Cult. Brain (2017) 5:71–89
DOI 10.1007/s40167-016-0042-7

ORIGINAL RESEARCH ARTICLE

The relationship between parents' social network diversity and pulmonary function among children with asthma

Cynthia S. Levine[1] · Erika M. Manczak[1] · Paula J. Ham[1] · Van Le[1] · Edith Chen[1]

Accepted: 17 September 2016 / Published online: 22 September 2016

Abstract Regular contact with people from another racial or ethnic group can have physiological benefits. The present research explored whether these benefits extend to children who live in families with greater intergroup contact. Specifically, it investigated whether children with asthma had better pulmonary function if their parents reported having more people in their social network who were of a different race or ethnicity, and whether this relationship was moderated by the quality of the relationship between children and their parents. Consistent with hypotheses, results showed that the percentage of people in parents' social networks who were of a different race or ethnicity predicted better pulmonary function among children who reported higher quality relationships with their parents, but not among children who reported lower quality relationships. Thus, the racial/ethnic diversity of parents' social networks may play a role in protecting children's health, particularly when children are close to their parents.

Keywords Network diversity · Parent–child relationships · Asthma · Pulmonary function

Asthma is one of the most prevalent chronic health problems facing children in the United States today, affecting approximately 7 million people under the age of 18 (Bloom et al. 2013). Asthma complications are not only a large contributor to health care use, including nearly three-quarters of a million emergency department visits each year, but also have negative implications in other domains, such as children's

✉ Cynthia S. Levine
cynthia.levine@northwestern.edu

[1] Institute for Policy Research and Department of Psychology, Foundations of Health Research Center, Northwestern University, 1801 Maple Avenue, Suite 2450, Evanston, IL 60201, USA

well-being, school attendance, and academic performance (Bahadori et al. 2009; Centers for Disease Control and Prevention 2009; Ainbami et al. 2011; Moonie et al. 2006; Taras and Potts-Datema 2005). Recent research shows that, in addition to the biological and physical environmental factors that contribute to asthma, a child's social environment may also play a role. Characteristics of both children's own social relationships and the social relationships of their parents are related to better outcomes among children with asthma (Chen et al. 2006; Chen and Schreier 2008; Ehrlich et al. 2015a, b; G. E. Miller et al. 2009; Mrazek et al. 1999; Wood et al. 2015). Here, we investigate how a novel aspect of parents' social relationships that is likely to be important in increasingly diverse societies—namely, the racial diversity of parents' social networks—relates to pulmonary function among children with asthma.

Diverse social networks and physiology

As the U.S. moves toward a demographic composition where no one racial or ethnic group is in the majority (U.S. Census Bureau 2012), navigating relationships with people from different racial or ethnic backgrounds is increasingly important. However, for many people, intergroup interactions can be anxiety-provoking (Richeson and Shelton 2007; Shelton and Richeson 2006; Stephan and Renfro 2002). For majority group members, the threat of such interactions can stem from concerns that one will appear prejudiced; for minority group members, concerns often center around being the target of prejudice (Shelton et al. 2005; Vorauer and Kumhyr 2001).

Under the right circumstances, however, meaningful contact or close relationships with people from other racial and ethnic groups—both of which are likely to occur when one has diverse social networks—can reduce some of this anxiety. These types of interactions and relationships offer benefits such as reduced prejudice, increased empathy for people in other racial or ethnic groups, and improved well-being among people from disadvantaged racial or ethnic groups (Dovidio et al. 2003; Mendoza-Denton and Page-Gould 2008; Pettigrew and Tropp 2008).

The potential benefits of diverse social networks extend to physiology and health, as well. For example, in one study, non-African-Americans tended to experience a physiological "threat" response (i.e., increased peripheral vascular resistance) while interacting with an African-American confederate. However, such a response did not occur among those who reported more interactions with African-Americans, including a greater likelihood of having them as neighbors or close friends in their social networks, (Blascovich et al. 2001). Similarly, another study found that frequent contact with racial or ethnic outgroup members predicted greater cortisol recovery and vagal rebound after giving a stressful speech when evaluated by an outgroup member but not when evaluated by an ingroup member (Page-Gould et al. 2010). In line with these results, immigrants whose social networks are more diverse (i.e., include more non-immigrants), have better self-rated health (Rostilla 2010). However, to our knowledge, little research has examined whether parents' network

diversity has implications for their children's health, or how intergroup contact or network diversity relates to objectively measured health symptoms, such as pulmonary function, among individuals with asthma.

Relationship between parents' network diversity and children's experiences

Here, we propose that the benefits of having a diverse social network may extend not only to individuals themselves but also to their children. Previous research links multiple positive aspects of parents' social relationships to their children's health. For example, when parents have strong ties to the community, their children have better health outcomes related to weight, height, and having nutritional needs met (De Silva and Harpham 2007; Nobles and Frankenberg 2009; Sujarwoto and Tampubolon 2013). With respect to asthma in particular, children with asthma whose parents have more social support wheeze less and are less likely to be admitted to the emergency department because of their asthma (Rand et al. 2000; Weil et al. 1999). To our knowledge, however, no research has examined how the diversity of parents' social networks relates to children's asthma outcomes. Thus, in the present research, we explore how this novel characteristic of parents' social relationships might also play a positive role in children's health.

We further propose that the transmission of these benefits of parents' social networks to children may only occur under specific circumstances. Specifically, we suggest that parents' diverse social networks are likely to be associated with better pulmonary function among children with asthma when parents and children have closer relationships. There is research to suggest that the characteristics of one person in a relationship (e.g., a parent) benefit another person (e.g., a child) physiologically specifically when the people in the relationship are closer. For example, people exhibit less cardiovascular reactivity when they receive emotional support from someone with whom they have a positive, rather than a negative, relationship (Uno et al. 2002). In addition, children are more likely to learn from their parents when they are attached to and identified with them (Bandura 1997; Bretherton et al. 1997; Sinclair et al. 2005). As a result, we propose that when children have higher quality relationships with their parents, the diversity of parents' social networks will predict better pulmonary function in their children, but when parents and children have lower quality relationships, no such relationship will emerge.

Study overview

The present research investigated whether children with asthma had better pulmonary function if their parents reported having a more racially or ethnically diverse social network and were close to their children. We tested whether parents' network diversity related to children's lung function and whether this relationship would be moderated by the quality of the parent–child relationship. We

hypothesized that parents' network diversity would predict better pulmonary function specifically among children who reported that they had better relationships with their parents. In addition, we conducted secondary analyses to explore the role of the child's race, the family's socioeconomic status, type of relationship that a social network member had with the parent (i.e., family member versus friend). We hypothesized that our expected patterns would hold across all of these factors.

