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Original Article

A Randomized Trial of a Gamified Mobile App for Improving Antibiotic Adherence and Completion Rates in Children with Acute Respiratory Infections

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ABSTRACT

Background: Adherence to short-course antibiotic treatment in children depends largely on caregivers, and missed or irregular doses may reduce prescribed treatment exposure. Mobile applications combining reminders, tracking, and rewards may support medication administration. Objective: To evaluate a caregiver-operated gamified mobile application for improving antibiotic adherence and prescribed-dose completion among children with acute respiratory infections. Methods: This parallel-group randomized controlled trial enrolled 80 children aged 2–10 years receiving outpatient oral antibiotic treatment in Central Punjab, Pakistan. Participants were allocated equally to a gamified mobile-application intervention or standard care. Complete follow-up data were available for 75 participants. Primary outcomes were adherence score and percentage of prescribed doses recorded as administered; secondary outcomes included caregiver-reported symptom severity and recovery. Results: The intervention group had higher post-treatment adherence than controls (91.4 ± 6.8 vs 78.2 ± 9.5; mean difference 13.2, 95% CI 9.4–17.0; $p<0.001$) and greater recorded-dose completion (94.6 ± 5.2% vs 81.3 ± 8.7%; mean difference 13.3%, 95% CI 10.0–16.6%; $p<0.001$). Symptom reduction was greater in the intervention group (5.2 ± 1.3 vs 3.5 ± 1.4; $p<0.001$), while caregiver-reported recovery occurred in 81.1% and 57.9%, respectively. Conclusion: The multicomponent mobile intervention was associated with improved short-term recorded adherence and caregiver-reported outcomes, although complete-case analysis and subjective measurement limit interpretation. Keywords: Acute Respiratory Infections; Antibiotic Adherence; Caregivers; Child; Gamification; Mobile Applications; Randomized Controlled Trial.

INTRODUCTION

Acute respiratory infections are among the most frequent reasons for pediatric outpatient consultations and contribute substantially to medicine use in children. Although many respiratory infections are viral and do not require antimicrobial therapy, antibiotics remain indicated for selected clinically suspected or confirmed bacterial infections. When an antibiotic is prescribed, the effectiveness and safety of treatment depend partly on caregivers administering the medication according to the prescribed dose, frequency, and duration. In pediatric care, this responsibility generally falls on parents or other caregivers, whose understanding of the regimen, daily routines, perceptions of symptom improvement, and ability to manage treatment can influence medication-taking behaviour (1, 2).

Adherence to short-course antibiotic therapy can be difficult even when treatment lasts only several days. Caregivers may miss doses because of complex schedules, competing responsibilities, medication refusal by the child, unpleasant taste, uncertainty regarding instructions, or the perception that treatment is no longer necessary once symptoms improve. Such difficulties may result in irregular dose administration, reduced exposure to the prescribed treatment, avoidable treatment failure, or the need for further clinical assessment (3, 4). Antibiotic adherence should nevertheless be considered within the broader framework of antimicrobial stewardship, which requires both clinically appropriate prescribing and correct use of the selected regimen. Interventions designed to improve adherence should therefore support prescriptions that have already been judged necessary by the treating clinician rather than promote indiscriminate antibiotic consumption (5, 6).

Conventional approaches to supporting caregivers commonly include verbal counselling, written dosing instructions, and advice to complete the prescribed regimen. These measures are important but may provide limited support after the child leaves the healthcare facility, particularly when caregivers must remember multiple daily doses without continued professional supervision (7, 8). Mobile health technologies offer an opportunity to extend adherence support into the home through scheduled reminders, medication records, educational information, and progress feedback. However, reminder-based interventions may lose effectiveness when users ignore repeated notifications or do not remain engaged throughout the treatment period (9).

