

Written action plan use in inner-city children: is it independently associated with improved asthma outcomes?

Jacob Sunshine BA*†; Lin Song, PhD‡; and James Krieger MD, MPH*‡

Background: Guidelines from the National Asthma Education and Prevention Program stipulate that multicomponent self-management interventions for asthma should include a written action plan (WAP). However the specific, independent effect of WAPs in improving outcomes remains unclear.

Objective: To measure the association between WAP use during the previous year and improved asthma outcomes.

Methods: We conducted a longitudinal quasi-experimental study using data from the Healthy Homes II (HH-II) randomized controlled trial in Seattle, WA. Action plan use during the previous year was measured at exit of HH-II. A participant was a WAP user if he used his action plan every day, almost every day, or once per week, and non-user if he did not meet these criteria. Sensitivity analyses explored less stringent criteria for WAP user designation. Prespecified outcomes were baseline-to-exit changes in asthma control in the previous 2 weeks, Pediatric Asthma Caregiver Quality of Life Scale score, and urgent health services utilization. We used robust linear and logistic regression to compare outcomes across groups.

Results: Two hundred fifty-one patients participated: 112 WAP users; 139 non-users. After adjustment, no significant differences in outcomes were observed between WAP users and non-users. Among a subgroup of participants with recent urgent health services utilization, WAP users had better asthma control than non-users. Changing WAP user criteria to include those who simply owned an action plan, irrespective of use, did not alter our results.

Conclusion: WAP use during the previous year was not associated with improved outcomes compared with non-use. Additional studies are needed to assess the long-term, independent benefit of this universally recommended intervention.

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INTRODUCTION

Asthma remains the most common chronic condition of childhood, affecting 9.1% of all American children. More than 6 million children have current asthma, leading to 205,000 pediatric hospitalizations and 697,000 emergency department visits each year.¹ The majority of children have asthma that is not well controlled, and low-income children are less likely to have controlled asthma than children from higher-income families.² Many strategies to control asthma symptoms and reduce unscheduled health care utilization exist, including review of medication dosage instructions and inhaler technique, guidance on self-monitoring and management of exacerbations, promotion of behaviors to reduce environmental triggers, and asthma education.³⁻⁷

One commonly recommended intervention to help control symptoms is the written action plan (WAP), a document that

describes day-to-day preventive practices in addition to clear steps a patient should take if asthma self-monitoring indicates a deterioration in asthma control.⁸⁻¹¹ The provision of a WAP is a standard component of asthma education and is a core part of national and international treatment guidelines.^{3,10,12,13} Multicomponent self-management interventions that include the provision of written asthma action plans have been shown to be effective.^{8,14,15} However the specific, *independent* effect of the WAP in controlling asthma remains less clear.^{8,16-20} In a Cochrane review by Bhogal and colleagues,¹⁷ the authors found a gap in knowledge regarding the efficacy of asthma action plans as part of recommended asthma education interventions. In addition, a Cochrane review by Toelle and Ram¹⁶ found no consistent evidence that asthma action plans led to better outcomes when compared with no action plans. In the most recent systematic review by Zemek et al,¹⁸ the authors concluded that, because of a paucity of trial data,²¹ the independent effect of the WAP in reducing symptoms in children remains uncertain. In light of the evidence gap surrounding this universally recommended intervention, more information is needed regarding its efficacy, particularly with respect to its long-term benefit.

We studied whether use of a WAP during the previous year was independently associated with improved outcomes among a cohort of low-income children with poorly controlled asthma.

Affiliations: * University of Washington School of Medicine, Seattle, WA; † University of Washington School of Public Health, Department of Epidemiology, Seattle, WA; ‡ Public Health, Seattle & King County, Seattle, WA.

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METHODS

A priori, we constructed a conceptual model of action plan use and its relationship to the primary outcomes of this study (Fig 1). We include the model here in an effort to make explicit the assumptions that underlie our analysis and to provide the context in which the WAP intervention is administered and used.

Our hypothesis was that WAP ownership and use, measured longitudinally and cross-sectionally, would improve asthma control, increase caregiver quality of life, and decrease urgent health services utilization among low-income children with asthma in the Seattle area, after adjusting for potential confounders. We conducted both a longitudinal, quasi-experimental study as well as a cross-sectional analysis to test this hypothesis.

