Resilience in low-socioeconomic-status children with asthma: Adaptations to stress

Edith Chen, PhD,[a] Robert C. Strunk, MD,[b] Alexandra Trethewey, BA,[a] Hannah M. C. Schreier, MA,[a] Nandini Maharaj, BA,[a] and Gregory E. Miller, PhD[a] *Vancouver, British Columbia, Canada, and St Louis, Mo*

Background: Low socioeconomic status (SES) is a strong predictor of many health problems, including asthma impairment; however, little is understood about why some patients defy this trend by exhibiting good asthma control despite living in adverse environments.

Objective: This study sought to test whether a psychological characteristic, the shift-and-persist strategy (dealing with stressors by reframing them more positively while at the same time persisting in optimistic thoughts about the future), protects low-SES children with asthma.

Methods: One hundred twenty-one children aged 9 to 18 years with a physician's diagnosis of asthma were recruited from medical practices and community advertisements (mean age, 12.6 years; 67% male; 61% white). Shift-and-persist scores and asthma inflammation (eosinophil counts and stimulated IL-4 cytokine production) were assessed at baseline, and asthma impairment (daily diary measures of rescue inhaler use and school absences) and daily peak flow were monitored at baseline and at a 6-month follow-up.

Results: Children who came from low-SES backgrounds but who engaged in shift-and-persist strategies displayed less asthma inflammation at baseline ($\beta = 0.19$, $P < .05$), as well as less asthma impairment (reduced rescue inhaler use and fewer school absences; $\beta = 0.32$, $P < .01$) prospectively at the 6-month follow-up period. In contrast, shift-and-persist strategies were not beneficial among high-SES children with asthma.

Conclusion: An approach that focuses on the psychological qualities that low-SES children develop to adapt to stressors might represent a practical and effective starting point for reducing health disparities. Moreover, the approaches that are effective in low-SES communities might be different from those that are optimal in a high-SES context. (J Allergy Clin Immunol 2011;128:970-6.)

Key words: *Socioeconomic status, asthma, children, psychological, stress*

Abbreviations used
PEF: Peak expiratory flow
SES: Socioeconomic status

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Among social factors, low socioeconomic status (SES) exhibits one of the strongest and most consistent associations with morbidity and mortality across a wide range of diseases,[1,2] including childhood asthma. For example, low-SES children with asthma are significantly more likely to be hospitalized or visit an emergency department for asthma. Compared with higher-SES children with asthma, they also have more symptoms and more severe exacerbations.[3-9]

However, these observations have often left unanswered one important question: Why do some persons not get sick despite facing persistent and severe adversity? Although there are certainly numerous environmental and behavioral factors that explain why low SES is detrimental to health, including heightened exposure to neighborhood pollutants, a greater likelihood of engaging in risky behaviors (eg, smoking), and the experience of negative psychological states (eg, depression),[10-12] these factors cannot explain why some subjects thrive despite confronting adverse circumstances (eg, poverty). This type of thriving has been labeled by researchers as resilience.[13,14]

Contributors to resilience among children facing adversity have been discussed extensively within the mental health literature.[15-17] However, rarely has the notion of psychological resilience been explored with respect to physical health outcomes. Moreover, the small existing literature with respect to physical health outcomes has typically relied on either self-report measures of health or nonspecific physiological indicators.[18-21]

Stress is known to be one of the primary psychological pathways linking low SES to poor health.[22,23] Hence our group has hypothesized that to the extent that low-SES subjects have specific strategies that allow them to adapt well to the types of stressors that accompany low-SES life, they might show reduced physiological responses to stressors and, over the long-term, lower risk for a number of diseases.

