

# Unraveling the Ecology of Risks for Early Childhood Asthma Among Ethnically Diverse Families in the Southwest

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For human beings, health and illness occur within biological and psychosocial contexts. The biological context includes factors such as nutrition and exposures to organisms and toxins. The psychosocial context includes attitudes, behaviors, and lifestyles that may affect health status directly; that influence biological exposures, which may affect health status; and that affect perceptions of health and illness. The process by which childhood asthma develops provides an apt illustration of the importance of such contexts and of the manner in which the biological and psychosocial are inextricably intertwined.<sup>1</sup> Current models view childhood asthma as resulting from a combination of genetic susceptibility and environmental exposures.<sup>2</sup> Biological exposures have been extensively investigated, and various factors have been implicated.<sup>3</sup> Increasing attention is being given to the role of psychosocial variables in asthma prevalence and morbidity.<sup>4–6</sup> However, we are only beginning to understand the patterns of covariation of social, biological, and behavioral variables that occur among diverse groups of people.

In the United States today, patterns of childhood asthma prevalence vary greatly according to socioeconomic status (SES) and racial/ethnic background. The highest prevalence and morbidity have occurred among Black children, particularly children of low SES residing in large urban areas.<sup>7–9</sup> It is argued that these racial/ethnic and economic asthma patterns are largely accounted for by social and environmental characteristics.<sup>10–12</sup> Not often addressed are differences in asthma prevalence within low-income, urban, minority racial/ethnic groups. In particular, epidemiological studies of childhood asthma prevalence have found significant differences among Hispanic subgroups, with Puerto Ricans having the highest rates and Mexican Americans the lowest rates.<sup>13,14</sup>

Investigations of the early onset of childhood asthma have not focused on how vari-

**Objectives.** We describe the prevalence of asthma risk factors within racial/ethnic and language groups of infants participating in an intervention study for reducing chronic asthma.

**Methods.** Low-income children aged 9 to 24 months with 3 or more episodes of wheezing illness were enrolled. Baseline information included family and medical histories, allergic status, environmental exposures, emotional environment, and caregiver psychosocial resources.

**Results.** Racial/ethnic and language groups—European Americans, African Americans, high-acclulturated Hispanics, and low-acclulturated Hispanics—showed different patterns of risk factors for childhood asthma, with low-acclulturated Hispanics showing the most distinctive pattern.

**Conclusions.** Patterns of covariation of biological and psychosocial risk factors for childhood asthma were associated with racial/ethnic and language status among urban, low-income children. (*Am J Public Health.* 2002;92:792–798)

ables known to increase children's risk for developing asthma vary by race/ethnicity. A primary risk variable for childhood asthma is maternal asthma,<sup>15,16</sup> so risk will be increased among groups with greater asthma prevalence. Prenatal and postnatal tobacco smoke exposure, which varies greatly across SES and racial/ethnic groups,<sup>11,17</sup> also has been associated with increased childhood asthma.<sup>16,18,19</sup> Exposure to indoor allergens such as cockroaches early in life appears to put children at higher risk for developing asthma.<sup>20,21</sup> Although cockroaches appear to be ubiquitous among the US urban poor, cockroach infestation nevertheless varies by region, climate, housing type, and population density.<sup>22–24</sup>

Young maternal age and single parenthood, as well as poor prenatal care and low birthweight in infants, all at increased levels among low-SES families, also have been associated with increased asthma prevalence.<sup>11,18,25</sup> Finally, empirical research has documented an association between mental health factors such as postnatal parenting difficulties and subsequent childhood asthma.<sup>26</sup> More mental health and parenting problems occur among lower-SES groups than among those at higher socioeconomic levels.<sup>27</sup> Low-income inner-city families often experience

high levels of stress and significant mental health problems, which have been associated with asthma morbidity<sup>5</sup> and may be related to higher overall prevalence of asthma in these settings.<sup>28</sup>

The Childhood Asthma Prevention Study has enrolled infants at risk for developing asthma because of multiple episodes of early wheezing and low-income status and is assessing the efficacy of a randomly assigned intervention. Biological and psychosocial risk factors have been comprehensively assessed as covariates in the evaluation of the efficacy of the intervention. More than half of the families in the study are Hispanic and of Mexican ancestry, but they vary widely in acculturation to the majority US culture. They range from fully acculturated English-speaking families who have been in the United States for several generations to low-acclulturated families who speak only Spanish and who are recent immigrants to the United States. The remainder of the sample is composed of African Americans and Americans of European ancestry.