DATA SOURCE

Our study used data from the Healthy Homes II (HH-II) randomized controlled trial, gathered from 2002 to 2004.²² Briefly, HH-II measured the benefit of adding community health worker asthma education and support visits in the home to standard clinic-based asthma education provided by nurses. The dataset contains extensive information on participant demographics, asthma severity and control, extent of action plan utilization, and variables related to health services utilization measured at baseline and exit of the trial. Exit data from the trial were collected approximately 1 year after participant enrollment.

STUDY POPULATION

The original HH-II cohort enrolled 309 low-income children aged 3 to 13 years with persistent or poorly controlled asthma. Low-income was defined as income below 200% of 2001 federal poverty threshold or child enrollment in Medicaid. Asthma was considered persistent or poorly controlled

if the caretaker reported that their child had symptoms or used β -agonist medications more than twice per week; the child was using daily controller medication; or the child had a hospitalization, emergency room, or unscheduled clinic visit because of an asthma exacerbation in the past 6 months. Trial participants whose action plan exposure status and outcomes data could not be ascertained because of missing information were excluded. The Institutional Review Board of Children's Hospital and Regional Medical Center approved the study.

EXPOSURE VARIABLES

We assessed the efficacy of the WAP in two ways.²³ First, we measured the effectiveness of action plans based on degree of usage during the previous year. Second, in a cross-sectional manner, we assessed the association of action plan ownership with the prespecified outcomes.

Definition of Written Action Plan Usage and Ownership

For the usage analysis, the primary exposure variable was action plan use during the previous year. Participants were considered action plan users if at exit interview of HH-II, they reported: (1) having an action plan ("In the past 12 months, has the child's doctor or other health professional given you a written action plan which tells you a) what to do if your child's asthma gets worse or he/she is having an asthma attack or b) how to take asthma medicines?") and (2) having used the action plan over the past 12 months and (3) having used the action plan "every day," "several times a week," or "once a week." Those not meeting all of these criteria (ie, participants who "never" used an action plan; were "not sure" whether they used an action plan; or who used their action plan "once a month" or "less than once a month") were considered non-users and constituted the comparison group for the study. Exploratory analyses used less stringent definitions of action plan use (eg, including those

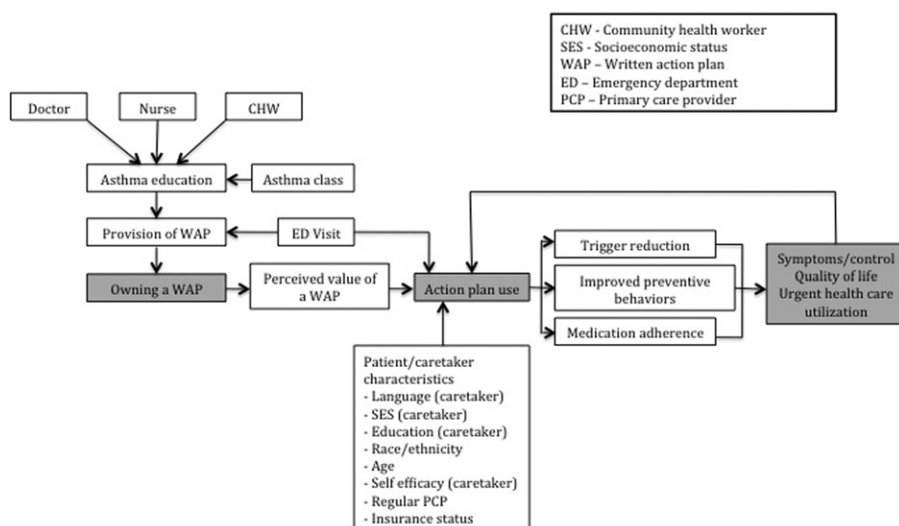


Figure 1. Conceptual model of caretaker-administered action plan use and outcomes.

who used less than once a month). The action plans used in the original trial had symptom-based and optional peak-flow components.^{24,25}

For the ownership analysis, the primary exposure was action plan provision, an exposure measure used in prior meta-analyses and systematic reviews.^{16–18} Participants were considered action plan owners if they reported being given an action plan.