Specifically, we postulated that low-SES children who are resilient will use a shift-and-persist approach to dealing with the stressors of low-SES life.[24] This approach entails both shifting (adjusting oneself to stressors through trying to find the positive in them) and persisting (staying optimistic about the future and pursuing future goals). In the context of some of the uncontrollable stressors that many low-SES families face, this approach is hypothesized to be more adaptive than actively trying to confront stressors. As a result, this model hypothesizes that this subgroup

From [a]the Department of Psychology, University of British Columbia, Vancouver, and [b]the Department of Pediatrics, Washington University School of Medicine, St Louis.
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Corresponding author: Edith Chen, PhD, University of British Columbia, 2136 West Mall, Vancouver, British Columbia, Canada V6T1Z4. E-mail: echen@psych.ubc.ca.
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of low-SES children will be less likely to display negative psychological responses and in turn reduced physiological activation (of the hypothalamic-pituitary-adrenal axis and of the sympathetic nervous system) acutely in response to stressors. Over time, with reduced exposure to the stress hormones secreted by these systems, pathogenic processes, such as inflammation, are diminished, ultimately reducing the risk for diseases involving those processes.[25-27]

We tested the idea that a shift-and-persist approach to dealing with stress could protect low-SES children from detrimental asthma outcomes. We recruited a sample of children with asthma across the SES spectrum and measured pulmonary and immune outcomes, as well as asthma impairment, with daily monitoring of pulmonary and impairment outcomes repeated 6 months later. We hypothesized that to the extent they used shift-and-persist strategies, low-SES children would be buffered from poor asthma outcomes over time relative to low-SES children who did not make use of these strategies. As a result, low-SES children who used a shift-and-persist strategy would have asthma outcomes similar to those of their high-SES counterparts.

METHODS

Participants

One hundred twenty-one youth with a physician's diagnosis of asthma (83% with allergic asthma) were recruited from Vancouver, British Columbia, from asthma clinics, newspaper advertisements, and school and community center postings. Youth ranged in age from 9 to 18 years, were fluent in English and free of acute respiratory tract illness at the time of their visit, had not had a prednisone course for at least 2 weeks, and had no chronic illnesses other than asthma.

Participants came for a laboratory visit and then completed home daily diaries (see below for a description of the questions) and peak flow monitoring for 2 weeks (time 1). Six months later, participants repeated daily diary and peak flow monitoring (time 2). The protocol was approved by the University of British Columbia Research Ethics Board, and informed consent was obtained from parents and assent from children.

Measures

SES. Socioeconomic resources were measured by asking parents about the amount of assets that their family could easily convert to liquid cash in an emergency (family savings). This measure is recommended by the MacArthur Research Network on Socioeconomic Status and Health (www.macses.ucsf.edu) and widely used in SES research.[28] Resource-based measures of SES like this have more robust associations with health-related outcomes in childhood than prestige-based measures (eg, education).[29,30]

Measure of shift-and-persist. The tendency to shift oneself in response to stressors was measured by using the Cognitive Restructuring scale of the Responses to Stress questionnaire.[31] Three items (eg, "I thought about the things I was learning from the situation or about something good that would come from it") were queried on a 4-point scale (ranging from "not at all" to "a lot"). These items tap the extent to which subjects try to deal with stressful situations by thinking about them in more positive ways. Items were coded such that higher scores indicated a higher tendency to positively reappraise stressful situations. This measure has been validated in children and linked to mental health outcomes, such as depression.[31,32]

As an indicator of future persistence, a measure of positive thinking about the future was included. The Life Orientation Test taps the extent to which subjects have positive expectations for their future (eg, "I always feel good about my future").[33] This measure consists of 6 items rated on a 3-point scale. Items were coded such that higher scores indicated higher optimism. This measure has been used in children[34] and has established links with disease outcomes in adults.[35,36]

Responses to the shift-and-persist measures were first standardized (because they are on different scales) and then summed to create a total shift-and-persist score. Thus higher scores indicate using a higher combination of both shift and persist strategies.

