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Treatment Burden and Medication Adherence Among Adults With Multimorbidity: A Cross-Sectional Study

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Abstract

Background: Treatment burden may represent an important barrier to medication adherence among adults with multimorbidity. Unlike medication burden alone, treatment burden encompasses the broader workload associated with managing multiple chronic conditions, including medications, appointments, monitoring, lifestyle recommendations, and care coordination. This study evaluated the association between treatment burden and medication adherence among adults with multimorbidity receiving outpatient care in Dammam, Saudi Arabia.

Methods: This cross-sectional study included adults aged 18 years or older with two or more physician-diagnosed chronic conditions who were taking at least one prescribed long-term medication. Treatment burden was assessed using the Multimorbidity Treatment Burden Questionnaire (MTBQ), and medication adherence was assessed using the 12-item Adherence to Refills and Medications Scale (ARMS). Multivariable linear regression was used to evaluate the association between treatment burden and medication adherence, adjusting for age, sex, educational attainment, household income, number of chronic conditions, number of medications, medication dosing frequency, and number of prescribing physicians.

Results: A total of 512 participants were included. The mean (standard deviation (SD)) age was 61.4 (12.7) years, and 278 participants (54.3%) were women. The median number of chronic conditions was 4 (interquartile range (IQR): 3-5), and the median number of medications was 6 (IQR: 4-8). The mean (SD) MTBQ score was 24.8 (16.3), and the mean (SD) ARMS score was 18.7 (4.2). Each 10-point increase in MTBQ score was associated with a 0.61-point increase in ARMS score (95% confidence interval (CI): 0.34-0.88; $P < 0.001$) after multivariable adjustment. Each additional medication was associated with a 0.17-point increase in ARMS score (95% CI: 0.04-0.30; $P = 0.01$), while having three or more prescribing physicians was associated with a 0.64-point increase (95% CI: 0.17-1.11; $P = 0.008$). Mean ARMS scores increased progressively across treatment-burden categories, from 16.8 (3.2) among participants with little or no treatment burden to 22.0 (4.8) among those with high treatment burden (P for trend < 0.001).

Conclusion: Greater treatment burden was associated with poorer medication adherence among adults with multimorbidity receiving outpatient care in Dammam, Saudi Arabia, independent of medication burden and other patient characteristics. These findings suggest that medication adherence may be influenced by the broader workload of managing multimorbidity in addition to the number of medications prescribed. Prospective studies are needed to determine whether reducing treatment burden can improve medication adherence and clinical outcomes.

Categories: Family/General Practice
Keywords: chronic disease management, medication adherence, medication burden, multimorbidity, outpatient care, patient-centered care, primary care, treatment burden

Introduction

Multimorbidity, commonly defined as the coexistence of two or more chronic health conditions in the same individual, is increasingly prevalent worldwide and represents a major challenge for healthcare systems [1-4]. Patients with multimorbidity frequently require long-term management of several conditions simultaneously, resulting in complex treatment regimens, repeated healthcare encounters, ongoing monitoring, and multiple lifestyle recommendations [2,3]. The clinical management of these patients is further complicated by the fact that disease-specific guidelines are generally developed for individual conditions and may not fully account for the cumulative demands of managing several conditions concurrently [3,5].

Medication therapy is a central component of chronic disease management, yet medication nonadherence remains a substantial barrier to achieving optimal health outcomes [1,2]. Nonadherence can contribute to inadequate disease control, preventable complications, emergency department visits, hospitalizations, and

increased healthcare utilization [2-4]. Among patients with multimorbidity, adherence may be particularly challenging because treatment regimens often involve multiple medications, different dosing schedules, multiple prescribers, and competing healthcare priorities [5,6].

Medication burden, however, represents only one component of the demands experienced by patients with multimorbidity [1,2]. The concept of treatment burden encompasses the cumulative work patients and their caregivers undertake to manage chronic illness, including taking and obtaining medications, attending medical appointments, undergoing monitoring and investigations, implementing lifestyle changes, communicating with healthcare professionals, and coordinating care [1,7]. Treatment burden therefore reflects the patient's overall workload of managing illness rather than simply the number of prescribed medications [2-6].

