, and manuscript revision. GH: Study design input, supervision, and critical review of the manuscript. ASA: Literature review, manuscript formatting, and final proofreading. SS: Overall supervision, validation, and project administration.

Acknowledgements

Ethical approval

The study approval was obtained from the Institutional Review Board of the DUHS with reference no: IRB-3385/DUHS/Approval/2024/107. Before the study, the objectives of the study were explained to the patients and they were informed that their participation was voluntary. Besides, they were also assured that their responses would be kept confidential.

Availability of data

The datasets used during the study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declared that they have no conflict of interest.

References

1. Bizuayehu HM, Dadi AF, Hassen TA, Ketema DB, Ahmed KY, Kassa ZY, et al. Global burden of 34 cancers among women in 2020 and projections to 2040: Population-based data from 185 countries/territories. Int J Cancer. 2024;154(8):1377-93. https://doi.org/10.1002/ijc.34809
2. Rodrigues R, Duarte D, Vale N. Drug repurposing in cancer therapy: Influence of patient's genetic background in breast cancer treatment. Int J Mol Sci. 2022;23(8):4280. https://doi.org/10.3390/ijms23084280.
3. Xu Y, Gong M, Wang Y, Yang Y, Liu S, Zeng Q. Global trends and forecasts of breast cancer incidence and deaths. Sci Data. 2023;10(1):334. https://doi.org/10.1038/s41597-023-02253-5.
4. Wilkinson L, Gathani TJTBjor. Understanding breast cancer as a global health concern. Br J Radiol. 2022;95(1130):20211033. https://doi.org/10.1259/bjr.20211033.
5. Mubarik S, Malik SS, Wang Z, Li C, Fawad M, Yu C. Recent insights into breast cancer incidence trends among four asian countries using age-period-cohort model. Cancer Manag Res. 2019;11:8145-55. https://doi.org/10.2147/CMAR.S208323.
6. Khan NH, Duan SF, Wu DD, Ji XY. Better reporting and awareness campaigns needed for breast cancer in pakistani women. Cancer Manag Res. 2021;13:2125-9. https://doi.org/10.2147/CMAR.S270671.
7. Lukasiewicz S, Czeczelewski M, Forma A, Baj J, Sitarz R, Stanislawek A. Breast cancer-epidemiology, risk factors, classification, prognostic markers, and current treatment strategies-an updated review. Cancers (Basel). 2021;13(17):4287. https://doi.org/10.3390/cancers13174287.
8. Burstein HJ, Lacchetti C, Anderson H, Buchholz TA, Davidson NE, Gelmon KA, et al. Adjuvant endocrine therapy for women with hormone receptor–positive breast cancer: Asco clinical practice guideline focused update. J Clin Oncol. 2019;37(5):423-438. https://doi.org/10.1200/JCO.18.01160
9. Chauke GD, Nakwafila O, Chibi B, Sartorius B, Mashamba-Thompson T. Factors influencing poor medication adherence amongst patients with chronic disease in low-and-middle-income countries: A systematic scoping review. Heliyon. 2022;8(6):e09716. https://doi.org/10.1016/j.heliyon.2022.e09716.
10. Yang SX, Davidson NE. Hormone receptors and endocrine therapy in breast cancer. Handbook of therapeutic biomarkers in cancer. Jenny Stanford Publishing; 2021. p. 149-86.
11. Xu H, Jin F, Zhang XJ, Wang DQ, Yu SF, Wang AP. Adherence status to adjuvant endocrine therapy in chinese women with early breast cancer and its influencing factors: A cross-sectional survey. Cancer Med. 2020;9(11):3703-13. https://doi.org/10.1002/cam4.3017.
12. Alosaimi K, Alwafi H, Alhindi Y, Falemban A, Alshanberi A, Ayoub N, et al. Medication adherence among patients with chronic diseases in saudi arabia. Int J Environ Res Public Health. 2022;19(16):10053. https://doi.org/10.3390/ijerph191610053.
13. Naqvi AA, Mahmoud MA, AlShayban DM, Alharbi FA, Alolayan SO, Althagfan S, et al. Translation and validation of the arabic version of the general medication adherence scale (gmas) in saudi patients with chronic illnesses. Saudi Pharm J. 2020;28(9):1055-61. https://doi.org/10.1016/j.jsps.2020.07.005.
14. Naqvi AA, Hassali MA, Rizvi M, Zehra A, Iffat W, Haseeb A, et al. Development and validation of a novel general medication adherence scale (gmas) for chronic illness patients in pakistan. Front Pharmacol. 2018;9:1124. https://doi.org/10.3389/fphar.2018.01124.
15. Naqvi AA, Hassali MA, Rizvi M, Zehra A, Nisa ZU, Islam