Gamification involves incorporating game-related features, such as points, rewards, progress indicators, challenges, and interactive feedback, into activities that are not primarily games. These features may reinforce desired behaviours by providing immediate feedback and making repetitive tasks more engaging. In pediatric healthcare, a gamified intervention may involve both the child and caregiver, although the caregiver remains responsible for medication administration and dose documentation. Evidence from health education, chronic-disease management, and other digitally supported behavioural interventions suggests that gamified tools may improve engagement and adherence-related behaviours, but their effectiveness depends on intervention design, user characteristics, and the clinical context (10–12).

Current evidence regarding digital support for short-course pediatric antibiotic treatment remains limited. Previous work has examined electronic medication monitoring, educational games, digital decision-support systems, and mobile interventions for chronic pediatric conditions, but comparatively little research has evaluated a caregiver-operated gamified application during an acute antibiotic course (13–15). Moreover, interventions combining reminders, dose tracking, rewards, and progress displays must be evaluated as multicomponent digital support packages because improvements cannot necessarily be attributed to gamification alone.

The present randomized controlled trial therefore evaluated whether access to a caregiver-operated gamified mobile application, in addition to standard treatment instructions, was associated with improved antibiotic adherence and prescribed-dose completion among children aged 2–10 years receiving outpatient treatment for acute respiratory infections. Secondary objectives were to compare changes in caregiver-reported symptom severity and perceived clinical recovery between the intervention and standard-care groups. It was hypothesized that participants allocated to the mobile-application group would demonstrate higher adherence scores and a greater percentage of prescribed doses administered during the one-week treatment period than participants receiving standard care alone (16, 17).

MATERIALS AND METHODS

A parallel-group randomized controlled trial was conducted over five months in outpatient pediatric clinics in Central Punjab, Pakistan. The trial evaluated a caregiver-operated gamified mobile application intended to support the administration of prescribed oral antibiotics to children with acute respiratory

infections. The overall study period included participant recruitment, the one-week antibiotic-treatment intervention, and short-term follow-up for outcome assessment. The intervention was evaluated as an adjunct to routine prescribing and caregiver counselling and was not intended to influence the clinician's initial decision to prescribe an antibiotic.

Children aged 2–10 years who had been clinically diagnosed with an acute respiratory infection in an outpatient pediatric setting and prescribed an oral antibiotic were assessed for eligibility. Participation required the child's caregiver to own or have regular access to a smartphone, be willing to use the mobile application, and provide informed consent. Children were excluded if they had a chronic respiratory disorder, had been hospitalized during the preceding month, had a known allergy to the prescribed medication, or had a caregiver who was unable to use the application because of literacy-related limitations. These eligibility criteria were applied before random allocation.

A total of 102 children were screened, of whom 80 fulfilled the eligibility criteria and were enrolled. The planned sample of 80 participants was selected with reference to comparable pediatric digital-adherence interventions and the practical feasibility of recruitment during the study period. Participants were allocated in a 1:1 ratio to either the intervention group or the standard-care control group, with 40 children assigned to each group.

The random-allocation sequence was computer generated. Allocation concealment was implemented using sequentially numbered, sealed, opaque envelopes prepared by a researcher who was not involved in participant recruitment. After enrolment and completion of baseline assessment, the next envelope in sequence was opened to determine group assignment. Because the intervention required active application use, caregivers and study personnel responsible for application instruction could not be blinded. Outcome assessors were kept unaware of group assignment where feasible; however, caregiver-reported outcomes remained susceptible to awareness of the allocated intervention.

Participants in the intervention group received access to a gamified mobile application containing scheduled medication reminders, caregiver-entered dose tracking, point-based rewards, interactive child-friendly visual elements, and a progress indicator showing advancement through the prescribed antibiotic course. At baseline, caregivers were instructed in the use of the application and shown how to record each administered dose. Reminder timing was aligned with the dosing schedule prescribed by the treating clinician. Points and visual progress indicators were generated after caregivers recorded scheduled doses, providing immediate feedback and encouraging continued engagement during the treatment period. Because medication intake was documented by caregivers, an application entry represented a recorded dose administration rather than independently observed ingestion.

