

ORIGINAL ARTICLE

Asthma Prevention in Urbanites

PETER W. HOUCK, M.D.,^{1,*} AND FRANCIS R. WHITEHOUSE, JR.²

¹Associate Clinical Professor, Department of Pediatrics, University of Virginia Medical School, Charlottesville, Virginia, USA

²Professor, School of Business and Economics, Lynchburg, Virginia, USA

Objectives. The purpose of this intervention was to evaluate the efficacy of low-literacy asthma education and the provision of free asthma controller medications to persons living in the urban inner-city. **Methods.** The intervention was conducted as a series of three studies. A health educator from the Johnson Health Center (JHC) performed chart reviews in the first two studies to identify urban asthma patients with frequent emergency department (ED) visits. The third study evaluated participants from the community-at-large who came to the ED for episodic asthma care. Free controller medications and education were provided to participants in all three studies. **Results.** Emergency department utilization, inpatient admissions, and consumer medical costs were greatly reduced in all three studies during the 5-year intervention period. Lung function improved, and participants reported an improved quality of life. **Conclusion.** The provision of free asthma controller medications resulted in greatly improved asthma management and reduced costs. There was no evidence that an asthma education component *per se* produced any of the changes.

Keywords asthma, controller medications, Rescue medications, low-literacy education, pulmonary function

INTRODUCTION

Asthma in American inner-cities continues to increase as a major public health problem (1). Called the nations top chronic disease, there have been numerous attempts to identify its increased incidence and ways to stop it (2). Recent programs to ameliorate the inner-city environment, where asthma is more prevalent, have been found to be both expensive and complicated by compliance issues (3). Entering the homes of asthma patients to give advice on environmental triggers that cause asthma is frequently met with resistance (4). Although removing triggers and changing lifestyles may be the ideal approach, the plan for this study was different to provide both low-literacy education and free asthma controller medications.

When one considers inner-city public health issues, the larger metropolitan downtowns of cities like New York, Atlanta, and Washington, D.C. leap to mind. However, medium-sized communities like Lynchburg, Virginia, with a population of only 65,000, have similar issues. Centra Health is Central Virginia's health care conglomerate located in Lynchburg and serves the entire service area of 225,000 people. Its two hospitals annually admit over 25,000 inpatients with over 75,000 annual visits to its regional emergency department (ED). A recent Louis Harris community survey conducted found that 3,086 inpatient admissions were asthma related and that 61% of those admissions were persons who resided in the poorest postal codes of the entire service area (5).

These two postal codes became the crux of a Centra Health analysis in 1998, which identified the area as a medically underserved Area. Based on the results of this analysis Centra Health initiated a medical presence in the inner-city by establishing a new downtown primary care center available to its

medically underserved population. The new Johnson Health Center (JHC), which targeted uninsured and under-insured residents, opened its doors in 2000.

Medical providers at JHC quickly found that many of its asthma patients, especially those who frequented the emergency room, were not filling prescriptions for controller medications—steroid inhalers and leukotriene inhibitors—due to cost. Most of these patients were not aware of the difference in controller medications versus rescue ones like albuterol inhalers, thus revealing the education challenges they presented. A plan emerged to accomplish two goals: (1) to provide asthma education with a low-literacy focus (since the majority of our clients were lacking in literacy) and (2) to procure their controller medications at no cost.

To assess the efficacy of this two-fold approach it was decided to monitor both the effect that free controller medications and education had on hospital admissions, their episodic ED visits, pulmonary function, and, inpatient and outpatient costs. An intervention spanning 5 years was designed, a low-literacy education program was devised, and three pharmaceutical companies donated controller medications. The patient group for the first study was selected from the JHC patient pool, but in the second and third studies participation was opened to the community-at-large.

METHODS

The intervention was conducted in three studies, each containing three phases, with the first study designated as a pilot. Each of the three studies involved three phases: a baseline (phase 1) data collection period; an intervention (phase 2) period; and a follow-up period (phase 3) where subsequent ED and inpatient admissions were tracked. A JHC health educator performed chart reviews to identify patients with frequent ED visits in the first two studies. Study 1 identified 100 JHC asthma patients through chart reviews. Study 2 used chart reviews on patients from the community-at-large who frequented the ED for episodic asthma care.

