Reducing Quality-of-Care Disparities in Childhood Asthma: *La Red de Asma Infantil* Intervention in San Juan, Puerto Rico

abstract

BACKGROUND AND OBJECTIVE: Although children living in Puerto Rico have the highest asthma prevalence of all US children, little is known regarding the quality-of-care disparities they experience nor the adaptability of existing asthma evidence-based interventions to reduce these disparities. The objective of this study was to describe our experience in reducing quality-of-care disparities among Puerto Rican children with asthma by adapting 2 existing evidence-based asthma interventions.

METHODS: We describe our experience in adapting and implementing 2 previously tested asthma evidence-based interventions: the Yes We Can program and the Inner-City Asthma Study intervention. We assessed the feasibility of combining key components of the 2 interventions to reduce asthma symptoms and estimated the potential cost savings associated with reductions in asthma-related hospitalizations and emergency department visits. A total of 117 children with moderate and severe asthma participated in the 12-month intervention in 2 housing projects in San Juan, Puerto Rico. A community-academic team with the necessary technical and cultural competences adapted and implemented the intervention.

RESULTS: Our case study revealed the feasibility of implementing the combined intervention, henceforth referred to as *La Red* intervention, in the selected Puerto Rican communities experiencing a disproportionately high level of asthma burden. After 1-year follow-up, *La Red* intervention significantly reduced asthma symptoms and exceeded reductions of the original interventions. Asthma-related hospitalizations and emergency department use, and their associated high costs, were also significantly reduced.

CONCLUSIONS: Asthma evidence-based interventions can be adapted to improve quality of care for children with asthma in a different cultural community setting. *Pediatrics* 2013;131:S26–S37

AUTHORS: Marielena Lara, MD, MPH,[a] Gilberto Ramos-Valencia, DrPH,[b] Jesús A. González-Gavillán, PhD, CIH,[b] Fernando López-Malpica, MD,[c] Beatriz Morales-Reyes, MS, Heriberto Marín, PhD,[b] Mario H. Rodríguez-Sánchez, PhD, MSEH, MPH,[b] and Herman Mitchell, PhD[d]

[a]RAND Corporation, Santa Monica, California; [b]Graduate School of Public Health and [c]School of Medicine, University of Puerto Rico, San Juan, Puerto Rico; and [d]Rho Federal Systems Division Inc, Chapel Hill, North Carolina

KEY WORDS

childhood asthma, quality of care, Latino/Hispanic, Puerto Rico, evidence-based interventions, translational research, fidelity of implementation, implementation science

ABBREVIATIONS

CHW—community health worker
ED—emergency department
ICAS—Inner-City Asthma Study
MCAN—Merck Childhood Asthma Network
NCICAS—National Cooperative Inner-City Asthma Study
YWC—Yes We Can

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Address correspondence to Marielena Lara, MD, MPH, RAND Corporation, 1776 Main St, PO Box 2138, Santa Monica, CA 90407-2138. E-mail: lara@rand.org

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Access to high-quality care can reduce unnecessary suffering among children with asthma and lower the costs associated with preventable asthma-related hospitalizations and emergency department (ED) visits.[1–4] Although there is currently no cure for asthma, the illness and its effects can be controlled by evidence-based practices that integrate clinical and environmental interventions, such as appropriate use of preventive medications and family education about how to reduce home exposures that trigger asthma symptoms, in community settings.[5] Unfortunately, a wide gap exists between evidence-based quality care and the actual care received by poor and minority children with asthma.[6]

Recognizing that there are multiple reasons why asthma evidence-based care is not being implemented in poor and minority communities, several national grant-funded initiatives have worked toward reducing this gap.[7–9] Under the rubric of implementation science and/or translational research,[10,11] some of these efforts seek to create knowledge about the uptake and adaptation of evidence-based practices in "real world" settings. For example, translational research efforts seek to answer questions such as: What adaptations of evidence-based interventions were successful, in what environments, and why?

The Merck Childhood Asthma Network (MCAN) initiative conducted translational research to evaluate the applicability and effectiveness of evidence-based asthma interventions, which were previously shown to be efficacious in reducing the asthma burden in experimentally controlled environments,[12–14] in communities with high rates of asthma prevalence, complex social issues, and infrastructure barriers.[15] For the research reported here, we hypothesized that a novel combination of 2 evidence-based asthma interventions, the Yes We Can (YWC)[14] program and ICAS (Inner-City Asthma Study)[13] home environmental interventions, would be effective when implemented among children with moderate and severe asthma living in 2 housing projects in San Juan, Puerto Rico.