Asthma measures. For inflammation, at baseline, a complete blood count with 5-part differential (ADVIA 70 Hematology System; Bayer, Holiston, Mass) was performed to obtain eosinophil counts. In addition, white blood cell secretion of the T_H2 cytokine IL-4 in response to mitogen stimulation was measured. At baseline, peripheral blood was drawn into BD Vacutainer Cell Preparation Tubes (BD, Franklin Lakes, NJ) containing sodium heparin, and 3×10^6 PBMCs were isolated through density gradient centrifugation. PBMCs were resuspended in culture medium consisting of RPMI plus 10% FCS and incubated with phorbol 12-myristate 13-acetate (25 ng/mL) and ionomycin (1 μg/mL) for a period of 48 hours at 37°C in 5% CO_2. This phorbol 12-myristate 13-acetate/ionomycin combination has been successful in stimulating asthma-relevant cytokines in other studies.[37,38] Supernatants were frozen until the end of the study and then assayed to determine levels of IL-4 by using ELISA. Intra-assay coefficients of variation ranged from 3.68% to 4.76%. Eosinophil and IL-4 values were standardized (z scores were calculated, given the different ranges for these 2 measures) and the 2 scores were then summed to create a composite measure.

For pulmonary function, at baseline and 6 months later, children monitored peak expiratory flow (PEF) at home by using an electronic monitor (Quadromed, Hoechberg, Germany). Three PEF readings were taken on awakening and again at bedtime each day for 2 weeks, and the highest value at each time point was used. Daily PEF variability was calculated as follows:

$$([\text{Morning PEF} - \text{Evening PEF}]/\text{Average of Morning PEF} + \text{Evening PEF}) * 100,$$ and averaged across the 2-week monitoring period.

For impairment, at baseline and 6 months later, children recorded daily rescue inhaler use (use of a short-acting β-agonist for symptom relief during the day) and school absences (missing school because of asthma) at the end of every day for 2 weeks. A composite measure was created reflecting the percentage of days inhaler use or absences were reported. Ninety-five percent of children completed daily diaries and peak flow measures at baseline, and 86% completed them at the 6-month follow-up.

Potential confounders. Variables included as covariates in statistical analyses included asthma severity, determined from the National Asthma Education and Prevention Program/Expert Panel Report 2 guidelines based on the higher of symptom frequency and medication use, paralleling the approach of previous researchers.[39] Children also brought in their asthma medications to the research center, and inhaled corticosteroid use was coded (yes/no in the past 2 weeks, as well as the number of times used in the past 2 weeks), as was β-agonist use (yes/no in the past 2 weeks). In addition, we included the demographic characteristics of the child's age, sex, and ethnicity as covariates in statistical analyses.

Statistical analyses

Descriptive information about the sample is provided in Table I.[40] Multiple regression analyses were conducted in which asthma variables were predicted from (1) time 1 asthma variable (for follow-up analyses) plus the covariates described above, (2) the main effect of SES (family savings) and the main effect of the shift-and-persist strategy, and (3) the interaction between SES and shift-and-persist scores. For inflammation, measures at baseline formed the dependent variable. For asthma impairment and pulmonary function, measures at the 6-month follow-up comprised the dependent variables. These prospective analyses allowed us to test directionality (ie, the notion that shift-and-persist scores at baseline would forecast asthma impairment or pulmonary function at a future time point [controlling for baseline values]). Including the interaction term allowed us to test the hypothesis that shift-and-persist strategies would benefit low-SES children differently from high-SES children. Tests of interactions were conducted according to the recommendations of Aiken and West,[41] whereby variables are first centered and then the interaction is calculated as the product of the 2 centered variables.

