Short Paper

A Digital Intervention Using Daily Financial Incentives to Increase Medication Adherence in Severe Mental Illness: Single-Arm Longitudinal Pilot Study

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Abstract

Background: Medication nonadherence is prevalent in severe mental illness and is associated with multiple negative outcomes. Mobile technology and financial incentives show promise to improve medication adherence; however, studies in mental health, especially with oral medications, are lacking.

Objective: The aim of this paper is to assess the feasibility and effectiveness of offering financial incentives through a mobile app based on behavioral economics principles to improve medication adherence in severe mental illness.

Methods: A 10-week, single-arm longitudinal pilot study was conducted. Patients earned rewards in the context of app-based adherence incentives. The reward was split into biweekly payments made in increments of US $15, minus any US $2 per day penalties for missed check-ins. Time-varying effect modeling was used to summarize the patients' response during the study.

Results: A total of 25 patients were enrolled in this pilot study, of which 72% (n=18) were female, and 48% (n=12) were of a White racial background. Median age was 24 (Q1-Q3: 20.5-30) years. Participants were more frequently diagnosed with schizophrenia and related disorders (n=9, 36%), followed by major depressive disorder (n=8, 32%). App engagement and medication adherence in the first 2 weeks were higher than in the last 8 weeks of the study. At study endpoint, app engagement remained high (n=24, Z=–3.17; *P*<.001), but medication adherence was not different from baseline (n=24, Z=–0.59; *P*=.28).

Conclusions: Financial incentives were effectively delivered using an app and led to high engagement throughout the study and a significantly increased medication adherence for 2 weeks. Leveraging behavioral economics and mobile health technology can increase medication adherence in the short term.

Trial Registration: ClinicalTrials.gov NCT04191876; https://clinicaltrials.gov/ct2/show/NCT04191876

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KEYWORDS

antipsychotic; adherence; digital; mobile health; mHealth; financial incentives

Introduction

Medication adherence is a challenge in all of medicine, as only an average of 50% of individuals affected by a chronic condition follow their care plan as prescribed [1]. In mental health, poor adherence is a significant public health challenge, fueled by chronicity, lack of insight, significant medication side effects, and other factors such as stigma and poor access to care [2-4]. Neuropsychiatric medication reduces the severity of serious mental illness and improves patient outcomes [5-9], but only for as long as the patient is adherent. Unfortunately, the rates of adherence to neuropsychiatric medication are far from optimal, which has been estimated to average 40%-50% for schizophrenia and bipolar disorder [10-13]. Similar rates are reported for major depressive disorder [14,15], with some studies reporting rates as low as 21% at 12 months, albeit with variations by drug type [16].

Medication nonadherence has been associated with increased risk of relapse, violence, and legal problems; increased risk of suicide attempts; use of emergency services; and poor social and occupational functioning [17-23]. Recently, financial reinforcement interventions based on behavioral economic principles have emerged as a potential tool to enhance medication adherence in severe mental illness [24,25]. A very recent study explored the use of financial incentives to increase oral antidepressant adherence [26], and 2 studies have focused on antipsychotic medication [27,28], both limited to long-acting injectables. To our knowledge, no study to date has examined the effects of financial incentives on adherence to neuropsychiatric treatments including oral antipsychotic medication.

For this project, we used an app that takes advantage of behavioral economics principles to increase adherence for patients with chronic diseases [29]. Mobile health technology can be designed to be persuasive and potentially increase medication adherence when coupled with incentives contingent on behavior [30,31]. The aim of this study was to assess the feasibility and effectiveness of offering financial incentives through an app to help improve adherence to oral medication in severe mental illness.

Methods

Ethics Approval

This study was carried out in accordance with the Declaration of Helsinki [32], and all participants provided written informed consent as approved by the local Institutional Review Board (IRB#190739).

Study Design

A 10-week, single-arm longitudinal pilot study was conducted (NCT04191876). Included were English-speaking patients 18-80 years old owning a smartphone and receiving treatment with psychotropic medication, with suspected or confirmed poor oral medication adherence. Patients were recruited from inpatient and outpatient units from a semiurban tertiary care facility that draws a representative racial or ethnic and sociodemographic mixture of eligible patients.

