

RESEARCH ARTICLE

An Evaluation of Asthma Interventions for Preteen Students

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ABSTRACT

BACKGROUND: Asthma is a serious problem for low-income preteens living in disadvantaged communities. Among the chronic diseases of childhood and adolescence, asthma has the highest prevalence and related health care use. School-based asthma interventions have proven successful for older and younger students, but results have not been demonstrated for those in middle school.

METHODS: This randomized controlled study screened students 10-13 years of age in 19 middle schools in low-income communities in Detroit, Michigan. Of the 6872 students who were screened, 1292 students were identified with asthma. Schools were matched and randomly assigned to Program 1 or 2 or control. Baseline, 12, and 24 months data were collected by telephone (parents), at school (students) and from school system records. Measures were the students' asthma symptoms, quality of life, academic performance, self-regulation, and asthma management practices. Data were analyzed using multiple imputation with sequential regression analysis. Mixed models and Poisson regressions were used to develop final models.

RESULTS: Neither program produced significant change in asthma symptoms or quality of life. One produced improved school grades ($p = .02$). The other enhanced self-regulation ($p = .01$) at 24 months. Both slowed the decline in self-regulation in undiagnosed preteens at 12 months and increased self-regulation at 24 months ($p = .04$; $p = .003$).

CONCLUSION: Programs had effects on academic performance and self-regulation capacities of students. More developmentally focused interventions may be needed for students at this transitional stage. Disruptive factors in the schools may have reduced both program impact and the potential for outcome assessment.

Keywords: asthma; preteen; disease management; interventions.

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Data regarding the prevalence of asthma in students in urban areas continue to be alarming. Prevalence estimates of over 20% of inner-city school-age children have been reported.¹⁻⁵ National data for children aged 10-13 years are not separated from older age groups. However, data evident for groups including low-income preteens are worrisome. The national prevalence estimate for children under 18 years of age is 9.3% and for those between 12 and 17 years is 4.5%. However, Crain et al¹ found rates 2 times higher for inner city, low-income adolescents. Prevalence has been shown to be higher at the younger end of the adolescent age range and continues to increase.⁶

Undiagnosed asthma is also a problem in urban minority populations. Joseph et al² found 14.3% of school-age children in Detroit schools met criteria for undiagnosed asthma, and others have reported high rates in similar communities.^{1,3,7,8}

Schools have been shown to be a good venue for reaching students with asthma and aiding them and their families to become better asthma managers. Open Airways for Schools, a self-management program disseminated through the American Lung Association (ALA), has been provided to a large number of elementary schools across the United States⁹ and has reached tens of thousands of elementary school students. Bruzzese et al,¹⁰ Joseph et al,¹¹ and Shah et al¹² have assessed high school asthma programs for older adolescents and have reported significant, positive health outcomes.

Although a few intervention studies for pre-adolescents in middle schools have been undertaken, evidence for this group is much less abundant. The majority of studies have involved small numbers of participants and assessments conducted over the short term and/or without controls. Bruzzese et al¹³ found that a program involving 24 parents and middle school children assessed in a pre-post only design 2 months postintervention resulted in students more frequently carrying their own medicines, taking more preventive steps, and awakening less often at night with asthma symptoms. Velsor-Freidrich et al¹⁴ employed the Open Airways Program¹⁵ with 52 children 8-13 years old and followed this with monthly nurse practitioner visits. Evaluation showed an increase in children's self-efficacy compared with the control group, but no significant health outcomes were reported. Shegog et al¹⁶ assessed a computer-based program with 76 children in middle school 1 week after program completion. They found higher levels of self-efficacy but no differences in health outcome. A study by Guendelman et al¹⁷ with 134 middle school students participating in a self-management "Health Buddy" program was assessed over 3 months. The study found decreases in activity limitation and fewer urgent calls to the hospital for asthma during the intervention for program children compared with controls.