TABLE I. Descriptive sample information (n = 121)

	Percentage	Mean	SD
Age (y)		12.61	2.63
Sex (% male)	67		
Ethnicity			
White	61		
Asian	26		
Other	13		
Family savings		4.76	2.50
Asthma control			
Well controlled	45		
Not well controlled	41		
Very poorly controlled	14		
Currently taking an ICS	70		
Shift strategies		7.14	2.26
Persist strategies		13.90	2.08
Eosinophils ($\times 10^9$ cells/L, time 1)		0.37	0.28
IL-4 production (pg/mL, time 1)		9.28	10.34
Peak flow variability (%, time 1)		10.84	8.98
Peak flow variability (%, time 2)		9.22	6.04
School absences (time 1)		0.63	3.61
School absences (time 2)		0.58	3.00
Rescue inhaler use (time 1)		17.14	28.27
Rescue inhaler use (time 2)		8.93	18.26

Note: Family savings is on a 1- to 9-point scale. Asthma control was determined based on impairment and risk scores, according to the National Heart, Lung, and Blood Institute's National Asthma Education and Prevention Program Expert Panel Report 3 guidelines.[40] Shift strategy scores ranged from 3 to 12. Persist strategy scores ranged from 3 to 18. School absences and rescue inhaler use refer to the percentage of days these were endorsed during the 2 week monitoring period.
ICS, Inhaled corticosteroids.

TABLE II. Multiple regression analyses of SES and shift-and-persist scores predicting asthma measures

Outcome	β	*P* value
Asthma inflammation composite (baseline)		
SES	−0.355	<.001
Shift-and-persist score	−0.083	.403
SES × shift-and-persist score	0.187	.047
Asthma impairment (at 6-mo follow up)		
SES	−0.273	.006
Shift-and-persist score	−0.160	.109
SES × shift-and-persist score	0.315	.001
Peak flow variability (at 6-mo follow-up)		
SES	−0.014	.899
Shift-and-persist score	−0.017	.881
SES × shift-and-persist score	0.186	.084

Note: All analyses control for the child's age, sex, ethnicity, asthma severity, inhaled corticosteroid use, and β-agonist use. In addition, analyses that predicted outcomes at the 6-month follow-up controlled for baseline values. The asthma inflammation composite is a standardized score reflecting eosinophil counts and stimulated IL-4 production. The asthma impairment measure is a composite reflecting the percentage of days of school absences and rescue inhaler use during the 2-week daily diary assessment. Peak flow variability was calculated based on 2 weeks of morning and evening peak flow readings.

RESULTS

Preliminary analyses

At baseline, lower SES was associated with greater asthma-related inflammation ($r = -0.26$, $P = .007$), as well as greater asthma impairment ($r = -0.34$, $P = .001$), although not with peak flow variability ($P = .39$) or inhaled corticosteroid use ($P = .85$). There were no significant differences by SES ($P = .64$), ethnicity ($P = .73$), or sex ($P = .09$) in use of shift-and-persist strategies; however, older children were more likely to engage in shift-and-persist strategies ($r = 0.18$, $P = .049$).

SES, shift-and-persist variables, and inflammation

Table II presents regression coefficients for SES and shift-and-persist variables for all asthma measures. After controlling for demographic variables, asthma severity, and asthma medication use, there was a significant main effect of SES ($P < .001$), such that lower SES was associated with greater asthma-related inflammation. There was no main effect of the shift-and-persist strategy ($P = .40$). There was, however, a significant interaction of SES with the shift-and-persist score ($P = .047$). Results remained the same if the number of days of inhaled corticosteroid use was included as a covariate instead of yes/no use (interaction $P = .047$).

Fig 1 depicts this interaction graphically. Note that although SES was modeled as a continuous variable in regression analyses, the nature of an interaction between 2 continuous variables can be difficult to visualize, and hence significant interactions were plotted by graphing the relationship between the shift-and-persist score and asthma outcomes at low (−1 SD) and high (+1 SD) levels of SES. This creates an artificial distinction within one of the continuous variables but allows one to more easily see how the relationship between the shift-and-persist score and asthma outcomes varies at different levels of SES. Thus the top graph in Fig 1 depicts estimated regression lines when asthma inflammation is regressed onto shift-and-persist scores (controlling for covariates) at 2 different levels of SES. As can be seen in the figure, children low in SES who were also low in shift-and-persist scores displayed the greatest scores on the inflammation composite. As shift-and-persist scores increased, low-SES children with asthma displayed inflammatory profiles more similar to those of high-SES children with asthma.