Method

Participants

Participants were 150 families who had a child (ages 9–17) diagnosed by a physician with asthma. Children came to the lab with one parent. Families were required to be fluent in English, and children were free of acute respiratory illness at the time of the visit and chronic physical illnesses other than asthma. Families were recruited via health care centers, and thus, all children had access to treatment for their asthma.

Children had a mean age of 14.12 (SD 2.07), were 56.6 % male. In terms of children's race/ethnicity, 15 were Asian, 9 were Hispanic/Latino, 30 were Black/African American, 74 were White, and 22 were multiracial. Parents had a mean age of 45.97 (SD 6.66) and were 12.0 % male. In terms of parents' race/ethnicity, 17 were Asian, 10 were Hispanic/Latino, 32 were Black/African American, 85 were White, and 6 were multiracial. In terms of parents' level of educational attainment, parents reported the highest degree they had earned on a scale where 1 = less than high school, 2 = high school diploma, 3 = some college, 4 = bachelor's degree, and 5 = graduate degree. The mean level of educational attainment was 3.81 (SD 1.15) on this scale, with 65.33 % of parents having attained at least a bachelor's degree.

Procedure

Parents' network diversity

Parents reported on the diversity of their social networks. They first listed up to 6 people with whom they discussed important matters and up to 6 people with whom they socialized (Marin and Hampton 2007). This method of probing members of participants' social networks has been found to produce a consistently reliable estimate of social network composition. For each person on this list of up to 12 names, participants reported on the demographics of that person, including whether that person was the same racial/ethnic group as them (yes/no). A network diversity score was calculated by dividing the number of people who were not the same race as the participant by the total number of people listed.

Parent–child relationship quality

Children reported on parent–child relationship quality by rating the frequency of negative interactions between mothers and their children (e.g., mother shouted or yelled at them, criticized them or their ideas) in the past 12 months. Children rated their agreement with 14 items, which were based on items used in research by Brody et al. (2001). Responses were given on a 4-point scale from "never" to "always." Scores were reverse coded and averaged to create a composite ($\alpha = .88$), such that higher scores indicated better relationship quality.

Child pulmonary function

Children's pulmonary function was assessed in the laboratory using spirometry (Microloop, CareFusion, Basingstoke, UK), according to American Thoracic Society guidelines (M. R. Miller et al. 2005). Spirometry is considered the gold standard for assessing pulmonary function (American Thoracic Society 2004). Assessments were conducted at least four hours after children had last used a short-acting bronchodilator and 24 h after children had last used a long-acting bronchodilator. Using a mouthpiece, children were asked to inhale as much air as possible and to exhale as hard and fast as possible and to continue exhaling for 6 s. This procedure yields three indices of pulmonary function: forced expiratory volume in 1 s (FEV_1; the amount of air expelled from the lung during the first second of a forced expiratory maneuver that is started from full lung capacity, i.e., maximal inspiration), forced vital capacity (FVC; the total amount of air forcefully exhaled following a maximal inspiration), and peak expiratory flow (PEF; the maximal exhalation rate achieved during a forced expiratory maneuver, expressed as liters per second). Each of these three measures indexes a different aspect of pulmonary function. FEV_1 captures whether obstruction in the lungs prevents a child from forcing air out quickly. FVC captures total lung capacity or how much air a child can get into his or her lungs at one time. PEF captures force, or how quickly air can be expelled. For all three outcomes, percentile scores were calculated as a percentage of predicted values, based on the child's age, gender, ethnicity, height, and weight (Wang et al. 1993). Higher scores indicate better pulmonary function.

Covariates

Analyses controlled for children's inhaled corticosteroid use (used in the past week: yes/no), children's beta-agonist use (used in the past week: yes/no), and asthma severity (based on symptom frequency and medications prescribed, following the recommendations of the National Asthma Education and Prevention Program/Expert Panel Report 2 Guidelines and following the approach of past researchers; Chen et al. 2007; Bacharier et al. 2004), as well as for age, gender, and ethnicity (White versus not White).

Results

Descriptive statistics for the sample are presented in Table 1, and correlations among the variables are presented in Table 2.

Multiple hierarchical regression analyses were conducted. Inhaled corticosteroid use, beta-agonist use, asthma severity, and demographics were entered in Step 1, network diversity and parent–child relationship quality were entered in Step 2, and the interaction between network diversity and parent–child relationship quality was entered in Step 3. Simple slope analyses tested the relationship between parent network diversity and pulmonary function among children who reported relationships with their parents that were 1 standard deviation above and below the mean (i.e., had better or worse relationships with their parents). Analyses were conducted separately for each outcome variable. See Table 3 and Fig. 1 for details.

For FEV_1, there was not a significant main effect of network diversity, $b = 1.63$, SE 1.14, $t(139) = 1.42$, $p = .16$. However, there was a significant main effect of the quality of children's relationships with their parents, such that better relationships predicted better FEV_1, $b = 3.22$, SE 1.19, $t(139) = 2.93$, $p = .008$. This main effect was qualified by the predicted significant interaction, $b = 4.29$, SE 1.46, $t(139) = 2.93$, $p = .004$. As expected, among children who had better relationships with their parents, greater network diversity predicted better FEV_1, $b = 5.92$, SE 1.86, $t(139) = 3.19$, $p = .002$. However, among children who had worse relationships with their parents, greater network diversity predicted marginally lower FEV_1, $b = -2.26$, SE 1.32, $t(139) = -1.72$, $p = .09$.

For FVC, there was a main effect of network diversity, $b = 2.31$, SE 1.19, $t(139) = 1.95$, $p = .053$, but no significant main effect of the quality of children's relationships with their parents, $b = 1.16$, SE 1.23, $t(139) = .94$, $p = .35$. The expected interaction between network diversity and quality of children's relationships with their parents was also not significant, $b = 1.79$, SE 1.52, $t(139) = 1.18$, $p = .24$, although it was in the predicted direction. Among children who had better relationships with their parents, greater network diversity predicted better FVC, $b = 4.10$, SE 1.92, $t(139) = 2.14$, $p = .03$. Among children who had worse

Table 1 Descriptive statistics

	N	*M* or %	*SD*
Age (years)	150	14.12	2.07
Child gender (% male)	150	56.6	
Child ethnicity (% White)	150	60.7	
Inhaled corticosteroid use (% yes)	150	70.4	
Beta-agonist use (% yes)	150	94.7	
Asthma severity	150	2.40	1.00
Network diversity (% other race/ethnicity)	149	0.17	0.25
Parent–child relationship quality	150	2.44	0.38
FEV_1 (% predicted)	150	95.35	14.08
FVC (% predicted)	150	100.78	13.83
PEF (% predicted)	150	97.34	16.72

