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Article

Exposure to Environmental Tobacco Smoke and Effects on Physical and Mental Health of Slovak School Children

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Abstract:

ETS exposure has been shown as an important environmental risk factor in vulnerable population groups. The aim of the project is to analyze the relationships among the ETS and behavior and health in 6−15-year-old children in Slovakia.

The status of physical and mental health of children in relation to exposure to tobacco smoke was examined in the representative group of 1,478 school children. The methods used, included anonymous questionnaires filled in by parents, Columbia Impairment Scale (CIS), Behavior Problem Index (BPI) and anthropometry. The prevalence of passive smoking is the highest in the capital (27%) and southern cities. Significant relationships have been confirmed between ETS and the age, socio-economic status, the incompleteness of the family, the level of mother's education and the significantly higher prevalence of respiratory diseases (26.7%).The relationships of ETS with emotional (CIS scores ≥16) and behavioral functions (BPI score ≥14) were significant in children exposed to mother‘s and father‘s smoking at home. In the multivariate analysis this association was not significant; the factors such as income and completeness of the family were dominant. The results confirmed the impact of ETS and social factors on health state and health behavior and could be the argumentation for legislative changes.

Key words: Environmental Tobacco Smoke (ETS), Slovak school children, mental health, physical health, Columbia Impairment Scale, Behavioral Problem Index

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Introduction

Numerous national and international studies and health reports provide evidence of the adverse impact of passive smoking on health during last decades [1,2,3,4,5,6,7]. ETS (Environmental Tobacco Smoke) also known as second hand smoke (SHS) or passive cigarette smoke is linked with premature deaths and many diseases, physical and mental disorders [8,9,10,11]. Exposure to ETS may cause lung cancer, eye, nose, and throat irritation, may affect the cardiovascular system and may cause stroke [12,13,14,15]**.** ETS is presented as a serious factor of indoor air pollution, which has an influence on health of predominantly vulnerable population groups - children of all ages [4,9,16,17,18] and pregnant women living in the same house as a habitual cigarette smoker [4,10]. Effects include sudden infant death syndrome (SIDS), asthma, bronchitis and pneumonia, and other respiratory diseases, and an adverse effect on the developing fetus. ETS exposure negatively affects birth outcomes, especially birth weight and behavior disorders [19,20,21]. More than a third of all people are regularly exposed to the harmful effects of smoke. This exposure is responsible for about 600,000 deaths per year, and about 1% of the global burden of disease worldwide [22]. In 2004, 40% of children were exposed to second hand smoke in public places worldwide [14]. According to the 2007 Global Youth Tobacco Survey (GYTS), more than 50% of children in Slovakia between the ages of 13-15 were exposed to SHS [23].

The aim of the present study is to analyze the relationships among the SHS exposure and emotional and behavioral problems and health in 6-15 year old children in Slovakia.

Material and methods

The status of physical and mental health of children in relation to exposure to tobacco smoke in the family was examined in the representative group of 1,478 school children aged 6-15

years, equal number of boys and girls from all regions of Slovakia. Of the 2,023 questionnaires distributed to students of all grades in 11 primary schools from all over Slovakia 73% (1,478) was returned and processed, ranging from 43 to 93% in different schools and localities [24]. The standard methods for evaluation of the smoking and socio-economic status of family, environmental conditions, children regimen, their health status and anthropometric variables (height, weight, BMI) were used. General anonymous questionnaire, which was filled in by parents with informed consent, included questions regarding family and child demographic and socioeconomic characteristics, child gender and age, and SHS exposure in the home as determined by whether either the mother or the father reported that they smoked cigarettes at home. Demographic information included family income (>600 € vs. ≤600 €), ethnicity, maternal and paternal educational attainment, and town/city versus village residence.