*Corresponding author: Peter Houck, M.D., 320 Federal Street, Lynchburg, VA 24503; E-mail: papadoc7@aol.com

Study 3 was conducted using referrals throughout the service area.

The educational curriculum was designed to be as simple as possible with ample time for questions and discussion. Personal experiences and discussion were included as a component of the educational process. In study 1, 100 study patients were divided into groups of 10 and met once a month for 8 sessions. Education covered single topics in each session including basic anatomy and physiology of the pulmonary system, peak flow monitoring, common asthma triggers, trigger control methods, medications (especially differences in controller and episodic), infection control, smoking cessation, and an asthma action plan. Participants in studies 1 and 2 were awarded \$10 for attending each session, holding back payment for each session until the completion. A 1-month supply of asthma controller medications was distributed to each participant at each monthly session. Medications provided were both leukotriene inhibitors (montelukast, 5 mg or 10 mg daily) and steroid inhalers (budesonide 200 μ g or fluticasone 44, 110, or 220 μ g, two puffs BID). Each patient was initially provided with both controller medications. After phase 1 of each study was completed, each patient's medical provider would adjust dosages or make medication changes depending on clinical judgment.

In study 3 the educational component was modified and shortened to more closely resemble current disease management models. Participants attended three 2-hour sessions and were not paid for participation. Recruitment of participants was opened to and marketed throughout the entire service area. The same controller medications were provided with the use of fluticasone/salmeterol dry powder combination (three strengths) as an additional option. This additional controller medication was donated, as in the previous two phases, and on completion of the program (as in the first two studies) those participants unable to afford their medicines were provided with a way to procure their medicines through the medical assistance divisions of each pharmaceutical company.

Pre- and post-study spirometry testing was performed measuring forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV₁) to assess pulmonary function. The Asthma Quality of Life Questionnaire was administered to gauge changes in the quality-of-life experience before and after entry into the program. The frequency of ED visits and hospital admissions were monitored for a year before the study using chart review, during the participation phase, and for 1 year after completion of the program. Centra Health, which provided financial support for all three studies, has one regional ED and hospital system utilizing one computer database for the entire service area. This afforded the ability to obtain the costs of all inpatient and outpatient encounters.

Examination of the results from study 1 resulted in the following *a priori* hypotheses to be tested in studies 2 and 3. Specifically, it was hypothesized that participation in the Asthma-Stop study would:

1. reduce the frequency and costs of ED visits due to asthma during participation of the study; and subsequently
2. reduce the frequency and costs of inpatient admissions due to asthma during participation in the study; and subsequently

3. improve lung function during participation in the study; and subsequently
4. result in improved quality of life during the study; and subsequently
5. result in greater knowledge of asthma etiologies, prevention, and treatment; and
6. increased knowledge of asthma, its triggers, and its treatment will reduce the frequency and costs of hospital visits and improve lung function and quality of life.

RESULTS

A summary of the results for studies 2 and 3 is listed in Table 1, which shows the means for each variable by phase¹ and the results of statistical tests comparing those means. The results are also displayed in Figures 1 through 4. The first five hypotheses were supported. The sixth hypothesis was not.

Hypothesis 1

As Figure 1 shows, ED and inpatient hospital admission rates due to asthma decreased dramatically during intervention (phase 2) and remained low—or decreased further—during the post-study (phase 3) period. The average number of ED visits decreased further during phase 3 where they remained significantly lower (at 29%) than the phase 1 rate but not significantly lower than that for phase 2. Inpatient admissions for asthma decreased by 62.5% during phase 2 and remained low during phase 3. The decline from baseline to intervention was statistically significant. There was an increase in the inpatient rate of admission from phase 2 to phase 3, but this was not statistically significant. Thus, hypothesis 1 was supported in all particulars.

Hypothesis 2

Figure 2 displays the changes in costs for both emergency visits and inpatient admission for each phase. The average cost per participant for both types of admissions was \$791.28 during the baseline phase. These costs decreased to an average of \$364.12 per participant during the intervention phase. This represents a decline of nearly 54% for the participants in the two studies. Emergency department costs, which declined by 52% from baseline to intervention, decreased another 20% after the intervention period ended. However, the bulk of the cost declines occurred for inpatient admissions, which decreased by an average of \$337.57 per participant, or by a little over 54%. These increased slightly, but not statistically significantly, after the intervention phase ended. Inpatient admission costs remained significantly lower during the follow-up period than they were in the baseline period. Thus, hypothesis 2 was supported in all particulars.

