A tailored mobile health intervention to improve adherence and asthma control in minority adolescents

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Clinical Implications

- A tailored intervention delivered on a mobile phone platform, integrating low-literacy design strategies and basic principles of behavior change, may be a powerful way to promote increased adherence and asthma control among underserved minority adolescents.

TO THE EDITOR:

Low-income and minority children suffer disproportionately high rates of asthma moribidity.[1] An important contributing factor may be higher rates of low health literacy in underserved populations,[2] which is associated with poor adherence[3] and health outcomes.[2]

To date, no tailored health literacy intervention has demonstrated objective improvement in adherence to inhaled corticosteroids (ICS) and asthma control in underserved African American adolescents. This treatment group only proof-of-concept study aimed to assess the feasibility and explore the efficacy of an intervention featuring an electronic medication monitor and companion smartphone asthma application to deliver a tailored intervention to improve ICS adherence and asthma control in this low health literacy population. This intervention integrates principles of behavior change based on social cognitive theory[4] with recommended design strategies for effective communication with low-literacy populations.[5] Feasibility was measured in terms of acceptability (and use). Efficacy was measured in terms of ability to achieve participant ICS adherence to the clinically significant target ($\geq$50%)[6] and 3-point improvement (minimal clinically important difference = 3) on the Asthma Control Test (ACT).[7]

Study participants met the following inclusion criteria: age 11 to 16 years, African American, a diagnosis of persistent asthma,[8] possession of an active prescription for ICS verified by pharmacy records, and completion of the baseline run-in protocol. Participants were recruited from the Rush Pediatric Primary Care Center, which serves a primarily urban minority patient population.

The Rush University Medical Center Institutional Review Board approved the study protocol. After each caregiver and child dyad provided written consent and assent, 12 participants entered a 3-week run-in period to determine baseline characteristics and ICS adherence. Adherence was measured using the Mobile Adolescents' Disease Empowerment and Persistency Technology (M-ADEPT) electronic medication monitor (see Figure E1 in this article's Online Repository at www.jaci-inpractice.org), which was fitted to participants' ICS. All caregivers and adolescents were informed that this device would collect the date and time of each actuation of medication. Upon completion of the run-in period, the 12 adolescents entered the 8-week treatment phase.

For the duration of their participation in this research, all participants received a smartphone (HTC One V, Virgin Mobile USA, Warren, NJ) with an unlimited texting, talking, and data plan (Virgin Mobile USA); ICS (fluticasone propionate HFA MDI 110 μg inhalation aerosol) and short-acting beta$_2$-agonist (SABA) (albuterol sulfate HFA MDI 90 μg inhalation aerosol) medications (provided by GlaxoSmithKline, Research Triangle Park, NC) fitted with M-ADEPT electronic medication monitors; and the M-ADEPT asthma application loaded onto their study smartphones.

Figure E2 in this article's Online Repository at www.jaci-inpractice.org illustrates the M-ADEPT system. The electronic medication monitors and the smartphone application were developed and built by the investigators (Invention: NIH EIR #0577703-13-0020). The application (Figure 1) was programmed to deliver stimulus control using twice daily visual reminders to take their ICS (Figure1, *A*), immediate reinforcement for taking ICS provided by the opportunity to shoot a basket (Figure 1, *B*) and a positive text message for each ICS puff taken (Figure 1, *C*), and immediate and long-term rewards each time they completed a full dose of ICS within the preselected morning and evening time windows. These rewards included immediate rewards of accessories to customize their game avatar (eg, hairstyles, sunglasses, and animation) as illustrated in Figure 1, *D*, and the long-term reward of monetary incentives (up to $1.00/dose) to purchase age-appropriate (ie, radio-edited) music, movies, applications and games for download onto their study smartphones (Figure 1, *E*).[4,5] Participants met weekly with an asthma specialist (G.M.) for 30 minutes. The doctor provided standard asthma education as outlined in the asthma guidelines[8] and tailored feedback (based on participant ICS and SABA use) to promote adherence to ICS. To ensure treatment fidelity, participants met with a research assistant each week to complete questionnaires and testing for proper functioning of their M-ADEPT medication monitoring devices, smartphone, and application.

The primary efficacy outcome was percent daily ICS adherence measured using the electronic medication monitor and truncated at 100% of the prescribed dose. Average daily adherence over the previous 7 days was assessed at baseline and each week of the 8-week treatment phase.

Baseline assessments included demographic characteristics and asthma history. Asthma control (using the ACT)[9] was assessed at baseline and week 8. Daily SABA use data were collected for the duration of their participation in this research.

Descriptive statistics were used to summarize continuous and discrete variables. Discrete variables were summarized as the total number and percentage in each category. Continuous variables were summarized as the 25th percentile, median, and 75th percentile.