Emotional and behavioral functions of children were assessed using validated questionnaire Columbia Impairment Scale (CIS) and Behavior Problem Index (BPI). CIS is a tool for emotional problems screening by 13 structured questions having fixed response options, with scores ranging from 0 to 52 and tap four major areas of functioning as: 1) interpersonal relations, 2) broad psychopathological domains (e.g. anxiety, depression or behavior problems); 3) functioning in job or school and 4) use of leisure time. When an item is not applicable (e.g. problems getting along with siblings for an only child), or missing, the mean of all scored items for that individual is assigned as that item score. A score of 16 or higher is considered clinically impaired [25,26,27]. BPI has 25 questions with scores ranging from 0 to 25 (how much of a problem with antisocial behavior, cheating, disobedience at home, at school, bullying or cruel behavior, anxious/depressed behavior, headstrongness, short temper, irritability, sensitivity, nervousness, hyperactivity, difficulty concentrating, impulsive

thinking, restlessness, conflicting behavior or social isolation, social immaturity). A score of 14 or above is indicating behavior problems [24,28].

Surveys were included if they were missing fewer than five responses. For included surveys with missing data, the data was imputed by replacing the missing values from blank responses with the average of all the other questions.

The association between maternal and paternal smoking in the household and emotional and behavioral problems (CIS≥16) and (BPI≥14), and other child, maternal, and family characteristics were examined in bivariate analyses using chi-square tests and crude odds ratios with 95 % confidence intervals. The age (6–10 or 11–15 yrs.), gender, residence (town or country), income (≤600 € or >600 €) were investigated as well as basic life style habits and anthropometric characteristics (BMI) in relation to SHS smoke exposure in the household. The most important questions on CIS and BPI were analyzed separately in bivariate analysis with household smoking. Multivariate analyses were then performed to identify those factors independently associated with increased scores, indicative of child emotional and behavioral problems, for all of these variables using adjusted odds ratios. All analyses were conducted in SAS and SPSS 25 programs. The statistically significant level was determined at p values <0.05.

The project was approved by Ethical Committee Faculty of Medicine, Comenius University Bratislava, Slovakia and by Institutional Review Board of New York University School of Medicine, New York, U.S.A.

Results

The prevalence of passive smoking in Slovak children (mother or father reported smoking at home) has been 19 %. (Tab.1). It was significantly the highest in the capital (27.6 %) and southern border cities (24–27 %) [24].

The characteristics of smoking with social status of families are presented in Table 1.

Significant relationships have been confirmed among passive smoking and the age of children, the level of mother‘s and father‘s education, father‘s employment, socio-economic status and completeness of the family. The significantly higher prevalence of respiratory diseases in children exposed to passive smoking has been shown (Table 2).

The results of bivariate analysis revealed, that older school children have been more exposed to passive smoke. Exposure to passive smoke decreases with the level of parental education – especially mother. The relationships with socio-economic status and incompleteness of the family have been shown. The significantly higher prevalence of respiratory diseases in children exposed to passive smoke was confirmed ($p = 0.02$). Children exposed to SHS have worse eating habits and regimen, watch TV longer time daily. The relationship between passive smoking and lower physical activity and sports has not been statistically significant. The exposure to second hand smoke is associated with an increased prevalence of overweight in the sample of Slovak children (Table 2).

There were 4.6% boys and 2.5 % girls in our sample with smoking experiences. These children were exposed to passive smoking in the family (boys–88%, girls–94%).

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Table 1. Characteristics of the sample of Slovak children (n=1,478)

Indicator*	N	%
Age group (years)		
6-10	953	64.8
11-15	517	35.2
Gender		
Boys	738	50.6
Girls	720	49.4
Mother education		
Primary	51	3.5
High school	360	24.6
High school completed	739	50.6
University	311	21.3
Mother smokes		
Yes	309	21.3
No (ex-smoker)	114	7.9
No	1025	70.8
Father education		
Primary	41	2.9
High school	566	40.4
High school completed	505	36.1
University	289	20.6
Father smokes		
Yes	484	36.5
No (ex-smoker)	161	12.2
No	680	51.3
The child smokes		
Yes, more times	22	1.54
Yes, one time	30	2.11
No, never	1373	96.35
Mother or father smokes		
Yes	610	41.16
No	872	58.84
Mother or father smokes at home		
Yes	278	18.8
No	1204	81.2
The child lives in the		
Uncomplete family	287	19.62
Complete family	1176	80.38
Monthly household income		
≤400 €	146	11.6
401-600 €	233	18.6
> 600 €	877	69.8
Number of siblings		
0	289	20.2
1-2	949	66.3
≥3	194	13.5
Residence		
Urban	1169	81.01
Rural	274	18.99