Hypothesis 3

Table 1 shows the average FEV₁ scores for each phase as calculated for all available cases, first for both studies 2 and 3 combined, and then for study 3 only where FEV₁ measures were obtained a third time during the follow-up period. It is clear that the mean FEV₁ score increases significantly during intervention when the combined means are contrasted.

¹Phase I designates the pre-study baseline period. Phases II and III designate the study and post-study periods, respectively.

TABLE 1.—Asthma stop results studies 2 and 3 combined.*

Measure	Phase 1 (baseline) mean (all cases)	Phase 2 (intervention) mean (all cases)	Phase 3 (follow- up) mean (all cases)	Phase 2 vs. phase 1	Phase 3 vs. phase 2	Phase 3 vs. phase 1
ED and in-patient admissions combined	0.6	0.242	0.201	$z = 3.89$ ($p = 0.0001$)	$z = 0.9335$ ($p = 0.3506$)	$z = 3.874$ ($p = 0.0001$)
ED and in-patient costs combined	\$791.28	\$364.12	\$446.01	$z = 2.579$ ($p = 0.0099$)	$z = 0.1917$ ($p = 0.8479$)	$z = 3.3149$ ($p < 0.001$)
E Department admissions	0.432	0.179	0.126	$z = 3.1$ ($p = 0.0019$)	$z = 0.5398$ ($p = 0.5894$)	$z = 3.774$ ($p = 0.0002$)
ED costs	\$170.76	\$81.17	\$64.73	$z = 2.712$ ($p = 0.0067$)	$z = 0.0027$ ($p = 0.9978$)	$t = 4.069$ ($p = 0.0004$)
Inpatient admissions	0.168	0.063	0.074	$z = 2.022$ ($p = 0.0432$)	$z = 0.0039$ ($p = 0.9969$)	$z = 2.467$ ($p = 0.0136$)
Inpatient costs	\$620.52	\$282.95	\$381.28	$z = 1.729$ ($p = 0.0844$)	$z = 0.008$ ($p = 0.9937$)	$z = 2.76$ ($p = 0.0058$)
FEV score	78.93	81.75		$t = 2.383$ ($p = 0.0194$)		
FEV score (Phase 3 only)	79.4	83	77.38	$t = 2.149$ ($p = 0.0391$)	$t = 0.4067$ ($p = 0.689$)	$z = 2.5785$ ($p = 0.0099$)
Asthma Knowledge Test Score	73.32	87.31	87.91	$z = 7.385$ ($p < 0.00001$)	$t = 1.499$ ($p = 0.1489$)	$t = 7.143$ ($p < 0.0001$)
Asthma Quality of Life Score (Phase 3 only)	3.75	4.27	4.89	$t = 3.604$ ($p = 0.0013$)	$t = 1.283$ ($p = 0.2261$)	$t = 3.053$ ($p = 0.0109$)

*All statistical tests were repeated measures tests. Student's t test was used where distributional assumptions were met; otherwise the Wilcoxon Signed-Rank test was used. All probability values reported are based on non-directional (two-tailed) tests. The means tested vary from those reported elsewhere due to missing cases.

The means displayed for study 3 (only) suggests that FEV₁ scores increased during the intervention period and then declined during the follow-up period, actually falling below the baseline period values. One should note that the means listed in Table 1 were calculated using all available cases. The statistical tests show different patterning for study 3, where the mean FEV scores (when compared to the baseline pe-

riod) are even higher in the follow-up period than during the baseline. The means that were statistically tested vary from the All cases means due to the nature of the statistical tests, which only include cases where FEV values are available for both of the phases contrasted. Missing values for one or the other phase exclude a case from analysis. The differences between means for study 3 are shown in Figure 3. All

