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Improvement of Rural Children's Asthma Self-Management By Lay Health Educators

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Abstract

Background—The purpose of the present analysis is to examine changes in rural children's asthma self-management after they received Lay Health Educator-delivered classes.

Methods—Elementary schools were randomly assigned to the treatment or attention-control condition and their participating students received either asthma education or general health promotion education, respectively. The tri-ethnic sample was composed of 183 children (46% Hispanic, 29.5% non-Hispanic White, 22% African American, 2.6% other categories) who had a mean age of 8.78 years (s.d. = 1.24). The time frame from baseline to post-intervention was 12-weeks.

Results—Repeated measures ANOVA analyses found main effects in changes in scores for children's asthma knowledge, asthma self-management, self-efficacy for managing asthma symptoms, and metered dose inhaler technique, and significant group interaction effects for the treatment intervention on the measures of children's asthma knowledge, asthma self-management, and metered dose inhaler technique.

Conclusions—The delivery of an asthma health education intervention by trained lay health educators to school-age children was an effective means for improving children's knowledge and skills in asthma self-management.

Keywords

Asthma; children; self-management; rural

Introduction

Asthma is a significant problem with 13.9% of 5- to 14-year old children nationwide diagnosed with asthma during their lifetimes and 9.5% reporting asthma symptoms in the previous 12 months.¹ A survey of 19,138 children in grades K-5 in Texas showed that 8.5% of the children had a current diagnosis of asthma.² Most studies of childhood asthma have been conducted in densely populated urban areas.³⁻¹¹

Rural America

Rural areas have serious resource deficits for meeting the health needs of rural dwellers as they have fewer health care and social service resources in comparison to urban communities.^{12, 13} Only 10% of physicians work in rural areas even though this is where 25% of the population

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resides.¹³ Rural Americans work in more high-poverty jobs that do not have insurance or sick care benefits.¹⁴

The rural environment presents families with risk factors that can complicate asthma management.¹⁵ The rural environment has a rich mix of airborne allergens and “contained” allergens (e.g. silos and barns have molds, grains, and storage mites), agricultural dust, and animal dander that can present significant health risks to children with asthma.^{16,17} Because of a lack of health insurance and less expendable income, rural families tend to delay seeking health care when symptoms first arise, but as symptoms either do not respond to home interventions or become more severe, they then will seek care at urban urgent care centers.^{12,18}

Asthma Education Programs

Asthma educational programs were first developed for families who attended specialty-care clinics or for hospitalized children.³⁻⁵ These programs improved parents' and children's reported asthma management and asthma knowledge, but had variable success in improving health outcomes. Health outcomes may be confounded by medication adherence as studies have found approximately half of patients take their prescribed long-term controller medications.^{6,7}

Recognizing the limitations of health care system-based programs, investigators developed educational programs for the larger population of children with asthma in public schools and community settings.⁸⁻¹⁰ These programs were effective in improving parents' and children's asthma knowledge and perceptions of asthma symptoms. Bartholomew and colleagues found that combining school-based asthma self-management education with referral to an asthma specialist yielded greater improvements in health and school outcomes than the education program alone.¹¹ All of these programs were conducted in urban areas.

Two studies that were conducted with rural populations have been reported in the literature. Horner's pilot study with rural families who had a child with asthma that combined nurse-delivered in-school classes for the children with home-visit education for parents demonstrated significant improvements in children's asthma self-management and asthma knowledge one year after the program.¹⁹ Butz and colleagues provided asthma self-management education through a workshop format for rural children and parents and found significant improvements in asthma knowledge and reductions in asthma symptom frequency one year after the intervention.²⁰

Lay Health Educator Programs

There is a growing body of evidence to support the use of lay health educators (LHE) in programs designed to meet the needs of under-resourced communities.²¹ A review of studies with LHE (e.g. community health workers, *promotoras*) reveals that all those reported in the literature have been conducted with adult populations.^{22,23} Education provided in the home has targeted detrimental health behaviors of persons with chronic disease, and focused on improving cancer screening participation rates by communities with significant improvements in these lifestyle behaviors.^{22,23} These community-based interventions built upon the social supports inherent in underserved diverse communities where people look to their ethnic peers for information and advice.