* There are some data missing in each variable category

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Table 2. Relations among selected indicators and children's exposure to SHS*

Indicator**	Exposure SHS − (%)	Exposure SHS + (%)	p-value
Age (years)			
6-10	82.7	17.3	=0.05
11-15	78.5	21.5	
Mother education			
Primary	57.9	45.1	
High school	74.2	25.8	
High school completed	82.7	17.3	<0.0001
University	90.0	10.0	
Father education			
Primary	48.8	51.2	
High school	75.1	24.9	
High school completed	84.2	15.8	<0.0001
University	92.7	7.3	
Father employment			
Unemployed	55.9	44.1	<0.0001
Employed	81.9	18.1	
Monthly household income			
≤400 €	61.6	38.4	
401-600 €	71.7	28.3	<0.0001
> 600 €	85.6	14.4	
Completeness of the family			
No	69.0	31.0	<0.0001
Yes	83.7	16.3	
Respiratory system diseases			
No	82.8	17.2	=0.02
Yes	73.3	26.7	
Child eating healthy (vegetable, fruits, number of portions)			
Yes	84.4	15.6	<0.001
No	75.2	24.8	
Child doing sports			
No sports, rarely	74.8	25.2	
Recreationally, 1-2 times a week	80.5	19.5	=0.067
Regularly more time a week / daily	82.9	17.1	
TV/Games combined			
≤ 2 hours daily	67.5	32.5	=0.002
> 2 hours daily	58.1	41.9	
Overweight			
No	73.7	26.3	=0.046
Yes	68.7	31.3	

* SHS = mother or father smokes at home

** There are some data missing in each variable category

The relationships among environmental tobacco smoke exposures (father or mother smoking at home) with disorders of emotional and behavioral functions (CIS scores ≥16 and BPI scores ≥14) were significant in bivariate analysis ($OR_{crude,\ CIS\geq16}$ = 1.82 (95% CI=1.05-3.16; $OR_{crude,\ BPI\geq14)}$ = 1.66 (95% CI=1.08-2.51) (Table 3).

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Table 3. Relations among behavioral functions (BPI) and emotional functions (CSI) and the exposure of children to father‘s or mother‘s smoking at home

Indicator	Exposure SHS (%)	Risk estimation			
		OR (crude)	95 % CI	Chi- square	p-value
CSI score ≥16	6.99	1.82	1.05 – 3.16	4.67	0.03
BPI score ≥14	12.55	1.66	1.08 – 2.51	5.65	0.02

The influence of a smoking mother (at home or elsewhere) was found to be very high and it is demonstrated in Tables 4 and 5.

Table 4. Relations among behavioral (BPI) and emotional (CSI) functions and the exposure of children to mother‘s smoking at home

Indicator	Exposure SHS (%)	Risk estimation			
		OR (crude)	95 % CI	Chi- square	p-value
CSI score ≥16	7.7	1.93	1.01-3.69	4.04	0.04
BPI score ≥14	12.9	1.62	0.98-2.71	3.53	0.06

Table 5. Relations among emotional functions (CSI) and behavioral functions (BPI) and the exposure of children to mother‘s smoking [†]

Indicator	Exposure SHS (%)	Risk estimation			
		OR (crude)	95 % CI	Chi- square	p-value
CSI score ≥16	6.95	1.85	1.08-3.17	5.19	0.02
BPI score ≥14	11.92	1.56	1.03-2.34	4.50	0.03

[†] mother smokes elsewhere

In the more profound analysis of individual behavioral and emotional characteristics of the child in relation to mother‘s and father‘s smoking, the association with antisocial behavior of children, anxiety, depressed mood, feeling of unhappiness and sadness and problem with behavior at school were revealed (Tables 6−8).