After consent, patients were instructed to download the study app, assisted by a digital navigator when necessary. The app automatically prompts the participant to take their medication by generating a reminder at a preset time of day. Patients were instructed to take a photo of the medication in their hand, as prescribed by their doctor, and submit it through the app, which was considered as a check-in or engagement. Engagement was defined as the number of app check-ins. Additionally, all photo check-ins were manually reviewed and verified by the study personnel to ensure accuracy and estimate reliability. Adherence was calculated by dividing the number of pills collected by the app at every check-in by the total number of pills required to be taken and was monitored throughout the study. Baseline adherence in relation to the number of pills required to be taken was determined by subject self-reports at the time of enrollment, which were then confirmed on the health care system's electronic medical records as well as administrative data from the Medicaid claims database when available. Medication changes occurring during the study period were taken into account, and the number of pills to be taken was adjusted accordingly.

Patients were not compensated for participation in this project. They earned rewards in the context of adherence incentives based on successful check-ins. The reward was split into 5 biweekly payouts made in increments of US $15, minus any US $2 per day penalties for missed check-ins, up to a maximum reward of US $75 per participant over the study period. This incentive design is based on the loss aversion strategy, which has shown to be more powerful than gain-framed incentives in daily health behaviors such as physical activity [33] and smoking cessation [34].

Data Analysis

Measures of mean engagement and adherence were used to summarize patient's response over the 10 weeks of the study using intercept-only time-varying effect modelling (TVEM) [35,36]. We selected intercept-only TVEM to summarize longitudinal trends with 95% confidence intervals. This approach uses a spline function to approximate the average change in engagement and adherence over time [37]. Wilcoxon signed-rank test were used to compare baseline adherence to 10-week engagement and 10-week adherence. Pearson correlations were conducted to assess the relationship between baseline adherence and number of prescribed pills. All statistical analyses were performed using the R software, version 4.0.5 (The R Foundation).

Results

A total of 25 patients were enrolled in this pilot study between January and July 2020 (Figure 1); 72% (n=18) were female, and a majority were of a White racial background (n=12, 48%), followed by Black (n=6, 24%) and Asian (n=4, 16%). Median age was 24 years (Q1-Q3: 20.5-30). The participants were diagnosed with schizophrenia and related disorders (n=9, 36%), followed by major depressive disorder (n=8, 32%). Detailed characteristics of the patient sample are included in Table 1.

Treatment regime for each study participant is described in Multimedia Appendix 1. Study participants received treatment with a variety of oral antipsychotics, antidepressants, and mood stabilizers. The number of prescribed pills taken per day per subject varied from a minimum of 1 per day to a maximum of 9 per day (mean 2.82, SD 1.99). This measure did not correlate with baseline adherence (r=0.01).

Engagement and adherence were generally higher than baseline adherence but fluctuated throughout the study period (Figure 2). At study endpoint, engagement was higher compared to baseline (n=24, Z=–3.17; P<.001) but adherence was not different from baseline (n=24, Z=–0.59; P=.28). One study participant was removed from this analysis as the app was not downloaded. We conducted an additional sensitivity analysis including only those who finished participation (n=16), but the results remained unchanged for engagement (n=16, Z=–2.22; P=.01) and adherence (n=16, Z=–0.66; P=.25).

We additionally conducted a TVEM to understand how engagement and adherence change over time, showing significantly higher engagement and adherence in the first 2 weeks compared with the last 8 weeks of the study (Figure 3).

Figure 1. CONSORT (Consolidated Standards of Reporting Trials) flow diagram.