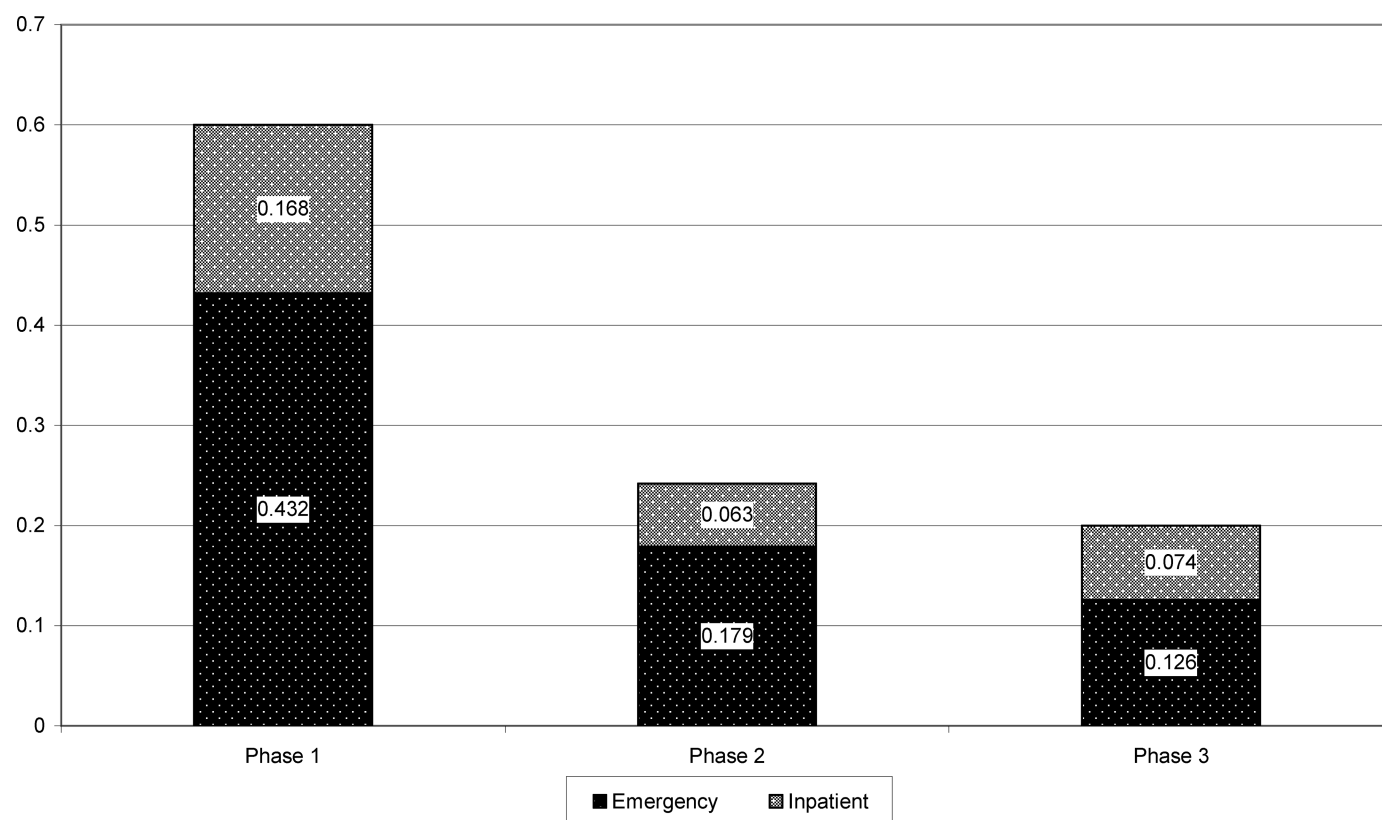


FIGURE 1.—Mean number of inpatient and emergency admissions by phase.