The primary objective of our case study was to assess the feasibility of implementing an adapted combination of these 2 asthma interventions in the selected Puerto Rican communities and hopefully to improve the quality of asthma care in these communities that experience a disproportionately high level of asthma burden. A secondary objective was to explore the effectiveness and potential cost savings of the combined intervention associated with reductions in hospitalizations and ED visits for asthma. Because an important goal of the project was to learn about the process of translation and implementation research, we chose interventions that, in our judgment, were fairly universal in addressing risk factors for children with asthma across geographic and cultural environments, as well as flexible enough to allow for the Puerto Rico–specific idiosyncrasies that we knew were important from our previous field experience.[16]

METHODS

Formative Work and Conceptual Framework

Our adaption of the chosen interventions to the local community environment was based on formative work, discussed in detail elsewhere, including extensive needs assessments, implementation planning, and refinement of approaches conducted over 2 cycles of funding.[7,16–18] The adaptation of the interventions was guided by the conceptual model shown in Fig 1 that draws on structural, process, and outcome components first defined by Donabedian and applied here in the context of a community-based intervention.[17,18] Structural core elements include the material resources, characteristics of the physical/social-organizational setting, and the number and qualifications of staff.[18,19] Process core elements consist of the protocol including how, when, and by whom the intervention is delivered.[18,19] Context includes the various community and organizational characteristics that influence adaptation and implementation of the intervention.[18]

In previous work, we defined explicit criteria to assess implementation fidelity for the chosen evidence-based interventions as follows[18]: high fidelity

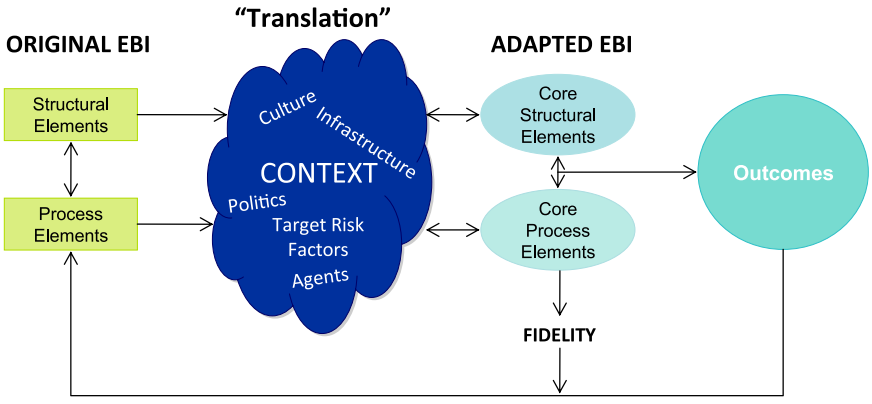

FIGURE 1
Conceptual model for adaptation of evidence-based interventions (EBIs). Reprinted with permission from the Society of Public Health Education; originally published in Lara et al[18], p. 65S.

(replication of an intervention key component without adaptation), minor adaptation (relatively minor modifications of the component as intended by the developers), major adaptation (significant modifications of the core component to address contextual demands of the environment), and low fidelity (adaptation of the core components to an extent that they could not be named or recognized as being part of the original evidence-based intervention).

La Red Intervention

The *La Red* intervention is our 1-year combined clinic- and home-based intervention adapted from YWC and ICAS. Tables 1 and 2 summarize the specific adaptations that we made to the structural and process components, respectively, as well as their rationale and degree of fidelity when compared with the original evidence-based interventions.

YWC

We adapted the YWC intervention to define and extract its most critical structural and process elements.[14,18] For example, a critical structural component we retained was an interactive multidisciplinary team including a physician "asthma champion," a community nurse/coordinator, and a community health worker (CHW) who work with families to improve management of asthma using a medical/social care model during regular visits to an asthma-specific clinic. The salaries of the community nurse/coordinator and the CHWs were provided by the grant, as were small financial incentives for the physician asthma champions who found time from their busy practices for this role.

In terms of process, our adaptation of YWC retained an initial comprehensive baseline risk assessment, including symptom control, allergic skin testing, and initial medical evaluation by the physician asthma champion and community nurse. In our adaptation, allergic testing included 17 allergens composed of those used in the ICAS (dog, cat, roach, mold, mouse, rat)[13] and additional local allergens identified by a group of local allergy specialists.

ICAS Home Environmental Intervention

Our adaptation of ICAS maintained the scientific integrity of the intervention's goals as follows: immediate remediation of allergen burden in the home and maintenance of an allergen-free home over the long term.[13] For the process of remediation we replicated ICAS's initial assessment of each child's environmental risks, including a home evaluation to determine the presence of environmental tobacco smoke and allergens and delivered educational modules about how to recognize and reduce specific allergen groups or environmental tobacco smoke exposures. The modules were delivered to the family by a CHW through a series of scheduled home visits.

As shown in Table 2, our adaptation reduced the number of home visits and interventions (originally ≥6) as follows:

1. All children (with or without exposure and sensitivity data) received an initial "Safe Sleeping Zone module" visit. For this module, the environmental counselors assisted the families in placing dust mite–impermeable covers on the child's bed and demonstrated vacuuming of rugs and removal of unnecessary sources of dust allergen, such as curtains, area rugs, and stuffed toys.
2. During the second visit, families received home-based education on avoiding cockroaches (eg, in the kitchen) and remediation strategies (eg, working with the housing authority to fumigate for cockroaches). We chose to provide the cockroach module to all participants because it was the second most common allergic sensitivity tested in the study population.
3. During the last visit, the CHW concluded with a brief overview of other risk factors and provided an attractive easy-to-read poster summarizing these risk factors, which families could place on their refrigerator door.

