



Letters

Secondhand smoke effects on rhinoconjunctivitis and sleep quality in an adolescent asthma study

Secondhand smoke (SHS) exposure is an important public health issue worldwide.¹ According to the surveillance data in Taiwan in 2018, 13.0% of adults and 2.8% of adolescents were current smokers. Although the prevalence of smoking has decreased, the rate of household SHS in Taiwan remained as high as 21.1% in 2018. Previous studies have revealed inconsistent associations between SHS and rhinitis. Tobacco smoke exposure has been associated with an increased prevalence of rhinitis symptoms, but not with allergic sensitization.² In addition, SHS has been associated with poor sleep quality in both children and adults.³ It is likely that SHS exposure is an upper airway irritant, increasing symptoms of sleep-disordered breathing and, thus, contributing to overall sleep disturbances.⁴ Early SHS exposure, in utero or during infancy, has been reported to influence the development of allergic disease up to adolescence.⁵ Having a diagnosis of asthma in adolescence may be a confounding factor when evaluating the effect of SHS on rhinoconjunctivitis and sleep quality, because people may avoid smoking at home if there is a family member with asthma.

We performed a cross-sectional analysis using baseline data from the Genetic and Biomarkers study for Childhood Asthma,⁶ which was originally designed as a community-based case-control study, including 240 adolescents with physician-diagnosed asthma and 233 controls without asthma. Adolescents were excluded if they were active smokers ($n = 12$), had other major diseases ($n = 4$), or had missing urinary cotinine data ($n = 6$). Each participant underwent face-to-face interviews with well-trained research assistants from our research team. The questionnaire included information on demographic features, household environmental factor exposure, the smoking habit or SHS exposure status of the participants, the rhinoconjunctivitis quality of life questionnaire (RQLQ),⁷ and the Chinese version of the Pittsburgh Sleep Quality Index (PSQI).⁸ Objective SHS exposure was assessed by measuring the urinary cotinine. Cotinine is a major primary metabolite of nicotine, and we calculated the urinary cotinine-to-creatinine ratio (CCR) to quantify the exposure.

A total of 451 adolescents aged 10 to 16 years were recruited in our study. There were 264 boys (58.5%) and 187 girls (41.5%), with a mean age of 13.2 plus or minus 1.3 years. Adolescents with asthma were younger and had a higher proportion of boys ($P < .001$), allergic rhinitis ($P < .001$), allergic conjunctivitis ($P < .001$), and atopic dermatitis ($P < .001$). Adolescents without asthma reported higher rates of household SHS exposure ($P < .001$) and school SHS exposure ($P = .31$). At home, 34.3% of adolescents with asthma and 49.1% of adolescents without asthma reported paternal smoking, whereas 4.7% of adolescents with asthma and 6.9% of adolescents

without asthma reported maternal smoking. The mean level of urinary CCR was 1.99 plus or minus 2.58 ng/mg in patients with asthma and 2.62 plus or minus 2.71 ng/mg in patients without asthma. Adolescents with asthma had higher RQLQ overall scores (0.95 ± 0.90 vs 0.38 ± 0.48 ; $P < .001$) and a greater percentage, with PSQI global scores greater than 6 (20.2% vs 11.0%; $P = .008$).

Multiple linear regression models were used to assess the effects of SHS exposure on the RQLQ scores, and stratified analyses were performed to assess the relationship between SHS exposure and the RQLQ score by asthma. The changes in RQLQ total scores were not statistically significant in adolescents with asthma (Table 1). The RQLQ consists of the following 7 domains: activity limitation, sleep symptoms, nose symptoms, eye symptoms, non-nose or eye symptoms, practical problems, and emotional function. Adolescents with asthma with higher urinary CCR had higher domain scores for activity limitation ($\beta = 0.15$; 95% confidence interval [CI], 0.03–0.27) and eye symptoms ($\beta = 0.14$; 95% CI, 0.04–0.24). The RQLQ overall scores were increased when adolescents without asthma had a lifetime household SHS exposure ($\beta = 0.14$; 95% CI, 0.02–0.26), were exposed to approximately 1 to 20 cigarettes per week at home ($\beta = 0.17$; 95% CI, 0.02–0.33), and lived with 1 smoker ($\beta = 0.17$; 95% CI, 0.04–0.29) (Table 1). In adolescents without asthma, the scores on the activity limitation domain were higher for those with lifetime household SHS exposure ($\beta = 0.19$; 95% CI, 0.04–0.33) and current household SHS exposure ($\beta = 0.19$; 95% CI, 0.05–0.33). The sleep problems domain scores were also increased for those with lifetime household SHS exposure ($\beta = 0.16$; 95% CI, 0.01–0.31). The emotional function domain scores were increased for those with lifetime household SHS exposure ($\beta = 0.19$; 95% CI, 0.04–0.34). Multiple logistic regression analyses were applied to estimate the odds ratios for the association of SHS exposure with PSQI global scores. Among adolescents with asthma, a higher urinary CCR level was associated with an increased risk of poor sleep (PSQI global score of >6) after adjustment for potential confounders (adjusted odds ratio of 1.43 for logarithmic CCR increase). Adolescents with asthma who reported having current household SHS exposure had a 2.69 times higher risk of poor sleep (95% CI, 1.21–6.00). Adolescents with asthma living with 2 or more smokers had a 4.66-fold likelihood of poor sleep (95% CI, 1.47–14.7).