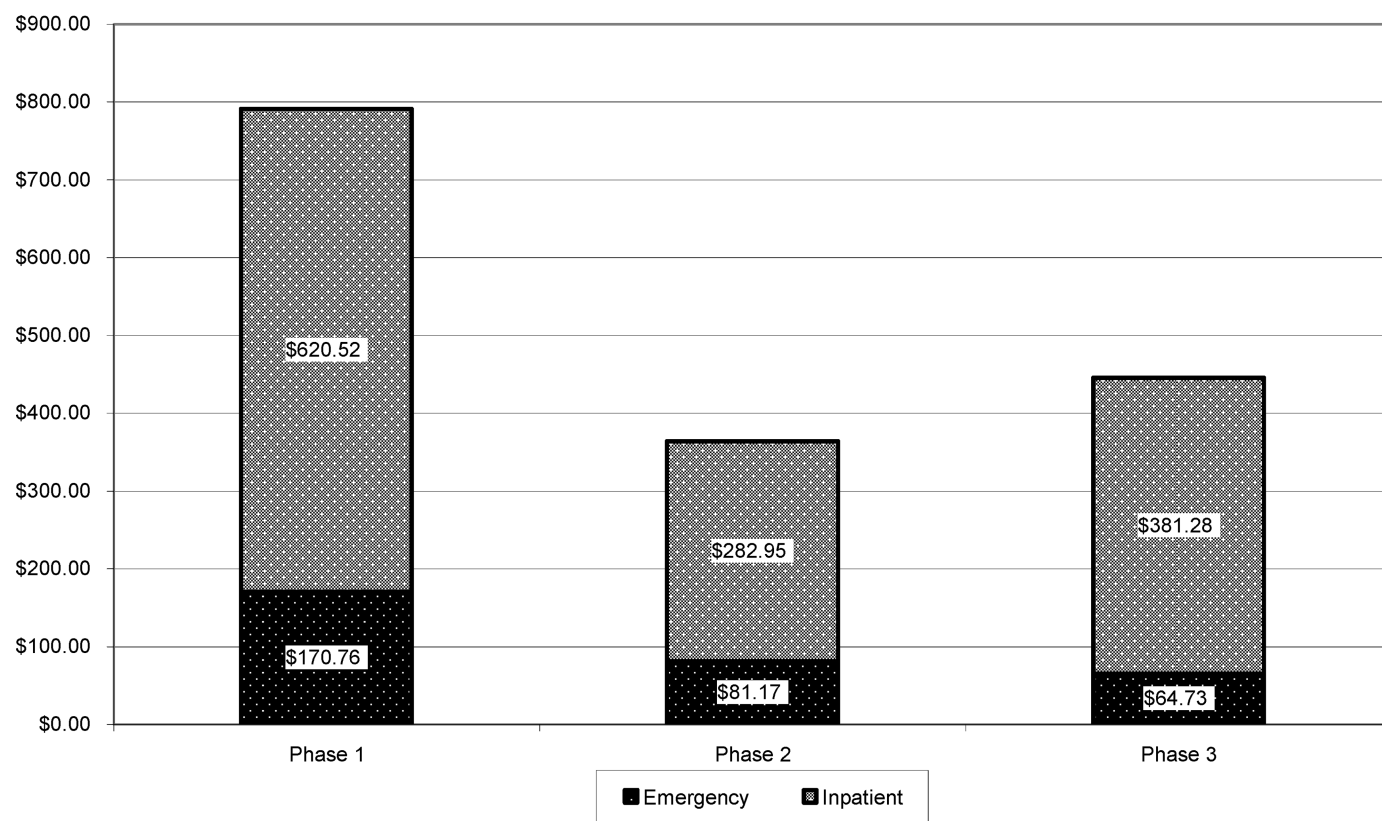


FIGURE 2.—Mean inpatient and emergency admissions costs by phase.