There are fewer studies that focus on child health concerns and most were focused on improving perinatal and infant outcomes through programs delivered to parents.^{24,25} In one of the few studies with parents of older children, Conway and colleagues conducted a home-based intervention to reduce children's exposure to environmental tobacco smoke (ETS). The LHE

provided six educational sessions to families over a 4-month period. Both the treatment and control groups significantly decreased their exposure to ETS based on parent self-report and radioimmunoassay tests for nicotine and cotinine biomarkers in samples of the children's hair.²⁶

A common finding in these studies that included LHE was the acceptance of the health messages, the sense of support, and the opportunity to ask questions without feeling intimidated reported by the studies' participants.²² Furthermore, LHE reported a strong sense of satisfaction in the contributions they were able to make to their communities.²⁶

There are no studies in the literature in which LHE provided some or all of an intervention to children. Nevertheless, there is strong evidence from the studies with adult participants that community members can be trained to provide health promotion and disease reduction education to members of their communities. A primary strength of such lay health educators is their familiarity with the physical and social community, issues of concern to the community, and an understanding of cultural nuances that might impact upon studies conducted in their communities.²¹ Building on this prior work, a community-based intervention study was designed that combined in-school classes for rural children delivered by LHE and follow-up individualized family education provided in the home by trained graduate research assistants (GRA). The purpose of the present analysis is to examine changes in rural children's asthma self-management after they received the LHE-delivered classes, but prior to receiving the family education session. It was hypothesized that children in the asthma treatment group would demonstrate significantly greater improvements in asthma knowledge, self-management, self-efficacy for managing asthma, and metered dose inhaler (MDI) technique than would children in the attention-control group. If the hypothesis is supported, this would provide evidence for using LHE to increase the translation of research into community practice.

Methods

This intervention study used an experimental design with children randomized into treatment ($n=10$) or attention-control ($n=8$) schools. Randomization was at the level of the school to prevent the cross-contamination that can occur as children interact in their respective schools. The attention-control intervention mirrored the treatment intervention in class times to control the extraneous variable of children having additional contact with supportive adults. Each of the four participating rural school districts participated for one academic year but the project spanned 2003 to 2006 academic years. The present analysis spanned 12-weeks of the academic year from study enrollment with baseline data collection (Time1) to 6-weeks post-intervention (Time2) data collection.

Subjects

The participants lived in rural areas with small towns (largest has 1,200 population) and unincorporated communities, located 20-45 miles from a densely populated urban center. Sample inclusion criteria were: (a) the child had a diagnosis of asthma made by a medical provider; (b) the child had experienced asthma symptoms in the previous 12 months; (c) the child did not have significant co-morbidity that would preclude participation in classes (e.g., severe cerebral palsy, oxygen dependent conditions); (d) the child spoke either English or Spanish; and (e) the child was enrolled in grades 2 through 5.

Human Subjects Procedures—The study was reviewed and approved by the Institutional Review Board of a large southwestern university. Study invitations were mailed to all families of children ($n=541$) who had a history of asthma listed on their school medical records. Follow-up telephone calls were made to non-responding families by personnel hired to work with the school nurses. From the sample pool of 541 children, 270 (50%) parents gave permission for

the researchers to contact them and 183 children (33.8% of sample pool) were enrolled in the study. Assessment of children's demographic data (i.e., grade, gender, ethnic/racial group) demonstrated no significant differences between the study participants ($n=183$) and the non-participating children in the sample pool ($n=358$). Consent, assent, and baseline data (Time1) were collected at the first meeting with the 183 families who agreed to be in the study.

Intervention Design

The intervention was designed so that content, skills practice, and problem-solving exercises could be covered in 16 sequential 15-minute sessions. This allowed the sessions to be provided during the children's school lunch breaks. Use of non-academic time for the intervention was paramount in order to meet the restrictions on the use of academic time imposed by School Boards and the state Department of Education. Children met two or three times a week which allowed for reinforcement of prior content and introduction of new content in subsequent sessions.

Asthma intervention—The curriculum was presented as a 7-step asthma self-management plan designed for rural children. Content included information on asthma pathophysiology, symptoms, and management; skills practice with placebo MDI and peak flow meters; problem-solving using common problems encountered in rural areas using vignettes (e.g. caring for animals; what to do when crops are being dusted, agricultural dust is blowing in the wind, or when they are physically active) to increase self-efficacy of asthma management.