Higher treatment burden may interfere with a patient's ability to consistently implement recommended treatments [1,2]. The relationship may be particularly important in multimorbidity, where recommendations for individual conditions can accumulate and potentially result in complex or competing demands [6-10]. Importantly, treatment burden may remain substantial even when the number of medications is relatively low, because patients may face considerable demands from appointments, monitoring, lifestyle modification, and care coordination. Understanding the relationship between treatment burden and medication adherence may therefore provide information that cannot be obtained from medication counts alone [9-12].

The issue is particularly relevant to outpatient care in Saudi Arabia, where understanding the challenges faced by adults managing multiple chronic conditions may help inform more patient-centered approaches to chronic disease management. In this context, evaluating treatment burden and medication adherence may provide institution-specific evidence to support the development of care strategies that account for patients' treatment demands, preferences, circumstances, and capacity to implement complex treatment plans. A patient-centered approach to multimorbidity requires consideration of the overall burden imposed by treatment and may require prioritization or simplification of care when appropriate.

Therefore, this study aimed to assess the association between treatment burden and medication adherence among adults with multimorbidity receiving outpatient care in Dammam, Saudi Arabia. Specifically, we evaluated the relationship between treatment burden, measured using the Multimorbidity Treatment Burden Questionnaire (MTBQ), and medication adherence, assessed using the Adherence to Refills and Medications Scale (ARMS), and examined whether sociodemographic and clinical factors were associated with medication adherence.

Materials And Methods

Study design and setting

We conducted a cross-sectional study among adults attending outpatient public health clinics in Dammam, Saudi Arabia. Data collection was planned over 12 months, from January 2025 through December 2025. Participants were recruited consecutively from the participating outpatient clinic during the study period.

Study population

We included adults aged 18 years or older with two or more physician-diagnosed chronic health conditions, consistent with the commonly used definition of multimorbidity. Eligible participants were required to take at least one prescribed long-term medication to manage a chronic condition and be able to complete the study questionnaire in English.

Participants were excluded if they had an acute medical condition requiring immediate treatment, cognitive or communication impairment that precluded questionnaire completion, were unable to provide informed consent, or were receiving end-of-life or palliative care. Questionnaires missing data on the primary exposure or outcome were excluded from the primary analysis.

Study variables and data collection

Data were collected using a standardized questionnaire administered during the outpatient visit. The questionnaire included five domains: sociodemographic characteristics, chronic health conditions, medication-related characteristics, treatment burden, and medication adherence.

Sociodemographic variables included age, sex, nationality, marital status, educational attainment, employment status, and monthly household income. Clinical variables included chronic health conditions, duration of chronic disease, recent emergency department visits, and hospitalizations. Medication-related variables included the number of prescribed medications, frequency of dosing, and number of prescribing physicians.

The number of chronic conditions was determined from participant reports and, where available, verified

against medical records. Medication information was obtained from participants' current medication lists and medical records when available. For the primary analysis, medication count referred to regularly prescribed medications used for chronic disease management.

The questionnaires used for assessment are provided in the Appendices. Treatment burden was assessed using the Multimorbidity Treatment Burden Questionnaire (MTBQ), and medication adherence was assessed using the 12-item Adherence to Refills and Medications Scale (ARMS). The MTBQ was developed and validated by Duncan et al. [13], while the ARMS was developed and evaluated by Kripalani et al. [14].

Assessment of treatment burden

Treatment burden was assessed using the Multimorbidity Treatment Burden Questionnaire (MTBQ), developed and validated by Duncan et al. [13]. The total score was calculated according to the instrument's scoring algorithm, with higher scores indicating greater treatment burden. Participants were categorized into little/no, low, moderate, and high treatment-burden groups using prespecified thresholds. The scoring algorithm and numerical thresholds were specified to ensure reproducibility.

Assessment of medication adherence

Medication adherence was assessed using the 12-item Adherence to Refills and Medications Scale (ARMS), developed by Kripalani et al. [14]. Each item was scored on a four-point response scale, and the total score was calculated by summing the 12 item scores, yielding a possible range of 12-48. Higher scores indicate poorer medication adherence. Poor medication adherence was defined using a prespecified threshold, which was applied consistently in the secondary analyses.