The goal of this paper is to show the differences in patterns of covariation of family history, environmental allergens, and psychosocial stressors within and across racial/ethnic groups. Furthermore, by separating out the ef-

fects of acculturation among Hispanics, we hope to gain insight into the combinations of variables that may differentially influence the development of asthma.

## METHODS

Children and their families were recruited from pediatric departments of local hospitals and clinics in the metropolitan Denver, Colo, area. Eligible children were between 9 and 24 months of age, born after 34 weeks' gestation, required oxygen at birth for no more than 48 hours, had medical record documentation of at least 3 separate episodes of respiratory illness with wheezing, and were from low-income (Medicaid-eligible) families. Interested caregivers signed consent forms approved by the institutional review boards of participating institutions. Primary caregivers of infants were interviewed in their homes in English or Spanish to obtain baseline medical, environmental, and behavioral information. Infant urine specimens and dust samples from the homes were obtained. During a single clinic visit for medical testing, 1 to 6 months after enrollment, infant blood was drawn to determine serum immunoglobulin E (IgE) levels.

### Subjects

Although baseline data were obtained for 180 subjects in the Childhood Asthma Prevention Study, this report focuses on the 172 families of infants meeting entry criteria who classified themselves as European American, African American, or Hispanic (Table 1). Hispanics were classified as high acculturated or low acculturated on the basis of the caregiver's preferred language (English vs Spanish) and country of birth (United States vs Latin America).

### Measures

**Child IgE level.** Blood was obtained from 142 children during their clinic visits. Total serum IgE levels were determined for each child by fluoroenzyme immunoassay.

**Environmental tobacco smoke.** The infants' urine was sent to the American Health Foundation Labs in Valhalla, NY, for radioimmunoassay analysis of cotinine, a specific metabolite of nicotine. Levels are re-

ported as nanograms of cotinine per milligram of creatinine.<sup>29</sup>

**Indoor allergens.** Baseline house dust samples were collected by a research assistant who vacuumed the family room, dining room, or living room; the bedroom carpet beside and underneath the child's bed and the upper surface of the bed; and the kitchen floor areas adjoining the cupboard. The combined dust was sieved (>200 mg per household) and was sent for analysis to the Johns Hopkins University DACI Reference Laboratory for determination of allergens, including cockroach (Blag 1) and cat dander (Fel d 1).<sup>24,30,31</sup>

**Caregiver mental health.** For the mental health assessment, the 38 items in the Rand Mental Health Battery<sup>32</sup> were read to the caregiver during the interview. A mean summary score (higher score reflecting better mental health) is reported here.

**Cognitive screening.** Caregivers were administered 2 scales from the Woodcock–Johnson Tests of Cognitive Ability<sup>33</sup> or the Woodcock–Munoz Battery<sup>34</sup>: Picture Vocabulary (comprehension and knowledge) and Analysis–Synthesis (fluid reasoning). Recent norms are available for both the English and the Spanish versions.

**Quality of caregiving.** The Home Observation for Measurement of the Environment (HOME–0 to 3 years),<sup>35</sup> a combination observation and interview technique, was administered to the child's primary caregiver in the home while the child was present and awake. The score presented here (higher is better) is a summary of 5 subscale scores assessing parent–child interaction, cognitive stimulation, and home organization. The HOME Inventory has been found to be valid for Whites, African Americans, and Hispanics.<sup>36–38</sup>

**Life events.** A series of 21 questions about possible stressful life events in the past year was verbally administered to each caregiver.<sup>39</sup> The sum of stressful life events is reported here.

### Data Analysis

Data are presented as means (SD) when variables were normally distributed. Laboratory data (IgE, urinary cotinine, and cat and cockroach allergen levels) were log

transformed for analysis and back transformed for presentation as geometric means (95% confidence intervals). Each of the risk measures was analyzed by racial/ethnic and language grouping. For normalized data, analysis of variance was followed by post hoc analysis. Post hoc analyses were performed with the Fisher least significant difference test when the overall analysis of variance was significant, allowing us to find the source of the group difference. When data had a skewed distribution, the Wilcoxon nonparametric procedure was used to test group differences. Chi-square analyses were performed on categorical data and to detect risk differences between groups. Analyses were performed with SAS software (SAS Institute Inc, Cary, NC). All tests were 2-sided and were considered significant at  $\alpha = .05$ .