Participants in the control group received the standard verbal and written instructions routinely provided in the participating outpatient settings. These instructions addressed the prescribed dose, administration schedule, and duration of treatment. Control-group caregivers did not receive application-based reminders, electronic progress feedback, or gamified rewards. Caregivers in both groups continued to follow the antibiotic regimen determined by the treating clinician, and the study did not standardize or modify the prescribed antibiotic agent, dose, or frequency.

The primary outcomes were antibiotic-adherence score and prescribed-dose completion. Adherence was assessed using a caregiver-adapted medication-adherence reporting measure and the treatment records maintained during the antibiotic course. In the intervention group, recorded dose administration was obtained from application logs, whereas caregivers in the control group maintained written dose records. Adherence scores were expressed on a 0–100 scale, with higher values indicating more consistent administration of the prescribed regimen. Prescribed-dose completion was calculated as the percentage of scheduled doses recorded as administered during the treatment period. This outcome represented dose-level completion and was distinct from the proportion of participants who remained enrolled until study follow-up.

Secondary outcomes included caregiver-reported symptom severity and perceived clinical recovery. Symptom severity was assessed at baseline and at the end of the treatment period using a Visual Analog Scale, with higher scores indicating greater symptom burden. Caregivers also completed a structured assessment covering prominent respiratory symptoms, including fever, cough, and breathing difficulty. Perceived recovery at follow-up was recorded as a categorical caregiver-reported outcome. These measures reflected caregiver observations and were not considered substitutes for independently confirmed clinical recovery.

Baseline demographic and clinical information was recorded before randomization. Follow-up contact was used to obtain end-of-treatment outcome information and determine whether participants remained in the study. Five participants did not provide complete follow-up data: three from the intervention group, including two who discontinued application use and one who relocated, and two from the control group who had incomplete follow-up information. Consequently, outcome analyses were conducted using available data from 75 participants, comprising 37 in the intervention group and 38 in the control group. The analysis was therefore a complete-case analysis rather than a full intention-to-treat analysis.

Data distribution was assessed using the Shapiro–Wilk test. Continuous variables were summarized as mean ± standard deviation, and categorical variables were presented as frequencies and percentages. Baseline characteristics were described by randomized group. Between-group comparisons of continuous post-intervention outcomes were performed using independent-samples t-tests, while within-group baseline-to-follow-up changes were evaluated using paired-samples t-tests. Repeated-measures analysis of variance was used to examine the effects of time, group allocation, and the time-by-group interaction on adherence scores. Pearson correlation analysis was used to explore the unadjusted association between adherence and change in symptom severity. Statistical significance was set at $p<0.05$. Because the reported correlation was unadjusted, it was interpreted as exploratory and not as evidence that improved adherence independently caused symptom improvement.