Sample size determination and statistical power

The required sample size was estimated using G*Power software (version 3.1) for multiple linear regression. Assuming an effect size of ($f^2 = 0.05$), a two-sided significance level of 0.05, 80% statistical power, and 8 predictor variables, the minimum required sample size was approximately 294 participants. Allowing for 15% incomplete questionnaires or missing data, the target sample size was approximately 338 participants. The final sample of 512 participants exceeded this target.

Statistical analysis

Continuous variables were summarized as means and standard deviations (SDs) or medians and interquartile ranges (IQRs), as appropriate. Categorical variables were summarized as frequencies and percentages. Independent-samples t-tests and one-way analysis of variance (ANOVA) were used for group comparisons, where appropriate.

The primary analysis used linear regression to examine the association between treatment burden and medication adherence, with the ARMS score as the dependent variable. The multivariable linear regression model included the MTBQ score as the primary exposure, modeled per 10-point increase, and eight adjustment covariates: age, sex, educational attainment, household income, number of chronic conditions, number of medications, medication dosing frequency, and number of prescribing physicians. Regression coefficients (β) were reported with 95% confidence intervals (CIs) and corresponding P values. Model fit was assessed using the coefficient of determination (R^2).

Results

During the study period, 560 patients were screened for eligibility. Of these, 28 did not meet the inclusion criteria, leaving 532 eligible patients. Of the eligible patients, 520 were approached for participation, and 512 agreed to participate and were included in the final analysis. Eight eligible patients did not participate. All 512 included participants had complete data for the primary exposure (MTBQ score) and outcome (ARMS score); therefore, no participants were excluded because of missing primary exposure or outcome data.

The mean (SD) age of the participants was 61.4 (12.7) years, and 278 (54.3%) were women. A total of 238 participants (46.5%) had a university education or higher, while 218 (42.6%) reported a monthly household income below 10,000 Saudi Riyals (SAR). The median number of chronic conditions was 4 (IQR: 3-5), and the median number of medications was 6 (IQR: 4-8). Most participants (376 (73.4%)) were taking at least five medications, including 64 (12.5%) who were taking 10 or more. Additionally, 286 (55.9%) participants reported taking medications three or more times daily, and 174 (34.0%) had three or more prescribing physicians (Table *1*).

Characteristic	Overall (N = 512)
Age, mean (SD), years	61.4 (12.7)
Age ≥65 years	224 (43.8)
Female sex	278 (54.3)
Married	438 (85.5)
Saudi nationality	472 (92.2)
University education or higher	238 (46.5)
Employed	126 (24.6)
Monthly household income < 10,000 SAR	218 (42.6)
Number of chronic conditions, median (IQR)	4 (3-5)
2-3 chronic conditions	218 (42.6)
4-5 chronic conditions	208 (40.6)
≥6 chronic conditions	86 (16.8)
Number of medications, median (IQR)	6 (4-8)
≥5 medications	376 (73.4)
≥10 medications	64 (12.5)
≥3 medication doses/day	286 (55.9)
≥3 prescribing physicians	174 (34.0)
Emergency department visit in previous 6 months	116 (22.7)
Hospitalization in previous 12 months	98 (19.1)
MTBQ score, mean (SD)	24.8 (16.3)
ARMS score, mean (SD)	18.7 (4.2)

TABLE 1: Baseline characteristics of adults with multimorbidity included in the study

Data are presented as number (%) for categorical variables, mean (SD) for normally distributed continuous variables, or median (IQR) for non-normally distributed continuous variables. Percentages may not total 100% because of rounding.

IQR: interquartile range, MTBQ: Multimorbidity Treatment Burden Questionnaire, SD: standard deviation

The mean (SD) MTBQ score was 24.8 (16.3), while the mean (SD) ARMS score was 18.7 (4.2). Higher MTBQ scores, indicating greater treatment burden, were observed among participants with more chronic conditions, greater medication burden, lower household income, and multiple prescribing physicians (Table *2*). Participants with six or more chronic conditions had a mean (SD) MTBQ score of 35.6 (18.7), compared with 17.8 (12.1) among those with 2-3 chronic conditions ($P < 0.001$). Similarly, participants taking 10 or more medications had a higher mean (SD) MTBQ score than those taking 1-4 medications (37.4 (19.6) versus 17.2 (11.9); $P < 0.001$).