Table 2 Correlations among variables

	1	2	3	4	5	6	7	8	9	10
Age (1)										
Gender (2)	.09									
Ethnicity (3)	.12	.06								
Inhaled cortico-steroid Use (4)	.001	−.05	.03							
Beta-agonist use (5)	−.02	.04	−.03	.04						
Asthma severity (6)	.01	.04	−.16^{+}	.49***	.13					
Network diversity (7)	.007	−.02	−.16*	−.10	−.10	.12				
Relationship quality (8)	−.14	.09	.13	−.11	.02	−.09	−.02			
FEV_1 (9)	.07	.10	.13	−.14^{+}	−.03	−.20*	.09	.18*		
FVC (10)	.09	.09	.07	−.07	.01	−0.08	.14	.08	.74***	
PEF (11)	.06	.09	.06	.07	−.05	−.05	.05	.09	.60***	.32***

$^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

relationships with their parents, greater network diversity did not predict FVC, $b = .52$, SE 1.93, $t(139) = .27$, $p = .79$.

For PEF, there was not a significant main effect of network diversity, $b = 1.35$, SE 1.41, $t(139) = .96$, $p = .34$, but there was a marginal main effect of the quality of children's relationships with their parents, $b = 2.64$, SE 1.46, $t(139) = -1.81$, $p = .07$. In addition, the expected significant interaction between network diversity and quality of children's relationships with their parents emerged, $b = 5.29$, SE 1.80, $t(139) = 2.94$, $p = .004$. Among children whose relationships with their parents were better, greater network diversity predicted better PEF, $b = 6.64$, SE 2.28, $t(139) = 2.92$, $p = .004$. Among children whose relationships with their parents were worse, greater network diversity did not predict PEF, $b = -3.94$, SE 2.29, $t(139) = -1.72$, $p = .09$.

Secondary analyses

We also conducted additional analyses to further explore these effects. First, we tested whether children's race moderated the effect of parents' network diversity and parent–child relationship quality on children's pulmonary function. To do so, we again conducted multiple hierarchical regression analyses, testing the three-way interaction between network diversity, parent–child relationship quality, and child race (White versus not White). These three-way interactions were not significant for FEV_1, $b = -2.99$, SE 2.89, $t(135) = -1.00$, $p = .32$; FVC, $b = 3.75$, SE 3.10, $t(135) = 1.21$ $p = .23$; or PEF, $b = -4.95$, SE 3.63, $t(135) = -1.36$, $p = .17$, indicating that network diversity and parent–child relationship quality interacted to predict pulmonary function in the same way for both children who were White and children who were not White.

Table 3 Multiple regression analyses

	Model 1 *b* (SE)	Model 2 *b* (SE)	Model 3 *b* (SE)
Forced expiratory volume			
Age	.68 (6.41)	.98 (1.16)	.68 (1.13)
Gender	2.82 (2.33)	2.53 (2.31)	2.53 (2.25)
Ethnicity	2.62 (2.40)	2.35 (2.42)	2.13 (2.36)
Inhaled corticosteroid use	−2.00 (2.91)	−.86 (2.92)	−.48 (2.85)
Beta-agonist use	−2.17 (5.84)	−1.33 (5.80)	.94 (5.71)
Asthma severity	−2.25 (1.34)$^{+}$	−2.53 (1.35)$^{+}$	−2.26 (1.32)$^{+}$
Network diversity		1.65 (1.18)	1.63 (1.14)
Parent–child relationship quality		2.25 (1.18)$^{+}$	3.22 (1.19)**
Diversity × relationship			4.29 (1.46)**
R^2 change		.04^{+}	.05**
Forced vital capacity			
Age	1.12 (1.16)	1.19 (1.17)	1.06 (1.17)
Gender	2.00 (2.34)	1.99 (2.33)	1.99 (2.33)
Ethnicity	1.48 (2.41)	1.84 (2.44)	1.75 (2.44)
Inhaled corticosteroid use	−1.09 (2.92)	.05 (2.95)	.20 (2.95)$^{+}$
Beta-agonist use	.95 (5.86)	2.33 (5.86)	3.28 (5.91)
Asthma severity	−.80 (1.35)	−1.25 (1.36)	−1.14 (1.36)
Network diversity		2.32 (1.19)$^{+}$	2.31 (1.19)$^{+}$
Parent–child relationship quality		.75 (1.19)	1.16 (1.23)
Diversity × relationship			1.79 (1.52)
R^2 change		.03	.01
Peak expiratory flow			
Age	.85 (1.40)	1.04 (1.42)	.66 (1.39)
Gender	3.08 (2.83)	2.91 (2.84)	2.91 (2.76)
Ethnicity	1.06 (2.91)	.97 (2.97)	.69 (2.89)
Inhaled corticosteroid use	4.68 (3.52)	5.55 (3.58)	6.01 (3.49)$^{+}$
Beta-agonist use	−3.20 (7.07)	−2.47 (7.13)	.34 (7.01)
Asthma severity	−1.75 (1.63)	−2.00 (1.66)	−1.66 (1.62)
Network diversity		1.37 (1.44)	1.35 (1.41)
Parent–child relationship quality		1.44 (1.44)	2.64 (1.46)$^{+}$
Diversity × relationship			5.29 (1.80)**
R^2 change		0.01	0.06**

The table shows regression coefficients for the analyses predicting forced expiratory volume, forced vital capacity, and peak expiratry flow. Age, gender, ethnicity (White versus not White), inhaled corticosteroid use in the last week, beta-agonist use in the past week, and asthma severity were entered in Model 1, followed by network diversity and parent–child relationship quality in Model 2, followed by the interaction between network diversity and parent–child relationship quality in Model 3