OUTCOME VARIABLES

The primary outcomes were asthma control in the previous 2 weeks and Pediatric Caregiver Quality of Life Scale score. Asthma control in the previous 2 weeks was dichotomized to well controlled or not well controlled, with well controlled being 4 or fewer symptom days in the prior 2 weeks, as defined by the latest National Asthma Education and Prevention Program Expert Panel Recommendations.²⁶ Symptom days are self-reported number of 24-hour periods during the prior 2 weeks with wheezes, tightness in chest, cough, shortness of breath or slowing down activities because of asthma. The Pediatric Caregiver Quality of Life Scale score is a validated scale that ranges from 1–7, with higher scores indicating better quality of life.²⁷

The secondary outcome was urgent health services utilization (any self-reported emergency department, hospital, or unscheduled clinic visit in the past 3 months for asthma).

Parent-reported symptoms and parent-reported health care utilization have been shown to be reliable assessments of asthma severity.²⁸

MINIMUM DIFFERENCES DETECTABLE

For the primary analysis comparing baseline-to-exit changes between WAP users and non-users, the sample size had 80% power to detect a change of 1.07 symptom-free days, a 0.4-point difference in quality of life score, and an 18% change in urgent health services utilization. In assessing statistical comparisons, the level of significance was set at $P < .05$ for all outcomes.

STATISTICAL METHODS

Univariate comparisons of demographic and baseline asthma severity measures used the χ^2 test for categorical variables and the two-sample t test (two-tailed) for continuous variables. In the usage analysis, univariate comparisons of within-group baseline-to-exit changes were calculated using the paired t test (two-tailed). To discern the between-group effect of action plan usage, robust linear and logistic regression models were developed. These between-group effects are reported as coefficients for continuous variables or odds ratios for categorical variables. Residual plots confirmed model fit in the linear regression models; the Hosmer-Lemeshow statistic was used to assure model fit in the logistic regression models. In the ownership analysis, mean baseline and exit values were compared across owners and non-owners using a similar approach.

WAP Usage Regression Model

The prespecified outcomes (exit values) were the primary dependent variables of the models. User designation (user or nonuser) was the primary independent variable, with nonusers as the referent group. The usage base models also included the respective baseline value of the dependent variable, as well as the following prespecified covariates: baseline asthma severity, race/ethnicity, original HH-II arm, poverty level, parent's education, and primary language. Beyond these baseline covariates, we assessed confounding on statistical grounds using liberal inclusion criteria; we tested all a priori potential confounders and included only those whose P -values were ≤ 0.20 in the base model.²⁹ The following prespecified potential confounders were tested for inclusion in the base model: education on how to use a WAP from a primary caregiver in the prior 12 months (measured at HH-II baseline), asthma class attendance in the past 12

Table 1. Baseline Characteristics of Written Action Plan (WAP) Users and Non-users ($N = 251$)^a

Age, mean	7.7	8.0
% Male	64.3	61.1
Race/ethnicity		
White	8.9	12.2
African American	20.5	22.3
Other Asian	8.9	2.9
Hispanic	47.3	47.5
Vietnamese	10.7	6.5
Other	3.6	8.6
Caretaker Language		
English	45.5	49.6
Spanish	42.9	41.0
Vietnamese	11.6	9.3
Household income <2001 poverty line	45.5	54.7
Caretaker education		
Less than HS	42.9	43.8
HS/GED	30.4	28.4
Some college	22.3	25.6
College graduate	4.5	2.2
Asthma severity		
Mild Intermittent, %	17.9	20.1
Mild persistent, %	48.2	36.7
Moderate persistent, %	25.0	34.5
Severe persistent, %	8.9	8.6
Smoker in home	42.6	43.4
Environmental trigger score, mean	0.24	0.26
Intervention group in HH-II, %	51.8	46.7
Asthma class past 12 months, %	7.1	9.4
Baseline urgent health services utilization in prior 3 months, %	49.1	50.4
Baseline WAP owner, %	34.3	34.4
Regular PCP	97.8	98.2
Public insurance, %	88.0	88.9

Abbreviations: WAP, written action plan; PCP, primary care provider; HH-II, Healthy Homes II randomized controlled trial; HS, high school; GED, general equivalence degree.

^a No significant differences in baseline characteristics between WAP users and non-users.