Study Design

The study protocol was approved by both the RAND and the University of Puerto Rico institutional review boards. Recruitment of the participating families took place over >1 year. The assessment of asthma symptoms and health care use at entry and at 12 months minimized seasonal influence and provided sufficient time for the intervention to have an effect. Data for the evaluation were gathered through a caregiver survey at baseline and at a 12-month follow-up as described below. As described previously, a baseline home environmental assessment was conducted. Additional evaluation components and types of data collected as part of the national MCAN initiative are described elsewhere.[20]

Setting and Population

The study was conducted in the Luis Lloréns Torres and the Manuel A Pérez housing projects in San Juan, Puerto Rico.[16] For both communities, the proportion of households with an annual average income <$10 000 was ≥80%.

Eligibility Criteria

We recruited children aged 0 to 17 years with moderate or severe asthma according to an 8-item interviewer-delivered screening tool we had tested as part of the formative work.

TABLE 1 Comparison of Structural Elements of *La Red* Intervention to YWC and ICAS Interventions

Component	*La Red* Intervention Elements	Comparison with Original		Adaptation	Rationale
		YWC[a]	ICAS[b]		
Setting	Interventions held in clinic and home	High fidelity[c]	High fidelity	None	Participants attended centrally located clinic and were receptive to home visits
Intervention team composition	Multidisciplinary team including asthma clinician (champion), community nurse, and CHW/environmental counselor	High fidelity	High fidelity	CHWs supplemented by health educators and public health students in environmental counselor role; provided small financial inventive to asthma clinician (champion)	Difficult to find CHWs from communities served with necessary skill set; commitment of asthma clinician (champion) is key
Intervention team interaction	1:1 interaction between asthma clinician (champion) and community nurse/care coordinator during asthma clinic visits 1:1 interaction between community nurse/care coordinator/CHWs conducting home visits	Minor adaptation	N/A	Substituted regular team meetings to discuss participant cases with 1:1 ad hoc discussions	Difficulty in finding other times/modes of communication between clinician and CHWs
Training	Used same protocols and materials as original interventions, translating into Spanish when necessary	High fidelity	High fidelity	Emphasized "hands on" demonstrations for low literacy of population	Previously developed training and materials feasible to implement with special attention to lower health literacy
Eligibility criteria	Moderate or severe persistent cases only, as defined by NHLBI and HEDIS criteria	Low fidelity	High fidelity	Did not include intermittent or mild persistent cases	Not feasible to serve all; hypothesized would have greater impact in moderate/severe cases
Use of clinical registry or EMR	Not able to implement electronic linkage between project registry and medical records	Low fidelity	N/A	Registry documented only intervention component(s) reach for participants	Not feasible because community clinics were not EMR friendly
Materials provided to participants	Provided all families with mattress/pillow covers and basic cleaning supplies	High fidelity	Minor adaptation	Did not provide HEPA vacuum cleaners	Too costly to provide HEPA vacuum cleaners

EMR, electronic medical record; HEDIS, Health Plan Employer Data & Information Set; HEPA, high-efficiency particulate air filter; N/A, not applicable; the original intervention did not have this component; NHLBI, National Heart, Lung, and Blood Institute.

[a] Adapted from Thyne et al.[14]

[b] Adapted from Morgan et al.[13]

[c] Fidelity of implementation refers to the degree to which the adapted core elements adhere to the original evidence-based interventions as assessed retrospectively by implementers and original intervention developers.[18]

TABLE 2 Comparison of Process Elements of *La Red* Intervention to YWC and ICAS Interventions

Key Intervention Component	*La Red* Intervention Elements	Comparison with Original		Adaptation	Rationale
		YWC[a]	ICAS[b]		
Standardized educational materials and forms	Provided participants with some forms from the original interventions that were translated into Spanish	Major adaptation	High fidelity[c]	Developed a small summary poster for refrigerator with key educational environmental mitigation messages	Selection of forms to reduce duplicity across interventions and eliminate messages not relevant to context (eg, gas stoves in Puerto Rico)
Assess risk	Baseline asthma symptom assessment by survey; allergic skin testing	Survey and allergic testing: high fidelity Spirometry: low fidelity	High fidelity	Tested allergens from ICAS and local allergens Not feasible to do spirometry	Local allergy experts recommended additional allergic panel; primary care clinician(s) did not know how to do or read spirometry
Target intervention according to risk	Offered all participants the same intervention	Low fidelity	Low fidelity	Did not tailor home environmental intervention according to allergic history	Chose population-based environmental intervention based on overall community (instead of individual) allergic data; low feasibility of 1:1 tailoring of intervention
Standardized home evaluation	Implemented standardized checklist assessment of asthma environmental triggers (pet, dust mites, etc) in the home	High fidelity	Minor adaptation	Did not measure concentration of dust and other triggers at baseline for all participants	Lack of resources for processing and analysis of home dust and other samples
Home environmental mitigation	Implemented standardized educational scripts in Spanish including the ICAS "Safe Sleeping Zone" and "Cockroach" modules	Minor adaptation	High fidelity	Summarized educational messages from other environmental triggers (pets, mold, rodents, and ETS) in refrigerator poster	Not enough time in 2–3 program home visits to include in-depth education for all triggers; chose priority modules on the basis of data for overall community exposures
Number of home visits	2–3 home visits in 12-mo intervention program; each visit lasted ∼2 h	Minor adaptation	Major adaptation	Reduced number of home visits considerably from ICAS protocol (2–7 according to risk)	Not feasible to do >2–3 visits per year
Content of home visits	First visit: checklist assessment and "Safe Sleeping Zone" module Second visit: "Cockroach" module Second or third visit: review with refrigerator poster	Minor adaptation	Minor adaptation	Modified content and order of visits as described in second column	Adaptation decisions based on community data and local pilot testing of protocol
Intensity of clinic follow-up	Frequency of follow-up clinic visits varied: mean of 2.8 (SD: 2.7) visits over 12 mo	Major adaptation	N/A	Interval of clinical follow-up was decided by clinician instead of at fixed intervals	Followed asthma clinician recommendation regarding follow-up because his/her buy-in was crucial for intervention
Intensity of phone follow-up	Phone call after each home visit	Minor adaptation	High fidelity	Decreased frequency of phone follow-up as compared with YWC protocol	Participants receptive to home visits but preferred less intensive phone follow-up