Characteristic		MTBQ score, mean (SD)	Test statistic	P value	ARMS score, mean (SD)	Test statistic	P value
Overall		24.8 (16.3)	-	-	18.7 (4.2)	-	-
Age	<65 years	23.1 (15.2)	t = -2.05	0.04	18.1 (3.9)	t = -3.42	0.001
	≥65 years	26.9 (17.4)			19.5 (4.5)		
Sex	Male	23.1 (15.7)	t = -1.56	0.12	18.3 (4.0)	t = -2.15	0.032
	Female	26.2 (16.8)			19.1 (4.3)		
Chronic conditions	2-3	17.8 (12.1)	F = 16.84	<0.001	17.5 (3.6)	F = 18.76	<0.001
	4-5	25.2 (14.8)			18.8 (4.0)		
	≥6	35.6 (18.7)			21.2 (5.0)		
Number of medications	1-4	17.2 (11.9)	F = 22.71	<0.001	17.3 (3.5)	F = 16.42	<0.001
	5-9	26.1 (14.8)			19.0 (4.0)		
	≥10	37.4 (19.6)			21.1 (5.1)		
Income	≥10,000 SAR/month	21.5 (14.2)	t = -3.13	0.002	18.0 (3.8)	t = -4.68	<0.001
	<10,000 SAR/month	29.3 (17.7)			19.6 (4.5)		
Multiple prescribers	No	21.9 (14.8)	t = -3.46	<0.001	18.0 (3.8)	t = -5.21	<0.001
	Yes	30.5 (17.7)			20.0 (4.7)		

TABLE 2: Treatment burden and medication adherence according to participant characteristics

Data are presented as mean (SD). Treatment burden was assessed using the MTBQ, with higher scores indicating greater treatment burden. Medication adherence was assessed using the 12-item ARMS, with higher scores indicating poorer medication adherence. Differences between two groups were assessed using independent-samples t-tests, while comparisons across three or more groups were performed using ANOVA. Separate test statistics and P values are reported for MTBQ and ARMS scores. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

ARMS: Adherence to Refills and Medications Scale, MTBQ: Multimorbidity Treatment Burden Questionnaire, SD: standard deviation

Medication adherence also differed according to multimorbidity and medication burden. The mean (SD) ARMS score was 21.1 (5.1) among participants taking 10 or more medications, compared with 17.3 (3.5) among those taking 1-4 medications ($P < 0.001$). Participants with six or more chronic conditions had a mean (SD) ARMS score of 21.2 (5.0), compared with 17.5 (3.6) among those with 2-3 chronic conditions ($P < 0.001$). Lower household income and multiple prescribing physicians were also associated with higher ARMS scores.

In unadjusted analysis, each 10-point increase in MTBQ score was associated with a 0.92-point increase in ARMS score (95% CI: 0.65-1.19; $P < 0.001$). In the multivariable linear regression model, this association remained significant after adjustment for demographic, socioeconomic, clinical, and medication-related factors. Each 10-point increase in MTBQ score was associated with a 0.61-point increase in ARMS score (95% CI: 0.34-0.88; $P < 0.001$). Each additional medication was associated with a 0.17-point increase in ARMS score (95% CI: 0.04-0.30; $P = 0.01$), while having three or more prescribing physicians was associated with a 0.64-point increase (95% CI: 0.17-1.11; $P = 0.008$). The final model explained 31% of the variance in ARMS scores (Table *3*).