Attention-control intervention—The attention-control intervention involved health promotion topics appropriate for children. Information on nutrition, exercise, and cold or flu avoidance was provided. Skills practice included brushing their teeth and washing their hands after using glow-in-the-dark lotion. A number of games and colorful worksheets were incorporated into the sessions for the different topics.

Lay health educator training—Eighteen LHE were nominated by school personnel who identified them as dependable school volunteers who lived in the community. The nominated LHE were already familiar with the school environment and personnel. The LHE who were hired by the project to provide the in-school interventions were female (100%), White (61%) or Hispanic (39%), and were a mean age of 38.78 (s.d.=8.74) years. The LHE were not involved with any data collection. The LHE for both interventions were trained in separate sessions by the principal investigator to deliver their respective curricula. Manuals with objectives, materials, and instructional content were used in the training of the LHE. Training consisted of 16 hours of intensive review of the content, education presentation strategies, classroom management; individual review of manuals and practice with educational materials; and a final feedback session before the LHE were ready to deliver their respective interventions. A member of the research team visited five of the sessions for each LHE to assess fidelity to the intervention design and adherence to the instructor manuals.²⁷

Instruments

Demographic and background data were provided by the parents and included the child's gender, ethnicity, age, and parents' education and occupation. Family socioeconomic status (SES) was derived from the parents' education and occupation by using Hollinghead's 4-factor index for calculating SES.²⁸ Children completed self-report questionnaires of asthma knowledge, asthma self-management, and asthma self-efficacy. Graduate research assistants (GRA) observed and scored the children's MDI technique.

Asthma knowledge—Asthma knowledge was assessed with the 20-item *Questions About Asthma* questionnaire that uses a true/false response scale. Internal consistency was 0.59 in the

original study with children in grades 1–6 who had asthma and was slightly higher in the present study ($KR=.67$, 95% CI [.59, .74]). Evidence of validity was supported by improvements in children's knowledge scores after an educational intervention that were significantly correlated with greater internal locus of control.⁹ The questionnaire uses simple age-appropriate items of asthma pathophysiology (e.g. “if you have asthma your body parts for breathing sometimes do not work right”), asthma symptoms (e.g. “You might notice a tight feeling in your chest before wheezing starts”), and asthma treatment (e.g. “you should only take medicine after you start wheezing”). Correct responses are totaled for a summed scale score, and are reported as percentage correct.

Asthma self-management—Children's asthma self-management was assessed with a 17-item *Asthma Inventory for Children* (AIC) that uses a 5-point response format ranging from 0 for “never” to 4 for “always.” The scale score is calculated as the mean of total item responses. The AIC was derived from critical incident analysis of 1,300 reports about asthma management from parents, health care providers, and 9- to 13-year-old children. Items were created pertaining to asthma preventive behaviors (e.g. “I stay away from things that cause asthma”) and behaviors for managing serious breathing problems (e.g. “I seek help from other people at the first sign of breathing problems”). Internal consistency was adequate ($\alpha=.71$) in the original study with predominately White school-age children,²⁹ and is similar ($\alpha=.76$) in the present study with a tri-ethnic sample of school-age children. Construct validity was supported as scores improved in the experimental group after participation in an asthma self-management program.²⁹

Asthma self-efficacy—Children's self-efficacy to manage asthma symptoms was assessed with the 6-item management subscale of the *Child Asthma Self-Efficacy* questionnaire. The 5-point response format indicates “how sure” the child is that the behavior can be enacted, with 1 indicating “not at all sure,” and 5 indicating “completely sure.” For example, “How sure are you that you know which medications to use during a serious breathing problem?” Scale scores are reported as the mean of item responses. The scale developers report good internal consistency ($\alpha=.82$).³⁰ Validity was supported as children's scores were significantly correlated with parents' self-efficacy scores and negatively correlated with emergency department use and asthma symptoms.³⁰ Internal consistency was slightly lower in the present study ($\alpha=.79$).