ETS, environmental tobacco smoke; N/A, not applicable; the original intervention did not have this component.

[a] Adapted from Thyne et al.[14]

[b] Adapted from Morgan et al.[13]

[c] Fidelity of implementation refers to the degree to which the adapted core elements adhere to the original evidence-based interventions as assessed retrospectively by implementers and original intervention developers.[18]

Inclusion criteria were based on the National Heart, Lung, and Blood Institute asthma guidelines and HEDIS criteria,[21,22] which required a caregiver report of a medical professional diagnosis of asthma and any of the following: (1) daily asthma symptoms in the past 2 weeks, (2) ≥2 nights of asthma symptoms in the past 2 weeks, (3) ≥1 asthma hospitalizations in the past year, (4) ≥2 ED asthma visits in the past year, or (5) use of preventive asthma medicine every day during the past week or rescue medicine at least twice a week.

We excluded children with asthma who received care at the local clinics but who did not live in the Luis Lloréns Torres or Manuel A Pérez housing projects. Children with intermittent or mild persistent asthma who were excluded were asked to return for reassessment if their asthma symptoms worsened. Although the investigators recognized that this decision resulted in a selection bias, ethically they could not deny the opportunity to participate in the program to those children who in the course of the study became eligible as their asthma worsened.

Recruitment

Participants were recruited from the local health care clinics that serve the studied housing projects. We worked with community leaders to recruit children with asthma who may be eligible, made community presentations, provided an in-service session for health care facility and social work personnel on the study's referral procedures, and provided staff to help with the referral process during pediatric clinic times. Promotional flyers were distributed to all apartments in the housing projects and posted in the health care facilities, pediatric clinics, and EDs where children are treated for asthma. Many families were recruited by "word of mouth" from enthusiastic and satisfied study participants living in the communities.

A total of 245 children with asthma living in the Luis Lloréns and Manuel A Pérez housing projects were recruited in 2 waves between January 2007 and August 2007 (wave 1, n = 100) and then between February 2008 and December 2008 (wave 2, n = 145). Several reasons contributed to the 6-month recruitment hiatus, including a midcourse correction required by the funder of the cross-site national common evaluation protocol described elsewhere[20] and a coincidental change in the local subcontractor conducting the data collection and intervention. The administrative change in subcontractor was not associated with a significant loss of trained core field staff nor a change in the content of the intervention. During the course of the change in subcontractor, however, there was a loss to follow-up for home visits for the wave 1 sample and a delay in the completion of home visits, which occurred toward the end of the 1-year intervention instead of during the first 3 months. Although children in both waves appeared to experience comparable reductions in hospitalization and ED rates, we limited this analysis to the later group of recruits (n =145), because we hypothesized that both the completion of the home visits and their timing during the course of the 1-year intervention were important to the adaptation we were evaluating.

The 12-month follow-up rate was 81% (n = 117). Characteristics of those participants completing follow-up were not significantly different from those who did not provide 12-month follow-up data.

Survey and Data Collection Methods

The baseline and 12-month follow-up caregiver surveys were based on the National Cooperative Inner-City Asthma Study (NCICAS)[23–25] and the National Asthma Survey supplemented with validated questions from other sources, including the RAND 8-item Bilingual Pediatric Asthma Symptom Scale (also referred to as the LASS or Lara Asthma Symptom Scale in the literature) which had been previously validated in Spanish.[26] For the survey items that had not been previously validated in Spanish, the investigators used a committee reconciliation process that included community representatives to ensure language and cultural equivalency. During the formative work,[16] several iterations of validity testing were conducted for the Spanish-language survey instruments used.

The survey data were collected face-to-face by trained Spanish native-speaker interviewers. After obtaining written consent, interviewers surveyed participants at the clinic (for baseline information) and at home (12-month follow-up).

