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Running title: **Al-Shashani et al.** Digital intervention for medication adherence

Title: **Video-based psychoeducation and a mobile application for medication adherence and relapse warning signs in schizophrenia**

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Video-based psychoeducation and a mobile application for medication adherence and relapse warning signs in schizophrenia

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ABSTRACT

Aim: To examine changes in antipsychotic medication adherence and relapse warning signs after an intervention combining video-based psychoeducation with a mobile reminder application in patients with schizophrenia.

Methods: This one-group pretest–posttest study included 55 adults with schizophrenia and baseline medication non-adherence recruited by convenience sampling from an outpatient mental health clinic in Amman, Jordan. Participants viewed a psychoeducational video and used the MyTherapy medication reminder application. Medication adherence was assessed using the Medication Adherence Rating Scale (MARS), and early warning signs using the patient-rated 10-item Early Warning Signs Questionnaire (EWSQ-10P), at baseline, two weeks, and three months. Changes were evaluated using repeated-measures analysis of variance (RM-ANOVA) with Bonferroni-adjusted pairwise comparisons. Results are reported as mean $\pm$ standard deviation.

Results: RM-ANOVA showed that mean MARS score increased from 3.49 ± 1.44 at baseline to 8.67 ± 1.14 at two weeks and 8.91 ± 0.67 at three months ($F = 385.48$; $p < 0.001$; partial $\eta^2 = 0.877$). Mean EWSQ-10P score decreased from 29.96 ± 3.64 to 14.92 ± 2.58 and 11.85 ± 2.04 , respectively ($F = 707.62$; $p < 0.001$; partial $\eta^2 = 0.929$).

Conclusion: The combined intervention was associated with higher MARS and lower EWSQ-10P scores over three months. Because the study lacked a control group and used convenience sampling, the findings should be interpreted as preliminary and do not establish causality.

Keywords: medication adherence; mobile applications; patient education as topic; schizophrenia

INTRODUCTION

Schizophrenia is a chronic psychotic disorder associated with disturbances in thought, perception, behaviour, and functioning (1). Its management commonly combines antipsychotic medication with psychosocial interventions. Digital interventions are increasingly used to support medication adherence and self-management (2).

Antipsychotic medication is central to acute symptom control and relapse prevention, although efficacy and adverse effects vary among patients (3). Medication adherence is the extent to which medication-taking behaviour corresponds with agreed recommendations from a healthcare provider (4).

Medication non-adherence has been reported among psychiatric patients in Jordan (5). It is associated with rehospitalisation (6) and greater mortality risk when antipsychotic treatment is not used (7). Interventions that support adherence are therefore clinically relevant.

Mobile reminders may address unintentional non-adherence, whereas psychoeducation may improve knowledge, treatment attitudes, and recognition of relapse warning signs.

The aim of this study was to examine changes in antipsychotic medication adherence and early warning sign scores after combined video-based psychoeducation and use of the MyTherapy medication reminder application among patients with schizophrenia in Jordan.

MATERIAL AND METHODS

Patients and study design

This quasi-experimental, one-group pretest–posttest study with repeated measurements was conducted at the outpatient mental health clinic of Istiklal Hospital, Amman, Jordan.

Participants were assessed at baseline (T1), two weeks after the intervention (T2), and three months after the intervention (T3). Recruitment was completed in October 2024, and follow-up ended in January 2025.

Sample size was estimated using G*Power (version 3.1.9.7, Heinrich Heine University Düsseldorf, Düsseldorf, Germany) for a one-way repeated-measures analysis of variance (RM-ANOVA; within-subjects design) (8), assuming an effect size $f = 0.25$, $\alpha = 0.05$, power = 0.90, one group, three measurements, a correlation of 0.50 among repeated measurements, and a non-sphericity correction $\epsilon = 1.00$. The required sample was 36 participants; 55 were enrolled to maintain an adequate final sample if attrition occurred. Eligible participants were aged 18 years or older, had a confirmed diagnosis of schizophrenia for at least one year, had poor medication adherence defined as a Medication Adherence Rating Scale (MARS) score of 7 or lower, had received the same antipsychotic medication for at least one year, had a Mini-Mental State Examination (MMSE) score of at least 25, owned a smartphone supporting Android or iOS applications, could read and write Arabic, and provided informed consent. Exclusion criteria were cognitive impairment, a comorbid psychiatric disorder including substance use disorder, current participation in psychoeducation, or visual or auditory impairment that prevented use of the intervention. Convenience sampling was used.