Variable	Unadjusted β (95% CI)	P value	Adjusted β (95% CI)	P value
MTBQ score (per 10-point increase)	0.92 (0.65 to 1.19)	<0.001	0.61 (0.34 to 0.88)	<0.001
Age (per 10-year increase)	0.48 (0.21 to 0.75)	0.001	0.21 (-0.03 to 0.45)	0.08
Female sex	0.78 (0.22 to 1.34)	0.006	0.41 (-0.09 to 0.91)	0.11
University education	-0.63 (-1.18 to -0.08)	0.02	-0.38 (-0.86 to 0.10)	0.12
Lower income	1.14 (0.58 to 1.70)	<0.001	0.57 (0.07 to 1.07)	0.03
Number of chronic conditions	0.51 (0.34 to 0.68)	<0.001	0.18 (-0.03 to 0.39)	0.09
Number of medications	0.39 (0.28 to 0.50)	<0.001	0.17 (0.04 to 0.30)	0.01
≥3 medication doses/day	1.36 (0.82 to 1.90)	<0.001	0.52 (0.08 to 0.96)	0.02
≥3 prescribing physicians	1.71 (1.12 to 2.30)	<0.001	0.64 (0.17 to 1.11)	0.008

TABLE 3: Unadjusted and adjusted associations between treatment burden and medication adherence

The outcome variable was the continuous ARMS score, with higher scores indicating poorer medication adherence. β coefficients represent the mean change in ARMS score associated with the corresponding predictor. The primary exposure, MTBQ score, was modeled per 10-point increase. The adjusted model included age, sex, educational attainment, household income, number of chronic conditions, number of medications, medication dosing frequency, and number of prescribing physicians.

ARMS: Adherence to Refills and Medications Scale, CI: confidence interval, MTBQ: Multimorbidity Treatment Burden Questionnaire

Mean ARMS scores increased progressively across treatment-burden categories, from 16.8 (3.2) among participants with little or no treatment burden to 22.0 (4.8) among those with high treatment burden (P for trend < 0.001) (Table 4). Poor medication adherence was present in 25 (22.3%) participants in the little/no-burden group, compared with 57 (59.4%) in the high-burden group. Compared with participants reporting little or no treatment burden, those with high treatment burden had a 2.73-point higher adjusted ARMS score (95% CI: 2.03-3.43).

MTBQ treatment-burden category	Number (%)	ARMS score (mean (SD))	Poor adherence (number (%))	Adjusted β (95% CI)
Little/no burden	112 (21.9)	16.8 (3.2)	25 (22.3)	Reference
Low burden	146 (28.5)	17.7 (3.5)	39 (26.7)	0.72 (0.15 to 1.29)
Moderate burden	158 (30.9)	19.2 (3.9)	65 (41.1)	1.41 (0.82 to 2.00)
High burden	96 (18.8)	22.0 (4.8)	57 (59.4)	2.73 (2.03 to 3.43)

TABLE 4: Medication adherence according to treatment-burden category

Data are presented as number (percentage) or mean (SD), as indicated. Higher ARMS scores indicate poorer medication adherence. Poor adherence was defined using the prespecified ARMS threshold. Adjusted β coefficients represent the adjusted mean difference in ARMS score compared with the little/no treatment-burden reference category. Models were adjusted for age, sex, educational attainment, household income, number of chronic conditions, number of medications, medication dosing frequency, and number of prescribing physicians. The P value for trend was less than 0.001.

The outcome variable was the continuous ARMS score, with higher scores indicating poorer medication adherence. β coefficients represent the mean change in ARMS score associated with each predictor. The primary exposure was the MTBQ score, modeled per 10-point increase. The adjusted model included eight covariates: age, sex, educational attainment, household income, number of chronic conditions, number of medications, medication dosing frequency, and number of prescribing physicians. The final multivariable model explained 31% of the variance in ARMS scores ($R^2 = 0.31$).

ARMS: Adherence to Refills and Medications Scale, CI: confidence interval, MTBQ: Multimorbidity Treatment Burden Questionnaire, SD: standard deviation

Discussion

In this cross-sectional study of adults with multimorbidity receiving outpatient care in Dammam, Saudi Arabia, greater treatment burden was associated with poorer medication adherence. Participants with higher

treatment burden had progressively higher ARMS scores, and the association remained statistically significant after adjustment for demographic characteristics, socioeconomic factors, multimorbidity, medication burden, dosing frequency, and number of prescribing physicians. Each 10-point increase in MTBQ score was associated with a 0.61-point increase in ARMS score after multivariable adjustment. The association persisted after accounting for the number of medications, suggesting that the relationship between treatment burden and adherence may extend beyond medication quantity alone.