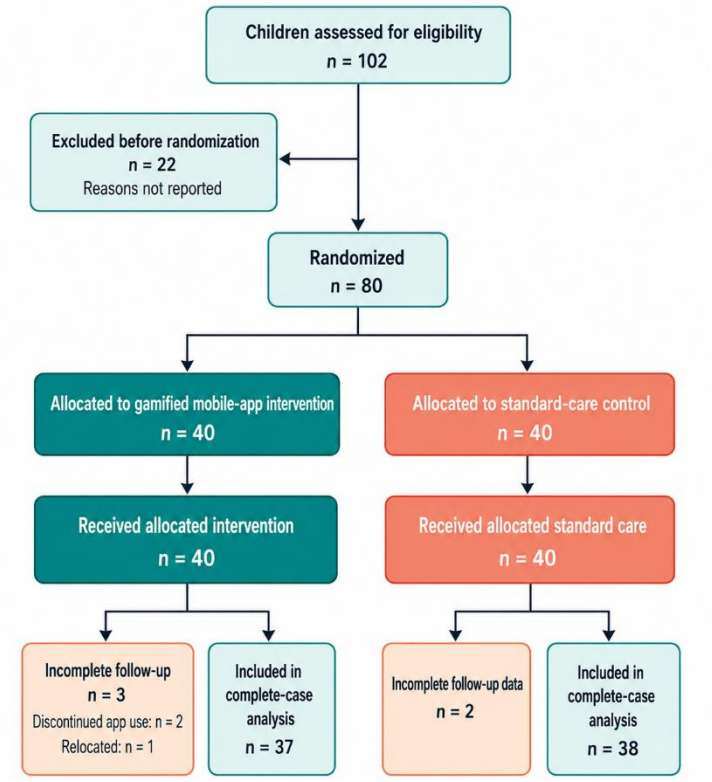

Figure 1 CONSORT flow diagram of participant recruitment, randomization, follow-up, and analysis. Of 102 children screened, 80 were randomized equally to the gamified mobile-application intervention and standard-care control groups. Complete follow-up data were available for 37 intervention participants and 38 control participants. Outcome analyses were therefore based on a complete-case population of 75 participants rather than a full intention-to-treat population.

Ethical approval was obtained from the relevant institutional review board before participant enrolment. Written informed consent was obtained from the caregivers of all participating children. Participation was voluntary, and caregivers could withdraw their child from the study without affecting routine clinical care. Study information was handled confidentially, and mobile-application records were used only for study-related adherence monitoring and analysis.

RESULTS

A total of 102 children were screened during the recruitment period. Eighty met the eligibility criteria and were randomized equally to the mobile-application intervention and standard-care groups. Five participants did not provide complete follow-up data: three in the intervention group, including two who discontinued application use and one who relocated, and two in the control group who had incomplete follow-up information. The complete-case outcome population therefore included 75 participants, comprising 37 in the intervention group and 38 in the control group. The outcome analysis was based on participants with available follow-up data and was not a full intention-to-treat analysis.

Table 1. Participant Flow and Analysis Population

Participant stage	Total, n	Intervention, n	Control, n
Screened for eligibility	102	—	—
Excluded before randomization	22	—	—
Randomized	80	40	40
Incomplete follow-up	5	3	2
Discontinued application use	2	2	0
Relocated	1	1	0
Incomplete follow-up information	2	0	2
Included in complete-case outcome analysis	75	37	38

Table 2. Baseline Demographic and Clinical Characteristics of Randomized Participants

Characteristic	Total sample (N=80)	Intervention (n=40)	Control (n=40)
Age, years	5.8 ± 2.1	5.9 ± 2.0	5.7 ± 2.2
Male sex, n (%)	42 (52.5)	21 (52.5)	21 (52.5)
Baseline symptom severity, VAS score	7.2 ± 1.1	7.3 ± 1.0	7.1 ± 1.2
Caregiver education ≥secondary level, n (%)	46 (57.5)	24 (60.0)	22 (55.0)

Table 3. Primary Outcomes in the Complete-Case Population

Outcome	Intervention (n=37)	Control (n=38)	Mean difference (95% CI)	Hedges' g	p-value
Post-intervention adherence score, 0–100	91.4 ± 6.8	78.2 ± 9.5	13.2 (9.4 to 17.0)	1.58	<0.001
Prescribed doses recorded as administered, %	94.6 ± 5.2	81.3 ± 8.7	13.3 (10.0 to 16.6)	1.83	<0.001

Table 4. Within-Group Changes in Adherence and Symptom Severity

Outcome	Group	Baseline	Post-intervention	Mean change	p-value
Adherence score, 0–100	Intervention	74.3 ± 8.1	91.4 ± 6.8	17.1	<0.001
Adherence score, 0–100	Control	73.9 ± 7.8	78.2 ± 9.5	4.3	0.020
Symptom severity, VAS score	Intervention	7.3 ± 1.0	2.1 ± 1.2	−5.2	<0.001
Symptom severity, VAS score	Control	7.1 ± 1.2	3.6 ± 1.5	−3.5	<0.001

The randomized groups were descriptively similar at baseline. The mean age was 5.9 ± 2.0 years in the intervention group and 5.7 ± 2.2 years in the control group. Both groups included 21 boys, representing 52.5% of each group. Mean baseline symptom-severity scores were 7.3 ± 1.0 and 7.1 ± 1.2, respectively, while 60.0% of intervention-group caregivers and 55.0% of control-group caregivers had at least secondary-level education.