SES, shift-and-persist variables, and asthma impairment

With respect to functional impairment, there was a main effect of SES ($P = .006$), such that lower SES at baseline was associated prospectively with greater asthma impairment at time 2 (greater rescue inhaler use and school absences). There was no main effect of the shift-and-persist strategy ($P = .11$). There was, however, a significant interaction of SES with shift-and-persist scores ($P = .001$). This pattern of results remained the same if the number of days of inhaled corticosteroid use was included as a covariate instead of yes/no use (interaction $P = .001$). As depicted in Fig 2, children low in SES who were also low in shift-and-persist scores had the greatest asthma impairment at time 2 (adjusting for time 1 values plus other covariates). As shift-and-persist scores increased, low-SES children showed less asthma impairment at time 2 and began to resemble high-SES children with asthma.

SES, shift-and-persist variables, and pulmonary function

With respect to daily peak flow, there were no main effects of either SES ($P = .90$) or the shift-and-persist strategy ($P = .88$). There was, however, a marginal interaction of SES with shift-and-persist scores ($P = .084$). This interaction was such that as SES decreased, greater shift-and-persist scores at baseline were associated with less peak flow variability at time 2.

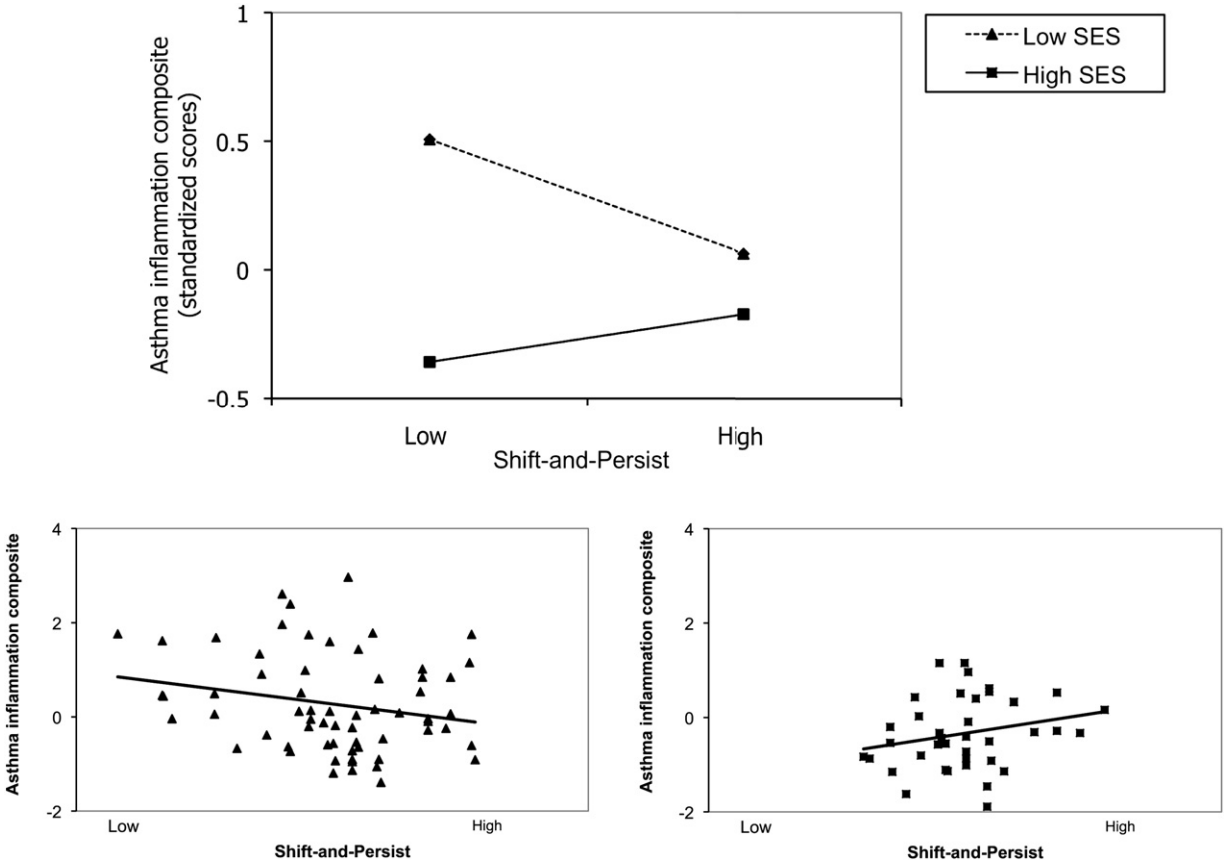

FIG 1. *Top*, Interaction of SES (family savings) by shift-and-persist scores predicting the asthma inflammation composite at baseline. The inflammation composite reflects eosinophil counts and stimulated IL-4 production. Estimated values are plotted at ±1 SD of SES. *Bottom*, Individual data points for low- and high-SES subjects by median split. Asthma inflammation was regressed onto covariates and residualized scores were plotted by shift-and-persist scores to obtain adjusted values for each participant.

Inflammation links to asthma over time

Given that similar patterns emerged for inflammation measures at baseline and asthma impairment prospectively, we tested the connection between these findings by examining whether our measures of inflammation at baseline predicted asthma impairment or pulmonary function at time 2. After controlling for baseline impairment and other covariates described above, greater inflammation at baseline predicted greater asthma impairment at the 6-month follow-up ($\beta = 0.47$, $P < .001$). No significant associations were found for pulmonary function.