The 5-year randomized controlled trial presented here involved 1292 low-income, African American students with asthma attending middle schools in Detroit, Michigan. It assessed 2 in-school interventions to enhance management of the condition at home and school. One comprised an age-adapted version of Open Airways at School (OAS)¹⁸⁻²⁰ that provided adult-led, problem-centered group activities, including self-management decision making and action exercises. The second was the adapted OAS program plus an age-appropriate adaptation of Peer Asthma Action (PA2),¹² a proven intervention for older adolescents that involved classroom peer teaching and students relating what they learned through performances presented at school assemblies. The adapted OAS program was expected to produce less frequent symptoms of asthma and better grades for the participants compared with a control group. The adopted OAS + PA2 intervention was expected to achieve these outcomes plus higher levels of quality of life and asthma self-regulation.

METHODS

Subjects

Randomization. Preteens in 19 Detroit middle schools were enrolled in the study over a 2-year period beginning in 2003. Before the start of student recruitment, randomization of schools to the interventions was carried out. Schools were stratified by geographic location and disease prevalence (based on asthma hospitalizations per 10,000 children²¹) to ensure homogeneity across groups. Within each of the resulting 4 strata, schools were randomized using a table of random numbers. The 3 study arms were OAS (7 schools), OAS + PA2 (6 schools), and control (6 schools).

Sample Size. Sample size calculations were based on expected intervention effects at 12 months. We assumed an intra-school correlation of .005 (based on previous studies), 6 schools per intervention arm, a 4% type I error rate, and a 20% attrition rate. Under these assumptions, a total sample size at enrollment of 1215 allowed us to detect with 80% power a 15 symptom day mean difference between control and each of Programs 1 and 2. This sample size also allowed us to detect changes in the other anticipated outcomes, with 96% to 85% power.

Identification of Children With Asthma. An 11-item health survey with questions enabling identification of asthma was sent home with all sixth-grade children in each participating middle school (6827 student total). The survey was to be completed by students' parents. A total of 4194 screening surveys were returned (71.4%: return rate adjusted for 10% Detroit Public Schools daily absentee rate) and of these, 4038 were usable.

Thirty-two percent of children surveyed (N = 1292) met criteria for probable asthma. The definition of probable asthma as well as levels of severity was based on National Asthma Education and Prevention Program (NAEPP) guidelines²² and required the child to (a) have a diagnosis of asthma and have active asthma symptoms and/or have received a prescription for asthma medications in the last year, or (b) report the presence of 3 to 5 non-exercise-related asthma symptoms in the last year on 5 or more occasions, or (c) report 2 or more exercise-related asthma symptoms in the past year on 5 or more occasions, or (d) have a severity classification of persistent disease (mild, moderate, and severe) based on nighttime symptom questions.

The sample of children with asthma was 52% male and predominantly African American (93%). The racial identification of the remaining children was 2% Latino, 1% White, 1% Asian, and 3% whose race was listed as biracial or was not specified. The mean age of the children was 11.6 ± 0.6 years. At screening, 55% of children were classified as having mild intermittent asthma based on nighttime symptoms, with 20%, 12%, and 11% classified as having mild, moderate, and severe persistent asthma, respectively. Parents of 22 children (1.7%) did not complete the screening question relating to nighttime symptoms and the child's asthma severity could not be determined.

Interventions

Both programs were provided during regular class time and received strong support and assistance from participating school personnel. In order to ensure student participation in the screening process, sixth-grade teachers received a \$20 office supply gift card for their assistance and cooperation with our recruitment efforts. The classroom with the highest participation rate at the end of the recruitment period received a pizza party. A key contact in each school office was identified to assist with tracking students and scheduling the intervention and was given an office supply \$20 gift card each year for her assistance. Each participating principal also received annually a \$50 gift card for office supplies for his/her support of and assistance with the research.

Program 1: Open Airways for Preteens. The first intervention tested was an adaptation of Open Airways.¹⁸⁻²⁰ The original 7 lesson curriculum included interactive problem-solving activities appropriate for groups of preteens. The topics in the lessons included (a) basic information and feelings about asthma; (b) facts about asthma medicines and their use (this session emphasized partnership with the physician with take home materials detailing sources and financing for clinical care; (c) how to monitor one's physical activity; (d) how to manage an asthma attack

at home or school, deciding when to go to the doctor and making the doctor visit more effective; (e) how to keep yourself healthy, including smoking avoidance; and (f) personal characteristics, actions, and environmental factors that lead to successful asthma control. Take-home assignments and handout materials for parents were part of each session. In the adapted program, groups of preteens met during school hours for approximately 1 ½ hours each week for 6 weeks. Sessions were led by graduate students and community leaders who were trained by the principle investigator and health education coordinator in the program methods and approach, including specialized instruction regarding working with middle school students and in a predominantly African American, urban school setting.