MDI technique—Children's skill in using the MDI was observed and scored by GRA using an 8-item scoring tool. There are 8 steps in correct MDI technique and the child receives 1 point for each step correctly performed (range 0-8).³¹ Inter-rater reliability for MDI scoring was established during GRA training, by having each person learn and then demonstrate correct MDI technique while being scored by other members of the team. This continued until 100% inter-rater reliability was obtained. The principal investigator accompanied every GRA on 10% of the home visits to monitor adherence to the study protocols and assess reliability in the MDI observation score.

Data Analysis

Data analysis was performed with SPSS, version 13. Independent sample *t*-tests and chi-square analyses were run on the demographic and study variables to first compare the dropouts with those retained in the study. No significant differences were found for any of these variables between the participants who dropped out ($n=20$) and those who remained ($n=163$) in the study.

Analysis by schools—General Linear Mixed Effects Model Analysis (GLM) procedures were utilized to assess the impact of the intervention over time on children's asthma knowledge, asthma self-efficacy, asthma self-management, and MDI scores. Because randomization to

treatment condition occurred at the school level, and the interventions were conducted in small classes within each school, it was important to address the possible intercorrelation among individuals within each school and to consider the class and the school as possible units of analysis. Participants per school ranged from 1 to 18 (mean=10.1, s.d.=2.0), with one school contributing a single study participant. There were 58 classes conducted across the 18 schools with class size ranging from 1 to 7 (mean=3.1, s.d.=4.7).

To account for the possible intercorrelation of observations within schools, school was first considered as the independent unit of observation and the dependency across the individuals in the schools was modeled. Using GLM analysis, there were sufficient cases to test the effect of treatment condition on the Time 2 scores while controlling for scores at Time 1. The Wald's z-test was not significantly different between groups, suggesting that further analyses could treat individuals within schools as independent units of observation. In the analyses with school as the unit of analysis, rho across individuals was estimated to be the following: For asthma knowledge [.039 (SE=.064), $z=.612$, $p=.541$], self-efficacy [-.005 (SE=.075), $z=-.070$, $p=.944$], asthma management [.019 (SE=.043), $z=.435$, $p=.663$], and MDI skill [.017 (SE=.066), $z=.268$, $p=.789$]. Although, the intercorrelation between individuals within schools was not statistically significant because small groups of children had attended classes together, we considered the necessity of modeling the possible intercorrelation of observations within classes by treating class as the independent unit of observation and considering different correlation models within class. Again, Rho was estimated to be not significantly different from zero: For asthma knowledge [.038 (SE=.091), $z=.416$, $p=.677$], self-efficacy [-.004 (SE=.103), $z=-.042$, $p=.966$], asthma management [.053 (SE=.085), $z=.625$, $p=.532$], and MDI skill [-.005 (SE=.166), $z=-.034$, $p=.973$].

The combined results from modeling the within-school and the within-class correlation structures suggest that individuals can be treated as independent units of observation. In order to capitalize on this and minimize the effect of missing data, GLM analyses were run with the child as the unit of analysis. Compound symmetric models with homogeneous and heterogeneous variances, as well as an identity structure were considered. As expected because of the repeated measures over time, the identity structure was not appropriate. The Wald z-test of the between timepoint correlation indicated a statistically significant correlation. When estimated separately the magnitude of the timepoint variances were similar with overlapping 95% confidence intervals, and model fit according to goodness of fit indices (e.g., AIC, AICC, CAIC, BIC, etc.) was consistently better for the homogenous variance than for the heterogeneous variance compound symmetric models for asthma knowledge, self-efficacy, asthma management, and MDI skill. Thus GLM analyses were conducted for each variable, where scores on each measure were modeled as a function of group, time, and group by time interaction, and the between timepoint covariance structure was modeled using the homogeneous variance compound symmetric covariance model. Restricted maximum likelihood was used to estimate parameters in each model. Wald z-tests were conducted for each covariance model parameter, and consistent with the parameterized model were each statistically significantly different from zero. F-tests were conducted for each fixed effect, model-based parameter and standard error estimates were obtained. In those models that had statistically significant group by time interaction effects, simple effects analyses were interpreted to contrast change from Time1 to Time 2 for each group.

