through use of less-invasive blood biomarkers would be valuable. Thus, in our study, 8/14 (57%) of patients would have avoided endoscopy due to correctly classified inactive disease. Such a biomarker of "disease inactivity" would be clinically beneficial for this population because it might alleviate many of the burdens associated with repeated invasive esophageal biopsies.

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REFERENCES

1. Bullock JZ, Villanueva JM, Blanchard C, Filipovich AH, Putnam PE, Collins MH, et al. Interplay of adaptive Th2 immunity with eotaxin-3/C-C chemokine receptor 3 in eosinophilic esophagitis. J Pediatr Gastroenterol Nutr 2007;45:22-31.
2. Blanchard C, Stucke EM, Rodriguez-Jimenez B, Burwinkel K, Collins MH, Ahrens A, et al. A striking local esophageal cytokine expression profile in eosinophilic esophagitis. J Allergy Clin Immunol 2011;127:208-17, e1-7.
3. Liacouras CA, Furuta GT, Hirano I, Atkins D, Attwood SE, Bonis PA, et al. Eosinophilic esophagitis: updated consensus recommendations for children and adults. J Allergy Clin Immunol 2011;128:3-22.e6.
4. Konikoff MR, Blanchard C, Kirby C, Buckmeier BK, Cohen MB, Heubi JE, et al. Potential of blood eosinophils, eosinophil-derived neurotoxin, and eotaxin-3 as biomarkers of eosinophilic esophagitis. Clin Gastroenterol Hepatol 2006;4:1328-36.
5. Sehmi R, Howie K, Sutherland DR, Schragge W, O'Byrne PM, Denburg JA. Increased levels of CD34+ hemopoietic progenitor cells in atopic subjects. Am J Respir Cell Mol Biol 1996;15:645-54.
6. Makowska J, Grzegorczyk J, Ciéslak M, Biénkiewicz B, Kowalski ML. Recruitment of CD34+ progenitor cells into peripheral blood and asthma severity. Ann Allergy Asthma Immunol 2008;101:402-6.
7. Mori Y, Iwasaki H, Kohno K, Yoshimoto G, Kikushige Y, Okeda A, et al. Identification of the human eosinophil lineage-committed progenitor: revision of phenotypic definition of the human common myeloid progenitor. J Exp Med 2009;206:183-93.
8. Smith SG, Gugilla A, Mukherjee M, Merim K, Irshad A, Tang W, et al. Thymic stromal lymphopoietin and IL-33 modulate migration of hematopoietic progenitor cells in patients with allergic asthma. J Allergy Clin Immunol 2015;135:1594-602.
9. Henderson CJ, Abonia JP, King EC, Putnam PE, Collins MH, Franciosi JP, et al. Comparative dietary therapy effectiveness in remission of pediatric eosinophilic esophagitis. J Allergy Clin Immunol 2012;129:1570-8.
10. Martin LJ, Franciosi JP, Collins MH, Abonia JP, Lee JJ, Hommel KA, et al. Pediatric Eosinophilic Esophagitis Symptom Scores (PEESS v2.0) identify histologic and molecular correlates of the key clinical features of disease. J Allergy Clin Immunol 2015;135:1519-28.e8.

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Synergistic effects of air pollution and psychosocial stressors on adolescent lung function

To the Editor:

A growing body of evidence has found that air pollutants, including traffic-related pollutants such as NO, NO_2, and NO_X, decrease lung function in children and adolescents.[1] It has been suggested that stress experienced in youth may modify the effects of air pollution on lung function, but data on stressors in adolescents are scarce. The Children's Health Study (CHS) conducted in Los Angeles, California, found that impairments in lung function due to traffic-related pollutants varied by parental stress levels measured earlier in the child's life.[2] However, a UK study of 11- to 13-year-olds found that perceived racism was not associated with lung function, and did not modify the effects of $PM_{2.5}$ on lung function.[3] Particularly in older children, it is important to capture their own perception of stressors, as peers or other social networks may alter perceived stress. Here, we explore whether self-reported psychosocial stress related to family, school, and neighborhood in adolescents' aged 10 to 17 years modifies estimated effects for the traffic-related air pollutants NO, NO_2, NO_X, and $PM_{2.5}$ on lung function measured by spirometry.