	WAP users (N = 112)			WAP non-users (N = 139)			Intervention effect (WAP users vs. non-users)		
	Baseline	Exit	Δ (95% CI)	P-value	Baseline	Exit	Δ (95% CI)	P-value	P-value ^b
Primary outcomes									
Asthma well-controlled, %	59.8	77.6	17.8 (6.0–29.7)	*	61.1	77.6	16.5 (6.5–26.5)	*	0.85 (0.45–1.61)
Asthma Caregiver Quality of Life Scale Score, mean	5.63	6.24	0.608 (0.37–0.84)	*	5.52	6.11	0.59 (0.36–0.79)	*	0.04 (–0.20–0.27)
Secondary outcome									
Hospitalization, ED visit or nonscheduled clinic visit for asthma within last 3 mos, %	49.1	28.5	20.5 (8.9–32.0)	*	50.3	23.7	26.6 (16.8–36.4)	*	1.60 (0.81–3.16)

^cModel includes patient age, because this variable met statistical criteria for inclusion in the model.

Because we had information regarding trial participants' action plan use before enrolling in HH-II, we conducted an exploratory cross-sectional analysis to test whether before-enrollment action plan usage had any effect on outcomes at baseline. For this analysis, we defined action plan use in the

same way as the primary analysis. Thirty-nine participants met criteria for action plan users before HH-II enrollment. After adjustment, action plan users had higher odds of being well-controlled in the previous 2 weeks compared with non-users (OR = 2.76; 95% CI, 1.02–7.45; $P = .045$). Curiously, action plan users had statistically significant higher odds of urgent health services utilization in the prior 3 months compared with non-users before enrollment in HH-II after adjusting for covariates (WAP users OR = 4.72; 95% CI, 1.72–12.96; $P = .003$). On account of these findings, we conducted a post hoc analysis to explore whether urgent health services utilization in the previous 3 months modified the effect of action plan use on baseline symptom-free days. We found that, among the subset of patients with recent urgent utilization, there was a significant increase in the odds of being well controlled comparing WAP users with non-users (OR = 4.82; 95% CI, 1.38–16.76; $P = .013$). This relationship was not present among the subset of participants without recent health services utilization, indicating that effect modification was present (OR: 1.82; 95% CI, 0.237–14.01; $P = .563$). Among the subset with recent urgent health services utilization, no differences were seen in baseline Caregiver Quality of Life Scale Scores between WAP users and non-users (data not shown).

Ownership Cross-Sectional Analysis

Two hundred ninety-two participants had complete data for the baseline cross-sectional analysis. There were 98 action plan owners and 194 non-owners at baseline of HH-II. After adjustment, the odds ratio of urgent health services utilization comparing owners with non-owners was 1.98 (95% CI, 1.13–3.48; $P = .016$). Two hundred fifty-four participants were eligible for the exit cross-sectional analysis. At exit of the trial, 197 action plan owners and 61 non-owners were eligible. After controlling for the same covariates, in addition to study arm, the association with urgent health services was no

longer present (WAP owners at exit OR = 1.24 (95% CI, 0.58–2.68; $P = .57$). For the Caregiver Quality of Life Score and control outcomes, no statistically significant differences were seen at either baseline or exit between WAP owners and non-owners (Table 3).

DISCUSSION

Among a cohort of low-income children with asthma in Seattle, we found no independent association of WAP use during the previous year with improvement in the following prespecified outcomes: asthma control as measured by symptom-free days, caretaker Asthma Caregiver Quality of Life score, and urgent health services utilization. We also examined the effect of isolated action plan ownership on these outcomes. For all 3 outcomes, no benefit was conferred from action plan ownership compared with non-ownership, controlling for demographic and baseline asthma severity measures.

When we liberalized our definition of action plan use, there remained no improvements in the prespecified outcomes compared with the control group. In an exploratory analysis, we found that among participants requiring recent urgent health services utilization, action plan use was associated with better asthma control compared with no use. This finding is in some ways consistent with a recent randomized trial finding that action plan use, after an ED visit for an asthma exacerbation, can increase medication utilization and improve control in the short term (within 28 days).³⁰

To our knowledge, in the non-emergency room setting, only 1 positive randomized trial explicitly compared action plan use with non-use.²¹ This study was limited by its small sample size ($n = 68$) and relatively short follow-up (3 months). Nevertheless, the authors found a symptom benefit in using an action plan. Why our results (with the exception of our exploratory analyses) differed is not entirely clear.