At follow-up, the mean adherence score was 91.4 ± 6.8 in the intervention group and 78.2 ± 9.5 in the control group. The unadjusted between-group mean difference was 13.2 points (95% CI 9.4 to 17.0; $p<0.001$), corresponding to a large standardized effect estimate of Hedges' $g=1.58$. The mean percentage of prescribed doses recorded as administered was also higher in the intervention group than in the

control group, at 94.6 ± 5.2% versus 81.3 ± 8.7%. The mean difference was 13.3 percentage points (95% CI 10.0 to 16.6; p<0.001), with Hedges' g=1.83. These estimates describe recorded dose administration rather than independently observed medication ingestion.

Adherence scores increased from 74.3 ± 8.1 to 91.4 ± 6.8 in the intervention group, representing a mean increase of 17.1 points (p<0.001). In the control group, adherence increased from 73.9 ± 7.8 to 78.2 ± 9.5, representing a mean increase of 4.3 points (p=0.020). Repeated-measures analysis demonstrated significant effects of time (F=112.6, p<0.001), group (F=28.4, p<0.001), and the time-by-group interaction (F=19.7, p<0.001). The interaction indicated that the pattern of change differed between the two groups, with a greater increase in recorded adherence in the intervention group.

Table 5. Secondary Outcomes in the Complete-Case Population

Outcome	Intervention (n=37)	Control (n=38)	Effect estimate (95% CI)	p-value
Reduction in symptom-severity score	5.2 ± 1.3	3.5 ± 1.4	MD 1.7 (1.08 to 2.32)	<0.001
Post-intervention symptom-severity score	2.1 ± 1.2	3.6 ± 1.5	MD −1.5 (−2.12 to −0.88)	<0.001
Caregiver-reported recovery, n (%)	30 (81.1)	22 (57.9)	RD 23.2% (3.0% to 43.3%)	0.030
Caregiver-reported recovery, n (%)	30 (81.1)	22 (57.9)	RR 1.40 (1.02 to 1.91)	0.030
Caregiver-reported recovery, n (%)	30 (81.1)	22 (57.9)	OR 3.12 (1.10 to 8.86)	0.030