## RESULTS

The proportions of families with high-risk demographic characteristics varied significantly among the racial/ethnic and language groups (Table 1). Significantly more mothers from the high-acculturated Hispanic group were young (<20 years) at the time of their infants' births. Single parenthood was significantly more likely for the European Americans, African Americans, and high-acculturated Hispanics than it was for the low-acculturated Hispanics. All Hispanic mothers were less likely to have completed high school than were either the European American or the African American mothers, but the low-acculturated Hispanics were significantly less likely to have a high school education than were the high-acculturated Hispanics ( $P = .004$ ).

Regarding biological risk factors, mothers differed in prevalence of asthma, depending on their racial/ethnic and language group. Low-acculturated Hispanic mothers were significantly less likely to report having asthma than were mothers in any of the other groups. Infant birthweights differed significantly across groups, with the highest among the European Americans and the lowest among the African Americans ( $P < .003$ ). Prenatal smoke exposure was significantly different across groups, with the highest levels among the Eu-

**TABLE 1—Childhood Asthma Prevention Study Baseline Infant and Caregiver Characteristics for Children With Early Wheezing: Comparisons Among Racial/Ethnic and Language Groups**

	European American (EA) (n = 38)	African American (AA) (n = 40)	High-Acculturated Hispanic (HA) (n = 57)	Low-Acculturated Hispanic (LA) (n = 37)	Whole Sample (N = 172)	P (Model) (Post Hoc Difference)
Infant age, mo, mean (SD)	17.0 (4.6)	17.2 (4.6)	16.6 (4.5)	16.7 (5.0)	16.8 (4.6)	.90
Sex, % male	28 (74%)	27 (68%)	42 (74%)	24 (65%)	121 (70%)	.75
Caregiver relationship, % biological mother	35 (92%)	35 (88%)	50 (88%)	36 (97%)	156 (91%)	.38
Maternal age, <sup>a</sup> % <20 y	5 (13%)	6 (15%)	29 (51%)	5 (14%)	45 (26%)	.001
Marital status, % single	20 (53%)	27 (68%)	31 (54%)	8 (22%)	86 (50%)	.001
Maternal education, % <high school	7 (18%)	12 (30%)	32 (56%)	31 (84%)	82 (48%)	.001
Maternal employment, % working	23 (61%)	23 (58%)	30 (53%)	12 (32%)	88 (51%)	.07
Maternal asthma, <sup>a</sup> % with asthma	17 (45%)	9 (23%)	17 (31%)	2 (5%)	45 (27%)	.001
Birth order, % firstborn	10 (26%)	16 (40%)	27 (47%)	12 (32%)	65 (38%)	.18
No. of children, mean (SD)	2.6 (1.6)	2.8 (1.5)	2.8 (1.5)	2.8 (1.7)	2.7 (1.5)	.92
Birthweight, g, mean (SD)	3368 (622)	2929 (474)	3070 (601)	3273 (519)	3147 (581)	.003 EA vs AA, HA; AA vs LA
Prenatal smoke exposure, % exposed	20 (53%)	11 (28%)	21 (37%)	1 (3%)	53 (31%)	.001
Child immunoglobulin E, IU/mL, geometric mean (95% CI)	16.0 (9.2, 27.9)	15.6 (9.9, 24.4)	12.6 (8.8, 17.9)	17.0 (10.4, 27.8)	14.8 (11.9, 18.5)	.76

Note. CI = confidence interval.  
<sup>a</sup>n lower because of adoptive or foster parents.

**TABLE 2—Childhood Asthma Prevention Study Baseline Environmental Exposures for Children With Early Wheezing: Comparisons Among Racial/Ethnic and Language Groups**

	European American (EA)	African American (AA)	High-Acculturated Hispanic (HA)	Low-Acculturated Hispanic (LA)	P (Model) (Post Hoc Differences)
Tobacco smoke: cotinine ng/mg creatinine, geometric mean (95% CI)	10.1 (5.1, 20.1)	26.1 (12.9, 52.7)	18.9 (10.9, 32.6)	2.2 (1.4, 3.4)	<.001 LA vs EA, AA, HA; EA vs AA
Cat: Fel d 1, ng/g, geometric mean (95% CI)	1921 (728, 5070)	361 (159, 819)	565 (306, 1043)	120 (57, 254)	<.001 EA vs AA, HA, LA; HA vs LA
Cockroach: Bla g 1, U/g, geometric mean (95% CI)	1.2 (1.2, 1.3)	1.4 (1.2, 1.6)	1.6 (1.3, 2.0)	1.7 (1.3, 2.4)	.09
Mental health, mean (SD)	3.7 (0.7)	3.7 (0.6)	3.6 (0.5)	3.8 (0.5)	.43
Cognitive score, mean (SD)	91.5 (10.7)	84.4 (11.6)	82.5 (9.3)	76.8 (7.4)	<.001 EA vs AA, HA, LA; LA vs AA, HA
HOME Inventory, mean (SD)	37.2 (4.6)	36.2 (6.5)	36.8 (4.2)	36.5 (4.3)	.82
Life events, mean (SD)	5.0 (2.4)	4.4 (2.1)	4.4 (2.5)	2.6 (2.3)	<.001 LA vs EA, AA, HA