Table 3. Written Action Plan Ownership Associations with Outcomes: Cross-sectional Analysis at Baseline and Exit of HH-II

Baseline ($n = 292$)	WAP owners ($n = 98$)	WAP non-owners ($n = 194$)	Coefficient/OR (95% CI) ^a	P-value ^b
Asthma well-controlled, %	62.2	62.8	1.29 (0.69–2.42)	.42
Caregiver Quality of Life Scale score	5.47	5.66	0.04 (–0.26–0.35)	.79
Used urgent health services within 3 mos, %	61	40	1.98 (1.13–3.48)	.016
EXIT ($n = 258$)	WAP owners ($n = 197$)	WAP non-owners ($n = 61$)	Coefficient/OR (95% CI) ^a	P-value ^c
Asthma well controlled, %	77	78.6	0.95 (0.42–2.12)	.90
Caregiver Quality-of-Life score	6.61	6.07	0.17 (–0.17–0.52)	.33
Used urgent health services within 3 mos, %	26	21	1.24 (0.58–2.68)	.57

Abbreviations: WAP, written action plan; HH-II, Healthy Homes II randomized controlled trial; OR, odds ratio; CI, confidence interval.

^a The coefficient of the WAP ownership group assignment term is reported for continuous variables (non-owner = referent group) and the logistic OR (WAP owner vs. non-owner) is reported for categorical variables.

^b Difference between WAP owner and non-owner, controlling for race/ethnicity, primary language, poverty level, baseline asthma severity, asthma class attendance in past 12 months. Patient age is additionally controlled for in the quality-of-life scale model.

^c Difference between WAP owner and non-owner, controlling for race/ethnicity, primary language, poverty level, baseline asthma severity, asthma class attendance in past 12 months and HH-II arm assignment. Patient age is additionally controlled for in the quality-of-life scale model.

Perhaps action plan owners and users have more symptoms and are thus prone to have worse outcomes, which may mask a benefit from the intervention if it is not assigned randomly. Strong efforts were made to control for underlying asthma severity, and still we found no benefit in our primary analysis. Another possibility is that it may not be WAP ownership or usage per se that leads to beneficial outcomes, but the appropriate *behavior* on the part of caregivers when their child's asthma deteriorates. When we tested this idea, we found that action plan ownership and use were both associated with improved asthma management behaviors (measured by increased Parent Self Regulation Scores); however, these self-management scores were not in turn associated with our outcomes (data not shown), although in other studies they have been.^{31,32}

A more uncomfortable conclusion could be that asthma action plans are not as effective over time as originally believed, at least among patients with less severe asthma as measured by the absence of recent urgent health services utilization. We are very cautious to draw this conclusion given that this is an observational study. However, this possibility should not be ignored, given the additional costs associated with action plan use²⁰ and the unclear perceived benefit³³ and limited time³⁴ on the part of providers to help administer this intervention.

There are limitations to our study. Because it is an observational study, unmeasured confounding potentially biased our results. The detail of the HH-II dataset on which the study is based, however, allowed us to control for an array of potential confounders. Consequently, we are cautiously optimistic that our results are not heavily biased. Second, our analysis may have limited external validity, given that the trial was conducted on a cohort composed predominantly of minority, low-income children with poorly controlled asthma. Thus, applying our findings to children with asthma from a different demographic group should be done with caution. Despite this limitation, we believe that our findings remain relevant on account of the significant asthma burden that disproportionately affects low-income and minority children.^{35–38} Third, even though our power calculations suggest it is unlikely, we cannot exclude the possibility of our findings being the result of a type II error, particularly in our subgroup findings.

Given the nature of action plan use, we cannot be certain of the reasons why some people did not use their action plans. Possibly patients used their action plan only when their symptoms worsened, and so patients who had symptoms less than once per week but used their action plans may not have been captured as an exposed individual. We tested this possibility by broadening our criteria of action plan usage and found no change in our initial findings. Finally, our exposure criteria may not have included patients who may have learned (or memorized) the content of their action plan. Consequently, some patients may have not consulted the plan regularly enough to be classified as an action plan user when in reality they were utilizing the contents of the plan.