Methods

The video content was adapted from a previously evaluated psychoeducational booklet (9). It addressed schizophrenia, symptoms, diagnosis, biological and genetic vulnerability, substance use, medication benefits and adverse effects, relapse and early warning signs, family support, caregiver burden, self-care, communication, problem-solving, expectations, and strategies for reducing stress.

The content was reviewed by an academic in psychiatric and mental health nursing and a psychiatrist using a three-point relevance scale and open-ended questions about clarity and potential modification. The reviewers considered the content accurate, clear, and comprehensive.

A five-minute Arabic-language video was produced from the educational material by a professional developer and reviewed by a psychiatrist before data collection. Participants retained access to the video throughout the study and could view it more than once. The booklet was provided after the T3 assessment for future reference.

MyTherapy (Smartpatient GmbH, Munich, Germany) is a freely available medication reminder and tracking application for Android and iOS devices and is available in Arabic and English (10).

At the intervention visit, the researcher demonstrated application installation, medication entry, reminder scheduling, and dose logging. Participants were instructed to use the application for three months. The application tracks missed doses; the researcher reviewed the missed-dose reports at T2 and T3 but did not record or analyse these data.

Collected data included age, sex, educational level, employment, monthly income, marital and living status, support with medication, duration since diagnosis and medication initiation, number of medication non-adherence episodes, relapses and hospitalisations, and comorbid conditions.

The Arabic MMSE was used to assess orientation, attention, recall, language, visuospatial ability, and the ability to understand and follow instructions. Scores range from 0 to 30; eligibility required a score of at least 25 (11).

The MARS is a 10-item self-report questionnaire with yes/no responses and a total score ranging from 0 to 10; higher scores indicate better adherence (12). A score of 7 or lower indicates poor medication adherence. An Arabic version previously used in a psychiatric outpatient setting was administered (13). In the present sample, Cronbach α was 0.65.

The patient-rated 10-item Early Warning Signs Questionnaire (EWSQ-10P) was administered using the original scoring system (14). An Arabic form previously used in Jordan was

employed (15). At T1, T2, and T3, participants rated symptom worsening during the preceding seven days, providing the same reference period at each assessment. Each item was scored from 0 (no worsening or improvement) to 4 (extreme worsening), giving a total score from 0 to 40; higher scores indicated greater worsening of early warning signs. The Arabic form was pilot-tested for clarity as described below; no separate psychometric validation was undertaken in this study. Cronbach α was 0.69 for the original patient version (14) and 0.765 in the present sample.

After written informed consent, eligible participants completed the demographic and clinical questionnaire, MMSE, MARS, and EWSQ-10P at baseline. The MARS and EWSQ-10P were repeated at T2 and T3. Each participant was assigned a unique study code.

Clinic staff screened medical records and referred potentially eligible patients. At both T2 and T3, follow-up assessments were completed by all 55 participants. Of these, 47 participants were assessed in person at the outpatient clinic, while 8 completed the assessments by telephone because they could not attend the scheduled visits. The same assessment method was maintained for each participant across both follow-up points, and all assessments were conducted by the same assessor using standardised procedures. Identical questionnaires and procedures were used for both administration modes; no formal analysis of mode-related differences was performed. Participants received a reminder call one day before each follow-up assessment. There were no missing outcome data.

The Arabic intervention materials and questionnaires were piloted with three patients with schizophrenia from an outpatient mental health clinic. The three participants included in the pilot study were excluded from the final study sample and did not contribute to the main study analysis. Participants were asked to identify unclear or culturally inappropriate content and reported that the video and questionnaires were clear and informative. No changes were

made following the pilot testing, as the procedures and instruments were found to be appropriate and feasible for the main study.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows (version 24.0, IBM Corp., Armonk, NY, USA). Distributional characteristics were examined using skewness; boxplots and standardised z scores were used to identify influential outliers, and none was identified. Categorical variables are presented as numbers and percentages, and continuous variables as mean $\pm$ standard deviation or median (quartiles, minimum, and maximum), as applicable. Pearson correlation coefficients were calculated as exploratory analyses without adjustment for multiple testing. Changes in MARS and EWSQ-10P scores across T1, T2, and T3 were evaluated using one-way RM-ANOVA. Sphericity was assessed using Mauchly's test; the Greenhouse–Geisser correction was applied when the assumption was violated. Pairwise comparisons were adjusted using the Bonferroni method. Effect sizes are reported as partial η^2 . All tests were two-sided, and $p < 0.05$ was considered statistically significant.