Given these links, we tested whether the shift-and-persist score's prospective association with asthma impairment was due to its concurrent relationship with inflammation. In further analyses in which baseline inflammation was controlled, the interaction between SES and shift-and-persist scores continued to forecast asthma impairment at time 2 ($\beta = 0.26$, $P = .009$). These findings indicate that the shift-and-persist strategy was protective to low-SES children above and beyond their baseline inflammation levels.

DISCUSSION

Our results demonstrated that among low-SES children, those who engaged in a specific psychological strategy for dealing with daily life stress, labeled the shift-and-persist strategy, showed better asthma profiles prospectively. In short, lower-SES children with asthma who worked to reinterpret stressors in a more positive light (shifting) while remaining optimistic about their futures (persisting) had less asthma inflammation at baseline, as well as less asthma impairment (less rescue inhaler use and school absences) at a 6-month follow-up assessment. In fact, low-SES children with asthma with high shift-and-persist scores resembled high-SES children with asthma on a number of these dimensions. This study is the first that we are aware of to demonstrate the health-protective effects, both biologically and clinically, of a psychological characteristic for coping with stress that uniquely protects low-SES children confronting a chronic disease.

There were no main effects of the shift-and-persist strategy, only an interaction with SES, indicating that shift-and-persist strategies are not uniformly beneficial but rather specifically helpful to those who come from low-SES backgrounds. Because low-SES subjects, on average, live under circumstances consisting of more frequent stressors that are more uncontrollable,[42] an approach that emphasizes shifting oneself (reframing stressors more positively) might be beneficial for slowing down the pathophysiologic processes that contribute to diseases such as asthma. In addition, maintaining optimism about the future might provide meaning in life and foster striving toward long-term goals, processes that in turn mitigate asthma-relevant physiologic processes over time. Thus there might be psychological qualities that are