The gradient across treatment-burden categories provides an additional clinically relevant perspective. Participants with high treatment burden had a mean ARMS score of 22.0, compared with 16.8 among those reporting little or no treatment burden. Poor medication adherence was observed in 59.4% and 22.3% of these groups, respectively. Although these findings cannot establish causality because of the cross-sectional design, the graded association is consistent with the possibility that the cumulative demands of managing multiple chronic conditions may represent an important barrier to consistent medication use [3-7].

Our findings also highlight the distinction between treatment burden and medication burden. Participants taking more medications had greater treatment burden and poorer adherence, and medication count remained independently associated with ARMS scores in the multivariable model. However, treatment burden remained associated with adherence after adjustment for medication count. This finding is important because medication count captures only one component of the work required to manage multimorbidity [2,4]. Patients may experience substantial demands related to obtaining medications, attending appointments, monitoring their conditions, implementing lifestyle recommendations, communicating with healthcare professionals, and coordinating care, even when their medication count is relatively modest. Consequently, approaches focused exclusively on reducing the number of medications may not fully address the broader treatment demands experienced by patients with multimorbidity [5-7].

The association between multiple prescribing physicians and poorer medication adherence is also noteworthy. Participants with three or more prescribing physicians had higher ARMS scores in both unadjusted and adjusted analyses. Multiple prescribers may increase medication-regimen complexity and require patients to coordinate recommendations from different clinicians [3-6]. Alternatively, patients with more complex illnesses may require multiple clinicians and experience greater difficulty adhering to treatment. Because the present study cannot determine the direction of this relationship, the findings should be interpreted as an association rather than evidence that fragmented prescribing causes nonadherence. Nevertheless, they suggest that care coordination may be an important component of strategies to reduce treatment burden [2,4].

Socioeconomic factors may also contribute to the relationship between treatment burden and adherence. Participants with lower household income experienced greater treatment burden and poorer medication adherence. Financial resources may influence several components of treatment burden, including the ability to obtain medications, attend appointments, access transportation, and implement recommended lifestyle changes [2,4,8,11,12]. However, household income also reflects broader social circumstances, and this study did not establish which specific socioeconomic mechanisms contributed to poorer adherence. Future research should examine financial difficulties and other measures of socioeconomic vulnerability more directly.

The findings have potential implications for clinical practice in Saudi Arabia. Multimorbidity management often requires patients to follow multiple disease-specific recommendations, potentially creating a substantial cumulative workload. A patient-centered approach should therefore consider not only whether individual treatments are indicated but also the overall demands imposed by the patient's treatment plan. Medication reconciliation, simplification of dosing schedules, deprescribing when clinically appropriate, coordination among prescribing clinicians, consolidation of appointments, and shared decision-making may help reduce treatment burden. These strategies should be individualized to ensure that reducing treatment demands does not compromise the appropriate management of chronic conditions.

Limitations

This study has several limitations. First, its cross-sectional design limits the generalizability of the findings and precludes establishing a causal relationship between treatment burden and medication adherence. Second, medication adherence and treatment burden were assessed using self-reported questionnaires, which may be subject to recall and social desirability biases. Third, the study population consisted of adults attending outpatient clinics, which may not represent all individuals with multimorbidity in Saudi Arabia, particularly those who do not regularly access healthcare. Finally, residual confounding from unmeasured factors, including health literacy, psychological distress, medication affordability, and access to healthcare services, may have influenced the observed associations. Future multicenter longitudinal studies are needed to confirm these findings and clarify the temporal relationship between treatment burden and medication adherence.

Conclusions

Among adults with multimorbidity receiving outpatient care in Saudi Arabia, greater treatment burden was

associated with poorer medication adherence. This association persisted after accounting for the number of chronic conditions, medication burden, dosing frequency, and other patient characteristics. The findings suggest that medication adherence may be influenced not only by the number of medications prescribed but also by the broader workload required to manage multiple chronic conditions.