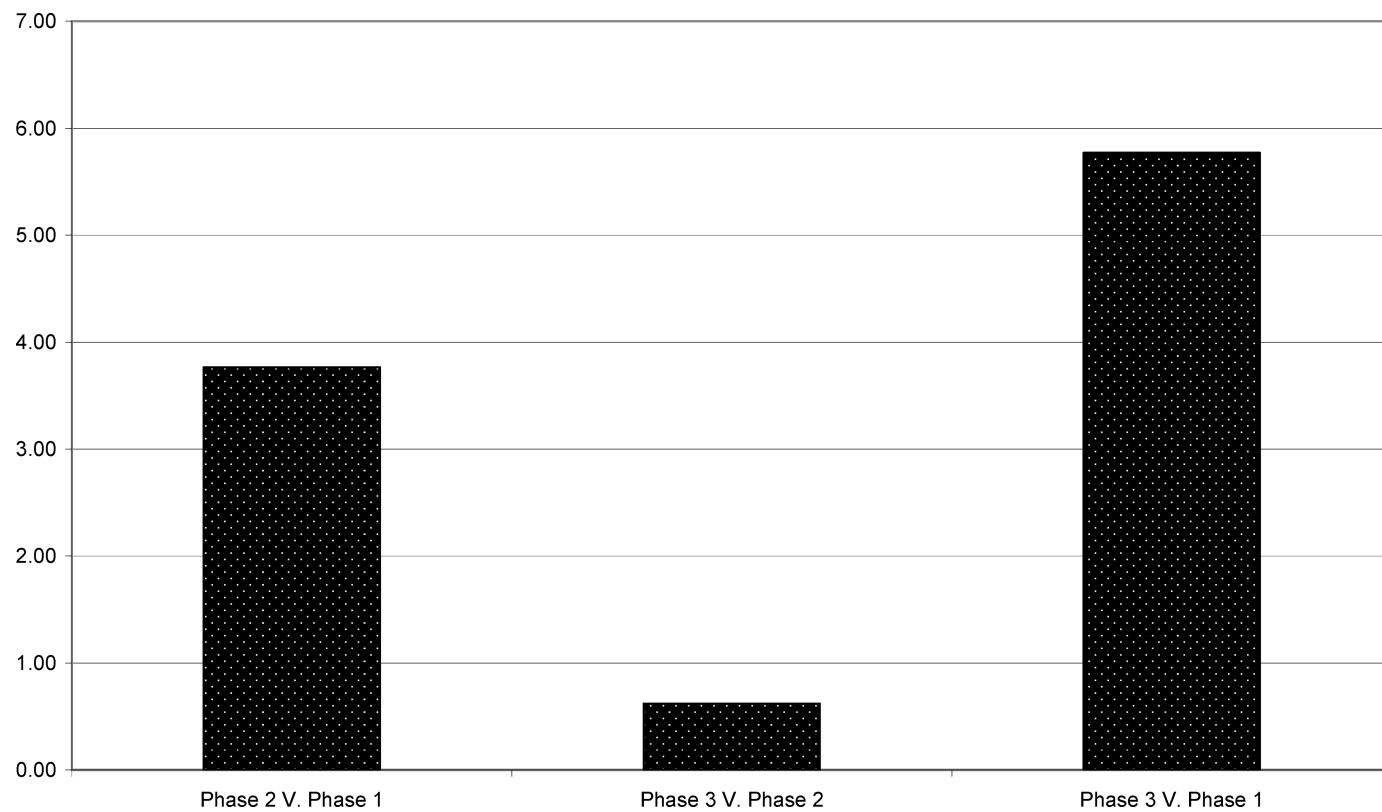


FIGURE 3.—Difference in mean FEV scores by phase comparison.

