Table E1. Descriptive and demographic data for participants ages 10-17 in L.A.FANS-2, a neighborhood and household survey in Los Angeles, CA, 2006-8 (n=551).

Spirometry	mean (sd)
FVC (mL) mean (sd)	3353.1 (961.2)
FEV_1 (mL) mean (sd)	2814.0 (823.6)
FEF_{25-75} (mL/s) mean (sd)	3114.2 (1153.2)
Psychosocial stressors	n (%)
Neighborhood feels safe	349 (63.4)
missing	2 (0.4)
School feels safe	423 (76.8)
missing	5 (0.9)
Family does not fight	490 (88.9)
missing	2 (0.4)
Dad lives in the house	367 (66.6)
Child covariates	
Age mean (sd)	13.4 (2.3)
Height (cm) mean (sd)	158.9 (11.7)
Weight (kg) mean (sd)	61.4 (19.3)
Race	
Hispanic	369 (66.8)
non-Hispanic white	80 (14.5)
Black	27 (4.9)
Asian/Pacific Islander	28 (5.1)
Other (multiple races)	47 (8.5)
Child's nativity	
US-born	505 (91.7)
Child smokes	10 (1.8)
missing	4 (0.7)
Asthma diagnosis with wheeze (12 months)	37 (6.7)
Family/household covariates	
Maternal Education	
$\leq$ 8th grade	133 (24.1)
9-12th grade	191 (34.7)
Vocational school	32 (5.8)
AA/some college	116 (21.1)
College+	76 (13.8)
missing	3 (0.5)
Federal poverty level	
<100%	158 (28.7)
101-200%	161 (29.2)
201-300%	93 (16.9)

301%+	139 (25.2)
Current smoker in house	119 (21.6)

Table E2. Pollutant median values and ranges for L.A.FANS adolescent respondents with spirometry measures (n=551)

Pollutant	Median, Range	IQR
NO_2 (ppb)	23.7 (6.2, 34.6)	5.3
NO_X (ppb)	47.7 (11.8, 90.1)	16.5
NO (ppb)	23.5 (3.5, 56.5)	10.4
$PM_{2.5}$ µm/m3	21.7 (8.5, 23.6)	1.8

METHODS

Sample

Los Angeles Family and Neighborhood Survey 2

Participants were drawn from the Los Angeles Family and Neighborhood Survey (L.A.FANS) wave 2. The first wave (L.A.FANS-1) sampled 3,090 households from 65 neighborhoods in Los Angeles County in 2000-2001, interviewing 3,140 children ages 0-17 with oversampling of very poor and poor households. The cohort included 55% Hispanic, 26% White, 10% Black, and 7% Asian participants. In 2006-2008, L.A.FANS-2 re-interviewed L.A.FANS-1 participants and added additional households from within the same neighborhoods. 1,091 children were re-interviewed (64% response rate) and 296 new children were added to the sample, for a total of 1,387 children. This second wave also added spirometry data collection to its protocol. To minimize lung function measurement error issues, likely to be larger in younger children, and to allow us to assess adolescents' self-reported psychosocial stress, we restricted our analyses to individuals ages 10-17 years (here referred to as "adolescents" following the World Health Organization nomenclature[1]) with a reproducible spirometry curve (n=551).

Outcome, exposure and covariate definitions

Spirometry

Of the 1,387 children in L.A.FANS-2, 1,070 children aged 5-17 years participated in spirometry assessments. Evaluation and acceptance criteria for spirometry curves have been previously detailed.[2] Briefly, an expert with specific experience evaluating spirometry data from children as part of the UC Berkeley Fresno Asthmatic Children's Environment Study reviewed all curves. To determine acceptability, all grading of spirometry curves was done based on the following criteria (some of which overlap with the 1994 American Thoracic Society criteria[3]): (1) The Back Extrapolated Volume must be ≤5% or 150mL, whichever is greater; (2) Time to Peak Flow must be ≤120 milliseconds; (3) No abrupt end to test; (4) Forced expiratory time must be ≥ 2 seconds; (5) Time/Volume curve must begin at origin (to ensure proper start of test); (6) Curve must show that subject exhaled using only one continuous blast of air; and (7) Curve must show no leaks or negative flow throughout test (i.e. no inhalation). Only curves judged acceptable by the reviewer were included; curves judged acceptable by the EasyOne™ portable spirometer without reviewer approval were not included in analyses. Of the 775 children with at least one acceptable curve for analysis, 551 children were between 10-17 years of age.

Air pollution estimates

Our air pollution measures have been described previously in detail.[2] We monitored pollution using 186 passive Ogawa sampler badges for NO_X and NO_2 in two seasons of 2006/7 in neighborhoods in which LAFANS participants resided. This neighborhood level NOx and NO_2 measurement data were then used to develop a land use based regression (LUR) model for the Los Angeles Basin, building LUR prediction surfaces[4,5] for NO, NO_2 and NO_X. $PM_{2.5}$ estimates were generated by kriging available government monitoring data from 23 state and local district monitoring stations in the LA basin for the year 2000. Participants in L.A.FANS-2 provided residential history information for the six years between survey waves, allowing us to create annual average measures weighted for time spent at each location for the past 5+ years. In a previous analysis we showed that exposure measures for the 5 year, 2 year, 12 month, and current home only models were very similar.[2] Thus for the current analyses, we extracted from our models annual average measures of each pollutant, weighted for time spent at both residences and schools in the past 12 months.