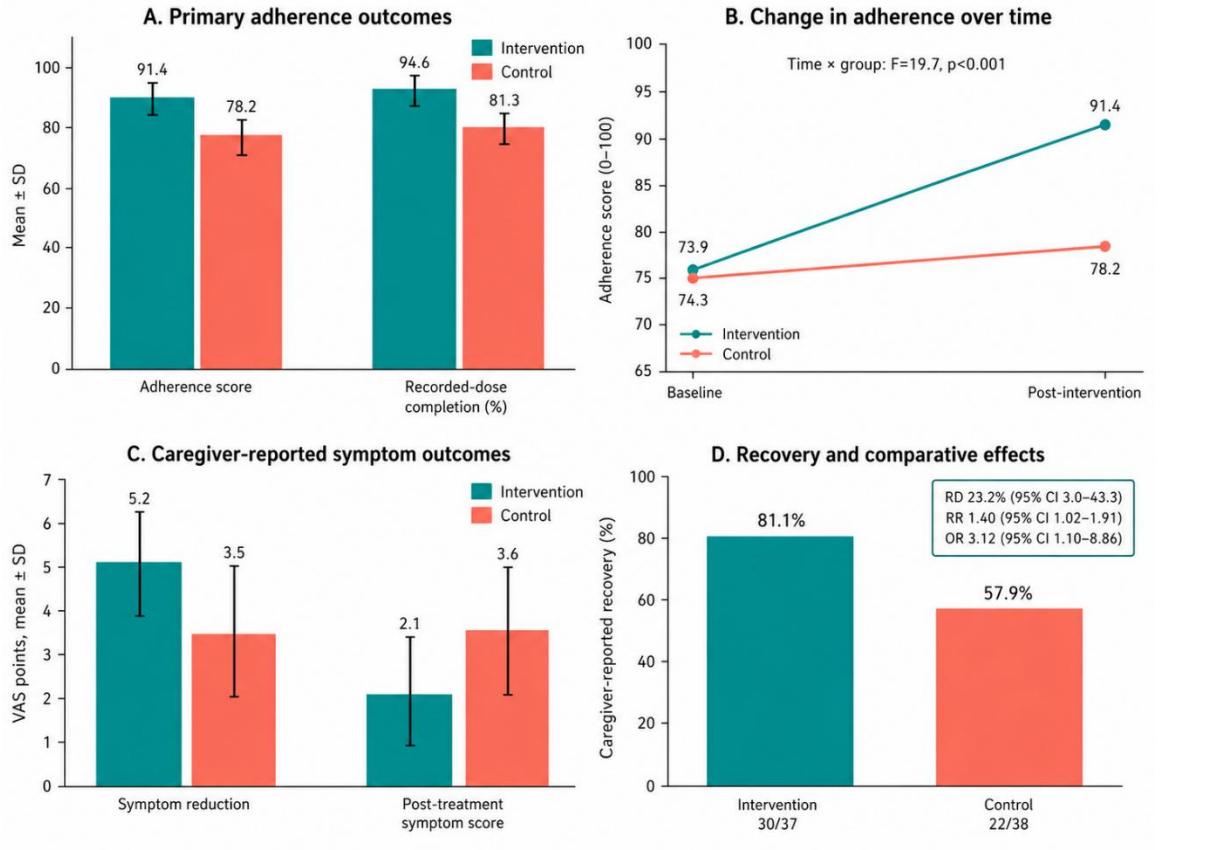

Figure 2 Comparative effects of the gamified mobile application on antibiotic adherence and caregiver-reported clinical outcomes. Panel A shows higher post-intervention adherence scores and recorded-dose completion in the intervention group than in the control group. Panel B demonstrates a greater increase in adherence over time in the intervention group, with a significant time-by-group interaction (F=19.7, p<0.001). Panel C presents greater caregiver-reported symptom reduction and lower post-treatment symptom scores in the intervention group. Panel D shows a higher proportion of caregiver-reported recovery in the intervention group than in the control group, with a risk difference of 23.2% (95% CI 3.0–43.3), relative risk of 1.40 (95% CI 1.02–1.91), and odds ratio of 3.12 (95% CI 1.10–8.86). Error bars represent standard deviations.

Caregiver-reported symptom severity decreased in both groups. Mean scores declined from 7.3 ± 1.0 to 2.1 ± 1.2 in the intervention group and from 7.1 ± 1.2 to 3.6 ± 1.5 in the control group. The mean symptom reduction was 5.2 ± 1.3 points in the intervention group and 3.5 ± 1.4 points in the control group, producing an unadjusted between-group difference of 1.7 points (95% CI 1.08 to 2.32; p<0.001). At follow-

up, symptom-severity scores were on average 1.5 points lower in the intervention group than in the control group (95% CI −2.12 to −0.88; p<0.001).

Table 6. Repeated-Measures and Correlation Analyses

Analysis	Effect	Statistic	p-value
Repeated-measures ANOVA for adherence	Time	F=112.6	<0.001
Repeated-measures ANOVA for adherence	Group	F=28.4	<0.001
Repeated-measures ANOVA for adherence	Time × group	F=19.7	<0.001
Pearson correlation	Adherence and symptom improvement	r=0.62	<0.001

Caregiver-reported recovery was recorded for 30 of 37 children in the intervention group and 22 of 38 children in the control group, corresponding to 81.1% and 57.9%, respectively. The absolute risk difference was 23.2 percentage points (95% CI 3.0% to 43.3%), while the relative risk was 1.40 (95% CI 1.02 to 1.91) and the odds ratio was 3.12 (95% CI 1.10 to 8.86). The corresponding approximate number needed to treat was five, although this estimate requires cautious interpretation because recovery was caregiver reported rather than independently clinically confirmed.

