Exposure to Secondhand Smoke and Academic Performance in Non-Smoking Adolescents

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Objective To study the association between exposure to secondhand smoke (SHS) and academic performance in non-smoking adolescents.

Study design A questionnaire survey of 23 052 non-smoking students aged 11 to 20 years was conducted. Information on academic performance, number of days of SHS exposure per week at home and outside the home, number of smokers at home and their relationship with the student, and sociodemographic characteristics was recorded.

Results Students exposed to SHS at home 1 to 4 and 5 to 7 days per week were 14% (95% confidence interval, 5%-25%) and 28% (15%-41%) more likely, respectively, to report poor academic performance compared with students who were not exposed to SHS. Living with one, two, and ≥3 smokers, compared with no smoker, was also associated with 10% (0.1%-20%), 43% (23%-65%) and 87% (54%-127%), respectively, higher odds of poor academic performance (*P* for trend <.001). The greatest excess risks were observed with SHS exposure from co-residing non-relatives, followed by siblings, visitors, co-residing grandparents and relatives, and parents.

Conclusion SHS exposure is associated linearly with poor academic performance in non-smoking adolescents, and the effect of SHS exposure at home is stronger from smokers other than the parents. *(J Pediatr 2010;157:1012-7)*.

Prenatal tobacco exposure and postnatal secondhand smoke exposure (SHS) were shown to be associated with poor cognition in children,[1] but the evidence is still insufficient to infer causality.[2] A recent review has suggested that adolescent cognition was not associated with prenatal or early life tobacco exposure,[3] but was associated with the SHS exposure during adolescence.[4] It has been suggested that carbon monoxide in SHS can bind with hemoglobin to form carboxyhemoglobin in blood, depleting oxygen supply to the brain, and adversely affect mental performance.[5]

A PubMed search from January 1960 to April 2009 using the criteria "passive or second-hand or involuntary or environmental" AND "smok$ or tobacco$ or cigarette$" AND "cogniti$ or recogniti$ or neuro$ or memor$ or intelligen$ or intellect$ or IQ or learning or academic$" AND "adolescent$ or teenage$ or youth$ or juvenescen$" ($ indicates one or more characters) yielded only 3 relevant reports on exposure to SHS and cognition in adolescents.[4-6] However, these studies invariably focused on SHS exposure from parents, neglecting other potential sources.[4,5]

Educational success is of utmost importance to Chinese families. Therefore, any adverse effect of SHS exposure on adolescent academic performance, especially when supported by local data, will likely give new impetus for Chinese families to establish smoke-free homes. This is particularly important in places like Hong Kong, where homes are typically small and the effect of indoor smoking is magnified. We investigated the association between SHS exposure, particularly at home, and academic performance in Hong Kong Chinese non-smoking adolescents and compared the effects of SHS exposure from parents and other sources.

Methods

From February 2003 to April 2004, a youth smoking survey with a self-administered questionnaire was conducted in Hong Kong with a high response rate (98%) from students in 85 mainstream secondary schools (non-international schools), which were randomly selected with a probability proportional to school enrollment size pursuant to the requirement of the Global Youth Tobacco Survey.[7] Classes from Form 1 to 5 (grades 7-12 in the United States) of the participating schools (total = 1012 classes) were surveyed. The institutional review board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster granted ethical approval for the study.

The students reported their SHS exposure on the basis of two standard questions used in the Global Youth Tobacco Survey:[7] "How many days in the past 7 days did someone smoke near you when you were at home?" and "How many

CI	Confidence interval
ER	Excessive risk
SHS	Secondhand smoke

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days in the past 7 days did someone smoke near you when you were outside home?" The total number of co-residing smokers and their relationships with the student were also reported. Information about basic demographic characteristics, socioeconomic status, respiratory health, academic aspirations, smoking, and other lifestyle factors of the students was also collected. Academic performance was assessed with the item "your academic performance is," with options of very poor, poor, average, good, and very good, which were analyzed as poor (very poor and poor) versus average/good/very good. Students were expected to rate their academic performance by comparing it with that of their classmates. Our sample is quite representative of the general population because the rates of housing types were fairly similar to those from census data,[8] with a small Cohen effect size (w = 0.08).[9]