A project registry was also developed to provide a detailed process summary of the intervention and to track its milestones: children screened into the program, recruited, evaluated by a physician, visited by a CHW, evaluated and/or given an educational session by a nurse, and given medications and/or equipment.

Outcome Measures

Our primary outcomes were the survey measures of improved parent-reported symptom control (see Table 5) that had been validated in Spanish speaking populations and had been used in evaluating the original interventions. Secondary outcomes included cost saving associated with decrease in preventable asthma hospitalizations and ED visits. Key intermediate outcomes included the improvements in process and structural quality of care indicators shown in Table 6, previously

described in the literature and outlined by the Guidelines Implementation Panel for the National Heart, Lung, and Blood Institute's EPR-3 Guidelines for the Diagnosis and Management of Asthma.[2,5,27,28]

Economic Analysis

We simulated the potential cost savings for changes in asthma-related ED visits and hospitalizations associated with the intervention from available secondary data sources from the US health care system. Actual reductions in ED and hospitalization use associated with the intervention were estimated on the basis of parent reported data. We could not estimate costs associated with increased outpatient visits and preventive medication use because we did not have access to the participants' health insurance claims data, and parent report of outpatient visit use and medication use was not thought to be as reliable as ED and hospitalization use. Specifically, we

1. Used 2 US national databases from the Agency for Healthcare Research and Quality for the year 2009: the Healthcare Cost and Utilization Project Kid's inpatient database (http://hcupnet.ahrq.gov/), and the Medical Expenditure Panel Survey (http://meps.ahrq.gov/mepsweb/data_stats/meps_query.jsp). Estimates of the mean and SE for pediatric asthma hospital stay charges and general pediatric ED visit charges, stratified by age group and gender, were obtained from the Healthcare Cost and Utilization Project Kid's inpatient database and the Medical Expenditure Panel Survey database, respectively.
2. Identified study participants for whom complete health care utilization data were available pre- and postintervention (n = 117).
3. Used the software SimulAr (http://www.simularsoft.com.ar/SimulAr1e.htm) to develop a mathematical model that generated hypothetical values of ED visits and hospitalization expenditures pre- and postintervention and the associated savings (post/pre expenditures). We used means and SEs for hospital stays and ED visits from the Agency for Healthcare Research and Quality databases, stratified by age and gender, as inputs to the statistical distribution that better fit the health care utilization data for study participants.
4. We performed with the use of SimulAr a Monte Carlo simulation of the model with 10 000 iterations. This simulation was equivalent to generating 10 000 simulations for each of the 117 cases with complete pre/post data to then generate random estimates for the actual number of ED visits, hospitalizations, and associated expenditures, before and after the intervention, on the basis of the statistical distribution, means, and SEs generated by the model.

The Monte Carlo simulation allowed us to estimate the hypothetical potential savings in asthma-related ED visits and hospitalizations if *La Red* intervention would have been implemented in similar groups of pediatric asthma patients in the continental United States in 2009. However, most if not all of the health care expenditures generated by participants of the study in Puerto Rico were paid by the public health insurance (financed through state funds, Medicaid, and the Children's Health Insurance Program or CHIP) known as *Mi Salud*. Still, it is very important for national and local policy makers to know about the size of the net potential health care savings this intervention may have generated.

RESULTS

Study Population

Children with asthma in the final sample were on average young, male, and living in a single parent household where more than half of the primary caregivers did not have a high school education (Table 3). The population was also highly allergic, with 75% reacting to the allergens tested; the most common allergens were dust mites and cockroach.

Intervention Reach

Participating children received a fairly intense intervention with an average number of 8.9 encounters over the 12 months (Table 4). An encounter was any of the following: initial clinical evaluation and baseline survey; follow-up home visit(s) or phone call; follow-up clinic visit(s) and baseline home evaluation (checklist), safe sleeping zone, and/or cockroach home educational modules; and exit interview and assessment. On average, 2.8 of the 8.9 encounters were for clinic visits. Although the frequency of the ICAS home intervention component was less than the original intervention, participants received a fairly intense environmental intervention over the course of the year, with 96% receiving the baseline environmental checklist and home visit and safe sleeping zone and almost 80% receiving the cockroach module.

Reduction in Asthma Symptoms

Figure 2 compares the 12-month change in symptom days per 2 weeks for the *La Red* intervention with the original ICAS, YWC, and NCICAS interventions. Although we did not choose to adapt the NCICAS intervention, we included it for comparison purposes because it has been used in other studies in minority children with asthma.[12,25] The *La Red* combined

intervention showed a 24% greater reduction in symptoms than the original ICAS environmental intervention, a 154% greater reduction in symptoms than found by the NCICAS Asthma Counselor intervention, and a 99% greater reduction than the YWC intervention. The ICAS, NCICAS, and YWC interventions resulted in a 62%, 35%, and 45% decrease, respectively, in asthma symptoms from baseline to the 12-month follow-up; the *La Red* intervention resulted in a 72% decrease in asthma symptoms.