$^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

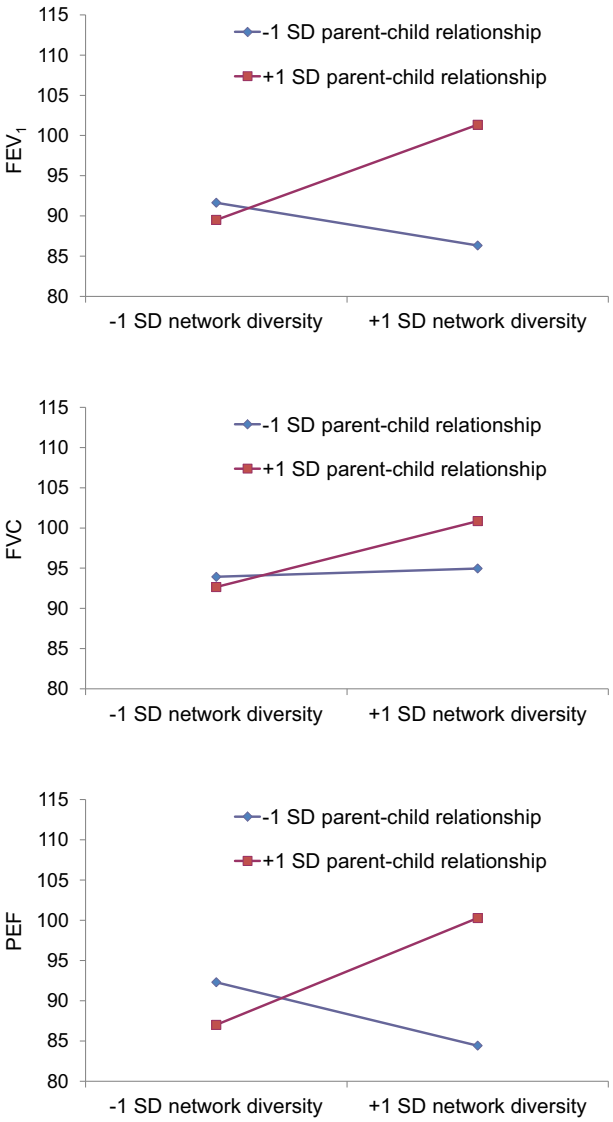

Fig. 1 Relationship between parent network diversity and child lung function as a function of the quality of the relationship between parents and children

We also explored whether level of parents' educational attainment could account for or moderate our findings. When parents' highest degree was added as a covariate in the analyses parent network diversity and parent–child relationship quality still interacted to predict FEV_1, $b = 4.41$, SE 1.47, $t(138) = 3.00$, $p = .003$ and PEF, $b = 5.29$, SE 1.81, $t(138) = 2.92$, $p = .004$, with the interaction for FVC still not reaching significance, $b = 1.99$, SE 1.52, $t(138) = 1.31$, $p = .19$. In addition, we tested whether parents' educational attainment moderated our findings. The three-

way interactions between network diversity, parent–child relationship quality, and parents' highest degree was not significant for FEV_1, $b = -.18$, SE 1.63, $t(135) = -.11$, $p = .91$, FVC, $b = -.41$, SE 1.66, $t(135) = -.25$ $p = .81$, or PEF, $b = -1.88$, SE 2.03, $t(135) = -.93$, $p = .35$, indicating that network diversity and parent–child relationship quality interacted to predict pulmonary function in the same way across parents' levels of educational attainment.

Finally, we explored whether it made a difference whether the members of parents' social networks that were of a different race/ethnicity than the parents were family members or non-family members. For each member of the social network, parents indicated whether the person was a family member (spouse, partner, other family member) or non-family member (friend or acquaintance). We then calculated two separate network diversity scores. One reflected diversity of social network members who were family and was calculated by dividing the total number of people listed who were family members and who were of another race/ethnicity by the total number of people listed who were family members. Another reflected diversity of social network members who were friends and was calculated in a similar manner. These two scores were correlated with each other ($r = .48$, $p < .001$). When we conducted regression analyses using these family and friends social network diversity scores, rather than the overall social network diversity scores, they both interacted with parent–child relationship quality to predict the outcomes in the same way that the general network diversity score did. For the family network diversity score, significant interactions emerged for FEV_1, $b = 2.47$, SE 1.12, $t(139) = 2.20$, $p = .03$ and PEF, $b = 3.71$, SE 1.35, $t(139) = 2.76$, $p = .007$, and as with the overall network diversity score, the interaction predicting FEC was not significant, $b = 1.12$, SE 1.18, $t(139) = .96$, $p = .34$. For the friend network diversity score, significant interactions emerged for FEV_1, $b = 4.59$, SE 1.56, $t(139) = 2.94$, $p = .004$ and PEF, $b = 6.53$, SE 1.92, $t(139) = 3.40$, $p = .001$, and as with the overall network diversity score, the interaction predicting FEC was not significant, $b = 1.75$, SE 1.62, $t(139) = 1.08$, $p = .29$. Thus, diversity of both family and friendship social networks among parents seems to play a similar role in children's health.

Discussion

Our results suggest that a culturally-relevant psychological variable in parents—the racial/ethnic diversity of their social networks—matters for health outcomes in their children. Specifically, among children with asthma who had higher quality relationships with their parents, the more diverse parents' networks, the better children's pulmonary function. Among children who had lower quality relationships with their parents, there was no relationship between parents' network diversity and children's pulmonary function. These findings hold across racial groups, are neither explained nor moderated by socioeconomic status, and occur when both parents' family networks and friendship networks are diverse. Our results add to the literature showing that social relationships in general and parents' relationships in particular matter for children's health (Mrazek et al. 1999; Wood et al. 2015). Furthermore, they highlight the importance of diverse social networks, which are

likely to have multiple positive implications in an increasingly diverse American society, where racial harmony is seen as a cultural ideal.

Within a particular cultural context, the prevalent cultural ideas, institutions, and interactions give shape and meaning to people's psychological experiences (Markus and Kitayama 2010; Markus and Conner 2014). In U.S. society, pervasive cultural ideas such as the value placed on racial equality and diversity (Ball-Rokeach and Loges 1994) and changing demographics increasingly require people to interact with others whose racial and ethnic backgrounds differ from their own. At the same time, continuing individual- and institutional-level discrimination against people of color, and White people's fears of appearing prejudiced can make the prospect of interracial interactions fraught for everyone (Markus and Conner 2014; Shelton and Richeson 2006; Shoff and Yang 2012). We speculate that diverse social networks may help to mitigate this tension between the ideals of equality and the need to interact with racial outgroup members on one hand and concerns about such interactions on the other. By helping to build trust across groups, such networks may provide resources to parents and children with asthma, which, in turn, may have protective effects for children's health.

As such, the present findings extend the existing research on intergroup contact and physiological outcomes. This previous work—primarily conducted in the laboratory—has found that intergroup contact is associated with more of a physiological "challenge," rather than a "threat" response when interacting with a partner of a different race and greater cortisol recovery and vagal rebound when being evaluated by someone of a different race (Blascovich et al. 2001; Page-Gould et al. 2010). Here, we show that, under the right circumstances, similar benefits extend to children.

Notably, this previous work and present research differ not only in their focus on benefits to individuals versus benefits to their children, but also in that the previous work focused on responses to a specific intergroup stressor, while the present work does not. Nonetheless, we believe that the implications may be similar. Though we do not have data to address this point, we suggest that, because the participants in our research live in a diverse major metropolitan area, they are likely to have to interact with people from other racial groups on a regular basis. If these regular interactions are stressful or threatening to them—which, we speculate is more likely for people in families with less diverse networks—then they could experience these regular interactions as a source of stress or threat. Such stress or threat could, in turn, influence how parents interact with their children, how families cope with children's asthma, or the severity of children's own physiological responses and, in turn children's pulmonary function.