In this observational study, we observed no association between written asthma action plan provision or use in the past year and increased symptom free days, increased caregiver quality of life, or decreased use of urgent health services. Definitive confirmation of these findings with a sufficiently powered randomized controlled trial is needed to reevaluate the utility of this universally recommended intervention.

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REFERENCES

1. Akinbami LJ, Moorman JE, Garbe PL, Sondik EJ. Status of childhood asthma in the United States, 1980–2007. *Pediatrics*. 2009;123(Suppl 3):S131–S145.
2. Fuhlbrigge AL, Adams RJ, Guilbert TW, et al. The burden of asthma in the United States: level and distribution are dependent on interpretation of the national asthma education and prevention program guidelines. *Am J Respir Crit Care Med*. 2002;166:1044–1049.
3. NAEPP. National asthma education and prevention program: Expert panel report III: Guidelines for the diagnosis and management of asthma. *Asthma Diagnosis and Management Guidelines*. Bethesda, MD: National Heart, Lung, and Blood Institute; 2007. Report No.: (NIH publication no. 08-4051).
4. Coffman JM, Cabana MD, Halpin HA, Yelin EH. Effects of asthma education on children's use of acute care services: a meta-analysis. *Pediatrics*. 2008;121:575–586.
5. Wolf FM, Guevara JP, Grum CM, Clark NM, Cates CJ. Educational interventions for asthma in children. *Cochrane Database Syst Rev*. 2003;(1):CD000326.
6. Flores G, Bridon C, Torres S, et al. Improving asthma outcomes in minority children: a randomized, controlled trial of parent mentors. *Pediatrics*. 2009;124:1522–1532.
7. Morgan WJ, Crain EF, Gruchalla RS, et al. Results of a home-based environmental intervention among urban children with asthma. *N Engl J Med*. 2004;351:1068–1080.
8. Gibson PG, Powell H. Written action plans for asthma: an evidence-based review of the key components. *Thorax*. 2004;59:94–99.
9. Ducharme FM, Bhogal SK. The role of written action plans in childhood asthma. *Curr Opin Allergy Clin Immunol*. 2008;8:177–188.
10. Bateman ED, Hurd SS, Barnes PJ, et al. Global strategy for asthma management and prevention: GINA executive summary. *Eur Respir J*. 2008;31:143–178.
11. Fishwick D, D'Souza W, Beasley R. The asthma self-management plan system of care: what does it mean, how is it done, does it work, what models are available, what do patients want and who needs it? *Patient Educ Couns*. 1997;32:S21–S33.
12. Levy ML, Thomas M, Small I, Pearce L, Pinnock H, Stephenson P. Summary of the 2008 BTS/SIGN british guideline on the management of asthma. *Prim Care Respir J*. 2009;18(Suppl 1):S1–S16.
13. McNally AJ, Frampton C, Garrett J, Pattemore P. Application of asthma action plans to childhood asthma: national survey repeated. *N Z Med J*. 2004;117:U932.
14. Guevara JP, Wolf FM, Grum CM, Clark NM. Effects of educational interventions for self management of asthma in children and adolescents: systematic review and meta-analysis. *BMJ*. 2003;326:1308–1309.