A sample of 551 participants was drawn from the Los Angeles Family and Neighborhood Survey (L.A.FANS) wave 2, which has been previously described.[4] Spirometry was assessed via EasyOne portable spirometers, which measured forced vital capacity (FVC), FEV_1, and forced expiratory mean flow between 25% and 75% of FVC (FEF_{25-75}). We created land use regression models relying on monitoring campaigns with passive Ogawa sampler badges for NO_X and NO_2 in 2 seasons of 2006-2007 to estimate spatially distinct annual average NO, NO_X, and NO_2 concentrations. In addition, $PM_{2.5}$ concentrations were generated by kriging applied to available government monitoring data. Stress was operationalized on the basis of self-reported dichotomized measures of family fighting, school safety, neighborhood safety, and paternal absence. We performed multiple linear regression for each lung function outcome (FVC, FEV_1, FEF_{25-75}) with single pollutant analyses (in separate models) for NO, NO_2, NO_X, and $PM_{2.5}$ while adjusting for all covariates and individual psychosocial stressors. Robust standard errors were included to adjust for nonindependence due to the participation of siblings (112 sibling sets). In additional models we included Air pollutant × Stressor interaction terms, and subsequently stratified on presence/absence of stressors to assess the magnitude of effect measure modification. Additive interaction was confirmed when the interaction term had a P value of less than .10. In sensitivity analyses, we excluded those who reported ever having received

TABLE I. β (95% CI) for main effects of presence of father and select air pollutants, and modification of the effects of pollutants on lung function by presence/absence of father (n = 551)

Lung function measure	Pollutant	Main effect of father absence coadjusted for pollutant	Main effect of pollutant coadjusted for father absence	Pollutant: Father present (n* = 355)	Pollutant: Father absent (n* = 178)	*P* value†
FEV_1						
	NO_2	−51.5 (−154.4 to 51.4)	−59.5 (−107.9 to −11.2)	−31.5 (−85.6 to 22.6)	−142.3 (−243.5 to −41.2)	.02
	NO_X	−52.4 (−155.5 to 50.6)	−75.9 (−134.6 to −17.2)	−55.8 (−124.3 to 12.7)	−126.4 (−237.2 to −15.7)	.10
	NO	−57.9 (−161.3 to 45.5)	−60.7 (−122.4 to 1.0)	−48.2 (−119.5 to 22.9)	−98.9 (−204.6 to 6.7)	.18
	$PM_{2.5}$	−56.2 (−158.9 to 46.5)	−38.1 (−61.4 to −14.8)	−34.7 (−61.4 to −7.9)	−60.7 (−125.4 to 4.0)	.44
FVC						
	NO_2	−62.9 (−180.3 to 54.5)	−45.6 (−102.7 to 11.5)	−11.6 (−71.6 to 48.4)	−161.7 (−305.5 to −17.9)	.04
	NO_X	−63.4 (−181.5 to 54.6)	−59.0 (−129.7 to 11.6)	−42.7 (−122.4 to 36.9)	−106.9 (−262.5 to 48.8)	.30
	NO	−67.5 (−185.9 to 51.0)	−48.5 (−122.2 to 25.3)	−45.2 (−130.4 to 39.9)	−65.6 (−205.7 to 74.6)	.53
	$PM_{2.5}$	−65.3 (−182.8 to 52.2)	−32.3 (−59.9 to −4.7)	−24.4 (−52.1 to 3.3)	−80.4 (−167.1 to 6.4)	.29
FEF_{25-75}						
	NO_2	−79.9 (−254.5 to 94.6)	−85.8 (−191.2 to 19.5)	−47.8 (−170.7 to 75.1)	−164.1 (−344.5 to 16.3)	.13
	NO_X	−81.7 (−255.4 to 92.0)	−107.3 (−224.2 to 9.6)	−56.6 (−194.2 to 81.0)	−218.5 (−402.0 to −34.9)	.05
	NO	−91.0 (−264.6 to 82.5)	−75.2 (−188.8 to 38.4)	−29.0 (−158.2 to 100.2)	−195.3 (−370.6 to −20.1)	.06
	$PM_{2.5}$	−90.2 (−265.2 to 84.8)	−51.6 (−108.0 to 4.9)	−53.2 (−120.7 to 14.3)	−54.9 (−166.7 to 56.9)	.92

Models are adjusted for age, race/ethnicity, sex, federal poverty level, household smoking, height, height-squared, weight, weight-squared, and Sex × Age.
*Adjusted n.
†*P* for interaction of stressor (paternal presence/absence) and select pollutant.