MA, et al. Validation of the general medication adherence scale in pakistani patients with rheumatoid arthritis. Front Pharmacol. 2020;11:1039. https://doi.org/10.3389/fphar.2020.01039.
16. Bhardwaj R, Agrawal U, Vashist P, Manna S. Determination of sample size for various study designs in medical research: A practical primer. J Family Med Prim Care. 2024;13(7):2555-2561. https://doi.org/10.4103/jfmpc.jfmpc_1675_23.
17. Ali A, Manzoor MF, Ahmad N, Aadil RM, Qin H, Siddique R, et al. The burden of cancer, government strategic policies, and challenges in pakistan: A comprehensive review. Front Nutr. 2022;9:940514. https://doi.org/10.3389/fnut.2022.940514.
18. Fung KW, Xu J, McConnell-Lamptey S, Pickett D, Bodenreider O. A practical strategy to use the icd-11 for morbidity coding in the united states without a clinical modification. J Am Med Inform Assoc. 2023;30(10):1614-21. https://doi.org/10.1093/jamia/ocad128.
19. Skrivankova VW, Richmond RC, Woolf BAR, Yarmolinsky J, Davies NM, Swanson SA, et al. Strengthening the reporting of observational studies in epidemiology using mendelian randomization: The strobe-mr statement. JAMA. 2021;326(16):1614-21. https://doi.org/10.1001/jama.2021.18236.
20. Mokkink LB, Prinsen CA, Bouter LM, Vet HCd, Terwee CBJBjopt. The consensus-based standards for the selection of health measurement instruments (cosmin) and how to select an outcome measurement instrument. Braz J Phys Ther. 2016;20(2):105-13. https://doi.org/10.1590/bjpt-rbf.2014.0143.
21. Kalkbrenner MT. Alpha, omega, and H internal consistency reliability estimates: Reviewing these options and when to use them. Counseling Outcome Research and Evaluation. 2023 Jan 2;14(1):77-88.
22. McNeish D, Wolf MG. Dynamic fit index cutoffs for confirmatory factor analysis models. Psychol Methods. 2023;28(1):61-88. https://doi.org/10.1037/met0000425.
23. Schreiber JB. Issues and recommendations for exploratory factor analysis and principal component analysis. Res Social Adm Pharm. 2021;17(5):1004-11. https://doi.org/10.1016/j.sapharm.2020.07.027.
24. Uchmanowicz B, Jankowska EA, Uchmanowicz I, Morisky DE. Self-reported medication adherence measured with morisky medication adherence scales and its determinants in hypertensive patients aged >/=60 years: A systematic review and meta-analysis. Front Pharmacol. 2019;10:168. https://doi.org/10.3389/fphar.2019.00168.
25. Haag M, Hersberger KE, Arnet I. Assessing medication adherence barriers to short-term oral antibiotic treatment in primary care-development and validation of a self-report questionnaire (biotica). Int J Environ Res Public Health. 2021;18(15):7768. https://doi.org/10.3390/ijerph18157768.
26. Maryem A, Younes I, Yassmine M, Morad G, Karima B, Amal K, et al. Translation, cultural adaptation and validation of the general medication adherence scale (gmas) in moroccan patients with type-2 diabetes. BMC Nurs. 2023;22(1):302. https://doi.org/10.1186/s12912-023-01457-9.
27. Mahmoud MA, Islam MA, Ahmed M, Bashir R, Ibrahim R, Al-Nemiri S, et al. Validation of the arabic version of general medication adherence scale (gmas) in sudanese patients with diabetes mellitus. Risk Manag Healthc Policy. 2021;14:4235-41. https://doi.org/10.2147/RMHP.S325184.
28. Nguyen TH, Truong HV, Vi MT, Taxis K, Nguyen T, Nguyen KT, editors. Vietnamese version of the general medication adherence scale (gmas): Translation, adaptation, and validation. Healthcare; 2021: MDPI.
29. Nanda A, Mohapatra BB, Mahapatra AP, Mahapatra AP, Mahapatra AP. Multiple comparison test by Tukey's honestly significant difference (HSD): Do the confident level control type I error. Int j stat appl math. 2021 Jan 1;6(1):59-65.
30. Naqvi AA, Hassali MA, Jahangir A, Nadir MN, Kachela B. Translation and validation of the english version of the general medication adherence scale (gmas) in patients with chronic illnesses. J Drug Assess. 2019;8(1):36-42. https://doi.org/10.1080/21556660.2019.1579729.
31. Elshafie S, Trivedi R, Villa-Zapata LA, Tackett RL, Zaghloul IY, Young HN. Adherence, clinical benefits, and adverse effects of endocrine therapies among women with nonmetastatic breast cancer in developing countries: A systematic review and meta-analysis. Cancer. 2025;131(1):e35550. https://doi.org/10.1002/cncr.35550.
32. Inotai A, Agh T, Maris R, Erdosi D, Kovacs S, Kalo Z, et al. Systematic review of real-world studies evaluating the impact of medication non-adherence to endocrine therapies on hard clinical endpoints in patients with non-metastatic breast cancer. Cancer Treat Rev. 2021;100:102264. https://doi.org/10.1016/j.ctrv.2021.102264.
33. Dragvoll I, Bofin AM, Soiland H, Taraldsen G, Engstrom MJ. Predictors of adherence and the role of primary non-adherence in antihormonal treatment of breast cancer. BMC Cancer. 2022;22(1):1247. https://doi.org/10.1186/s12885-022-10362-4.
34. Yusufov M, Nathan M, Wiley A, Russell J, Partridge A, Joffe H. Predictors of increased risk for early treatment non-adherence to oral anti-estrogen therapies in early-stage breast cancer patients. Breast Cancer Res Treat. 2021;185(1):53-62. https://doi.org/10.1007/s10549-020-05920-y.
35. Cavazza M, Banks H, Ercolanoni M, Cukaj G, Bianchi G, Capri G, et al. Factors influencing adherence to adjuvant endocrine therapy in breast cancer-treated women: Using real-world data to inform a switch from acute to chronic disease management. Breast Cancer Res Treat. 2020;183(1):189-99. https://doi.org/10.1007/s10549-020-05748-6.
36. Brett J, Fenlon D, Boulton M, Hulbert-Williams NJ, Walter FM, Donnelly P, et al. Factors associated with intentional and unintentional non-adherence to adjuvant endocrine therapy following breast cancer. Eur J Cancer Care (Engl). 2018;27(1):e12601. https://doi.org/10.1111/ecc.12601.
37. Saleem S. Multidisciplinary care plan and adherence to clinical practice guidelines is needed to improve breast cancer outcome in pakistan. J Univ Med Dent Coll. 2024;15(2):vii-viii. https://doi.org/10.37723/jumdc.v15i2.1037
38. Wang Y, Wang X, Wang X, Naqvi AA, Zhang Q, Zang X. Translation and validation of the chinese version of the general medication adherence scale (gmas) in patients with chronic illness. Curr Med Res Opin. 2021;37(5):829-37. https://doi.org/10.1080/03007995.2021.1901680.
39. Whittaker AL, George RP, O'Malley L. Prevalence of cognitive impairment following chemotherapy treatment for breast cancer: A systematic review and meta-analysis. Sci Rep. 2022;12(1):2135. https://doi.org/10.1038/s41598-022-05682-1.
40. Ma S, Shepard DS, Ritter GA, Martell RE, Thomas CP. Cost sharing for breast cancer hormone therapy: How do dual eligible patients' copayment impact adherence. PloS one. 2021;16(5):e0250967. https://doi.org/10.1371/journal.pone.0250967
41. Yussof I, Mohd Tahir NA, Hatah E, Mohamed Shah N. Factors influencing five-year adherence to adjuvant endocrine therapy in breast cancer patients: A systematic review. Breast. 2022;62:22-35. https://doi.org/10.1016/j.breast.2022.01.012.