15. Kelly CS, Morrow AL, Shults J, Nakas N, Strobe GL, Adelman RD. Outcomes evaluation of a comprehensive intervention program for asthmatic children enrolled in medicaid. *Pediatrics*. 2000;105:1029–1035.
16. Toelle BG, Ram FS. Written individualised management plans for asthma in children and adults. *Cochrane Database Syst Rev*. 2004;(2)(2): CD002171.
17. Bhogal S, Zemek R, Ducharme FM. Written action plans for asthma in children. *Cochrane Database Syst Rev*. 2006;3:CD005306.
18. Zemek RL, Bhogal SK, Ducharme FM. Systematic review of randomized controlled trials examining written action plans in children: what is the plan? *Arch Pediatr Adolesc Med*. 2008;162:157–163.
19. Lefevre F, Piper M, Weiss K, Mark D, Clark N, Aronson N. Do written action plans improve patient outcomes in asthma? An evidence-based analysis. *J Fam Pract*. 2002;51:842–848.
20. Polisena J, Tam S, Lodha A, Laporte A, Coyte PC, Ungar WJ. An economic evaluation of asthma action plans for children with asthma. *J Asthma*. 2007;44:501–508.
21. Agrawal SK, Singh M, Mathew JL, Malhi P. Efficacy of an individualized written home-management plan in the control of moderate persistent asthma: a randomized, controlled trial. *Acta Paediatr*. 2005;94: 1742–1746.
22. Krieger J, Takaro TK, Song L, Beaudet N, Edwards K. A randomized controlled trial of asthma self-management support comparing clinic-based nurses and in-home community health workers: the Seattle-King County healthy homes II project. *Arch Pediatr Adolesc Med*. 2009;163: 141–149.
23. Ring N, Malcolm C, Wyke S, et al. Promoting the use of personal asthma action plans: a systematic review. *Prim Care Respir J*. 2007;16: 271–283.
24. Healthy homes II asthma project [Internet]. Public Health—Seattle & King County; Public Health—Seattle & King County; 2010 [updated Aug. 19, 2010; cited August 30, 2010]. Available from: <http://www.kingcounty.gov/healthservices/health/chronic/asthma/healthyhomes2.aspx>. Accessed
25. Asthma action plans [Internet]. Oakland, CA: Regional Asthma Management and Prevention (RAMP); [Updated 2009; cited 1/18/2011]. Available from: <http://www.rampasthma.org/info-resources/asthma-action-plans/>. Accessed May 9, 2011.
26. National Institutes of Health (US), National Heart, Lung, and Blood Institute. Expert panel report 3: Guidelines for the diagnosis and management of asthma section 3, component 1: measures of asthma assessment and monitoring. Clinical Practice Guidelines. Bethesda, MD: NIH, NHLBI; 2007. Report No.: 07-4051.
27. Juniper EF, Guyatt GH, Feeny DH, Ferrie PJ, Griffith LE, Townsend M. Measuring quality of life in children with asthma. *Qual Life Res*. 1996;5:35–46.
28. Sharek PJ, Mayer ML, Loewy L, et al. Agreement among measures of asthma status: a prospective study of low-income children with moderate to severe asthma. *Pediatrics*. 2002;110:797–804.
29. Vittinghoff E. *Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models*. New York: Springer; 2005.
30. Ducharme FM, Zemek RL, Chalut D, et al. Written action plan in pediatric emergency room improves asthma prescribing, adherence and control. *Am J Respir Crit Care Med*. 2010;Aug 27.
31. Bonner S, Zimmerman BJ, Evans D, Irigoyen M, Resnick D, Mellins RB. An individualized intervention to improve asthma management among urban latino and African-American families. *J Asthma*. 2002;39: 167–179.
32. Clark NM, Gong M, Kaciroti N. A model of self-regulation for control of chronic disease. *Health Educ Behav*. 2001;28:769–782.
33. Wisnivesky JP, Lorenzo J, Lyn-Cook R, et al. Barriers to adherence to asthma management guidelines among inner-city primary care providers. *Ann Allergy Asthma Immunol*. 2008;101:264–270.
34. Cabana MD, Chaffin DC, Jarlsberg LG, Thyne SM, Clark NM. Selective provision of asthma self-management tools to families. *Pediatrics*. 2008; 121:e900–e905.
35. Wissow LS, Gittelsohn AM, Szklo M, Starfield B, Mussman M. Poverty, race, and hospitalization for childhood asthma. *Am J Public Health*. 1988;78:777–782.
36. Lieu TA, Lozano P, Finkelstein JA, et al. Racial/ethnic variation in asthma status and management practices among children in managed medicaid. *Pediatrics*. 2002;109:857–865.
37. Eggleston PA, Buckley TJ, Breyse PN, Wills-Karp M, Kleeberger SR, Jaakkola JJ. The environment and asthma in U.S. inner cities. *Environ Health Perspect*. 1999;107(Suppl 3):439–450.
38. Grant EN, Alp H, Weiss KB. The challenge of inner-city asthma. *Curr Opin Pulm Med*. 1999;5:27–34.

Requests for reprints should be addressed to:
 Jacob Sunshine
 University of Washington School of Medicine
 1959 NE Pacific St. A-300 Box: 356340
 Seattle, WA 98195-6340
 E-mail: jesun@uw.edu