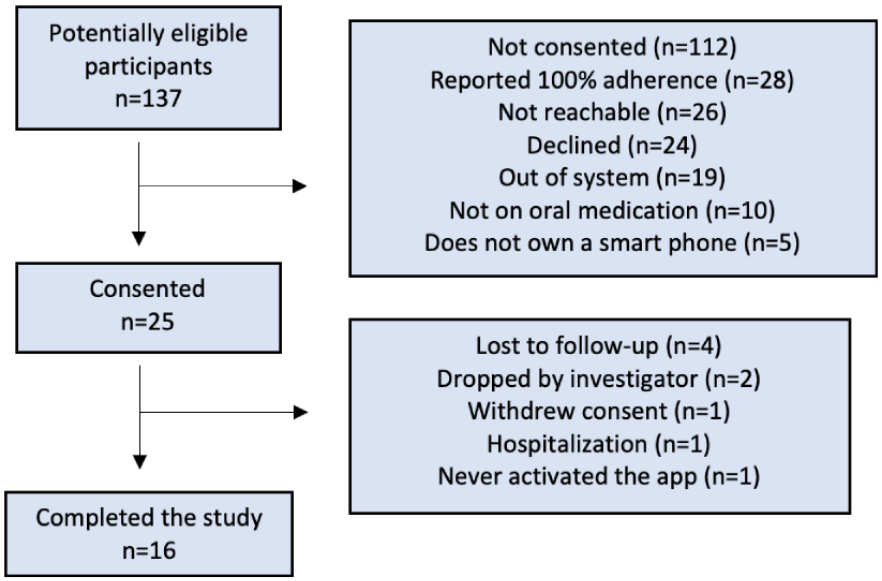


Table 1. Sociodemographic characteristics of the patient sample (N=25).

Variable	Value
Age (years), mean (Q1-Q3)	24 (20.5-30)
Sex, n (%)	
Female	18 (72)
Male	7 (28)
Race, n (%)	
White	12 (48)
Black or African American	6 (24)
Asian	4 (16)
Mixed or other	3 (12)
Primary diagnosis, n (%)	
Schizophrenia and related disorders	9 (36)
Major depressive disorder	8 (32)
Bipolar disorder	4 (16)
Schizoaffective disorder	2 (8)
Other	2 (8)
Marital status, n (%)	
Single	20 (80)
Married	4 (16)
Divorced or separated	1 (4)
Education status, n (%)	
Some college	11 (44)
High school	5 (20)
College graduate	3 (12)
Master’s degree	2 (8)
Some master’s	2 (8)
Unfinished high school	2 (8)
Employment status, n (%)	
Unemployed	15 (60)
Employed	10 (40)
Retired	0 (0)
Disabled	0 (0)
Insurance type, n (%)	
Private	16 (64)
Medicaid or Medicare	9 (36)

Figure 2. Summary measures of adherence and engagement throughout the 10-week study period. Blue dotted line represents mean baseline adherence of the sample.