The association between SHS exposure and rhinoconjunctivitis may not be as robust as that found for SHS exposure and asthma.² In our study, SHS exposure was associated with higher rhinoconjunctivitis symptom scores in both adolescents with asthma and without asthma, which might indicate that passive tobacco exposure may cause rhinoconjunctivitis symptoms through not only immunoglobulin E-mediated inflammation but also direct irritation or neurogenic inflammation. Differentially, asthma may address the mediation effect on the relationship between SHS exposure and sleep quality. Notably,

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Table 1
The Association of SHS Exposure With RQLQ and PSQI Among Adolescents With Asthma and Without Asthma

SHS indicators	Adolescents with asthma (n = 233)		Adolescents without asthma (n = 218)	
	RQLQ overall score β (95% CI) ^a	PSQI global score of >6 aOR (95% CI) ^b	RQLQ overall score β (95% CI) ^a	PSQI global score of >6 aOR (95% CI) ^b
Urinary CCR In CCR ^c	0.07 (−0.03 to 0.17)	1.43 (1.01–2.03) ^d	−0.10 (−0.16 to −0.04) ^d	0.81 (0.52–1.27)
Household SHS exposure				
Lifetime	−0.01 (−0.23 to 0.21)	1.51 (0.71–3.22)	0.14 (0.02–0.26) ^d	2.14 (0.75–6.12)
Current	0.09 (−0.15 to 0.33)	2.69 (1.21–6.00) ^d	0.10 (−0.02 to 0.22)	2.04 (0.76–5.53)
SHS source				
Paternal smoking	0.96 (0.49–1.88)	1.35 (0.62–2.94)	1.34 (0.64–2.81)	2.59 (0.92–7.29)
Maternal smoking	0.98 (0.22–4.39)	1.06 (0.18–6.22)	1.96 (0.52–7.44)	2.25 (0.38–13.3)
Number of smokers at home				
0	0	1	0	1
1	−0.17 (−0.48 to 0.13)	1.01 (0.43–2.40)	0.17 (0.02–0.33) ^d	2.04 (0.69–6.04)
≥2	0.12 (−0.16 to 0.41)	4.66 (1.47–14.7) ^d	0.10 (−0.04 to 0.24)	2.69 (0.54–13.4)
P for trend	.65	.04	.12	.15
Number of cigarettes smoked at home weekly				
0	0	1	0	1
≤20	−0.01 (−0.25 to 0.23)	0.95 (0.31–2.90)	0.17 (0.04–0.29) ^d	0.94 (0.24–3.67)
>20	−0.02 (−0.40 to 0.36)	1.89 (0.74–4.86)	0.02 (−0.19 to 0.23)	3.03 (1.00–9.20) ^d
P for trend	.92	.23	.16	.05

Abbreviations: aOR, adjusted odds ratio; CCR, cotinine-to-creatinine ratio; CI, confidence interval; PSQI, Pittsburgh Sleep Quality Index; RQLQ, Rhinoconjunctivitis Quality of Life Questionnaire; SHS, secondhand smoke.

^aAnalyzed using multiple linear regression models and data were presented as β (95% CI). All models were adjusted for age, sex, body mass index, atopic dermatitis, allergic rhinitis, puberty status, outdoor exercise, carpet, cockroaches, and mold.

^bAnalyzed using multiple logistic regression models and data were presented as aOR (95% CI). All models were adjusted for age, body mass index, atopic dermatitis, allergic rhinitis, puberty status, outdoor exercise, carpet, cockroach, and mold.

^cUrinary CCR using natural log-transformed values.

^d $P < .05$ was considered statistically significant.

SHS exposure may stimulate inflammatory responses, provoke wheezing, and promote respiratory infections, contributing to overall sleep disturbances⁹; therefore, the effect of SHS on poor sleep quality was observed to be more conspicuous in the group with asthma. In addition, there was a higher prevalence of sleep-disordered breathing in children with asthma, and the prevalence of sleep-disordered breathing increased with increasing asthma severity.¹⁰

We examined the effect of SHS exposure on rhinoconjunctivitis symptoms and sleep quality in defined groups of adolescents with and without asthma. Although SHS exposure had an adverse impact on rhinoconjunctivitis symptoms among both adolescents with asthma and without asthma, adolescents with asthma exposed to more SHS had a higher risk of experiencing poor sleep quality. These findings aid in clarifying the complex relationship between tobacco exposure and allergic airway diseases.

Yi-Tsen Lin, MD^{*,†}

Ming-Hung Lin, MD[‡]

Kuen-Yuh Wu, PhD[§]

Yungling Leo Lee, MD, PhD^{||,¶}

^{*}Department of Otolaryngology

National Taiwan University Hospital

Taipei, Taiwan

[†]Graduate Institute of Clinical Medicine

College of Medicine

National Taiwan University

Taipei, Taiwan

[‡]Institute of Epidemiology and Preventive Medicine

College of Public Health

National Taiwan University

Taipei, Taiwan

[§]Institute of Occupational Medicine and Industrial Hygiene

College of Public Health

National Taiwan University

Taipei, Taiwan

^{||}Institute of Biomedical Sciences

Academia Sinica

Taipei, Taiwan

[¶]College of Public Health

China Medical University

Taichung, Taiwan

leolee@ibms.sinica.edu.tw

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