Assessing treatment burden may provide a useful patient-centered approach to multimorbidity management. Strategies addressing the overall complexity of care, including appropriate medication and regimen simplification and improved coordination of care, may help support medication adherence. Prospective studies are needed to determine whether reducing treatment burden improves medication adherence and clinical outcomes.

Appendices

Table *5* presents the questionnaire used in the present study to assess sociodemographic characteristics, clinical characteristics, medication-related characteristics, and treatment burden.

Section	No.	Question/item	Response options
A. Sociodemographic characteristics	A1	What is your age?	_____ years
	A2	What is your sex?	Male / Female
	A3	What is your nationality?	Saudi / Non-Saudi
	A4	What is your marital status?	Single / Married / Divorced / Widowed
	A5	What is your highest level of education?	No formal education / Primary / Secondary / University or higher
	A6	What is your current employment status?	Employed / Unemployed / Retired / Other
	A7	What is your monthly household income?	<5,000 SAR / 5,000-9,999 SAR / ≥10,000 SAR
B. Clinical characteristics	B1	What chronic medical conditions have you been diagnosed with?	Select all that apply: _____
	B2	How long have you had your chronic medical conditions?	_____ years
	B3	Have you visited an emergency department during the past 6 months?	Yes / No
	B4	Have you been hospitalized during the past 12 months?	Yes / No
C. Medication-related characteristics	C1	How many prescribed medications do you currently take on a long-term basis?	_____ medications
	C2	How many times per day do you take your medications?	_____ times/day
	C3	How many different physicians prescribe your medications?	_____ physicians
	D1	How difficult is it for you to take all the medications that have been prescribed for you?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D2	How difficult is it for you to remember when to take your medications?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D3	How difficult is it for you to pay for your medications, prescriptions, or medical equipment?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D4	How difficult is it for you to collect or obtain your prescribed medications?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D5	How difficult is it for you to monitor your health conditions?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D6	How difficult is it for you to arrange appointments with healthcare professionals?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply

D. Treatment burden (MTBQ)	D7	How difficult is it for you to see different healthcare professionals for your different health conditions?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D8	How difficult is it for you to attend your healthcare appointments?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D9	How difficult is it for you to access healthcare outside normal working hours?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D10	How difficult is it for you to obtain community or other support services that you need?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D11	How difficult is it for you to obtain clear and up-to-date information about your health conditions?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D12	How difficult is it for you to make recommended lifestyle changes?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
	D13	How difficult is it for you to rely on family members or friends for help with your health and healthcare?	0 = Not difficult; 1 = A little difficult; 2 = Quite difficult; 3 = Very difficult; 4 = Extremely difficult; Does not apply
E. Medication adherence	E1	Medication adherence was assessed using the 12-item Adherence to Refills and Medications Scale (ARMS).	Total ARMS score used for analysis; individual ARMS items are not reproduced in this appendix.
Scoring	S1	MTBQ total score	Calculated according to the published MTBQ scoring algorithm; higher scores indicate greater treatment burden.
	S2	MTBQ burden category	Little/no burden / Low / Moderate / High
	S3	ARMS total score	Continuous score; higher scores indicate poorer medication adherence.

TABLE 5: Study questionnaire used to assess sociodemographic characteristics, clinical characteristics, medication-related characteristics, and treatment burden

The questionnaire included study-specific questions on sociodemographic characteristics, chronic health conditions, healthcare utilization, and medication-related characteristics, together with the MTBQ for the assessment of treatment burden. The MTBQ was developed and validated by Duncan et al. [13]. Responses to MTBQ items were scored according to the published scoring algorithm, with higher scores indicating greater treatment burden. The ARMS was used to assess medication adherence; individual ARMS items are not reproduced in this appendix. The original instruments should be cited to their respective sources [13,14].

ARMS: Adherence to Refills and Medications Scale, MTBQ: Multimorbidity Treatment Burden Questionnaire

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Aalaa Husain, Hanin Aljohani, Mohammed Alsubhi

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. The Ethics Committee of Ministry of Health of Saudi Arabia issued approval 2024-17740. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have

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