After excluding the poorly answered questionnaires, such as those with response sets and excessive missing answers, 36 612 questionnaires remained (98% of the original sample). Of these, 23 052 questionnaires (63%) from non-smoking students aged 11 to 20 years were analyzed after successive exclusion of current smokers and ex-smokers (n = 4522), students older than 20 years (n = 104), and missing data on academic performance (n = 3020), SHS exposure (n = 109), socioeconomic and demographic information (n = 250), and the identity of co-residing smokers (n = 551). In addition, students who were living with one or more smokers but unexposed to SHS at home in the past 7 days were also excluded (n = 5004), because they might still have been exposed to SHS earlier.

Logistic regression on the basis of generalized estimating equations to control for cluster effect within the same school was used to calculate adjusted odds ratios for poor academic performance caused by exposure to SHS from other people who smoked next to the students at or outside home (categorized in 0, 1-4, and 5-7 days per week). Co-variate adjustments included sex, age, highest parental education, housing type, and, when appropriate, SHS exposures at or outside home. These adjustments took into account the potential effect of socioeconomic status on academic performance.

To compare the effect sizes of SHS exposure at home from different sources, (defined as SHS exposure at home for one or more days per week), students exposed to SHS from co-residing parents, siblings, grandparents, relatives, non-relatives, and non-co-residing visitors (deduced by the reported absence of co-residing smokers but presence of SHS at home in the past 7 days) were compared with the unexposed students (defined as no SHS exposure at home in the past 7 days and did not have any smokers at home) in the logistic regression model adjusting for co-variates as mentioned and mutually adjusting for different sources of exposure. To focus on the SHS exposure at home, the odds ratios for poor academic performance caused by the number of smokers at home (categorized in 0, 1, 2, and ≥3) were also calculated. To further control for potential confounding caused by socioeconomic status, subgroup analyses were conducted, stratified by parental education and the type of housing.

Results

Of all non-smoking students, 19% reported poor academic performance, 68% aspired to achieve a bachelor degree or higher, and 95% realized the harmful effects of SHS. Exposure to SHS at home (36%) and outside the home (66%) was common. One in 3 students lived with one or more smoker (33%), most commonly parents (24%), followed by non-parent family members (9%) and visitors (3%). **Table I** shows that poor academic performance was associated with male sex, older age, lower parental education, temporary housing, exposure to SHS at home and outside the home, and the presence of co-residing smokers.

Non-smoking students who were exposed to SHS at home for one to 4 and 5 to 7 days per week had excess risks (ERs) of poor academic performance of 14% (95% CI, 5%-25%) and 28% (95% CI, 15%-41%), respectively, compared with students who were not exposed to SHS (*P* for trend <.001; **Table II**). Significant ER of 29% (95% CI, 16%-44%) was only observed for SHS exposure outside the home for 5 to 7 days per week (*P* for trend <.001). Similar ERs for SHS

Table I. Prevalence of poor academic performance by basic characteristics

	n	%	χ^2 *P* value
Sex			<.001
Male	10 442	20.4	
Female	12 610	17.7	
Age group			<.001
≤15 years	13 386	16.2	
>15 years	9666	22.7	
Highest parental education level			<.001
Unknown	3938	20.5	
Uneducated or Kindergarten	333	36.6	
Primary school	2763	20.6	
Form 1-3	5237	20.4	
Form 4-5	5997	17.7	
≥Form 6	4784	15.2	
Housing type			<.001
Public housing estate	9718	19.4	
Home ownership scheme	2271	21.0	
Private (owner)	7837	17.3	
Private (tenant)	1878	18.5	
Temporary	161	32.9	
Others	1187	19.9	
SHS exposure at home			<.001
0 day per week	14 804	17.3	
≥1 days per week	8248	21.8	
SHS exposure outside home			<.001
0 day per week	7779	17.3	
≥1 days per week	15 273	19.7	
Smokers at home, n			<.001
0	15 481	17.5	
≥1	7571	21.7	
Type of home smokers			<.001
No smokers	14 804	17.3	
Co-residing parents	5593	19.7	
Co-residing non-parents	2064	26.8	
Visitors	591	23.4	