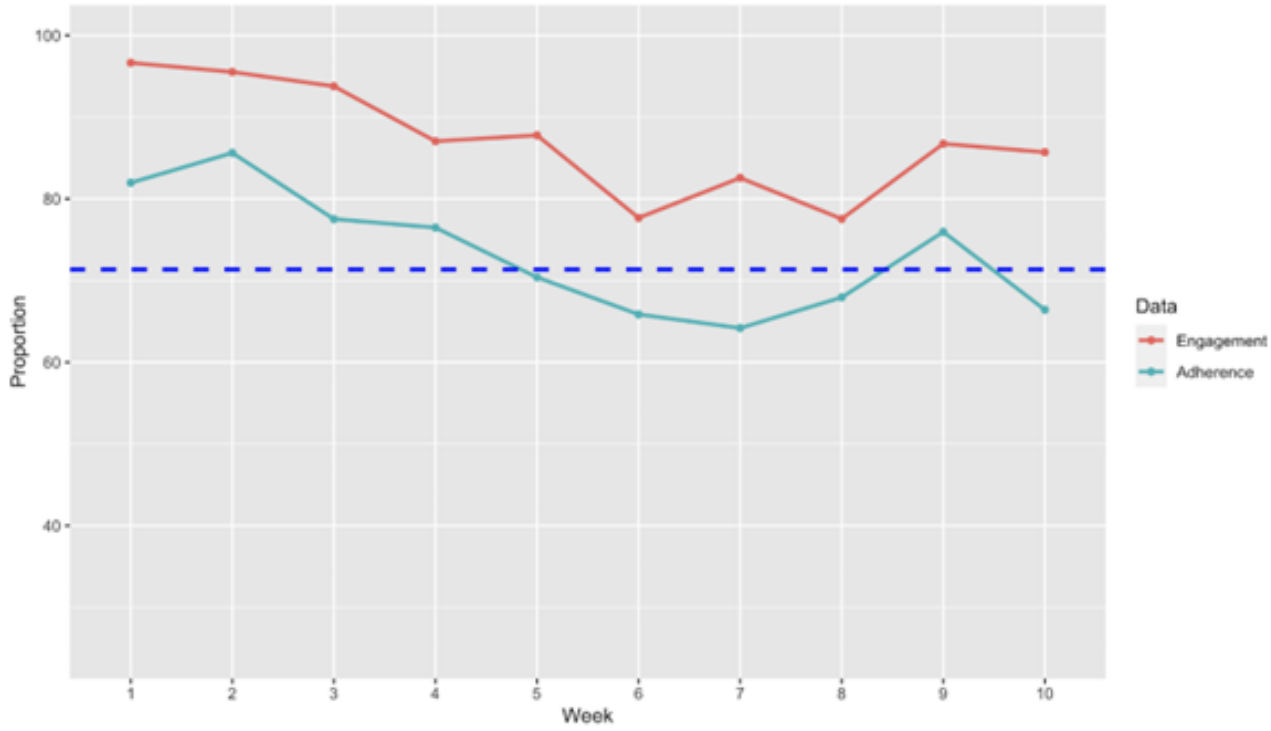
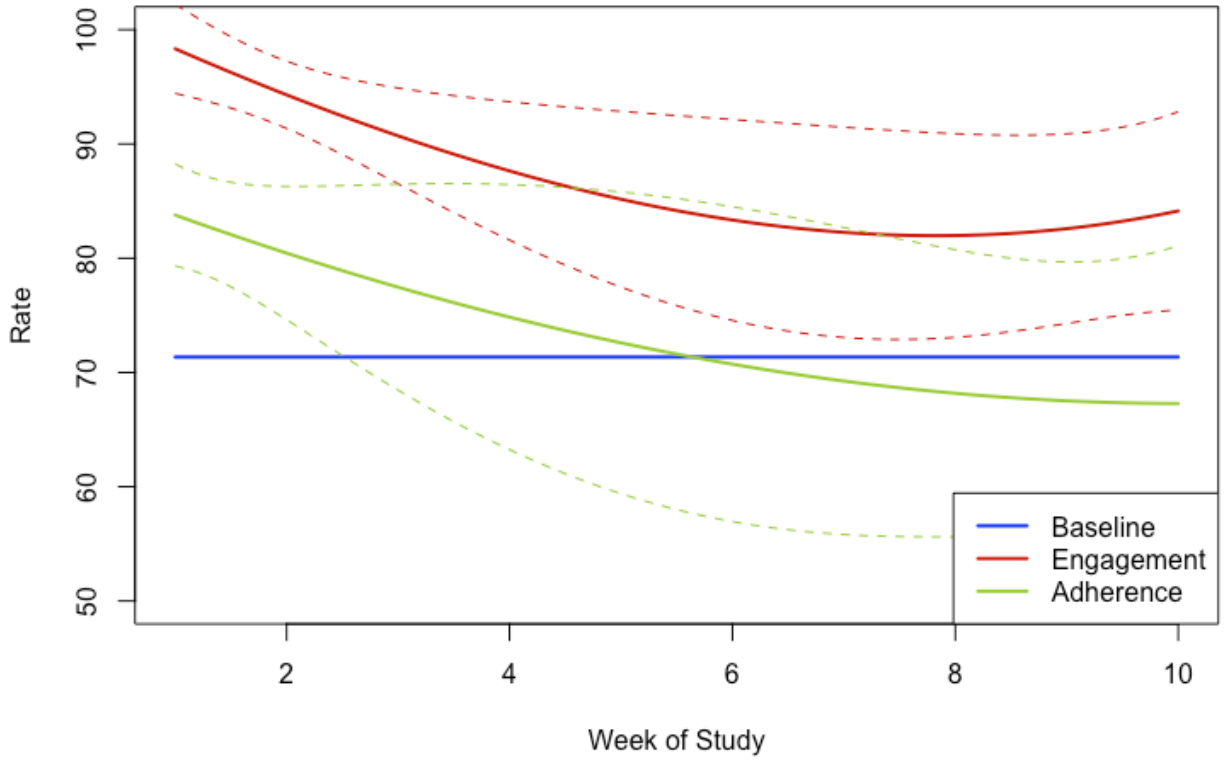