Possible mechanisms

The goal of this study was to document a relationship between the diversity of parents' social networks and the pulmonary function of children with asthma. The study was not equipped to explore potential pathways underlying the interaction between parents' network diversity and parent–child relationship quality in predicting children's pulmonary functioning. However, below we speculate about

reasons why the diversity of parents' social networks in conjunction with high parent–child relationship quality could matter for their children's health. All of these potential mechanisms would need to be tested in future research.

One possibility is that parents with diverse networks have greater social support, which would also have positive implications for children's asthma (Rand et al. 2000; Weil et al. 1999). It is also possible that parents with diverse social networks have access to more tangible resources, such as better professional advice or connections that, in turn, improve children's asthma when children have higher quality relationships with their parents. In addition to these more general resources, parents who have more diverse social networks might have greater access to asthma-specific resources, such as medical knowledge and knowledge about medical resources, which could improve children's asthma outcomes (Bindman et al. 1995).

We also speculate that reduced levels of anxiety in parents could underlie our observed effects. For both majority and minority group members, intergroup interactions can be stressful and anxiety-provoking (Richeson and Shelton 2007; Shelton and Richeson 2006; Stephan and Renfro 2002), but having diverse social networks could reduce the extent to which this is true. Such changes, could, in turn, have protective effects for children's asthma (Wolf et al. 2008; Wright et al. 2002).

Other possible mechanisms might involve children's psychological and social experiences. Specifically, parents' diverse social networks, in combination with high quality parent–child relationships, could reduce the stress that children experience, in turn, improving their asthma (Chen and G. E. Miller 2007). We further speculate that children who are close to their parents may interact directly with members of their parents' diverse social networks or develop more diverse networks or accepting attitudes themselves (Bigler and Liben 2007; Castelli et al. 2008; Edmonds and Killen 2009; Espinoza et al. in press; Meeusen 2014; Sinclair et al. 2005). Such experiences would have the potential to protect children physiologically when they interact with people of other races (Blascovich et al. 2001; Page-Gould et al. 2010).

A final potential psychosocial mechanism involves interactions with healthcare providers, especially among members of stigmatized racial groups. For many African American and Latino families, whose racial groups are underrepresented in the medical profession, seeking treatment for their children's asthma involves interacting with and trusting physicians who are of a different race (Deville et al. 2015). Having diverse social networks might help these parents to trust these physicians, which, in turn, could improve the care their children receive or the extent to which they make use of this care (Boulware et al. 2003; Piette et al. 2005; Stepanikova et al. 2006). Again, this is speculative and would need to be tested in future research.

In addition to the psychosocial mechanisms, there are multiple biological pathways that we speculate might be relevant. Asthma is characterized by inflammation and airway obstruction that occurs as a result of hyper-responsiveness to triggers such as allergens or infections. As a part of this process, T-helper lymphocytes release chemical messengers called cytokines. One particular type of

cytokine, Th-2 cytokines, such as interleukin 4, interleukin 5, and interleukin 13 (IL-4, 5, and 13), are believed to play a key role in asthma (Chung and Barnes 1999; Mackay et al. 2001). IL-4 and IL-13 promote the release of immunoglobulin E (IgE) molecules, which then bind to mast cells in the lungs, and cause the release of mediators that increase mucus production and inflammation. In addition, the Th-2 cytokine IL-5 recruits cells called eosinophils, which, in turn, release mediators that contribute to airway inflammation. Parasymapethic activation is also relevant to asthma. Specifically, asthma triggers can increase the extent to which the parasympathetic fibers that connect the vagus nerve to the airway are activated in children with asthma, thus increasing bronchoconstriction (B. D. Miller and Wood 1994; Wright et al. 1998). Psychosocial factors such as stress or characteristics of the social environment can exacerbate or minimize these inflammatory and parasympathetic processes (Brunst and Wright 2016; Chen and G. E. Miller 2007; Chen and Schreier 2008). We speculate that the combination of parents' network diversity and high quality parent–child relationships could play a similarly protective role.

Finally, it is possible that social relationships could have implications for brain function, and through brain-immune pathways, could then influence health. For example, when children have strong relationships with their parents, parents' diverse social networks might reduce the sense of threat that children would otherwise perceive from other racial groups. Perceptions of threat give rise to increased activation of the amygdala and prefrontal cortex (Amodio 2008). Repeated activation in these regions has been linked to heightened inflammation (G. E. Miller et al. 2011; Nusslock and G. E. Miller 2015). In turn, heightened inflammatory profiles are implicated in asthma exacerbations. Thus, to the extent that exposure to parents' diverse networks reduces the sense of threat that children perceive from outgroups, their asthma could be improved.

Limitations

Despite its contributions, this study has limitations. First, it is correlational. Consequently, it is not possible to know whether parents' diverse networks help to foster better lung function in children when parents and children are close, whether healthier children allow parents the freedom and flexibility to form more diverse social networks, or whether a third variable is at play. For example, parents who have better mental health might be both better able to develop friendships with people who are different from them (i.e., of a different race or ethnicity) and better able to provide support for their children in a manner that translates into improved pulmonary function among children. Future research could measure both parents' network diversity and children's and pulmonary function over time or experimentally create intergroup friendships in order to better understand the directionality and causality of these relationships.

Another set of limitations relates to the measures of several constructs. Network diversity was measured by a single yes/no item for each network member and did not assess the frequency or nature of contact with any of these individuals. In

addition, children's health was measured only by pulmonary function on one day in the laboratory, rather than by physician assessment or by repeated measurements.

Implications and future directions

Future research could test the potential mechanisms underlying the observed relationships, the causal direction of the relationships, and potential moderators of the effects. It would be especially important to understand more about how parents' diverse networks relate to children's experiences when parents and children have high quality relationships. We have speculated about a number of mechanisms that could underlie the interactive effects of parents' diverse social networks and parent–child relationship quality on children's pulmonary function. Future research might measure possible psychosocial mediators such as parents' support or access to resources, the extent to which children interact with members of parents' social networks or have diverse networks of their own, or the amount of stress or anxiety that parents or children experience. At the biological level, future research could test possible inflammatory, parasympathetic, or neurological pathways. Additional research might also examine children's physiological responses to specific intergroup stressors as a function of their parents' network diversity, in a manner similar to the previous network diversity and physiology research with adults (Blascovich et al. 2001; Page-Gould et al. 2010).