RESULTS

All 55 participants completed the three assessments. Most participants were male, 45 (81.8%), unmarried, 37 (67.3%), and had completed secondary education, 27 (49.1%). Twenty-seven (49.1%) were employed and 28 (50.9%) were unemployed. Thirty-nine (70.9%) managed their medication without support, and all participants lived with their families (Table 1).

The mean age was 35.89 ± 5.49 years. The mean reported numbers of medication non-adherence episodes, relapses, and hospitalisations since schizophrenia diagnosis were $2.35 \pm$

1.17, 1.87 ± 1.17 , and 1.85 ± 1.18 , respectively. Mean monthly income was JOD 170.73 $\pm$ 183.07 per month (JOD 1 $\approx$ US\$1.41).

MARS scores increased over time. The mean total score was 3.49 ± 1.44 at T1, 8.67 ± 1.14 at T2, and 8.91 ± 0.67 at T3. At T2, 45 (81.8%) participants were classified as adherent, increasing to 54 (98.2%) at T3 (Table 2).

Mean EWSQ-10P score decreased from 29.96 ± 3.64 at T1 to 14.92 ± 2.58 at T2 and 11.85 ± 2.04 at T3 (Table 2).

MARS and EWSQ-10P scores were not significantly correlated with the examined demographic and clinical variables. In exploratory analyses, age correlated positively with the reported numbers of non-adherence episodes ($r = 0.75$), relapses ($r = 0.67$), and hospitalisations ($r = 0.67$). Non-adherence episodes correlated with relapses ($r = 0.91$) and hospitalisations ($r = 0.91$), and relapses correlated with hospitalisations ($r = 0.99$); all $p < 0.001$. These secondary analyses were not adjusted for multiple testing.

Mauchly's test indicated violation of sphericity for MARS scores ($W = 0.82$; $\chi^2 = 10.48$; $p = 0.005$); therefore, the Greenhouse–Geisser correction was applied ($\epsilon = 0.85$). RM-ANOVA showed a significant change over time ($F = 385.48$; $p < 0.001$; partial $\eta^2 = 0.877$). The T1–T2 mean difference was -5.18 ($p < 0.001$), and the T1–T3 mean difference was -5.42 ($p < 0.001$); the T2–T3 mean difference was -0.24 ($p = 0.199$) (Table 3).

Mauchly's test did not indicate violation of sphericity for EWSQ-10P scores ($W = 0.903$; $\chi^2 = 5.406$; $p = 0.067$). RM-ANOVA showed a significant change over time ($F = 707.62$; $p < 0.001$; partial $\eta^2 = 0.929$). The T1–T2 mean difference was 15.04 ($p < 0.001$), the T1–T3 mean difference was 18.11 ($p < 0.001$), and the T2–T3 mean difference was 3.07 ($p < 0.001$) (Table 4).

DISCUSSION

In this one-group pretest–posttest study, MARS scores increased markedly within two weeks and remained high at three months, while EWSQ-10P scores decreased over the same period. These findings describe within-participant changes after the combined intervention; they should not be interpreted as causal effects because the study did not include a control group.

The adherence findings are consistent with a time-series study of the MyTherapy application in Oman (16) and a randomised trial of the MedAdhere application (17). However, App4Independence did not produce a significant change in medication adherence (18). Differences in intervention content, duration, engagement, populations, and measurement instruments may explain variation across studies.

Psychoeducation may also have contributed to the observed changes. A study of family psychoeducation among patients with psychosis reported improved treatment adherence (19). Because the present intervention combined video-based psychoeducation with a reminder application, the contribution of each component cannot be separated.

The decrease in EWSQ-10P scores is compatible with findings from the LEAN mobile messaging intervention, which improved adherence and reduced relapse and rehospitalisation (20). Actual relapse incidence was not assessed as a longitudinal outcome in the present study.

Although MARS scores approached the upper limit and the observed changes persisted for three months, these findings should not be interpreted as evidence of long-term effectiveness.