Program 2: Self-Management With a Peer Component. Program 2 was a multicomponent model. The program included the adapted Open Airways program and the peer education component, originally developed and evaluated by Shah and colleagues for older students.^{23,24} The goal of the peer component was to create a positive social environment for students managing asthma (sixth graders) by engendering support for them among their classmates and older peers (seventh and eighth graders).

In step 1, peer leaders were sought from the general population of eighth-grade students who applied to be part of the peer leader group. Students did not need to have asthma to be a peer leader. Among peer leaders, 18% had asthma. The intention of the peer intervention was to create empathy and support for students with asthma among their classmates. Therefore, it was deemed important to include among peer leaders students with and without the condition themselves. This approach has been successfully used previously.²⁴⁻²⁶ These students were trained by project staff to provide 3 asthma awareness lessons to seventh-grade students. Two to 3 peer leaders were trained as a team. Peer leaders developed skits and game shows as part of training to impart an important message about asthma. These skits and games were used in their teaching to the seventh-grade students.

In step 2, teams of peer leaders taught the 3 asthma awareness lessons to seventh-grade students in their homerooms. Participants discussed a video, played games demonstrating and testing asthma knowledge, etc. Using a problem-posing methodology,²⁵ the older students assisted younger students to discuss these barriers. Finally, the younger students voted on key messages to communicate to their sixth-grade schoolmates.

In step 3, with help from the peer leaders, project staff, and a teacher, seventh-grade students translated asthma messages into skits, songs, creative dramas (eg, a game show), or music. They then performed these for

an assembly of sixth-grade students. All 3 steps focused on enabling students to understand and support their classmates with asthma. The skits developed by the seventh graders and subsequently delivered to the sixth-grade assemblies were validated for necessary content in several ways. First, in order to be informed regarding the dynamics of the actual delivery of the PA2 program by the eighth-grade peer leaders to the seventh-grade classes, trained classroom observers completed evaluations for at least 1 of the 3 sessions for each team of eighth-grade peer leaders. The observers were graduate students who completed the PA2 health educator training program. They understood the goals of the program and the way in which it was intended to be delivered and were able to provide feedback to the Intervention Coordinator regarding additional training needed. Second, the seventh graders who participated in the three 50-minute PA2 program classes led by the eighth-grade peer leaders completed a short-evaluation survey at the end of the program to measure asthma knowledge and peer leader effectiveness. The responses indicated that the delivery of key messages was well understood. Third, study research staff coordinated 3 assembly planning and rehearsal sessions with the seventh-grade teams prior to each assembly. They assisted the eighth grader peer leaders in providing assembly planning and guidance to the seventh graders and assured that the skits incorporated the key messages of the PA2 program.

Instruments

The 4 primary outcomes studied were reduction in asthma symptoms, increase in asthma-related quality of life, increase in self-regulation, and academic performance. Symptom level was captured with a series of questions used in prior research²⁰ about the frequency of specific asthma symptoms in the past year during the day and at night. Asthma-related quality of life was measured with the Pediatric Asthma Quality of Life Questionnaire.²⁷ Both the reliability and validity of this instrument have been extensively reported.²⁸ Self-regulation was assessed through a series of items developed by the authors and used in previous studies.^{20,29} Management practices of parent and child were assessed by the authors' scale used in previous research.^{15,20} Academic grade reports were provided by the Detroit Public Schools System Office of Testing and Evaluation.

Procedure

Data were collected from school district records, through face-to-face interviews with students in each school, and telephone interviews with their primary caretakers (parent). Research interviewers who conducted the baseline, 12- and 24-month follow-up

interviews in the schools received 8 hours of standardized training on conducting interviews in a consistent, unbiased manner and in addition received specialized instruction on working with students in a predominantly African American, urban school setting. In addition, all research staff signed confidentiality agreements. Interviewers were supervised by the Data Collection Coordinator, who conducted weekly phone check-in calls and held monthly staff meetings to discuss problematic interview questions or challenges encountered in completing the interviews. In addition, completed interviews were randomly checked through a verification process that was developed for this project to ensure that interviews were conducted as scheduled and that there was consistency across all interviewing staff. Interviewing questions did not change over the course of the study. The Data Collection Coordinator conducted regular assessments of the research assistants' progress and conduct in order to assure that both parent telephone interviewers and child face-to-face interviewers were adhering to the study interviewing protocol.