Note. CI = confidence interval; HOME = Home Observation for Measurement of the Environment.

European Americans and the lowest among the low-accultured Hispanics ( $P < .001$ ). Total serum IgE in the infants, a personal risk factor, did not vary significantly across racial/ethnic groups.

Environmental risk factors also showed different levels of exposure across racial/ethnic and language groups (Table 2). Infant urinary cotinine levels were significantly lower for low-accultured Hispanics than for all other groups. European Americans had the highest levels of dust-derived allergen levels for cat,

whereas low-accultured Hispanics had the lowest levels ( $P < .001$ ). Cockroach allergen levels were low and did not differ significantly across racial/ethnic and language groups.

Within the social environment, there were no differences across racial/ethnic and language groups in mothers' mental health scores. However, there were significant differences across groups on the cognitive screening ( $P < .001$ ). The European Americans scored higher than did the African

Americans or either Hispanic group, and the low-accultured Hispanics scored significantly lower than did the high-accultured group or the African Americans. The groups had comparable scores on the HOME Inventory. The low-accultured Hispanics reported significantly fewer stressful life events occurring in the past year than did any other group ( $P < .001$ ).

Table 3 shows intercorrelations between the social and physical environment variables. For the total sample, significant rela-

**TABLE 3—Correlations Between Childhood Asthma Prevention Study Baseline Stress and Environmental Variables for the Entire Sample and by Racial/Ethnic and Language Group**

	Mental Health	Cognitive Screen	HOME Inventory	Life Events
Whole Group (N = 172)				
Cotinine	-0.19*	-0.03	-0.16*	0.24**
Fel d 1	0.09	0.32***	0.18*	0.09
Bla g 1	-0.11	-0.22**	-0.29***	-0.12
European American (n = 38)				
Cotinine	-0.31 <sup>†</sup>	-0.18	-0.33*	0.17
Fel d 1	0.12	0.19	0.49**	-0.01
Bla g 1	-0.12	-0.43**	-0.43**	0.20
African American (n = 40)				
Cotinine	-0.40*	-0.41**	-0.35*	0.45**
Fel d 1	0.35*	0.16	0.20	-0.12
Bla g 1	-0.21	-0.09	-0.48**	-0.05
High-accultured Hispanic (n = 57)				
Cotinine	0.08	0.04	0.07	0.07
Fel d 1	-0.04	0.20	0.26 <sup>†</sup>	0.01
Bla g 1	-0.13	-0.17	-0.26 <sup>†</sup>	-0.19
Low-accultured Hispanic (n = 37)				
Cotinine	0.24	-0.01	-0.16	-0.19
Fel d 1	-0.07	0.11	-0.36*	0.09
Bla g 1	0.08	0.08	-0.03	-0.18

Note. HOME = Home Observation for Measurement of the Environment.  
\* $P < .05$ ; \*\* $P < .01$ ; \*\*\* $P < .001$ ; <sup>†</sup> $P < .10$ . All  $P$  values are 2-tailed.

tions were found between low infant urinary cotinine levels and better maternal mental health, higher HOME Inventory scores, and fewer stressful life events. By racial/ethnic and language group, these relations were most strongly present within the African American group but not within either of the Hispanic groups. Caregivers' cognitive scores were positively associated with presence of cat dander in the home. Also, a significant correlation was seen for the entire sample between HOME Inventory scores and presence of cat allergen in the home. Interestingly, this correlation was positive for the European Americans and negative for the low-accultured Hispanics. Finally, HOME Inventory scores had a significant negative relation with cockroach allergen. The relation was significant for the European American and African American groups, and there was a trend toward significance for the high-accultured Hispanic group; the relation was not significant for the low-accultured Hispanics.