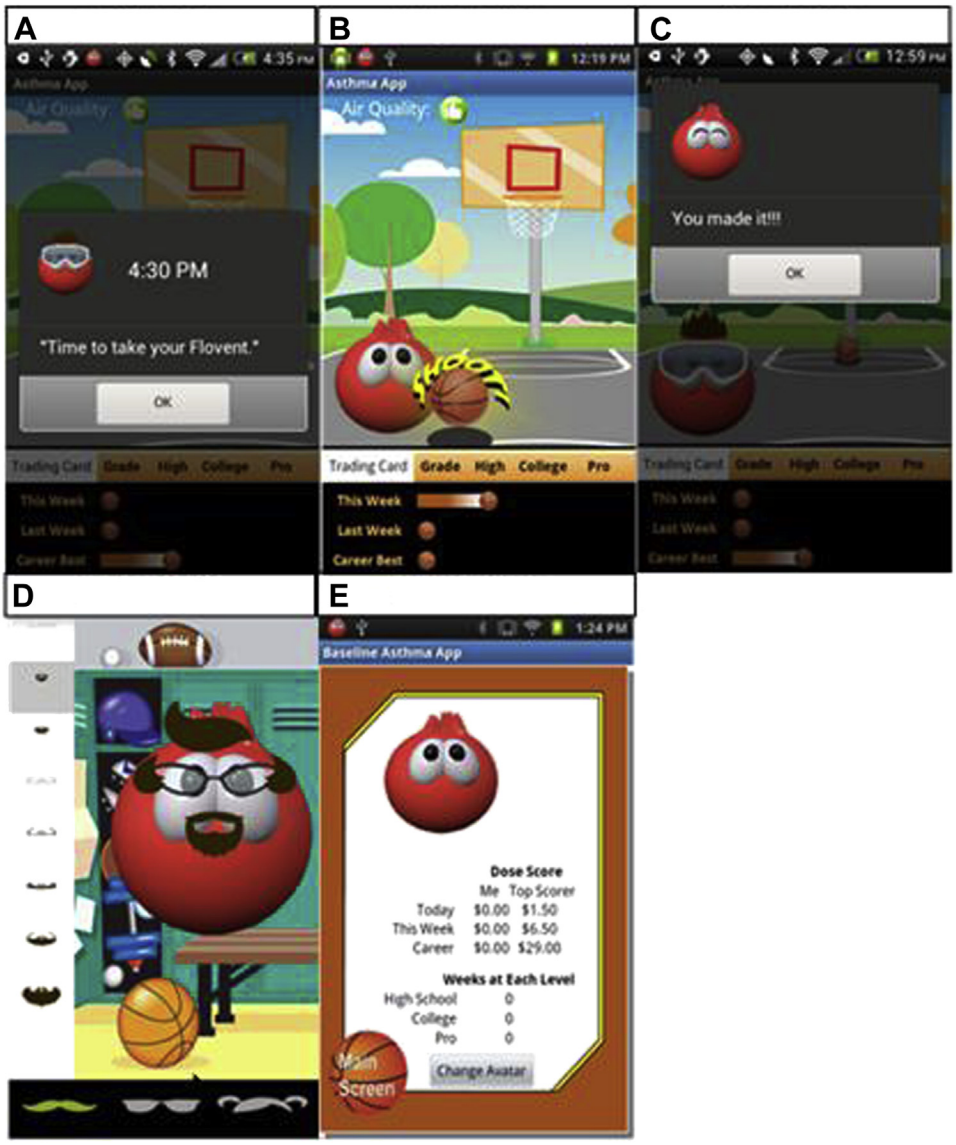

FIGURE 1. The M-ADEPT application. **A-E,** The behavioral principle integrated into each screenshot of the M-ADEPT smartphone application. (*A*) ICS reminder: stimulus control. (*B*) Basketball game: immediate reinforcement. (*C*) Text messages: immediate reinforcement. (*D*) Avatar rewards: immediate reinforcement. (*E*) Smartphone rewards: long-term reinforcement.

Of the 12 participants enrolled, 10 completed the 8-week treatment phase, all study data collection instruments, and 80% or more of study visits. For the 2 participants who did not complete the final assessment, the last observation carried forward was used for analyses.

Baseline characteristics of the 12 Medicaid-insured participants who entered the treatment phase include the following: median age of 14 years, 58% girls, 33% reading at 2 or more levels below their grade (measured using the Wide Range Achievement Test-4),[10] and 75% with uncontrolled asthma (ACT score $\leq$19).[9] Median baseline and week 8 ICS adherence values were 19% and 50% (intent-to-treat)/67% (observed), respectively (Figure 2). Eight percent and 58% of the participants met target ICS adherence ($\geq$50%) at baseline and week 8. ACT scores increased from a median of 18 at baseline to 23 at week 8. Fifty-eight percent of the participants achieved the minimal clinically important difference (3 points) in ACT score from baseline to week 8.[7] SABA use decreased from a median of 3 puffs per week at baseline to 0 puffs per week at 8 weeks.

Cognizant of important limitations (short time frame, small sample size, inclusion of participants from only 1 racial/ethnic group, and lack of a control group), this M-ADEPT—tailored low health literacy intervention is the first to demonstrate objective improvement in ICS adherence[5] and asthma control[7] among underserved minority adolescents. Eighty-three percent of the adolescents completed the 8-week treatment, indicating that the intervention was acceptable and feasible in our target population.

M-ADEPT integrates design strategies for communication with low-literacy populations[5] and principles of behavior change[6]

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