Figure 3. Time-varying effect model (TVEM) of engagement and adherence over time, plotting the estimated coefficient function for both engagement and adherence (solid line) with approximation of 95% confidence interval (dotted line) for the proportion at each time point (week).



Discussion

In this pilot study, we show that financial incentives can be effectively delivered through an app in severe mental illness. We found that small financial incentives increased medication adherence during the initial 2 weeks of our follow-up period, yet this increase was not maintained at study endpoint.

Our findings add to previous studies showing great potential for behavioral economics-based financial incentives to impact patient outcomes in severe mental illness including medication

adherence [24,25]; however, we additionally show that such incentives can be remotely delivered through an app, which allows real-time measures of engagement and adherence, thus paving the way for future studies to evaluate the efficacy different types of incentives or incentive combinations but also for clinicians to access daily adherence data, which could prompt specific interventions if nonadherence is detected.

Despite this study involving financial incentives, attrition was relatively high. This finding could relate to the amount of the incentive, lower than other recently published meta-analysis exploring strategies to incentivize medication adherence in the context of substance use disorders, reporting mean maximum daily earnings of over US $10 [38]. Alternatively, perhaps loss aversion strategies may be less effective in severe mental illness compared with traditional gain-framed incentives. Recent studies evaluating financial incentives to enhance adherence to oral treatment in depression show that escalating amounts up to US 7$ a day was more effective than de-escalating incentives or control groups [26]. Nonetheless, it is also possible that participants took some medications outside of their specific check-in window; therefore, pill count in each check-in photo may not truly capture all the medications an individual took that day, underestimating incentive effects. Lastly, specific app features could have influenced the results as well. Future study designs should include higher or escalating incentives, a larger sample size, an active control group, and additional measures of adherence.

The results should be interpreted with caution, as a pre-post single-arm study lacks control group and randomization, and factors unrelated to the intervention itself could be partially responsible for the differences detected. Nonetheless, this design can inform about the feasibility of offering financial incentives via an app to enhance medication adherence in severe mental illness. Engagement remained high during the initial 2 weeks of the study and was stable afterward, improving generally reported mental health app engagement rates [39]. Second, baseline measures of adherence were self-reported and thus subject to possible inaccuracies. However, chart and database reviews were conducted to confirm patient reports. Lastly, clinical outcomes were not measured, which is relevant as enhanced adherence may not necessarily reflect improved clinical outcomes [40].

In summary, financial incentives can be effectively delivered using an app. Leveraging behavioral economics and mobile health technology can increase medication adherence in the short term while maintaining high app engagement.

Acknowledgments

We thank the patients who took the time to participate in our study in such challenging times.

Conflicts of Interest

DG has been a consultant for and has received speaker honoraria from Otsuka America Pharmaceuticals, Janssen Pharmaceuticals, Lundbeck and Teva. JMK has been a consultant and advisor for or has received honoraria from Alkermes, Allergan, LB Pharmaceuticals, H Lundbeck, Intracellular Therapies, Janssen Pharmaceuticals, Johnson and Johnson, Merck, Minerva, Neurocrine, Newron, Otsuka, Pierre Fabre, Reviva, Roche, Sumitomo Dainippon, Sunovion, Takeda, Teva, and UpToDate, and is a shareholder in LB Pharmaceuticals and Vanguard Research Group. MS, BP, and MW declare no conflicts of interest.

Multimedia Appendix 1

Supplementary Table 1.
[DOCX File , 25 KB-Multimedia Appendix 1]

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Abbreviations

TVEM: time-varying effect modeling

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