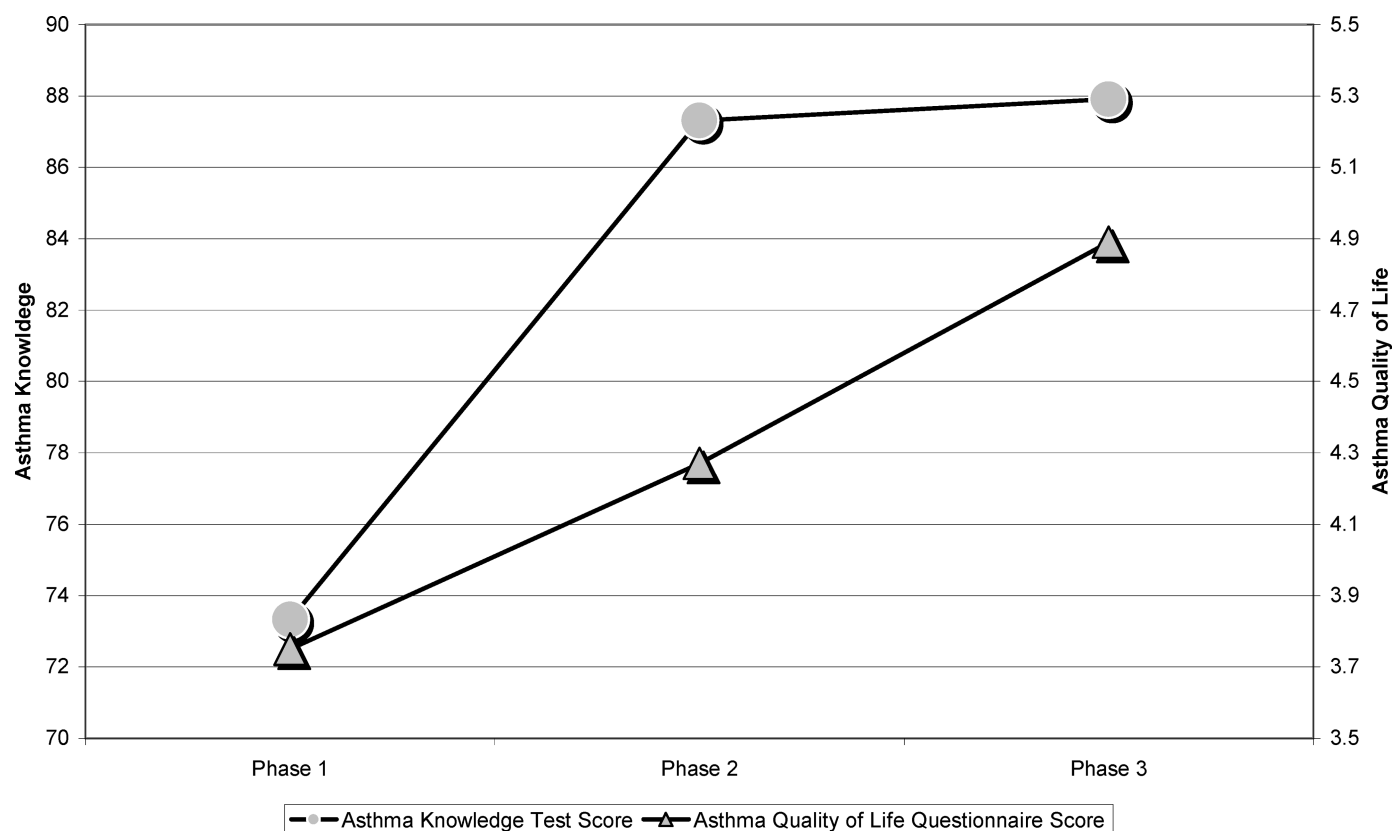


FIGURE 4.—Mean Asthma Knowledge Test and Asthma Quality of Life Questionnaire scores by phase.

differences, when comparing either the intervention or the follow-up means to the baseline mean, were statistically significant. Thus, hypothesis 3 was supported.

Hypotheses 4 and 5

Table 1 shows the means and the results for statistical tests applied to the Asthma Quality of Life Questionnaire (AQLQ) scores. (see also Figure 4). The mean AQLQ score increases significantly from baseline to intervention. The mean score increases again during the follow-up period, but not enough for the difference to be statistically significant when compared to the intervention period. The same pattern occurs for scores obtained using the Asthma Knowledge Test. These scores also increase significantly during the intervention period and remain elevated during the follow-up. Hypotheses 4 and 5 are thus supported.

Hypothesis 6

As Figure 4 shows, asthma knowledge test scores improved between baseline and the end of the intervention phases. The changes were statistically significant ($Z = 7.39$, $p < 0.00001$). The effects of the education component were tested by regressing change scores (the difference between the phase 2 and phase 1 values) for hospital visits, dollar costs, FEV values, and AQLQ scores on the differences between the asthma knowledge test scores collected at the beginning and end of phase 2. None of the regressions achieved conventional levels of statistical significance. The R-squared values obtained from the linear regressions ranged

from a high of 0.029 (for hospital visits) to 0.0001 (for FEV values). Comparable results were obtained when the absolute post-test knowledge scores were regressed on AQLQ scores, FEV scores, ED visits and costs, and inpatient admissions and costs obtained during the study phase. Thus, no support was found for this hypothesis.

DISCUSSION

The last half century has been one of decreased hospitalizations for most chronic diseases with the dramatic exception of one, asthma. Its increasing incidence and mortality stand out as a major public health problem, especially in America's inner-cities where it predominates (6). Environmental problems, unique to persons in poverty, are touted as major factors making asthma more common. Exposure to outside violence in particular means that children and adults spend more time crowded indoors where they are exposed to cigarette smoke, cockroaches, dust, and stress. To solve such a massive environmental problem has been found to be multifaceted and expensive (7). To involve the government in financing such a comprehensive venture appears problematic. If such is the case, a more practical approach is needed. Financial barriers have been cited as major contributors to asthma mortality and morbidity in this and other countries (8, 9).