The *La Red* intervention was also associated with a significant 38% reduction in the LASS asthma symptom score over the 12-month intervention (−8.1 points on a scale ranging from 8 to 40) (Table 5). A difference of ≥7 points in the mean composite asthma score has been reported to be clinically significant in adults,[29] whereas a difference of 6.1 points has been associated with clinical improvement after the resolution of an exacerbation in Spanish speakers (the corresponding clinical difference in English speakers is 4.6 points).[26]

The percentage reductions in individual symptoms were as follows: chest pain (52%), night symptoms (49%), wheezing (47%), shortness of breath (43%), asthma attack score (38%), cough (36%), and asthma attack number (31%). The parental score of perceived severity was the item with the lowest, yet significant, reduction at 14%.

TABLE 3 Baseline Participant Characteristics

Characteristic	Value
Demographic	
Age, mean (SD), y	5.00 (3.52)
Gender (male), %	61.4
Insured (Medicaid equivalent), %	100.0
Ethnicity (Hispanic/Puerto Rican), %	100.0
Spanish language preference, %	100.0
Caretaker completed high school, %	42.9
Single parent household, %	89.1
Total number of people living in household, mean (SD)	4.47 (1.46)
Total number of children living in household, mean (SD)	2.75 (1.33)
Households with monthly income <$10 000/y	94.5
Household environmental exposures,[a] %	
Cockroaches	61.4
Surrounding trees	53.8
Any caretaker smokes	42.4
Current smoker(s) in home	24.1
Furry pet[b] in the home	40.7
Pigeons	39.2
Mold in the home	36.6
Bats	14.7
Rodents	12.4
Allergic sensitivity by skin testing,[c] %	
At least 1 positive allergen skin test result	75.0
Dust mite allergen (Der p1)	69.8
Dust mite allergen (Der f1)	68.8
Cockroach allergen	43.8
Cat allergen	31.3
Rodent allergen	22.6
Dog allergen	12.7
Tree mix	12.7
Weed mix	12.7
Alternaria	4.8
Penicillum	3.2
Aspergillus	1.6
Clodosporium	1.6

n = 145.

[a] Reported in baseline survey or observed in home visit.

[b] Dog, cat, bird, or other animal with fur or feathers.

[c] Only for children aged 5–17 years who received allergic testing (*n* = 63).

Improvement in Quality-of-Care Indicators Associated With the Intervention

Preventable Asthma-Related Hospitalizations and ED Use

Implementation of the adapted interventions was associated with significant decreases in preventable hospitalizations and ED use (Table 6). Asthma-related hospitalizations were reduced by >60% and ED visits by ~50%.

Appropriate Asthma Medication Use

Use of preventive medications doubled overall, with a slighter larger increase among those who reported daily use.

TABLE 4 Reach and Intensity of *La Red* Intervention Components

Component	Value
Home environmental assessment/checklist, %	96
Safe sleeping zone module, %	96
Cockroach module, %	79
Had allergy testing (children ≥5 y),%	83
Total encounters, mean (SD)	8.9 (3.5)
Clinical encounters, mean (SD)	2.8 (2.7)
12-mo survey follow-up, *n* (%)	117 (81)

n = 145.

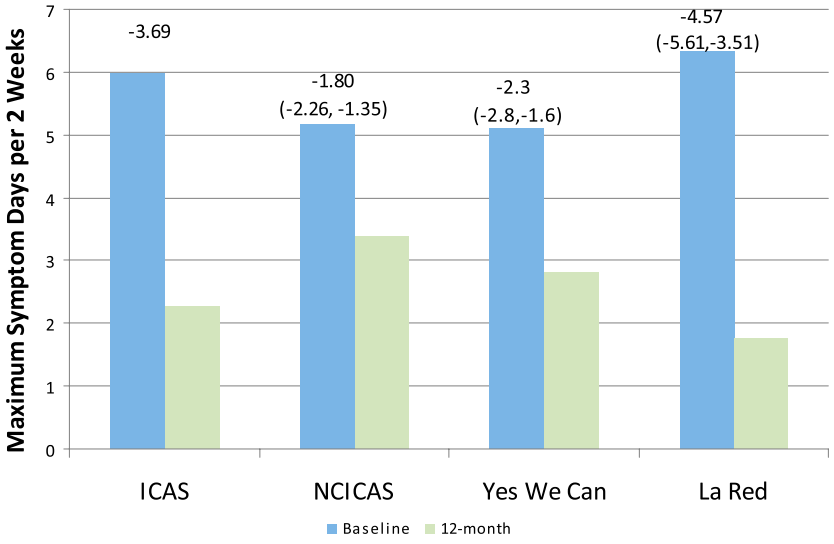

FIGURE 2
Comparison of *La Red* intervention symptom changes with original asthma interventions changes in maximum asthma symptom days per 2 weeks.