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Table 6. Behavioral characteristics of children (BPI) and mother's smoking† (bivariate analysis)

Behavioral characteristics of children	Exposure SHS (%)	Risk estimation			
		OR (crude)	95 % CI	Chi-square	p-value
Antisocial behavior of children					
She/he cheats or tells lies	35.22	1.35	1.03-1.77	4.80	0.03
She/he is disobedient at school	24.50	1.50	1.11-2.04	6.96	0.008
She/he hangs around with kids who get into trouble	22.41	1.23	0.90-1.68	1.67	0.20
Anxiety and depressed mood					
She/he has sudden changes in mood or feelings	26.82	1.36	1.02-1.82	4.25	0.04
She/he feels or complains that no one loves him/her	23.51	1.70	1.25-2.33	11.32	0.0008

† mother smokes elsewhere

Table 7. Behavioral characteristics of children (BPI) and father's smoking† (bivariate analysis)

Antisocial behavior of children	Exposure SHS (%)	Risk estimation			
		OR (crude)	95 % CI	Chi-square	p-value
She/he cheats or tells lies	33.12	1.27	0.998-1.63	3.78	0.052
She/he is disobedient at school	21.03	1.31	0.98-1.74	3.29	0.07
She/he hangs around with kids who get into trouble	21.51	1.18	0.89-1.57	1.32	0.25
Anxiety, depressed mood					
She/he has sudden changes in mood or feelings	28.45	1.69	1.30-2.21	15.22	0.0001
She/he feels or complains that no one loves him/her	21.12	1.60	1.19-2.15	9.74	0.002

† father smokes elsewhere

Table 8. Emotional characteristics of children (CIS) and mother's smoking[†] (bivariate analysis)

Emotional characteristics of children	Exposure SHS (%)	Risk estimation			
		OR (crude)	95 % CI	Chi- square	p-value
She/he has a problem with feeling unhappy or sad	27.57	1.35	1.00-1.80	4.1	0.043
She/he has a problem with [her/his] behavior at school	26.82	1.34	1.00-1.80	3.87	0.049
She/he has a problem with [her/his] behavior at home	31.68	0.89	0.68-1.17	0.69	0.41
She/he has a problem with feeling nervous or afraid	48.01	0.99	0.76-1.27	0.01	0.91
She/he has a problem getting along with mother	19.87	1.08	0.78-1.48	0.20	0.66
She/he has a problem getting along with father	22.52	1.23	0.90-1.67	1.69	0.19
She/he has a problem getting along with other kids of [her/his] age?	19.21	0.79	0.58-1.09	2.06	0.15

[†] mother smokes elsewhere

Social factors (income and completeness of the family) were dominant in multivariate analyses among factors independently associated with children's behavioral (BPI) and emotional (CSI) problems. The exposure to SHS at home did not appear to be significant in relation to disorders of emotional functions (CIS) and behavioral functions (BPI) in multivariate analysis (Tables 9 and 10).

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Table 9. Factors Independently Associated with Children's Behavioral Problems (BPI≥14) among Children in Multivariate Analyses (n=1,478)[+]

	Adjusted OR	95% CI
Secondhand smoke		
Yes	1.0014	0.58 − 1.71
No	1	−
Age		
6–10 yrs	1	−
11–15 yrs	0.75	0.46 − 1.22
Gender		
Male	1	−
Female	0.54	0.34 – 0.85
Residence		
Urban	1	−
Rural	1.64	0.97 − 2.76
Maternal education		
Primary+ Some high school	1.33	0.81 − 2.21
High school diploma+University	1	−
Paternal education		
Primary+ Some high school	1.33	0.82 – 2.14
High school diploma+University	1	−
Income		
≤600 €	2.15	1.27 − 3.65**
> 600 €	1	−
Completeness of the family		
No	1.97	1.11− 3.51*
Yes	1	−

[+]There are some missing data in each variable category
*p<0.05 **p<0.01

Table 10. Factors Independently Associated with Children's Emotional Problems (CSI≥16) among Children in Multivariate Analyses (n=1,478) [+]