Follow-up interviews occurred 12 and 24 months after baseline interviews. A total of 1183 baseline child interviews (92% of sample) and 962 parent interviews (74%) were completed. Follow-up interviews were attempted for all students and parents regardless of whether the baseline interview had been completed. A total of 921 12-month follow-up student interviews (71%) and 833 parent interviews (64%) were completed. At the 24-month interview, there were 794 (61%) completed child interviews and 761 (59%) completed parent interviews. The most common reasons for not completing interviews were that students were no longer attending a school in the district or that the parent had a nonworking phone number. The movement of students in and out of schools in the study school district was significant. School district records for the fifth-grade year (baseline prior to the child's enrollment in the program) through their eighth-grade year were compiled for 4 academic subjects: English, Mathematics, Science, and Social Studies. These subjects were identified as the most consistent across the school district. Subjects like physical education, art, music, and foreign languages were not offered at all of the Detroit Public School middle schools. Grade data were available for 1146 students at baseline, 1023 at 12 months, and 941 at 24 months. We were not able to collect grade data for children who had moved outside of the Detroit Public School System.

Data Analysis

Owing to missing data, complexity of data sources, and data patterns, a multiple imputation analysis was performed.³⁰ This allowed all collected data to inform

analyses. Imputation was conducted using IVEware, software that uses a sequential regression process to impute missing values.³¹ Variables included in the multiple imputations were primary outcomes, demographics, and related variables associated with outcomes. Continuous, binary, multicategory, and count variables were imputed using linear, logistic, multinomial, and Poisson regression. Skewed continuous variables were normalized using log transformation prior to imputation and retransformed to their original scale after imputation. All imputation models included a set of dummy variables for school to incorporate the clustered design. A total of 10 multiply imputed data sets were created.

After imputation, an intention-to-treat analysis was performed at the individual level, accounting for the intracluster correlation. Changes in scores from baseline to 12-month and baseline to 24-month were calculated. Differences were compared using linear and nonlinear mixed models, with school nested within recruitment year treated as a random factor. Estimates of intracluster correlation were in the range of .01-.03. All models controlled for baseline measures and subject demographics. Statistical analyses used the SAS® System, version 9.1.³²

RESULTS

At baseline, despite randomization, the OAS + PA2 program group had lower grades than controls. No other baseline differences were evident (Table 1). Grade data were analyzed for 3 time periods: change from sixth to seventh grade, from seventh to eighth grade, and from sixth to eighth grade. Fifth-grade scores were used as a covariate in these analyses. No significant effect on symptoms or quality of life for either intervention emerged at 12 or 24 months. Both intervention groups had higher but not statistically significant odds (OAS (Program 1): OR = 1.1, $p > .5$; OAS + PA2 (Program 2): OR = 1.3, $p = .3$) of a drop in daytime asthma symptoms compared with controls. Table 2 indicates that change in asthma-related self-regulation by students in the OAS + PA2 (Program 2) group was significantly improved compared with controls by the 24-month follow-up (mean change 0.35, $p = .01$). For the group of students without a diagnosis, those in the control group experienced a decline in self-regulation behavior, but students in both the intervention groups experienced significantly less decline at 12 months (OAS mean change—0.17, $p = .01$; OAS + PA2 mean change—0.06, $p = .002$) and experienced an increase at 24 months (OAS mean change 0.07, $p = .04$; OAS + PA2 mean change 0.24, $p = .003$). Similarly, for undiagnosed students in OAS + PA2, there was a less steep decline in their parent's asthma management scores at 12 months (mean change 0.02, $p = .05$), and at 24 months (mean

change 0.08, $p = .06$) compared with controls. Table 2 also shows that at 24 months, for OAS children overall there was a mean positive change in GPA from sixth to eighth grade compared with controls (mean change 0.09, $p = .02$). This period of grade improvement occurred within the overall picture of decline for all students.