Furthermore, in order to test whether parents' diverse social networks improve children's pulmonary function, parents might be experimentally induced to form close relationships with people from other racial or ethnic groups (Aron et al. 1997; Page-Gould et al. 2008), and then children's pulmonary function could be measured at a later time. Future research could also measure additional moderators, such as the diversity of the neighborhood in which the family lives. We speculate that diverse social networks are likely to be associated with better asthma outcomes for children when families live in diverse areas and, thus, parents and children encounter people of different racial backgrounds more regularly.

Messages in the culture

If parents' diverse social networks do better pulmonary function among children with asthma, changing cultural messages in order to promote more diverse social networks might benefit children's health. For example, the idea that interracial interactions offer opportunities to learn, rather than the prospect of making mistakes, can facilitate positive interracial interactions (Carr et al. 2012; Migacheva and Tropp 2012; Murphy et al. 2011). Societies that promote and foster such a mindset might lay the groundwork for more diverse social interactions, and eventually the formation of more diverse social networks. Furthermore, racial and ethnic minorities often feel more included and willing to engage with institutions such as schools, workplaces, or legal systems that promote messages of multiculturalism, the view that it is important to recognize and value differences,

rather than colorblindness, the idea that differences do not matter (Apfelbaum et al. 2012; Plaut 2010; Purdie-Vaughns et al. 2008). Multicultural messages might help to create diverse institutions and settings that might offer opportunities for interracial and interethnic friendships to grow. The present work suggests that this, in turn, might give rise to better health among family members of those in these diverse social networks.

Conclusion

Overall, our results suggest that, if parents and children have high quality relationships, then the racial/ethnic diversity in parents' social networks may help to promote more optimal lung functioning in their children with asthma. Parents who have more diverse social networks may have the potential to provide resources to children with asthma that could help improve their children's pulmonary function, particularly when their relationships with their children are good. More generally, the results raise the possibility that families that are socially integrated with a wide variety of people within a cultural context may have better health.

Acknowledgments This research was supported by a grant from the National Heart Lung and Blood Institute (HL108723) to Edith Chen, a grant from the National Heart, Lung, and Blood Institute (F32HL119021) to Cynthia S. Levine, and a grant from the National Institute of Mental Health (F31MH105092) to Erika M. Manczak.

References

Ainbami, L. J., Moorman, J. E., & Liu, X. (2011). Asthma prevalence, health care use, and mortality: United States, 2005–2009. *National Center for Health Statistics Reports, 32*, 1–15.

American Thoracic Society. (2004). *Standards for the diagnosis and management of participants with COPD*. New York: American Thoracic Society.

Amodio, D. M. (2008). The social neuroscience of intergroup relations. *European Review of Social Psychology, 19*, 1–54. doi:10.1080/10463280801927937.

Apfelbaum, E. P., Norton, M. I., & Sommers, S. R. (2012). Racial colorblindness: Emergence, practice, and implications. *Current Directions in Psychological Science, 21*, 205–209. doi:10.1177/0963721411434980.

Aron, A., Mellinat, E., Aron, E. N., Vallone, R. J., & Bator, R. J. (1997). The experimental generation of interpersonal closeness: A procedure and some preliminary findings. *Personality and Social Psychology Bulletin, 23*, 363–377. doi:10.1177/0146167297234003.

Bacharier, L. B., Strunk, R. C., Mauger, D., White, D., Lemanske, R. F., & Sorkness, C. A. (2004). Classifying asthma severity in children: Mismatch between symptoms, medication use, and lung function. *American Journal of Respiratory and Critical Care, 170*, 426–432. doi:10.1164/rccm.200308-1178OC.

Bahadori, K., Doyle-Waters, M. M., Marra, C., Lynd, L., Alasaly, K., Swiston, J., et al. (2009). Economic burden of asthma: A systematic review. *BMC Pulmonary Medicine, 9*, 24. doi:10.1186/1471-2466-9-24.

Ball-Rokeach, S. J., & Loges, W. E. (1994). Choosing equality: The correspondence between attitudes about race and the value of equality. *Journal of Social Issues, 50*, 9–18. doi:10.1111/j.1540-4560.1994.tb01195.x.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bigler, R. S., & Liben, L. S. (2007). Developmental intergroup theory: Explaining and reducing children's social stereotyping and prejudice. *Current Directions in Psychological Science, 16*, 162–166. doi:10.1111/j.1467-8721.2007.00496.x.

Bindman, A. B., Grumbach, K., Osmond, D., Komaromy, M., Vranizan, K., Lurie, N., et al. (1995). Preventable hospitalizations and access to health care. *Journal of the American Medical Associations, 274*, 305–311. doi:10.1001/jama.1995.03530040033037.

Blascovich, J., Mendes, W. B., Hunter, S. B., Lickel, B., & Kowai-Bell, N. (2001). Perceiver threat in social interactions with stigmatized others. *Journal of Personality and Social Psychology, 80*, 253–267. doi:10.1037/0022-3514.80.2.253.

Bloom, B., Jones, L. I., Freeman, G. (2013). Summary health statistics for U.S. children: National Health Interview Survey, 2012. *National Center for Health Statistics. Vital Health Statistics.*

Boulware, L. E., Cooper, L. A., Ratner, L. E., LaVeist, T. A., & Powe, N. R. (2003). Race and trust in the health care system. *Public Health Reports, 118*, 358–365.

Bretherton, I., Golby, B., & Cho, E. (1997). Attachment and the transmission of values. In J. E. Grusec & L. Kuczynski (Eds.), *Parenting and children' s internalization of values: A handbook of contemporary theory* (pp. 103–134). New York: Wiley.

Brody, G. H., Conger, R., Gibbons, F. X., Ge, X., Murry, V. M., Gerrard, M., et al. (2001). The influence of neighborhood disadvantage, collective socialization, and parenting on African American children's affiliation with deviant peers. *Child Development, 72*, 1231–1246. doi:10.1111/1467-8624.00344.

Brunst, K. J., & Wright, R. J. (2016). Social disparities in lung growth and respiratory health. In L. B. Gerald & C. E. Berry (Eds.), *Health disparities in respiratory medicine* (pp. 147–171). New York: Humana Press.

Carr, P. B., Dweck, C. S., & Pauker, K. (2012). "Prejudiced" behavior without prejudice? Beliefs about the malleability of prejudice affect interracial interactions. *Journal of Personality and Social Psychology, 103*, 452–471. doi:10.1037/a0028849.

Castelli, L., De Dea, C., & Nesdale, D. (2008). Learning social attitudes: Children's sensitivity to the nonverbal behaviors of adult models during interracial interactions. *Personality and Social Psychology Bulletin, 34*, 1504–1513. doi:10.1177/0146167208322769.