TABLE II. β (95% CI) for main effects of presence of family fighting and select air pollutants, and modification of the effects of pollutants on lung function by presence/absence of family fighting (n = 551)

	Pollutant	Main effect of family fighting coadjusted for pollutant	Main effect of pollutant coadjusted for family fighting	Pollutant: No family fighting (n* = 475)	Pollutant: Family fighting (n* = 56)	*P* value†
FEV_1						
	NO_2	−73.9 (−186.3 to 38.5)	−65.2 (−114.1 to −16.2)	−56.9 (−110.6 to −3.3)	−160.9 (−248.3 to −73.5)	.26
	NO_X	−74.5 (−186.4 to 37.3)	−82.1 (−141.4 to −22.7)	−72.6 (−136.5 to −8.7)	−184.6 (−294.6 to−74.6)	.32
	NO	−74.8 (−187.8 to 38.3)	−66.6 (−129.3 to −3.9)	−57.4 (−125.5 to 10.6)	−199.9 (−323.6 to −76.3)	.27
	$PM_{2.5}$	−64.8 (−181.7 to 52.1)	−39.5 (−63.4 to −15.6)	−39.3 (−63.9 to −14.8)	−75.6 (−173.3 to 22.1)	.28
FVC						
	NO_2	−61.3 (−192.1 to 69.6)	−52.0 (−109.8 to 5.7)	−46.9 (−110.3 to 16.5)	−133.6 (−252.6 to −14.7)	.44
	NO_X	−61.8 (−192.1 to 68.5)	−65.8 (−136.9 to 5.3)	−57.1 (−134.6 to 20.2)	−175.9 (−313.4 to −38.5)	.37
	NO	−62.1 (−193.2 to 69.0)	−54.8 (−129.3 to 19.7)	−47.2 (−128.8 to 34.4)	−197.1 (−352.4 to −41.8)	.35
	$PM_{2.5}$	−52.7 (−186.3 to 80.9)	−33.8 (−61.9 to −5.7)	−32.3 (−60.9 to −3.7)	−94.7 (−206.7 to 17.4)	.12
FEF_{25-75}						
	NO_2	−80.3 (−299.4 to 138.7)	−93.9 (−200.6 to 12.7)	−75.5 (−194.2 to 43.2)	−207.6 (−384.5 to −30.6)	.21
	NO_X	−81.2 (−300.2 to 137.9)	−116.1 (−235.1 to 3.0)	−101.7 (−231.2 to 27.9)	−183.5 (−422.6 to 55.6)	.44
	NO	−80.8 (−301.4 to 139.7)	−83.2 (−199.6 to 33.2)	−68.1 (−192.9 to 56.8)	−187.9 (−454.3 to 78.3)	.37
	$PM_{2.5}$	−73.2 (−299.3 to 153.0)	−55.5 (−113.1 to 2.1)	−55.4 (−115.2 to 4.4)	−96.1 (−325.3 to 133.2)	.59

Models are adjusted for age, race/ethnicity, sex, federal poverty level, house smoke, height, height-squared, weight, weight-squared, and Sex × Age.
*Adjusted n.
†*P* for interaction of stressor (family fighting yes/no) and select pollutant.

a doctor's diagnosis of asthma and reported wheeze within the past 12 months (n = 37). A more complete description of the methods is available in the Methods section in this article's Online Repository at www.jacionline.org.

Descriptive and demographic characteristics of participants are presented in Table E1 and air pollutant measurements are presented in Table E2 in this article's Online Repository at www.jacionline.org.

All air pollutants were independently associated with FEV_1 in separate models when adjusted for absence of the father (Table I); paternal absence was not independently associated with any of the spirometry outcomes. When stratified by paternal presence/absence, air pollutants were associated with larger decrements of lung function in households where the father was absent compared with homes with a father present. This interaction was statistically significant for NO_2 and the lung function measures FEV_1 and FVC, as well as for NO and NO_X for the outcome measure FEF_{25-75}.

Similar but weaker interaction effects were observed when examining family fighting (Table II). All air pollutants were independently associated with FEV_1; however, family fighting was not. Although the trends were stronger for air pollutant and spirometry measures in those who self-reported family fighting compared with those who did not, none of the interaction terms reached statistical significance.

Results for self-reported neighborhood safety, school safety, and sensitivity analyses are presented in the Results section in this article's Online Repository at www.jacionline.org.

Our findings of modification of air pollutant effects on lung function by select psychosocial stressors corroborate findings