## DISCUSSION

In the context of an early asthma intervention study, the documentation of risk factors for childhood asthma has identified several distinct patterns of co-occurring variables. Risk patterns were strongly differentiated by racial/ethnic and language group membership, with the most striking difference being apparent between high- and low-accultured Hispanics.

The sample of infants was relatively homogeneous in terms of personal risk factors. Despite no differences across groups in gestational age, differences in birthweights were significant between European Americans and African Americans.<sup>40</sup> Most striking, no significant differences were seen across groups in children's mean IgE levels, an important predictor of individual children's allergic tendencies.<sup>16,41</sup>

Besides early (i.e., assessed during the first year of life) child IgE levels, the strongest and most consistent predictor of childhood asthma

may be maternal asthma.<sup>15,16</sup> Mothers varied widely in reports of having asthma. Among the Hispanics, maternal asthma was associated with level of acculturation, with the Spanish-speaking mothers reporting very low prevalence. The mothers, most of whom were recent immigrants from rural Mexico, may have had culturally based views of physical illness in general and of asthma in particular that differed from those of the general US population,<sup>42</sup> or there may have been culture-related reticence to report personal information such as illness or stressful life events. Medical care use may have been different in this group, but other studies have found that Hispanic parents use conventional medical care for treatment of asthma in their children.<sup>43</sup>

It is of interest, however, that recent investigations reported consistent differences in asthma prevalence among Hispanic subgroups in the United States. Puerto Rican children have the highest rates of asthma, whereas Mexican Americans have the lowest rates.<sup>14,44</sup> Lara et al.<sup>45</sup> suggested that the differences in asthma prevalence between these 2 subgroups may be related to certain "protective" biological and social structure variables, such as greater prevalence of 2-parent households and lower rates of smoking among Mexican Americans compared with Puerto Ricans. Our data show variability within the Mexican American group for these variables. Importantly, when Hispanics were divided according to acculturation level, the low-accultured group was characterized by the hypothesized protective variables. This may be an instance of the "epidemiological paradox," which has been described most clearly in relation to prevalence patterns for low-birthweight infants. The paradox refers to the fact that despite low-income status and low educational attainment, foreign-born Mexican American women consistently have lower rates of low-birthweight infants.<sup>46,47</sup> In contrast, US-born Mexican American women have low-birthweight rates that are comparable to those of other racial/ethnic groups at low socioeconomic levels. We appear to be seeing the same phenomenon in relation to asthma prevalence.

We identified within the low-income Hispanic group a significant subgroup of poorly

educated women who were born in Mexico. The prevalence of (self-reported) asthma in these women was extremely low. Most of them are parenting with a partner, and they reported low numbers of stressful life events. Few of them reported smoking during pregnancy, and their children's urinary cotinine levels were consistent with very low levels of smoke exposure during infancy and toddlerhood. Although cockroach allergen was present in some of the homes in this subgroup, levels of indoor allergens that have been associated with asthma risk were generally low. This subgroup had lower scores on the cognitive screening.

In contrast, the high-acclulturated Hispanics had a high prevalence of the risk variables associated with low SES in the United States. Their rates of single parenthood were comparable to the high levels seen in the European and African American groups. They had the highest proportion of teenaged mothers relative to the other racial/ethnic and language groups. In this study, we did not see the paradox in the infants' birthweights, probably because our exclusion criteria selected healthier infants. Nevertheless, the pattern of risk variables of the high-acclulturated Hispanics was distinctly different from that of the Mexican-born group of Hispanics.

The patterns of risk factors of the African Americans and European Americans were similar in many ways. However, the African American mothers were less likely to report having asthma than were the European American mothers. The highest rates of urinary cotinine levels were seen among the African American infants. This finding contrasts with reports of lower prenatal smoke exposure among the African Americans, raising the possibility of changes in the environment after the infant's birth or inaccuracy in reporting prenatal exposure. The European American families had the highest levels of cat allergen in their homes. European Americans had the lowest prevalence of the low-educational-attainment and cognitive-disadvantage risk factors.

Current evidence indicates that presence of cockroach allergen in the home may have a role in the development of asthma and clearly exacerbates symptoms in individuals with asthma.<sup>48</sup> High levels of cockroach al-

lergen were present in a small proportion of the homes, and levels did not vary significantly across racial/ethnic and language groups. As with cockroach allergen, the role of cat allergen in the development of asthma is unclear,<sup>3</sup> but exposure to cat allergen is an important exacerbating agent for asthma.<sup>49</sup> Consistent with others' findings, the European Americans had the highest levels of cat allergen in their homes,<sup>20,50</sup> but for Hispanic Americans of Mexican origin and culture, where it is uncommon to have cats inside the home, levels of cat allergen were correspondingly low.