	Adjusted OR	95% CI
Secondhand smoke		
Yes	1.37	0.66 − 2.83
No	1	−
Age		
6–10 yrs	1	−
11–15 yrs	2.00	1.08 – 3.70*
Gender		
Male	1	−
Female	0.64	0.34 – 1.97
Residence		
Urban	1	−
Rural	1.60	0.77 – 3.34
Maternal education		
Primary+ Some high school	0.67	0.31 – 1.48
High school diploma+University	1	
Paternal education		
Primary+ Some high school	0.52	0.26 – 1.03
High school diploma+University	1	−
Income		
≤600 €	2.36	1.10 – 5.06*
> 600 €	1	−
Completeness of the family		
No	3.29	1.55 − 7.00**
Yes	1	−

[+]There are some missing data in each variable category
*p<0.05 **p<0.01

Discussion

The first data on household ETS exposure of Slovak school children are from 1996 in the framework of CESAR study (Central European Study on Air pollution and Respiratory health) on sample of 2,531 children 7-11 year old. They showed very high prevalence of ETS exposure − 48.4 % children [29].

Our results showed decreased prevalence of smoking parents; 21.3 % of smoking mothers and 36.5 % of fathers. Slovakia belongs to the countries with a relatively high prevalence of smoking. WHO Report on the Global Tobacco Epidemic presented the age and sex standardized adult daily smoking prevalence in 2009 in Slovakia 29 % (38% men and 19 %

women) [6]. Comparable national data of Tobacco and Health Education Survey in 2014 have shown the same prevalence 29 %, but with the higher numbers of women − 24%, in men − 34% [30].

The home is the primary source of ETS exposure for infants and children and a major source of ETS exposure for non-smoking adults, mostly mothers [10,31,32,33]. Our results confirmed that older school children, as expected, are more exposed to ETS.

Children of parents with lower education (especially mothers) are significantly more exposed to passive smoking. Many authors presented the interaction between short duration of maternal education, poverty and ETS exposure [34,35,36,37].

Children exposed to ETS were significantly more often ill, especially for respiratory system diseases. Many studies have reported adverse effects of prenatal and/or postnatal exposure on children‘s respiratory health [14]. Among children whose mothers smoke, the risk of asthma is higher [34]. A child with asthma is twice as likely to end up in the hospital if family members smoke [38]. Children exposed to second-hand cigarette smoke have an increased risk of developing lung cancer in adulthood, even if they never smoked [39]. These serious consequences from exposure to tobacco smoke for children‘s respiratory health need to be reduced urgently.

Children whose parents smoke and children from low-SES families are still most likely to be exposed to tobacco smoke [40]. The known relationships of ETS exposure with socio-economic status and incompleteness of the family [6,14] have been confirmed also in our study.

Children exposed to SHS have worse living habits, worse nutrition, less sport activities, and watch more TV and play computer games. Results demonstrate more sedentary activities daily in the exposed children. These negative habits in exposed children could be influenced also by lower socioeconomic status or education of smoking mother [41,42].

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Slovak school children exposed to ETS tend to be overweight and obese similarly as adolescents in USA [43]. The impact of ETS on children's mental health was presented in many studies [44,45]. Children exposed to SHS score higher (worse) in emotional and behavioral functions (CIS, BPI).

The relationships among environmental tobacco smoke exposures (father or mother smoking at home) with disorders of emotional and behavioral functions (CIS and BPI scores) were close. The association between maternal smoking (at home or elsewhere) and antisocial behavior of children, anxiety, depressed mood, feeling of unhappiness and sadness was found to be very high.

Children living with smokers are at increased risk for emotional or behavioral problems [45].

The associations among developmental, neurocognitive or behavioral problems in children and tobacco exposure may have substantial effects on functioning and quality of life and also other risks, in which genetic and societal factors have an essential impact [43,46,48,49]. Mental and physical load in school children could be associated also with the educational process [50], that we did not study in this sample. The exposure to environmental tobacco smoke, even at extremely low levels, is associated with decreases in certain cognitive skills in children and adolescents [51]. Both animal model and human epidemiologic data clearly suggest a causal relationship between prenatal tobacco exposure and adverse behavioral and neurocognitive effects on children [43]. Many studies described the association between ETS prenatal or postnatal exposure and the following adverse cognitive, behavioral and emotional outcomes: conduct disorder, attention-deficit/hyperactivity disorder, poor academic achievement, and cognitive impairment [48,52,53,54].