This three-study intervention revealed a dramatic decrease in ED visits and inpatient admissions. Money saved from reduced ED and inpatient care could go a long way in paying for controller drugs. Most persons who are uninsured and

eligible for discounts or free medications through medical assistance programs (from the pharmaceutical companies) are either unaware of such programs or find that applying for such medical assistance is timely and complicated. Inner-city asthmatics know little about this availability and or how to access it without a primary care facility like JHC. Our national medical system, which encourages episodic asthma care in EDs and urgent care centers, has no comprehensive plan to provide education or preventative medications for the uninsured.

It could be argued that the treatment of asthma as a chronic disease model applies to other similar diseases such as hypertension and diabetes so prevalent in the inner-city. Cost of medications and education can also lead to better control and prevention of inpatient and outpatient visits. Medicare and Medicaid benefits now pay for preventive asthma medicines, but not for education. Then there are the 44 million uninsured Americans who are unable in most cases to purchase controller medications and therefore usually do not.

The education component in this study did not perform according to expectations. The education protocol was designed with an understanding of the cultural and ethnic backgrounds of the participants. Low literacy rates precluded most participants' ability to understand published educational materials (10), and few of the published asthma educational materials had readability below the ninth grade (11). The educational materials used in this study were constructed to overcome this problem. Even so, improved knowledge of asthma *per se* did not seem to effect improvement in the outcome measures used. It is possible that encouraging participants to regularly meet for educational classes at the JHC, and receive their free medications, improved compliance with program protocols. Unfortunately, this effect cannot be isolated in the data obtained from this study.

CONCLUSION

We live in a world where providing medical care strives to be cost-effective. Inner-city persons who are more prone

to chronic health problems present challenges in mid-sized cities such as Lynchburg, Virginia, where thousands of preventable episodic cases of asthma occur annually. The cost of providing controller medications stands out as a major reason for asthma recidivism. Our study demonstrated that the provision of free asthma controller medications greatly reduced the costs and improved the management of urban asthmatics patients and increased their quality of life.

REFERENCES

1. Mannino DM, Homa DM, Akinbami IJ, et al. Surveillance for asthma—United States, 1980–1999. *MMWR* 2002; 51:1–13.
2. Jackson R, Sears MR, Beaglehole R, Rea HH. International trends in asthma mortality: 1970 to 1985. *Chest* 1988; 94:914–918.
3. Bush RK, Eggleston PA. Guidelines for control of indoor allergen exposure. *J Allergy Clin Immunol* 2001; 107:430–440.
4. Harish Z, Bregante AC, Morgan C, et al. A comprehensive inner-city asthma program reduces hospital and emergency room utilization. *Ann Allerg Asthma Immunol*. 2001; 86:185–189.
5. Louis Harris Community Survey of Health Indicators in Central Virginia, 1998.
6. Grant EN, Malone A, Little CS, Weiss KD. Asthma morbidity and treatment in the Chicago metropolitan area: one decade after National Guidelines. *Ann Allerg Asthma Immunol* 2005; 95:19–25.
7. Busse P, Wang J, Halm E. Allergen sensitization, evaluation and allergen avoidance education in an inner-city adult cohort with persistent asthma. *J Allerg Clin Immunol* 2005; 116:146–152.
8. Garrett J, Kolbe J, Richards G, Whitlock T, Reah H. Major reductions in asthma morbidity and continued reduction in asthma mortality in New Zealand: what lessons have been learned. *Thorax* 1995; 50:303–311.
9. Morgan WJ, Crain EF, Gruchalla RS, O'Connor GT, Kattan M, Evans R III, Stout J, Malindzak G, Smartt E, Plaut M, Walter M, Vaughn B, Mitchell H. Results of a home-based environmental intervention among children with asthma. *N Engl J Med* 2004; 351:1068–1080.
10. Dock GC, Doak, LG Root JH. Teaching patients with low literacy skills. New York: Lippincott, 1985.
11. Jackson RJ, Davis TC, Barnsfather LE, George RB, Crouch MA, Gault H. Patient reading ability: an overlooked problem in health care. *South Med J* 2001; 84:1172–1175.