The one-group design, convenience sampling, small single-clinic sample, baseline non-adherence, and lack of blinding leave the results vulnerable to regression to the mean, repeated testing and other time-related effects, changes in clinical care, and increased researcher attention. Self-reported outcomes may also have been influenced by social

desirability and assessment mode; application use was not documented, MARS showed limited internal consistency, and the Arabic EWSQ-10P underwent only pilot testing and assessment of internal consistency. Ceiling effects at T3 and eligibility requirements for smartphone ownership, Arabic literacy, and an MMSE score of at least 25 further limit generalisability.

CONCLUSION

Combined video-based psychoeducation and the MyTherapy application were associated with higher MARS and lower EWSQ-10P scores over three months. These uncontrolled findings are preliminary and require confirmation using objective adherence and clinical relapse outcomes.

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Conflicts of interest: None to declare.

Author contributions (CRediT): Conceptualisation: AAS, EAG; methodology: AAS, EAG, AH; formal analysis: AAS; investigation: AAS, ARAES, NTA, RWAH; data curation: AAS, RWAH; writing—original draft: AAS, AHK; writing—review and editing: EAG, AAS, AHK, AH; supervision: EAG; project administration: AAS, ARAES, NTA, RWAH; funding acquisition: EAG.

Ethics statement: The study was approved by the Scientific Research Committee of The University of Jordan (approval No. 2025-25/2024) and the Institutional Review Board of Istiklal Hospital (approval No. 23-9/2024) before data collection. All participants received written information about the study and provided written informed consent.

Data availability statement: The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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TABLES AND FIGURES

Table 1. Participant demographic and clinical characteristics (n = 55)

Variable	n (%)
Sex	
Male	45 (81.8)
Female	10 (18.2)
Marital status	
Married	18 (32.7)
Single	37 (67.3)
Divorced	0 (0)
Widowed	0 (0)
Educational level	
Illiterate	0 (0)
Elementary	7 (12.7)
Preparatory	14 (25.5)
Secondary	27 (49.1)
College	6 (10.9)
University	1 (1.8)
Employment status	
Employed	27 (49.1)
Unemployed	28 (50.9)
Living arrangement	
With family	55 (100)
Alone	0 (0)
Medication support	
Support available	16 (29.1)
Self-managed	39 (70.9)
Duration of antipsychotic treatment	
<1 year	0 (0)
≥1 year	55 (100)
Duration since schizophrenia diagnosis	
<1 year	0 (0)
≥1 year	55 (100)
Comorbid disease	
Yes	0 (0)
No	55 (100)

Table 2. Medication Adherence Rating Scale (MARS) and Early Warning Signs Questionnaire (EWSQ-10P) total scores across assessments

Assessment	M	SD	Minimum	Maximum	P25	P50	P75
Medication Adherence Rating Scale (MARS)							
T1 (baseline)	3.49	1.44	1	7	3	3	5
T2 (two weeks)	8.67	1.14	6	10	8	9	10
T3 (three months)	8.91	0.67	7	10	9	9	9
Early Warning Signs Questionnaire (EWSQ-10P)							
T1 (baseline)	29.96	3.64	24	40	27	29	32
T2 (two weeks)	14.92	2.58	9	23	13	15	16
T3 (three months)	11.85	2.04	7	16	11	12	13

M, mean; P25, 25th percentile; P50, median; P75, 75th percentile; SD, standard deviation

Table 3. Bonferroni-adjusted pairwise comparisons of Medication Adherence Rating Scale (MARS) scores across assessments

I	J	Mean difference, I-J (95% CI)	SE	Adjusted p
T1	T2	-5.18 (-5.71 to -4.66)	0.26	<0.001
T1	T3	-5.42 (-5.84 to -4.99)	0.21	<0.001
T2	T3	-0.24 (-0.60 to 0.13)	0.18	0.199

Pairwise comparisons were adjusted using the Bonferroni method.

I, first assessment in the pairwise comparison; J, second assessment in the pairwise comparison; CI, confidence interval; SE, standard error

Table 4. Bonferroni-adjusted pairwise comparisons of Early Warning Signs Questionnaire (EWSQ-10P) scores across assessments

I	J	Mean difference, I-J (95% CI)	SE	Adjusted p
T1	T2	15.04 (13.87 to 16.21)	0.58	<0.001
T1	T3	18.11 (17.10 to 19.12)	0.51	<0.001
T2	T3	3.07 (2.18 to 3.97)	0.45	<0.001

Pairwise comparisons were adjusted using the Bonferroni method.

I, first assessment in the pairwise comparison; J, second assessment in the pairwise comparison; CI, confidence interval; SE, standard error