Across the complete-case sample, adherence was positively correlated with symptom improvement (r=0.62, p<0.001). This unadjusted association was exploratory because it did not account for treatment allocation, baseline symptom severity, antibiotic regimen, or other potential confounding factors. It therefore did not establish that greater adherence independently caused the reported symptom improvement.

DISCUSSION

This randomized controlled trial found that the addition of a caregiver-operated gamified mobile application to routine treatment instructions was associated with higher recorded antibiotic adherence and a greater percentage of prescribed doses documented as administered during a one-week treatment period. The intervention group also demonstrated a greater reduction in caregiver-reported symptom severity and a higher proportion of caregiver-reported recovery than the standard-care group. These findings support further evaluation of multicomponent digital adherence support in pediatric outpatient care, but they should be interpreted in light of the complete-case analysis, reliance on caregiver documentation, and absence of independently verified medication ingestion or clinical recovery.

The magnitude of the between-group difference in adherence was substantial. Participants in the intervention group had a mean post-intervention adherence score 13.2 points higher than controls, while the percentage of prescribed doses recorded as administered was 13.3 percentage points higher. These differences were accompanied by large standardized effect estimates. Electronic support may be particularly useful during short-course treatment because caregivers must remember scheduled doses while simultaneously managing the child's symptoms, daily routines, medication refusal, and other household responsibilities. Electronically monitored pediatric antibiotic research has similarly shown that adherence to short-duration regimens may be incomplete even when caregivers understand that treatment has been prescribed (19).

The intervention combined scheduled reminders, dose recording, points, visual rewards, and progress tracking. The study therefore evaluated the combined effect of a digital adherence-support package rather than the isolated effect of gamification. The observed differences could have arisen from reminders, increased monitoring, caregiver attention, progress feedback, rewards, or interactions among these components. Previous digital-health research has shown that interactive systems may support treatment behaviour more effectively than passive information alone, although effectiveness varies according to clinical context, user engagement, accessibility, and intervention design (6, 8). Educational and serious-game approaches have also been explored as methods of improving knowledge and engagement regarding appropriate antibiotic use and antimicrobial resistance (1–3). Nevertheless, the

present design cannot establish that game-related features were more effective than a non-gamified reminder application.

Both groups showed improvement in caregiver-reported symptom severity, which would be expected during recovery from many acute respiratory illnesses. The reduction was larger in the intervention group, and caregiver-reported recovery was more frequent among intervention participants. However, these outcomes were reported by caregivers who knew the assigned intervention and may therefore have been influenced by treatment expectations, increased attention to symptoms, or greater engagement with the study. The study did not include clinician-confirmed recovery, objective physiological measurements, microbiological outcomes, relapse assessment, or healthcare reutilization. Consequently, the symptom findings indicate a difference in caregiver-reported recovery experience rather than definitive evidence of superior clinical resolution.

The positive correlation between adherence and symptom improvement was consistent with the possibility that more consistent administration of prescribed treatment was associated with better perceived recovery. However, the correlation was calculated across the combined sample and was not adjusted for randomized group. Because the intervention group had both higher adherence and greater symptom improvement, group allocation may have contributed materially to the association. In addition, both adherence and symptom change were substantially dependent on caregiver reporting, creating the possibility of common-method bias. The correlation should therefore be considered exploratory rather than evidence of a direct causal pathway.