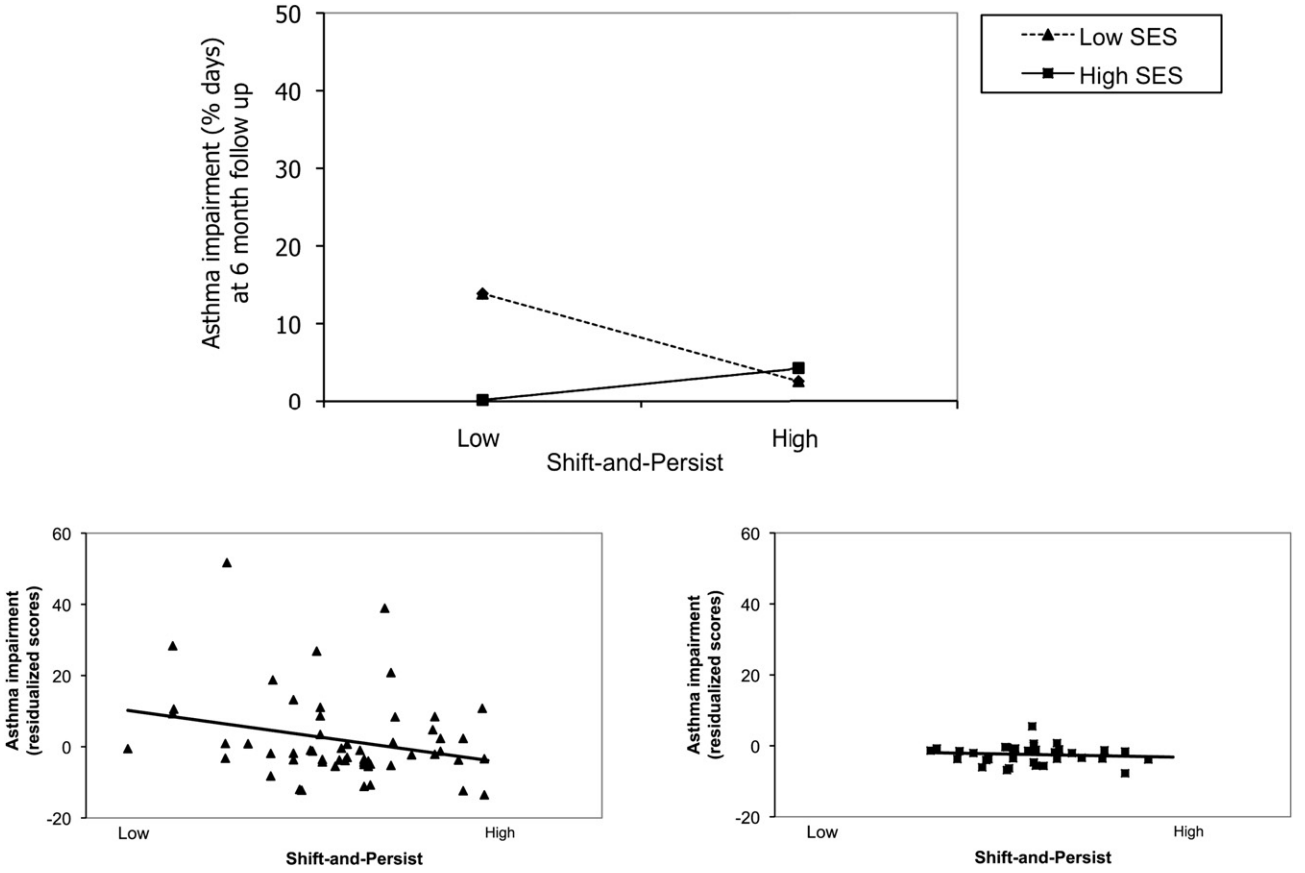

FIG 2. *Top*, Interaction of SES (family savings) by shift-and-persist scores predicting asthma impairment at the 6-month follow-up, controlling for time 1 values. Asthma impairment reflects school absences and rescue inhaler use. Estimated asthma impairment values are plotted at ±1 SD of SES. *Bottom*, Individual data points for low- and high-SES subjects by median split. Asthma impairment was regressed onto covariates and residualized scores were plotted by shift-and-persist scores to obtain adjusted values for each participant. Because these are standardized residuals, values can be less than 0.

uniquely beneficial to low-SES children's asthma and that are different from those that are beneficial to high-SES children.