Family and social structure variables are related to some aspects of children's emotional environments. Among inner-city families from the National Cooperative Inner City Asthma Study, high levels of stressful life events and mental health problems were found.<sup>4</sup> In the current study, the overall numbers of stressful life events reported were similar to those of the National Cooperative Inner City Asthma Study sample. However, the low-acclulturated Hispanics reported significantly fewer such events than did the other groups. The racial/ethnic and language groups did not differ from one another in terms of caregiver mental health or the infants' socioemotional environment.

Each racial/ethnic and language group had a distinctive combination of the biological and psychosocial factors that are currently believed to put children at risk for developing chronic asthma. The European Americans had the highest levels of cat allergen, whereas the African Americans had the highest exposure to cigarette smoke. The high-acclulturated Hispanics showed a pattern of risk factors similar to that of the African and European Americans but were at highest risk on the social structure variables. These 3 groups, which were more similar than different, all showed the covariation among variables that leads to difficulty in identifying specific etiologic variables. For example, maternal asthma was highest in the same groups that had significant allergen and cigarette smoke exposure. These groups also had the most young, single mothers and the highest reported numbers of stressful life events. Furthermore, number of stressful events was associated with evidence of cigarette smoke ex-

posure in the home, especially for the African Americans.

Although sophisticated data analytic techniques make it possible to statistically control for correlated variables, the reality is that certain of the variables cluster together because they are inextricably related. Successful interventions therefore must address not only the biological vulnerabilities and exposures but also the social and behavioral substrate that supports the biological exposures.

The other striking finding in this study was the sharply distinguished risk patterns that emerged when the Hispanic group was separated by acculturation. Mendoza et al.<sup>44</sup> noted that specific culturally based behaviors and attitudes directly affect health behaviors and exposures and may account for prevalence of chronic illnesses. In finding different rates of asthma within the same neighborhood, Ledogar et al.<sup>51</sup> also suggested that cultural practices closely tied to families' countries of origin might be exerting a protective effect.

The results of this study cannot be generalized to the entire population of young children with wheezing, because the data were derived from a highly specific group of families. These low-income urban families brought their wheezing infants in for medical evaluation multiple times, and it is unclear to what degree this in itself sets them apart from other low-income families with wheezing babies. At the very least, they were vigilant about their infants' health and willing to use the health care system. Furthermore, they agreed to participate in a long-term intervention study, and this sets them apart from families who declined to participate because they planned to move from the area, were wary of scrutiny or home visits, did not understand or mistrusted research, or had other priorities in their lives.

Nevertheless, we are extending previous findings in several ways with the data we have presented. First, we have shown that among low-income families, patterns of risk factors for asthma, including genetic risk, infant atopy, and environmental exposures, vary by racial/ethnic and language group. We hypothesize that the different risk patterns will be associated with varying morbidity among this group of wheezing infants;

we are in the process of examining baseline morbidity data to address this question. In addition, we expect that the different risk patterns will be associated with varying prevalence of chronic asthma as the children grow older. Furthermore, as we assess the efficacy of our intervention, we will evaluate whether the groups with different patterns of risk factors were differentially influenced by the nurse home visitor intervention. Second, we have shown that dividing the Hispanic subjects in our study according to acculturation level reveals very different combinations of biological and psychosocial asthma risk factors that characterize the environments within which these infants are developing. Finally, we have shown several ways in which biological and social and behavioral characteristics are inextricably intertwined within any given biopsychosocial context. ■

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#### Contributors

M.D. Klinnert (principal investigator) conceptualized the project, interpreted the data, and drafted the report. M.R. Price (study coordinator) analyzed and helped interpret the data and helped draft and finalize the report. A.H. Liu (co-investigator) participated in revisions of the final version. J.L. Robinson consulted on the project, helped conceptualize and interpret the data, and participated in revision of the report.

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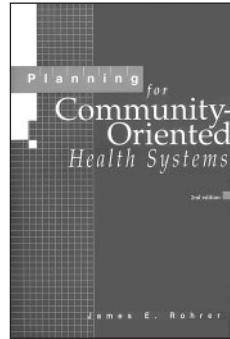
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