42. Bekalu YE, Wudu MA, Gashu AWJCC. Adherence to chemotherapy and associated factors among patients with cancer in amhara region, northeastern ethiopia, 2022. A cross-sectional study. Cancer Control. 2023:30:10732748231185010. https://doi.org/10.1177/10732748231185010
43. Tsai YF, Huang WC, Cho SF, Hsiao HH, Liu YC, Lin SF, et al. Side effects and medication adherence of tyrosine kinase inhibitors for patients with chronic myeloid leukemia in taiwan. Medicine (Baltimore). 2018;97(26):e11322. https://doi.org/10.1097/MD.0000000000011322.
44. Dwajani S, Prabhu M, Ranjana G, Sahajananda H. Importance of medication adherence and factors affecting it. IP international journal of comprehensive and advanced pharmacology. 2018 Apr;3(2):69-77.
45. Ibrar M, Peddie N, Agnew S, Diserholt A, Fleming L. Breast cancer survivors' lived experience of adjuvant hormone therapy: a thematic analysis of medication side effects and their impact on adherence. Frontiers in Psychology. 2022;13:861198.
46. Ingwu JA, Idoko C, Israel CE, Maduakolam I, Madu O. Factors influencing non–adherence to chemotherapy: Perspective of Nigerian breast cancer survivors. Nursing Practice Today. 2019 Jan 29.
47. Zheng C, Chagpar AB. Contribution of cost to treatment nonadherence in the us breast cancer survivors: A population-based analysis. Breast Cancer Res Treat. 2022;192(2):369-73. https://doi.org/10.1007/s10549-022-06510-w.