The relationships among disorders of emotional (CIS scores ≥16) and behavioral functions (BPI score ≥14) of children and the environmental tobacco smoke were significantly confirmed if mother had been smoking. The association between any exposure to ETS in

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household and higher BPI score in children were not significant in our previous analysis [24]. It turns out that the lower social status of the family associates with the prevalence of emotional and behavioral disorders of children [11,55]. The social factors such as income and family completeness were independently associated with the increased emotional and behavioral problems of children (CIS ≥ 16; BPI ≥ 14) in our study.

Results also confirmed that smoking of parents or the other adult member of the family significantly influences reported experiences with smoking in children. The causal relationship between environmental tobacco exposure and adverse behavioral and cognitive outcomes is suggested in many studies [43,48,53].

Children who live in incomplete families or families earning less than the average income had increased rates of behavioral and emotional problems in multivariate analyses. This analysis confirmed also relation of behavioral problems with the age of children. The number of children exposed to household smoking significantly differs in different Slovak regions; the highest prevalence was in the capital and the south of Slovakia. These areas require particular attention in interventions.

Our results confirmed that, children exposed to SHS are from socioeconomic weaker families. Negative attitude toward smoking alongside knowledge of the effects of ETS are very important in interventions for decisions to maintain a smoke-free home [56, 57]. The evidence of adverse effects of ETS exposure is growing rapidly [54].

Despite progress, in 2007, there were 2.7 billion people still having no protection from the disease, disability and death caused by tobacco use and second-hand smoke exposure, or from associated economic, environmental and social harms. All countries have the ability to implement strong tobacco control policies to protect their populations from tobacco use and second-hand smoke exposure, and the illness, disability and death that they cause [30].

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Conclusion

The study evaluates ETS exposure of Slovak school children and its influence on physical and mental health. Our results confirmed the negative impact of ETS exposure on health status and health behavior of school children; passive smoking possesses a high risk to children‘s health. The analysis of the exposure of Slovak school children to passive smoking revealed a high number of smoking parents (21% of mothers and 37% of fathers). There were 8% of ex-smokers among mothers and 12% among fathers.

The results showed that 19 % of children are exposed to passive smoking in the household. The significant differences among regions were revealed with the highest numbers of exposed children in the capital (Bratislava) and the cities in the south of Slovakia.

The exposure to passive smoking was documented as a high risk factor in the older children, children with lower parental education (especially mothers), lower socio-economic status of the family, and incompleteness of the family. Children exposed to tobacco smoke had significantly higher prevalence of respiratory diseases.

The significant relationship among negative dietary habits, lower exercise, longer TV watching, overweight and the exposure to passive smoking has been confirmed. Our study revealed a lack of intervention in the area of the children‘s protection from exposure to toxic tobacco smoke. The study indicates that the exposure of children to passive smoking is the serious environmental risk factor, which also indirectly negatively affects behavior and physical and mental health of children. Emotional and behavioral functions of children are in close relationship with ETS. We found more negative emotional as well as behavioral characteristics (anti-social behavior, anxiety) in children with mother smoking at home as well as the father. Generally, the high influence of mothers smoking at home was found.

In Slovakia more public health activities in children protection from tobacco smoke in the family and household smoking bans are needed. It is necessary to continue systematically and

more vigorously in activities that lead to secure of children's rights to protection against smoking, which started in Slovakia in the year 2000. Education concentrated on family and society and systematic preventive health-care during childhood and adolescence belong to fundamental aspects of the health policy. The results of the study contribute to the effective protection of children from exposure to toxic tobacco smoke. They can be argumentation for interventions to smoking cessation; stimulation of mothers to smoke-free home and further legislative changes. An important role is played by the education of all population groups and an intensive campaign against the risk to children's health through exposure to passive smoking.

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Stefanikova, Erika Machacova, Etela Janekova performed literature search and drafted sections of the manuscript. All authors have approved the submitted version.

Conflicts of interest

The authors declare no conflict of interest.

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