DISCUSSION

The introduction of asthma education programs in the school for elementary and high school-aged students has produced positive health outcomes for them and their families. This study sought similar improvements for middle school-aged students. The results concerning symptoms and quality of life did not illustrate the degree of treatment and control differences observed in programs for other age groups. Although daytime symptoms experienced by students in both the OAS and OAS + PA2 interventions were reduced compared with controls, these findings did not reach statistical significance. Significant improvements in grades and self-regulation were observed. Children's grades, of course, are of great importance in the life of most families. Data suggest that OAS (Program 1), a program focused on and directed toward asthma management, was useful in staving off a decline of academic grades. Generally, grades of students drop as they move forward in school, an occurrence that has been noted in previous research.^{15,20} Although the group differences were not large, this is an important finding suggesting that participating in the asthma program during class time did not detract from academic grades but indeed enhanced them. The activities in Program 1 mimicked classroom work and may have enhanced skills of children for performing regular schoolroom tasks. The fact that OAS + PA2 (Program 2) began the study with lower baseline grades may have deterred grade improvement in that group.

Self-regulation was enhanced in OAS + PA2 (Program 2), the program including peer support. It may have been that the peer-led activities within the school made students in general more aware of their health problem and the need to more actively manage it. They may have felt greater peer support for their efforts. For the group of children without an asthma diagnosis, both programs helped to arrest a decline in self-regulation. Both interventions may have called children's attention to the seriousness of asthma and the need to attend to it. Underdiagnosis of asthma among low-income and minority children is an ongoing problem.³³ These students do not receive adequate treatment, education, and counseling from clinicians and represent an important subgroup for assistance. Increased awareness of asthma problems

Table 1. Subject Demographics by Intervention Group, Multiply Imputed Data

| | Control (N = 408) | OAS (N = 468) | OAS and PA2 (N = 416) | Overall (N = 1292) |
|--|-------------------|---------------|-----------------------|--------------------|
| Demographics | | | | |
| Age (mean [SD])* | 11.6 (0.7) | 11.6 (0.6) | 11.6 (0.6) | 11.6 (0.6) |
| Female (%)* | 50 | 48 | 46 | 48 |
| African American race (%) | 92 | 90 | 98 | 93 |
| Body mass index Z-score [†] [mean (SD)] | 1.0 (1.3) | 1.1 (1.5) | 0.9 (1.4) | 1.0 (1.4) |
| Primary caretaker's education (%) | | | | |
| Less than high school | 19 | 22 | 24 | 22 |
| High school degree | 36 | 37 | 41 | 38 |
| More than high school | 45 | 41 | 35 | 40 |
| Household income (%) | | | | |
| <\$15,000 | 44 | 48 | 50 | 48 |
| \$15,000-\$40,000 | 41 | 34 | 38 | 38 |
| \$40,000+ | 15 | 17 | 11 | 15 |
| Disease status at screening | | | | |
| Asthma diagnosis (%) | 63 | 54 | 58 | 58 |
| Prescription for asthma meds in past year (%) | 57 | 50 | 48 | 52 |
| Persistent nighttime asthma (%) | 44 | 45 | 42 | 44 |

*Fully observed, no imputation for these variables.

[†]A Z-score is an individual's deviation from the population mean divided by the standard deviation of the population. A Z-score of 1 represents a mean BMI that is 1 standard deviation above the population mean. The reference population here is the United States.

Table 2. Estimated Changes in Child Self-Regulation Scores, Parent Asthma Management Scores, and Grade Point Average, Multiply Imputed Data