Results

There were 183 children (108 boys, 75 girls, mean age of 8.78 years [s.d.=1.24]) enrolled in the study. Sample ethnic composition was 46% Hispanic, 29.5% non-Hispanic White, 22% African American, 2.6% other ethnicity or non-reporters. Twelve weeks later 163 children provided Time2 data for an 89% retention rate. The groups were nearly equal at Time2 with

77 (47%) children in the attention-control group and 86 (53%) in the treatment group. There were no significant differences between groups in terms of child's gender ($X^2=.16$), child's age ($t[161]=- .32$), mothers' education ($t[159]=- .74$), or family SES ($t[159]=- .83$).

Table I lists the descriptive statistics for the treatment and attention-control groups at both Time1 and Time2 assessments. The results of GLM are reported in Tables II and III. Table II lists the mean change from Time1 to Time2, the corresponding estimated standard errors, and the F -test assessment of the significance of the changes from Time1 to Time2.

The results of the tests of the fixed effects from the GLM analyses are reported in Table III. In assessing the change in scores from Time1 to Time2 there were statistically significant time by group interaction effects obtained for asthma knowledge, self-management, and MDI technique, but not for self-efficacy for managing asthma symptoms. The treatment group showed the following gains relative to the attention-control groups: For asthma knowledge $[-9.325 (SE=1.392) \text{ v } -4.853 (SE=1.486)]$ yielding 4.47% greater mean change for the treatment group; self-efficacy $[-.380 (SE=.109), \text{ v } -.139 (SE=.124)]$ yielding .24% greater mean change on the 5-point scale for the treatment group; asthma management $[-.208 (SE=.064) \text{ v } .011 (SE=.069)]$ yielding .22% greater mean change on the 6-point scale for the treatment group; and MDI skill $[-1.758 (SE=.184) \text{ v } -.530 (SE=.212)]$ yielding 1.23% greater mean change on the 9-point scale for the treatment group.

The children in each of the conditions demonstrated statistically significant main effects with improvement in asthma knowledge and in MDI skill, but the improvement was significantly greater for the treatment group than for the attention-control group. The treatment group showed a statistically significantly greater improvement in asthma self-management, whereas the attention-control group showed no significant change in scores.

It is noteworthy that although there was not a statistically significant interaction effect for self-efficacy, and both groups showed improvements in self-efficacy over time; the simple effects analyses showed a statistically significant increase in self-efficacy for the treatment group, but not for the attention-control group, providing evidence that the significant improvement in self-efficacy scores over time was driven primarily by the significance of the time effect in the treatment group.

Discussion

Although both groups demonstrated improvement over time in asthma knowledge, the improvement was significantly greater among the treatment group. The treatment group increased asthma knowledge scores by 10% in comparison to the 5% increase realized by the attention-control group. It is possible that answering the questionnaire items raised the children's awareness of asthma management, but the treatment group had the added effect of the asthma intervention.³¹

The treatment group evidenced a small but statistically significant increase in their self-reported asthma self-management scores after the intervention, while the attention-control group scores were unchanged from Time1. Although small, the improvements in the asthma self-management scores among the treatment group can be attributed to the intervention. The content of the asthma intervention focused on presenting information in meaningful scenarios with which the children would be familiar. Children were exposed to learning situations to increase their ability to interpret situations (e.g. asthma symptoms, activities that could provoke asthma) and identify age-appropriate and safe solutions for managing those situations.

Although the lack of a significant interaction effect suggests that the treatment and attention-control groups demonstrated parallel improvements in their self-efficacy for managing asthma

scores from Time1 to Time2, the simple effects analysis showed improvement only in the treatment group. However, if the improvement pattern is indeed parallel, improvement could be due to the effects of testing since the children answered the self-efficacy instrument two times over 12-weeks.³¹

Finally while both the treatment group and attention-control groups exhibited statistically significant improvement in MDI technique scores, the attention-control group had much less of an increase in MDI technique scores than the treatment group. Improvement in MDI technique should translate into better medication delivery to the lungs and as such is a clinically significant improvement as well.