TABLE 5 Improvement in Asthma Symptoms Associated With *La Red* Interventions

	Mean (SD) Values		Difference	P
	Baseline (n = 145)	12-Month Follow-up (n = 117)		
Symptom days in past 2 wk				
Days of cough, wheeze, SOB, or chest pain	6.33	1.76	−4.57	<.001
Nights child woke up average/median	5.03	1.61	−3.42	<.001
Maximum symptom days[a]	6.33	1.76	−4.57	<.001
Asthma symptom scores[b] past month				
Cough score	3.18	2.03	−1.15	<.001
Wheezing score	2.49	1.32	−1.17	<.001
Shortness of breath score	2.22	1.27	−0.95	<.001
Chest pain score	2.48	1.17	−1.31	<.001
Asthma attack score	2.19	1.36	−0.83	<.001
How many attacks score	1.96	1.35	−0.61	<.001
Night symptoms score	2.86	1.47	−1.39	<.001
Caregiver severity rating	3.53 (1.95)	3.05 (1.007)	−0.48	<.001
Total 8-item score	21.12 (6.854)	13.03 (5.023)	−8.09	.000

[a] The largest value among the following: number of days with symptoms, number of nights awakened, and number of days with play limitation (not shown).

[b] The symptom score is calculated by adding 8 items rated from least frequent/least severe equals 1 to most frequent/most severe equals 5. A total score is calculated only for cases with no missing item data.[26]

Use of rescue medication decreased by ~75%.

Other Quality-of-Care Indicators

All of the process and structural indicators of quality of care measured improved significantly, including access to a regular asthma provider (increasing by 45%) and reports of having the necessary equipment such as nebulizers, spacer, and peak flows. The intervention was also associated with large significant improvements in the content of asthma education received.

TABLE 6 Improvement in Quality-of-Care Indicators Associated With *La Red* Intervention

	Baseline (n = 145), %	12-Month Follow-up (n = 117), %	*P*
Preventable health care utilization			
Hospitalized in past 12 mo	35.9	13.7	<.001
ED visit last in past 12 mo	82.1	45.3	<.001
≥2 ED visits in past 12 mo	69.0	34.2	<.001
Asthma medication use in past month			
Any controller medication in past month[a,b]	17.2	35.2	<.001
Appropriate (daily) controller medication use in past month[b]	13.8	30.3	<.001
Any rescue medication use in past month	70.3	16.6	<.001
Rescue medication in past 2 wk	62.2	24.7	<.001
Access to asthma providers and equipment			
Have a regular provider for asthma past 12 mo	65.2	93.4	<.001
Talked to a health care provider about asthma in past 12 mo	74.3	99.1	<.001
Had a nebulizer	64.1	87.2	<.001
Had a spacer	12.6	74.4	<.001
Had a peak flowmeter	0.7	43	<.001
Asthma education received in past 12 mo			
Taught to respond to early symptoms of an attack	37.2	88.8	<.001
Taught what to do in case of attack	49.0	88.8	<.001
Taught how to use inhaler	26.9	87.1	<.001
Taught how to use a spacer	17.9	79.1	<.001
Taught how to use a peak flowmeter	5.5	47.8	<.001
Given an asthma action plan in past 12 mo	3.5	53.4	<.001

[a] Inhaled steroids, methylxanthines, long-acting β agonist, leukotriene receptor antagonist, mast-cell stabilizers.

[b] Reported daily use of controller medication.

The number of caregivers who reported having been taught what to do in case of an asthma attack and/or how to respond early to asthma symptoms nearly doubled, whereas the number of those taught how to use an inhaler close to tripled, and those taught how to use a spacer more than quadrupled. Finally, by the end of the 12-month intervention, approximately one-half of the caregivers reported having an asthma action plan for their child as compared with a mere 4% at baseline.

Simulated Cost Savings Associated With the Intervention

The Monte Carlo simulation results suggest that *La Red* intervention was associated with a significant reduction in health care expenditures for asthma-related ED visits and hospitalizations among study participants who completed the intervention. As seen in Table 7, the average reduction in simulated total health care expenditures was $5913 (SD: $1888), equivalent to a 45% reduction. For ED visits, the average reduction was $1178 (SD: $233) or an average percentage reduction of 59%. In the case of hospitalizations, the average reduction was $4735 (SD: $1872) or a 42% average percentage reduction. The simulation suggests that 100% of participants generated savings in the associated health care expenditures, although with great variability among participants. For example, at the extremes of the distribution (5th and 95th percentiles), total savings ranged from $9040 to $2882, savings for ED visits range from $1564 to $802, and savings for hospitalizations ranged from $7824 to $1732, respectively.

DISCUSSION

The children with asthma in the 2 low-income Puerto Rico communities we studied experienced extraordinary disparities in access to quality primary

TABLE 7 Descriptive Statistics for the Distribution of Annual Health Care Expenditures per Participant for ED Visits and Hospitalizations Before and After *La Red* Interventions Generated by a Monte Carlo Simulation

Statistics	ED Visit Expenditures,[a] $			Hospitalization Expenditures, $			Total Expenditures, $		
	Pre	Post	Diff[b]	Pre	Post	Diff	Pre	Post	Diff
Percentile									
5th	1665	660	(1564)	8776	4803	(7824)	10 754	5623	(9040)
20th	1819	735	(1374)	9874	5548	(6332)	11 852	6353	(7522)
40th	1939	791	(1232)	10 715	6132	(5186)	12 715	6955	(6378)
50th	1991	815	(1173)	11 110	6408	(4711)	13 105	7221	(5889)
60th	2042	840	(1116)	11 513	6677	(4215)	13 491	7488	(5411)
80th	2172	900	(981)	12 484	7356	(3126)	14 488	8174	(4295)
95th	2348	986	(802)	13 846	8252	(1732)	15 845	9071	(2882)
Mean	1996	818	(1178)	11 187	6452	(4735)	13 183	7270	(5913)
SD	208	98	33	1542	1053	1872	1553	1054	1888

Number of patients =117; number of iterations = 10 000. Only participants for whom pre and post data were collected were used in the Monte Carlo simulation. Diff, difference.

