

Effectiveness of ongoing face-to-face anti-tobacco intervention in children with asthma

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ABSTRACT

Background: Interventions to help parents quit smoking may yield important benefits for children with asthma. Children's exposure to environmental tobacco smoke can be measured by reporting of an adult in the household and testing the child's biomarker, e.g., cotinine.

Objective: The aim of the study was to assess the effectiveness of "face-to-face" intervention carried out since 2016 in families with children diagnosed with asthma 3 years after beginning the anti-tobacco intervention.

Methods: This study was a follow-up to an interventional study that assessed the effectiveness of direct patient education versus educational leaflets alone about parental tobacco smoking. The patients with asthma (ages 4–17 years) enrolled in our original intervention study conducted in 2016 were under the care of the allergy outpatient clinic. The active group was individually educated about the harmful effects of environmental tobacco smoke on their children. The control group included patients and parents, among whom only leaflets were distributed. After 3 years of ongoing intervention, in patients from both groups, exposure to tobacco smoking was evaluated with a questionnaire addressed to parents and/or caregivers and measurement of cotinine in children's urine. The forced expiratory volume in the first second of expiration and fractional exhaled nitric oxide levels were measured.

Results: Seventy participants completed the study: 37 in the active group and 33 in the control group. In the active group, 27% of the parents quit smoking entirely compared with 9.4% of parents in the control group. In the group of active intervention, a significant decrease in the cotinine level ($p < 0.001$) and the number of cigarettes smoked daily were observed ($p < 0.001$) 3 years after the active intervention compared with values right after the intervention. In the control group, there were no significant changes in the above-mentioned parameters.

Conclusion: "Face-to-face" intervention among families with smokers were effective and lowered cotinine levels in children with asthma and the number of cigarettes smoked assessed 3 years after the intervention.

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Today approximately one billion people smoke worldwide, and every second child is exposed to second-hand tobacco smoke.¹ A survey showed that 8.7 million adult Polish citizens smoke tobacco daily.² The findings demonstrate that, in Poland, smoking is a serious social problem associated with allergic diseases.² Many children are exposed to tobacco smoke both in utero and postnatally,³ and up to 60% of mothers who quit smoking during pregnancy return to smoking within the first 6 months postpartum, and 80–90%

relapse ≤ 12 months after delivery.⁴ Early exposure to environmental tobacco smoke (ETS) has been shown to be related to the development of asthma and wheezing episodes,^{5,6} allergic sensitization and sensitization to food allergens,^{7,8} and the development of atopic eczema.⁹ If established asthma is present, then ETS is associated with a more severe course.⁵ Furthermore, unlike adults, children have limited options for avoiding exposure to second-hand smoke and are unable to reduce the quantity of products inhaled.¹⁰

Children's exposure to ETS can be measured by the report of an adult in the child's household and testing the child's or a household member's biomarker, e.g., cotinine. Urine cotinine is a sensitive and specific biomarker for discriminating the source of tobacco smoke exposure, especially when the biomarker is measured while a person receives ongoing exposure to tobacco smoke.¹¹ Rosen *et al.*¹² reported that parents exposed to interventions were more likely to quit smoking (23.1%) than parents not exposed to these interventions (18.4%). According to our investigations, the active intervention (monitored by the urine cotinine level)

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among families with smokers was effective and lowered the cotinine level in children with asthma.¹³ Children whose parents passed the whole intervention had higher forced expiratory volume in the first second of expiration (FEV₁) measurements and improvement in PEF.¹³

We decided to assess the effectiveness of “face-to-face” intervention that has been carried out by us since 2016 in families with children diagnosed with asthma¹³ by measuring urine cotinine levels. The secondary end point was the assessment of patients’ lung function 3 years after beginning of the anti-tobacco parental interventions. We hypothesized that an individual tobacco intervention that modifies parents’ smoking behavior should have an effect on decreasing children’s exposure to second-hand smoking.

METHODS

Patients

This study¹³ was a follow-up to an interventional study that assessed the effectiveness of direct patient education (in the form of face-to-face counseling) versus educational leaflets alone on parental tobacco smoking as measured by the urine cotinine level in children with asthma. The secondary end point was the children’s lung function.¹³ The patients (ages 4–17 years) enrolled in our original intervention study conducted in 2016 were cared for at our Allergy Outpatient Clinic.¹³ The active group was individually educated on the harmful effects of ETS on their children, the source of tobacco smoke in the home environment, and methods of preventing exposure of children. The control group included patients and parents, among whom only leaflets were distributed. The intervention lasted 1 month.

At that point, all the parents and children signed informed consent forms for the follow-up study. Every 4 months since the end of the original intervention study (at routine visits to our clinic), the parents from the active group were asked about their smoking status and were re-educated, as mentioned above. It took approximately 10 minutes on each of four visits per year, for 3 years. The control group was given only leaflets that informed them about the harmful effects of ETS and methods of preventing children from exposure.

After 3 years of the on-going intervention, in all the patients from both groups, exposure to tobacco smoking was evaluated with a questionnaire addressed to parents and/or caregivers (based on the Global Adult Tobacco Survey), and cotinine levels in the children’s urine was measured based on the method described previously.^{14,15} This visit also covered the following: asthma control evaluation based on the Childhood Asthma Control Test, GlaxoSmithKline Research and

Development Limited (GSK), lung function test, and fractional exhaled nitric oxide (FeNO) measurement. Pulmonary function testing was done with a Master Screen unit (Erich Jaeger GmbH, Hochberg, Germany) in accordance with the American Thoracic Society/European Respiratory Society guidelines.^{16–18} The study was approved by the medical ethics committee of the Medical University of Lodz, Lodz, Poland (approval RNN/76/14/KE).