Our findings are consistent with those of several adult studies that have examined individual psychological characteristics that moderate the effects of SES on health outcomes. For example, perceived control buffered a community sample of adults who were low in SES from poor self-reported health, acute health symptoms, and functional limitations.[18] Similarly, high purpose in life buffered a community sample of adults who were low in SES from high levels of the inflammatory cytokine IL-6.[19] Our study is novel in documenting specific protective factors that emerge in childhood and in documenting their relevance to clinically relevant outcomes in a chronic disease, such as asthma.

In addition, our findings are also consistent with other studies that have examined the benefits of positive childhood social relationships for those low in SES. These studies have documented that factors such as maternal warmth can buffer low-SES subjects from adverse physiological and inflammatory risk profiles in both childhood and adulthood.[21,43,44] In the present study, rather than focusing on broader family contexts, we focused on children themselves and the characteristics that they can acquire to protect themselves from adverse health outcomes.

This type of work has important implications for efforts to reduce the increased burden of asthma among those lower in SES.[45,46] Our findings are important in documenting that it is possible for some children, despite being dealt a life of adversity, to experience good asthma control. Furthermore, this study identifies a set of psychological factors that contributes to this resilience. Because we pinpointed qualities that naturally occur in some low-SES children, this will hopefully allow researchers and clinicians to identify realistic targets for future interventions: if we can identify characteristics that some low-SES children already possess that promote good asthma profiles, these might be ones that could be most possible to alter through intervention in other low-SES subjects. To meaningfully reduce health disparities, we might need to tailor interventions to the realities of low-SES life and to acknowledge that approaches that work in higher-SES communities might not be similarly effective in a low-SES context.

The strengths of the present study include the longitudinal design; the multiple measures of inflammatory, pulmonary, and impairment outcomes; and the novel approach of focusing on strengths (rather than detrimental factors) within low-SES communities. Limitations include not having objective records of physician's visits and hospitalizations and not having longer monitoring periods for asthma outcomes and for examining variations by seasonality in asthma. In addition, because this study was observational, we cannot draw firm conclusions about causality. Future studies could undertake experimental manipulations of

shift-and-persist strategies and test the effects on asthma impairment in low-SES children. Finally, future studies should explore other factors associated with shift-and-persist strategies, such as temperament or family relationships, that might help explain the use of shift-and-persist strategies and their association with asthma outcomes.

In sum, children who came from low-SES backgrounds and who engaged in shift-and-persist strategies (dealing with stressors by reframing them more positively while at the same time persisting in optimistic thoughts about the future) showed better asthma profiles, both in terms of reduced inflammation at baseline and less asthma impairment at a 6-month follow-up. In contrast, shift-and-persist strategies were not beneficial to high-SES children with asthma. Future studies should test whether these effects extend to other chronic illnesses as well. Given that broader social policies (eg, antipoverty programs) and environments (eg, neighborhoods) can be difficult to change, an approach that focuses on low-SES children themselves and the psychological qualities they could develop to adapt to the stressors they are forced to confront on a daily basis might be both a practical and effective starting point in efforts toward the long-term goal of eventually eliminating health disparities by social class.

Key messages

- **Low SES is one of the most well-established social predictors of poor health, including asthma impairment; however, little is understood about why some low-SES individuals are able to exhibit good asthma control despite living under adverse conditions.**
- **This study identifies a psychological characteristic (shifting and persisting in response to stress) that protects children living in low-SES homes from detrimental asthma outcomes.**
- **An approach that focuses on the psychological qualities that children can possess for dealing with the stress of low-SES life might represent a practical and effective starting point for efforts to reduce health disparities across society.**

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