[a] Annual expenditures for ED visits and hospitalizations are in 2009 nominal US dollars.

[b] This column shows the distribution of the simulated individual differences in expenditures before and after the intervention for all of the participants and thus, is not the difference between the aggregate pre and post expenditures for each row or percentile. Numbers in parenthesis are negative, which implies a reduction in expenditures associated with the intervention.

care for asthma. Only 17% of our study population (children with moderate or severe persistent asthma) reported taking a controller medication in the previous month at baseline as compared with the 100% dictated by national guidelines.[21] In other studies in children with persistent asthma, ~40% to 50% reported taking controller medications, with a lower proportion among minority children covered by Medicaid.[1,2,27]

Similarly, other quality-of-care asthma care process measures were deficient, with ~40% of caregivers in our sample reporting at baseline they had been taught by a health care provider how to respond to their child's asthma attacks or to recognize early signs and symptoms, as compared with ~60% in a national sample.[28] Less than 5% of caregivers reported receiving an asthma action plan at baseline versus ~30% nationwide.[28] These suboptimal standards for asthma care are particularly noteworthy because, in Puerto Rico, the populations we studied are almost universally covered by public health insurance, known as *Mi Salud*. In other words, these quality-of-care gaps were observed in a setting in which lack of health insurance is not a barrier to care.

La Red's adaptation of the YWC and ICAS interventions was very effective in improving asthma childhood outcomes and quality of care in the Puerto Ricans communities studied. Our case study offers important lessons learned for those "translating" these and other evidence-based practices in similar environments. We believe that an important factor in the observed success was the combination of the key intervention components of YWC and ICAS. *La Red* drew on the strengths of the YWC team-based model and supplemented it with the strength of the tightly designed, intense, and tailored environmental intervention established by ICAS. YWC did not emphasize identifying and remediating home environmental risk factors and ICAS did not provide asthma education or team-based case management. However, we believe that by integrating the 2 approaches, *La Red* was able to provide a more complete asthma intervention that transcended the limitations of these 2 evidence-based approaches.

Another important contributing factor was achieving a delicate balance between implementing the previous intervention's key components with sufficient fidelity while adapting it to our local characteristics and idiosyncrasies.[18] In our experience, the successful "translation" of the evidence-based interventions would not have been possible without the multidisciplinary team of academic and community staff, including the original intervention developers, who brought together the cultural and technical competencies necessary for the translation process.[16] In addition, from its earlier formative stages, the study was built on a community-based participatory research approach that drew on successful partnerships with key community and health care system stakeholders.[16,30,31]

We aimed to assess whether elements of 2 interventions that were successful in more controlled environments could be implemented successfully in the "real world" of the extremely disadvantaged housing project communities we studied. One might expect that the impact of these interventions would be attenuated by the complications of implementing them in this setting with very little control over the participating population. These families did not receive reimbursements for their participation nor were they required to attend repeated visits throughout the study period. Yet, the impact of *La Red* was not only comparable to that observed in the controlled experimental studies but in almost every case exceeded the original, separate interventions.[13,14] For example, the reduction in asthma symptoms was greater than that observed in ICAS, and health care utilization (hospitalizations and ED visits) was ~50% lower for the *La Red* children as compared with the previous 12 months, a difference >3 times greater than the difference observed between the intervention and control groups in the ICAS project.

Our results need to be evaluated in light of our study's limitations, including the existing threats to internal and external validity. Our study was not designed to evaluate the effects of each of the particular interventions but instead as a "bundled" intervention. Another important limitation was that as an observational study we lacked a control group. We also did not have a full year of data before and after the intervention to better evaluate a "washout" effect of the intervention.[32] As part of a multisite national project we were limited in the site-specific design changes we could execute.[20] We also had planned to collect population-based claims data for both our targeted communities and another control community in Puerto Rico with a similar sociodemographic profile. However, because of circumstances beyond our control, these data were not available, which limited our capacity for a direct comparison group. Similarly, our economic analyses were exploratory because of lack of local data regarding costs for some of the key components of the intervention. Finally, because we studied only 2 housing projects in San Juan, our findings are not generalizable to other geographic areas in Puerto Rico or nationwide.

CONCLUSIONS

Translating evidence-based research interventions into real-world applications can be fraught with compromises in fidelity due to resource limitations and a lack of "laboratory setting" controls. On the other hand, such translations give the public health practitioner the opportunity to demonstrate how the key components of evidence-based programs can be adapted to extend their benefit to underserved areas. The *La Red* case study provides an example of how translational research, in spite of all its challenges, can bear fruit in a real-world setting to reduce health and health care disparities in a population with an extraordinary asthma burden.

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