Psychosocial stressors

Adolescent-reported: Adolescents self-reported whether "people in my family fight a lot" (true vs. sometimes true or not true), whether they "feel safe in this neighbourhood" (yes vs. sometimes or no) and whether they "feel safe at this school" (yes vs. sometimes or no).

Caregiver/family: The individual who identified as head of household reported whether the father of each child lived in the house (yes/no).

Adolescent/household socio-demographic covariates

The following covariates were collected regarding the adolescents: gender, age, height and weight, race/ethnicity, nativity, self-reported smoking, asthma history, and wheeze within the past 12 months. Maternal education, household income (which was used to categorize federal poverty level (FPL)), and any reported smoking in the house were also collected in the survey.

Statistical analyses

Potential confounders were selected and included in all models based upon the previous literature and by assessing changes in estimates for air pollutants greater than 10%. These covariates included adolescent's age, FPL, smokers in the household, adolescent's race/ethnicity, height, height-squared, weight, weight-squared, sex, and sex*age. Few adolescents (n=10) reported smoking. Inclusion of this variable in the models did not change estimates for the air pollutants and thus was not retained in final models. Analyses were conducted in SAS 9.3 (Cary, NC).

RESULTS

Neither self-reported neighborhood safety nor school safety were associated with spirometry measures, although all co-adjusted air pollutant estimates were independently associated with the spirometry measures. We did not observe statistical interaction of these psychosocial stressors with any of the air pollutants (data not shown).

In sensitivity analyses, removing those with an asthma diagnosis who experienced wheeze in the past 12 months (n=37) resulted in slight attenuation but did not change air pollutant estimates or interactions by >10% (data not shown).

DISCUSSION

Using information on family, neighborhood and school-related psychosocial stressors collected in L.A.FANS, we were able to assess whether these measures modified the associations between select air pollutants and spirometry outcomes in adolescents ages 10-17 years. We found that paternal absence, while not independently associated with lung function measures, modified the association of NO_2 and both FEV_1 (p=0.02) and FVC (p=0.04). While associations were modest, the deficits of FEV_1 associated with NO_2 were ~2% of the median FEV_1 values in the sample (2814mL), while deficits were 5% accounting for the interaction with paternal absence. Although not statistically significant, NO, NO_X and $PM_{2.5}$ followed the same pattern, with stronger negative associations observed between the air pollutants and spirometry measures in adolescents from households without a father than in households with a father present. Similar trends were observed when we compared adolescents' self-reported family fighting with those who reported no family fighting, although interaction terms did not reach statistical significance. Neither self-reported school safety nor neighborhood safety modified associations of air pollutant and spirometry measures of lung function.

We were compelled by the findings of synergism between air pollutants and stress in the Children's Health Study,[6] but relying on early static measures of parental stress only may not appropriately represent and thus potentially misclassify the stress an adolescent is experiencing. The stress burden in a household likely changes with time and circumstance, and while parental measures of stress may influence the perceived stress of a five year-old child, to our knowledge the role of timing of stress during lung development in relation to decrements in lung function has not been established. As children age into adolescence, their own coping skills, peer networks and autonomy increase. This highlights the importance of considering an adolescent's stress burden on their pulmonary function from their point of view in addition to the parents'. Without having validated stress measures available in L.A.FANS, we employed measures that had face validity or previously reported associations with cortisol or lung function, as follows:

We examined school and neighborhood safety based on both their face validity (e.g.- do you feel safe in your school/neighborhood: yes, no, sometimes) as well as based on previous studies that found that a child's perceived neighborhood safety[7] and school safety[8] are associated with psychological distress. However, since few participants reported not feeling safe at all in their school or neighborhood, we combined the categories 'not at all' and 'sometimes' not feeling safe (reference: always feeling safe), which may have resulted in a measures representing much lower stress than has previously been assessed.

We selected self-reported 'family conflict' based upon findings associating interparental conflict with increased cortisol levels in children,[9,10] as well as findings that 6-7 year-old girls had reduced FEV_1 and FVC when mothers reported high levels of interparental conflict.[11] Previous research on interparental conflict found that the child's involvement in the family conflict (e.g. comforting the parent) as well as externalizing behaviors mediated cortisol response. However, we acknowledge that in this previous research the children were much younger (ages 5-7),[9,10] potentially limiting the relevance of the findings for our adolescent sample.

A large body of evidence suggests that paternal absence has many negative consequences for children, including behavioral problems and psychological distress (review paper[12]). A previous study found father-absent male adolescents had higher cortisol levels compared with father-present adolescents, but there was no difference in cortisol levels between father-present/absent adolescent females.[13] In L.A.FANS, we were not able to assess if a father-surrogate (stepfather, grandfather) was present in the house, which would be helpful to assess in future work in order to understand what "father's absence" is measuring.

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