Centers for Disease Control and Prevention. (2009). *National Center for Health Statistics: National Hospital Ambulatory Medical Care Survey*. Washington, DC: US Department of Health and Human Services, National Center for Health Statistics.

Chen, E., Chim, L. S., Strunk, R. S., & Miller, G. E. (2007). The role of the social environment in children and adolescents with asthma. *American Journal of Respiratory and Critical Care Medicine, 176*, 644–649. doi:10.1164/rccm.200610-1473OC.

Chen, E., Hanson, M. D., Paterson, L. Q., Griffin, M. J., Walker, H. A., & Miller, G. E. (2006). Socioeconomic status and inflammatory processes in childhood asthma: The role of psychological stress. *Journal of Allergy and Clinical Immunology, 117*, 1014–1020. doi:10.1016/j.jaci.2006.01.036.

Chen, E., & Miller, G. E. (2007). Stress and inflammation in exacerbation of asthma. *Brain Behavior and Immunity, 21*, 993–999. doi:10.1016/j.bbi.2007.03.009.

Chen, E., & Schreier, H. M. C. (2008). Does the social environment contribute to asthma? *Immunology and Allergy Clinics of North America, 28*, 649–664. doi:10.1016/j.iac.2008.03.007.

Chung, K. F., & Barnes, P. J. (1999). Cytokines in asthma. *Thorax, 54*, 825–857. doi:10.1136/thx.54.9.825.

De Silva, M. J., & Harpham, T. (2007). Maternal social capital and child nutritional status in four developing countries. *Health and Place, 13*, 341–355. doi:10.1016/j.healthplace.2006.02.005.

Deville, C., Hwang, W.-T., Burgos, R., Chapman, C. H., Both, S., & Thomas, C. R. (2015). Diversity in graduate medical education in the United States by race, ethnicity, and sex, 2012. *JAMA Internal Medicine, 175*, 1706. doi:10.1001/jamainternmed.2015.4324.

Dovidio, J. F., Gaertner, S. L., & Kawakami, K. (2003). Intergroup contact: The past, preset, and the future. *Group Processes and Intergroup Relations, 6*, 5–21. doi:10.1177/1368430203006001009.

Edmonds, C., & Killen, M. (2009). Do adolescents' perceptions of parental racial attitudes relate to their intergroup contact and cross-race relationships? *Group Processes and Intergroup Relations, 12*, 5–21. doi:10.1177/1368430208098773.

Ehrlich, K. B., Miller, G. E., & Chen, E. (2015a). Family functioning, eosinophil activity, and symptoms in children with asthma. *Journal of Pediatric Psychology, 40*, 781–789. doi:10.1093/jpepsy/jsv045.

Ehrlich, K. B., Miller, G. E., & Chen, E. (2015b). Harsh parent–child conflict is associated with decreased anti-inflammatory gene expression and increased symptom severity in children with asthma. *Development and Psychopathology, 27*, 1547–1554. doi:10.1017/S0954579415000930.

Espinoza, G., Gonzales, N. A., & Fuligni, A. J. (in press). Parent discrimination predicts Mexican-American adolescent psychological adjustment 1 year later. *Child Development*. doi: 10.1111/cdev.12521

Mackay, I. R., Rosen, F. S., Busse, W. W., & Lemanske, R. F. (2001). Asthma. *New England Journal of Medicine, 344*, 350–362. doi:10.1056/NEJM200102013440507.

Marin, A., & Hampton, K. N. (2007). Simplifying the personal network name generator: Alternatives to traditional multiple and single name generators. *Field Methods, 19*, 163–193. doi:10.1177/1525822X06298588.

Markus, H. R., & Conner, A. (2014). *Clash! how to thrive in a multicultural world*. New York, NY: Plume.

Markus, H. R., & Kitayama, S. (2010). Cultures and selves: A cycle of mutual constitution. *Perspectives on Psychological Science, 5*, 420–430. doi:10.1177/1745691610375557.

Meeusen, C. (2014). The parent-child similarity in cross-group friendship and anti-immigrant prejudice: A study among 15-year old adolescents. *Journal of Research in Personality, 50*, 46–55. doi:10.1016/j.jrp.2014.03.001.

Mendoza-Denton, R., & Page-Gould, E. (2008). Can cross-group friendships influence minority students' well-being at historically White universities? *Psychological Science, 19*, 933–939. doi:10.1111/j.1467-9280.2008.02179.x.

Migacheva, K., & Tropp, L. R. (2012). Learning orientation as a predictor of positive intergroup contact. *Group Processes and Intergroup Relations, 16*, 426–444. doi:10.1177/1368430212455854.

Miller, G. E., Chen, E., & Parker, K. J. (2011). Psychological stress in childhood and susceptibility to the chronic diseases of aging: Moving toward a model of behavioral and biological mechanisms. *Psychological Bulletin, 137*, 959–997. doi:10.1037/a0024768.

Miller, G. E., Gaudin, A., Zysk, E., & Chen, E. (2009). Parental support and cytokine activity in childhood asthma: The role of glucocorticoid sensitivity. *Journal of Allergy and Clinical Immunology, 123*, 824–830. doi:10.1016/j.jaci.2008.12.019.

Miller, M. R., Hankinson, J., Brusasco, V., Burgos, F., Casaburi, R., Coates, A., et al. (2005). Standardisation of spirometry. *European Respiratory Journal, 26*, 319–338.

Miller, B. D., & Wood, B. L. (1994). Psychophysiologic reactivity in asthmatic children: A cholinergically mediated confluence of pathways. *Journal of the American Academy of Child and Adolescent Psychiatry, 33*, 1236–1245. doi:10.1097/00004583-199411000-00004.

Moonie, S. A., Sterling, D. A., Figgs, L., & Castro, M. (2006). Asthma status and severity affects missed school days. *Journal of School Health, 76*, 18–24. doi:10.1111/j.1746-1561.2006.00062.x.

Mrazek, D. A., Klinnert, M., Mrazek, P. J., Brower, A., McCormick, D., Rubin, B., et al. (1999). Prediction of early-onset asthma in genetically at-risk children. *Pediatric Pulmonology, 27*, 85–94. doi:10.1002/(SICI)1099-0496(199902)27:2<85:AID-PPUL4>3.0.CO;2-B.

Murphy, M. C., Richeson, J. A., & Molden, D. C. (2011). Leveraging motivational mindsets to foster positive interracial interactions. *Social and Personality Psychology Compass, 5*, 118–131. doi:10.1111/j.1751-9004.2010.00338.x.

Nobles, J., & Frankenberg, E. (2009). Mothers' community participation and child health. *Journal of Health and Social Behavior, 50*, 16–30. doi:10.1177/002214650905000102.