The improvements in the treatment group's asthma knowledge scores, self-reported asthma self-management, asthma management self-efficacy, and observed MDI technique provide supporting evidence that LHE-delivered education sessions can benefit school-aged children with asthma. Fidelity of the LHE to the intervention manual was verified through site visits to the schools conducted by the principal investigator and GRAs.²⁷ Changes in the intervention group's scores after completion of the asthma intervention reflect both the quality of the materials used in the classes and the high adherence to the intervention manual exhibited by the LHE. Similar to other studies, after the children's intervention was complete, the LHE reported their feelings of pride and a sense of accomplishment both in managing the classes and contributing something they saw as highly valuable to the school and the children.²⁶

A limitation of this study was that randomization occurred at the level of the school while many of the analyses were conducted at the level of the individual. A further limitation is that short-term data was used in this analysis and can only address immediate gains after the intervention classes. Subsequent analyses in the larger study reflect the influence of both LHE classes and the individualized family education provided in a home visit, such that only the Time2 data point reflects the LHE-only influences on children's asthma self-management.

In conclusion, the high prevalence of childhood asthma emphasizes the need to educate and support children in developing asthma self-management skills. Having the in-school education provided by trained LHE provides support for possible translation of this intervention design for community-based practices. With carefully designed intervention materials, school-age children can learn to manage many aspects of asthma self-management. Incorporating actual hands-on practice with equipment such as teaching inhalers and using scenarios that reflect common events children will have experienced is a way to work within the concrete thinking that dominates children's conceptualization during middle childhood.

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Table I

Descriptive Statistics

	Time	Intervention Condition					Attention-Control Condition				
		N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
Asthma Knowledge	1	101	35	100	74.31	14.70	82	35	95	74.51	13.46
	2	86	45	100	83.14	12.88	77	40	100	79.68	14.63
Self-Efficacy	1	94	1	5	3.33	0.94	76	1.33	5	3.49	0.92
	2	82	1.17	5	3.70	0.92	62	1.17	5	3.66	1.01
Management	1	101	0.82	4	2.67	0.62	81	0.71	3.88	2.85	0.56
	2	86	0.59	4	2.92	0.61	76	1.47	3.94	2.83	0.57
Metered Dose Inhaler	1	87	2	8	4.92	1.44	67	2	8	4.22	1.36
	2	81	2	8	6.64	1.33	60	2	8	4.80	1.44

Table II

General Linear Mixed Model Analysis of Estimated Marginal Means (EMM), Standard Errors (SE), and Simple Effects Analyses of the Effect of Time within Each Group

Variable	Time	Treatment Group		Attention Control Group	
		EMM	SE	EMM	SE
Asthma Knowledge N=183 Time 1- Time 2	1	74.31	1.40	74.51	1.55
	2	83.36	1.48	79.37	1.58
		-9.33	1.39	-4.84	1.47
		F(1,167.55)=44.85, p<.001;			
Self Efficacy N=178 Time 1- Time 2	1	3.32	.097	3.47	.108
	2	3.70	.10	3.61	.12
		-.38	.11	-.14	.12
		F(1,147.26)=12.17, p=.001;			
Asthma Management N=183 Time 1- Time 2	1	2.70	.06	2.85	.07
	2	2.90	.06	2.84	.07
		-.21	.06	-.011	.07
		F(1,172.44)=10.51, p=.001;			
MDI N=173 Time 1- Time 2	1	4.90	.15	4.22	.17
	2	6.65	.15	4.75	.18
		-1.76	.18	-.53	.21
		F(1,138.62)=91.05, p=.001;			

Note: N's represent the number of independent units of observation in each scale analyzed; MDI = metered dose inhaler skill.

Table III

Results of Tests of Fixed Effects in General Linear Mixed Effect Model Analyses for Each Measure

Effect	df1	df2	F	p
Measure 1: Asthma Knowledge				
time	1	164.66	48.47	<.001
group	1	176.72	1.19	.28
timeXgroup	1	164.66	4.82	.03
Measure 2: Self-efficacy for Managing Asthma				
_time	1	148.52	9.92	.002
group	1	169.56	.08	.78
timeXgroup	1	148.52	2.13	.15
Measure 3: Asthma Management				
time	1	170.06	4.36	.04
group	1	181.27	.28	.60
timeXgroup	1	170.06	5.37	.02
Measure 4: Metered Dose Inhaler Skill I				
time	1	137.29	66.53	<.001
group	1	153.48	49.38	<.001
timeXgroup	1	137.29	19.14	<.001