The findings should also be interpreted within the principles of antimicrobial stewardship. Many acute respiratory infections in children are viral, and digital adherence interventions should not encourage unnecessary antibiotic use. Such tools are most appropriately positioned after a qualified clinician has determined that antimicrobial therapy is indicated. Digital interventions may complement, but cannot replace, accurate diagnosis, appropriate antibiotic selection, clear counselling, dose verification, safety monitoring, and reassessment when symptoms worsen. Digital clinical decision-support and stewardship interventions have shown potential to improve pediatric management and prescribing practices, but adherence support and prescribing appropriateness remain distinct objectives (20, 21, 23–27).

The randomized design, concealed allocation, and use of a concurrent standard-care group strengthened the study. The intervention was delivered in an outpatient context and addressed a practical treatment-management problem in which caregivers have a central role. Reporting both adherence-related and symptom-related outcomes also allowed the behavioural findings to be considered alongside perceived recovery. In addition, the reported interaction between time and treatment group supported a differential pattern of adherence change rather than reliance solely on a cross-sectional follow-up comparison.

Several limitations materially affect interpretation. First, five randomized participants were excluded from the outcome analysis, making the reported analysis complete case rather than intention to treat. Differential attrition was modest but could still bias the effect estimate, particularly because two intervention participants discontinued application use. Second, adherence was measured differently between groups through application records in the intervention group and caregiver-maintained written records in the control group. This differential measurement may have affected completeness and accuracy. Neither method independently confirmed that the medication was administered or swallowed.

Third, the adherence instrument, its caregiver adaptation, scoring transformation, language, psychometric properties, and interpretation threshold were insufficiently documented. The clinical meaning of a 13-point difference is therefore uncertain despite its statistical magnitude. Fourth, caregivers and intervention personnel could not be blinded, and the secondary outcomes were subjectively reported. Fifth, the sample was relatively small, recruited from a single broad region, restricted to caregivers with smartphone access and sufficient literacy to use the application, and

analysed only among participants with available follow-up data. These factors limit generalizability, particularly to families experiencing digital exclusion or literacy barriers.

Additional limitations included the absence of a reproducible a priori sample-size calculation, prospective trial-registration information, detailed antibiotic indications and regimens, app-engagement metrics, intervention-fidelity measures, technical-failure data, safety outcomes, and longer-term follow-up. The control condition also did not receive a non-gamified digital reminder intervention, preventing separation of the effects of gamification from ordinary notifications and electronic tracking. Furthermore, no adjusted analysis accounted for diagnosis, antibiotic type, dosing frequency, caregiver education, age, or baseline symptom severity.

Future research should use prospectively registered, adequately powered multicentre trials with complete CONSORT-EHEALTH reporting. Studies should distinguish clinically appropriate antibiotic prescribing from subsequent adherence support and should document diagnoses, regimens, app use, treatment fidelity, technical problems, privacy safeguards, adverse events, and healthcare utilization. A three-group design comparing standard care, non-gamified digital reminders, and a gamified application would more directly estimate the added value of gamification. Future trials should also include independently verified medication administration where feasible, blinded clinical outcome assessment, prespecified missing-data procedures, and analyses of acceptability, accessibility, cost, and implementation feasibility.

Overall, the findings suggest that a caregiver-operated mobile intervention combining reminders, tracking, rewards, and progress feedback may improve short-term recorded adherence during prescribed pediatric antibiotic treatment. The results provide preliminary support for larger and more rigorously documented evaluations, but they do not by themselves establish independent medication ingestion, clinical effectiveness, antimicrobial-resistance reduction, long-term engagement, or scalability.

CONCLUSION

Among children receiving prescribed oral antibiotics for acute respiratory infections, the addition of a caregiver-operated gamified mobile application to standard treatment instructions was associated with higher short-term adherence scores, a greater percentage of prescribed doses recorded as administered, and greater caregiver-reported symptom improvement than standard care alone. These findings support further investigation of multicomponent mobile adherence support in pediatric outpatient care, although interpretation is limited by complete-case analysis, caregiver-reported measurements, differential adherence recording, and the absence of independently verified medication intake or clinical recovery.

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