| Outcome Measure | Estimated Mean Change* Baseline to 12 Months | | | Estimated Mean Change* Baseline to 24 Months | | |
|--------------------------------|---|--------------|--------------|---|-------------|-------------|
| | Control | OAS | OAS + PA2 | Control | OAS | OAS + PA2 |
| Child self-regulation score | | | | | | |
| Overall | 0.06 | 0.16 | 0.19 | 0.14 | 0.26 | 0.35 |
| (p-value vs control) | | (0.22) | (0.19) | | (0.10) | (0.01) |
| No diagnosis | -0.47 | -0.17 | -0.06 | -0.16 | 0.07 | 0.24 |
| (p-value vs control) | | (0.01) | (0.002) | | (0.04) | (0.003) |
| Diagnosis | 0.32 | 0.34 | 0.34 | 0.30 | 0.37 | 0.42 |
| (p-value vs control) | | (0.82) | (0.88) | | (0.36) | (0.17) |
| Parent asthma management score | | | | | | |
| Overall | -0.01 | 0.03 | 0.08 | 0.03 | 0.04 | 0.13 |
| (p-value vs control) | | (0.52) | (0.22) | | (0.93) | (0.25) |
| No diagnosis | -0.28 | -0.13 | -0.02 | -0.18 | -0.05 | 0.08 |
| (p-value vs control) | | (0.13) | (0.05) | | (0.19) | (0.06) |
| Diagnosis | 0.12 | 0.12 | 0.14 | 0.13 | 0.08 | 0.16 |
| (p-value vs control) | | (0.97) | (0.77) | | (0.51) | (0.74) |
| Grade point average** | -0.03 | 0.05 | -0.05 | -0.05 | 0.09 | -0.02 |
| (p-value vs control) | | (0.14) | (0.78) | | (0.02) | (0.57) |

Bolded change values highlight p-values <0.10.

*A positive change is the desired result.

**For grades, baseline = sixth grade, 12 months = seventh grade, and 24 months = eighth grade.

also may explain the improved asthma management efforts of parents whose children were in the OAS + PA2 program. Of those children undiagnosed at baseline that we were able to follow for the full 2 years, 35% eventually received a physician's diagnosis.

This study is significant in that it is the first large-scale trial of asthma interventions for middle school students. The findings echo previous smaller, less well-controlled studies in the same age group where health

outcomes have been difficult to demonstrate. Results were less robust than expected and observed in school-based studies in younger and older students. Students at this transition age may need programs with different emphases that develop different capacities.

The lack of greater impact on symptoms and quality of life may be related to several age-related factors. Middle school reflects a period of significant developmental transition where students are struggling with individuation and socialization

tasks.³⁴ Further, asthma itself changes by the time children reach adolescence. A number of recent studies indicate that hormonal shifts affect the course of the disease and present new asthma burdens and challenges.³² These may even give rise to gendered approaches to management.^{35,36} The interventions, although strong on creativity, asthma information, and skill rehearsal, may not have been sufficiently developmentally appropriate for this transitional age group and the tasks related to individualization and socialization.

Limitations

There were limitations to this research. A factor that cannot be overlooked was the crisis situation surrounding the 19 participating middle schools. During the study period, the school system faced severe economic cutbacks. Large numbers of students left the public school system.³⁷ Teachers, counselors, and families were distracted by these system-wide events, and these factors may have reduced the potential for the impact of the two interventions on symptoms and quality of life and/or the ability to adequately assess them. Also, dropout from the study exacerbated by these events was significant. However, sophisticated data analyses procedures greatly reduced the potential impact of attrition on the measurement of outcomes.

Conclusion

Two middle school-based programs designed to assist 10-13 year old students with asthma-produced grade and self-regulation-related results. This age group remains an important one to assist with asthma management. A more developmentally focused intervention may be needed to strengthen results related to symptoms and quality of life. Schools facing significant disruption may need special assistance in implementing programs to help students with asthma.

IMPLICATIONS FOR SCHOOL HEALTH PROFESSIONALS

Asthma continues to be a serious problem for students in middle schools especially in low-income urban areas. School personnel are faced with helping students both manage their condition during school hours and continue to achieve academically. School-based asthma interventions deserve support by administrators, teachers, and school nurses. Students who participated in the programs presented here developed skills valued in academic settings (ie, those related to self-regulation) and 1 intervention improved academic performance. When assisting students with asthma in this age group, school personnel may wish to pay particular attention to how management interacts with developmental tasks. These considerations include how asthma

management needs might interfere with students' peer relationships,³⁸ and how becoming an effective manager requires students' increasing independence from parents and other caretakers. Examples exist of asthma programs offered continuously in the school setting (eg, the ALA's ongoing sponsorship of Open Airways in elementary schools). Such volunteer and/or school nurse-provided efforts suggest means to build into middle school services that help students and staff need to manage asthma more effectively.

Human Subjects Approval Statement

All study procedures were approved by the University of Michigan institutional review board and parental consent and student assent received for all study participants.

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