Nusslock, R., & Miller, G. E. (2015). Early-life adversity and physical and emotional health across the lifespan: A neuroimmune network hypothesis. *Biological Psychiatry, 80*, 23–32. doi:10.1016/j.biopsych.2015.05.017.

Page-Gould, E., Mendes, W. B., & Major, B. (2010). Intergroup contact facilitates physiological recovery following stressful intergroup interactions. *Journal of Experimental Social Psychology, 46*, 854–858. doi:10.1016/j.jesp.2010.04.006.

Page-Gould, E., Mendoza-Denton, R., & Tropp, L. R. (2008). With a little help from my cross-group friend: Reducing anxiety in intergroup contexts through cross-group friendship. *Journal of Personality and Social Psychology, 95*, 1080–1094. doi:10.1037/0022-3514.95.5.1080.

Pettigrew, T. F., & Tropp, L. R. (2008). How does intergroup contact reduce prejudice? Meta-analytic tests of three mediators. *European Journal of Social Psychology, 38*, 922–934. doi:10.1002/ejsp.504.

Piette, J., Heisler, M., Krein, S., & Kerr, E. (2005). The role of patient-physician trust in moderating medication nonadherence due to cost pressures. *JAMA Internal Medicine, 165*, 1749–1755. doi:10.1001/archinte.165.15.1749.

Plaut, V. C. (2010). Diversity science: Why and how difference makes a difference. *Psychological Inquiry, 21*, 77–99. doi:10.1080/10478401003676501.

Purdie-Vaughns, V., Steele, C. M., Davies, P. G., Ditlmann, R., & Crosby, J. R. (2008). Social identity contingencies: How diversity cues signal threat or safety for African Americans in mainstream institutions. *Journal of Personality and Social Psychology, 94*, 615–630. doi:10.1037/0022-3514.94.4.615.

Rand, C. S., Butz, A. M., Kolodner, K., Huss, K., Eggleston, P., & Malveaux, F. (2000). Emergency department visits by urban African American children with asthma. *Journal of Allergy and Clinical Immunology, 105*, 83–90. doi:10.1016/S0091-6749(00)90182-9.

Richeson, J. A., & Shelton, J. N. (2007). Negotiating interracial interactions: Costs, consequences, and possibilities. *Current Directions in Psychological Science, 16*, 316–320. doi:10.1111/j.1467-8721.2007.00528.x.

Rostilla, M. (2010). Birds of a feather flock together—and fall ill? Migrant homophily and health in Sweden. *Sociology of Health and Illness, 32*, 382–399. doi:10.1111/j.1467-9566.2009.01196.x.

Shelton, J. N., & Richeson, J. A. (2006). Interracial interactions: A relational approach. *Advances in Experimental Social Psychology, 38*, 121–181.

Shelton, J. N., Richeson, J. A., & Salvatore, J. (2005). Expecting to be the target of prejudice: Implications for interethnic interactions. *Personality and Social Psychology Bulletin, 31*, 1189–1202. doi:10.1177/0146167205274894.

Shoff, C., & Yang, T. (2012). Untangling the associations among distrust, race, and neighborhood environment: A social disorganization perspective. *Social Science and Medicine, 74*, 1342–1352. doi:10.1016/j.socscimed.2012.01.012.

Sinclair, S., Dunn, E., & Lowery, B. (2005). The relationship between parental racial attitudes and children's implicit prejudice. *Journal of Experimental Social Psychology, 41*, 283–289. doi:10.1016/j.jesp.2004.06.003.

Stepanikova, I., Mollborn, S., Cook, K. S., Thom, D. H., & Kramer, R. M. (2006). Patients' race, ethnicity, language, and trust in a physician. *Journal of Health and Social Behavior, 47*, 390–405. doi:10.1177/002214650604700406.

Stephan, W. G., & Renfro, C. L. (2002). The role of threat in intergroup relations. In D. M. Mackie & E. R. Smith (Eds.), *From prejudice to intergroup emotions: Differentiated reactions to social groups* (pp. 191–207). New York: Psychology Press.

Sujarwoto, S., & Tampubolon, G. (2013). Mother's social capital and child health in Indonesia. *Social Science and Medicine, 91*, 1–9. doi:10.1016/j.socscimed.2013.04.032.

Taras, H., & Potts-Datema, W. (2005). Childhood asthma and student performance at school. *Journal of School Health, 75*, 296–312. doi:10.1111/j.1746-1561.2005.00041.x.

Uno, D., Uchino, B. N., & Smith, T. W. (2002). Relationship quality moderates the effect of social support given by close friends on cardiovascular reactivity in women. *International Journal of Behavioral Medicine, 9*, 243–263. doi:10.1207/S15327558IJBM0903_06.

U.S. Census Bureau. (2012). U.S. Census Bureau projections show a slower growing, older, more diverse nation half a century from now. https://www.census.gov/newsroom/releases/archives/population/cb12-243.html

Vorauer, J. D., & Kumhyr, S. M. (2001). Is this about you or me? Self- versus other-directed judgments and feelings in response to intergroup interaction. *Personality and Social Psychology Bulletin, 27*, 706–709. doi:10.1177/0146167201276006.

Wang, X. B., Dockery, D. W., Wypij, D., Fay, M. E., & Ferris, B. G. (1993). Pulmonary function between 6 and 18 years of age. *Pediatric Pulmonology, 15*, 75–88. doi:10.1002/ppul.1950150204.

Weil, C. M., Wade, S. L., Bauman, L. J., Lynn, H., Mitchell, H., & Lavigne, J. (1999). The relationship between psychosocial factors and asthma morbidity in inner-city children with asthma. *Pediatrics, 104*, 1274–1280. doi:10.1542/peds.104.6.1274.

Wolf, J. M., Miller, G. E., & Chen, E. (2008). Parent psychological states predict changes in inflammatory markers in children with asthma and healthy children. *Brain Behavior and Immunity, 22*, 433–441. doi:10.1016/j.bbi.2007.10.016.

Wood, B. L., Miller, B. D., & Legman, H. K. (2015). Review of family relational stress and pediatric asthma: The value of biopsychosocial systemic models. *Family Processes, 54*, 376–389. doi:10.1111/famp.12139.

Wright, R. J., Cohen, S., Carey, V., Weiss, S. T., & Gold, D. R. (2002). Parental stress as a predictor of wheezing in infancy: A prospective birth-cohort study. *American Journal of Respiratory and Critical Care Medicine, 165*, 358–365. doi:10.1164/ajrccm.165.3.2102016.

Wright, R. J., Rodriguez, M., & Cohen, S. (1998). Review of psychosocial stress and asthma: an integrated biopsychosocial approach. *Thorax, 53*, 1066–1074. doi:10.1136/thx.53.12.1066.