Urine Sampling

A 50-mL sample of morning urine was collected into a 100-mL polypropylene container (Bene, Poland). All the urine samples were transported to the laboratory within a cool box and were stored at –20°C until an analysis was conducted. Urinary cotinine levels, in ng/mL (marker of tobacco smoke exposure), were determined by using the method described and optimized by Stragierowicz *et al.*¹⁴

Pulmonary Function Testing

Pulmonary function testing was done with a Master Screen unit, as previously described.¹⁶ All pulmonary function tests were performed according to the American Thoracic Society/European Respiratory Society standards.¹⁷ The highest figure of three successful measurements was taken and used for analysis. The results were expressed as the percentage of a predicted value.

Nitric Oxide Measurement

FeNO was measured with a chemiluminescence analyzer (Sievers NOA 280i, GE Analytical Instruments, Boulder, CO). Exhalations were performed in accordance with the American Thoracic Society/European Respiratory Society guidelines.¹⁸ The children had to maintain a constant expiratory flow of 50 mL/sec for at least 3 seconds and exhalations were repeated until three measurements were within 5% of the mean.

Statistical Methods

After an estimation of the normality of distribution and homogeneity of variances, an analysis of variance or Wilcoxon rank-sum test was fitted. For discrete variables, the χ^2 test of independency was carried out. The FeNO and cotinine concentrations were natural-log transformed. Generalized estimating equations were used when analyzing co-dependency and changes during the study. Robust standard errors (sandwich estimators) were applied. A level of $p < 0.05$ was considered statistically significant. All the statistical computations were carried out by using Stata/Special Edition, release 14.2 (StataCorp LP, College Station, TX).

Table 1 Baseline characteristics by study group

Variables	Active Group (<i>n</i> = 37)	Control Group (<i>n</i> = 33)	Level of Statistical Significance, <i>p</i>
Females, <i>n</i> (%)	14 (37.8)	13 (39.4)	0.894
Ages, mean $\pm$ SD, y			
Patients	8.76 $\pm$ 3.68	8.27 $\pm$ 2.81	0.524
Mothers	34.68 $\pm$ 5.69	36.97 $\pm$ 6.14	0.109
Fathers	33.40 $\pm$ 5.17	35.39 $\pm$ 4.85	0.103
Mother's education, <i>n</i> (%)			0.400
Primary	1 (2.7)	1 (3.03)	
Vocational	3 (8.11)	7 (21.21)	
Secondary	26 (70.27)	21 (63.64)	
Higher	7 (18.92)	4 (12.12)	
Father's education, <i>n</i> (%)			0.006
Primary	7 (18.92)	3 (9.09)	
Vocational	12 (32.43)	2 (6.06)	
Secondary	14 (37.84)	25 (75.76)	
Higher	4 (10.81)	3 (9.09)	
Economic status, <i>n</i> (%)			0.574
Very low	12 (32.43)	8 (24.24)	
Low	12 (32.43)	16 (48.49)	
Average	10 (27.03)	6 (18.18)	
High	3 (8.11)	3 (9.09)	

RESULTS

All the patients were informed that resigning from the study would not result in any impact on the care provided in our public health outpatient clinic. The study was completed by 70 patients and their caregivers: 37 in the active group and 33 in the control group. There were no significant differences in the patients' and parents' age, gender, ethnicity, family socioeconomic status, or educational level of the mothers between the groups (Table 1). In the control group, the fathers significantly more often graduated from secondary school, whereas, in the active group, most of the fathers had primary and vocational education backgrounds (Table 1). These variables were included as confounders in the current analysis. The urine cotinine level was significantly higher at baseline in the active group ($p=0.017$).

In the group of active intervention, a significant decrease in the cotinine level ($p<0.001$) and a number of cigarettes smoked daily were observed ($p<0.001$) 3 years after the ongoing active intervention (Table 2). In the control group, there was no significant change in the cotinine level ($p=0.692$) and no change in the number of cigarettes smoked daily ($p=0.18$) at that time. A between-group analysis did not reveal any significant differences in the cotinine level in the urine. There was no statistical difference in FEV₁ after 3 years of ongoing active intervention in the active group (Table 2) ($p=0.802$) or in the control

group ($p=0.861$ as well as in a between-group analysis of FEV₁ ($p=0.41$). Changes in FeNO results did not differ before and after the intervention within the groups or between the groups (Table 2). An improvement in the CACT was observed after the intervention in the active group, $p<0.001$ as well as in the control group ($p=0.028$). (Table 2). The between-group analysis did not reveal any significant differences in changes in CACT scores. Twenty-seven percent of the parents quit smoking entirely in the active group compared with 9.4% of the parents in the control group ($p<0.001$).

DISCUSSION

Exposure to ETS places a greater burden on children than on adults,^{19,20} and most scientific research shows that 80% of parents smoke tobacco in the presence of their children.²¹ Parents are poorly prepared to quit smoking or reduce smoking in their home environment.^{22,23} Our results showed that active intervention (the "face-to-face" intervention monitored by the urine cotinine level) among families with smokers was effective and lowered tobacco consumption in the domicile, which, therefore, lowered the cotinine level in children with asthma. Children whose parents got only educational leaflets had higher FeNO levels 3 years later compared with the children in the "active" group. Lung function results did not change after the intervention in the control or active groups. We concluded

Table 2 Effects of interventions in the control and active groups: Within- and between-group comparisons

Investigated Trait	Study Group	Time Point	Statistical Parameter			Level of Statistical Significance, <i>p</i>
			Mean $\pm$ SD	95% CI	Minimum–Maximum	a# b§
CACT score, points	Active	Before intervention	22.05 $\pm$ 3.40	20.92–23.19	16–27	<0.001
		3 Years after intervention	23.27 $\pm$ 3.03	22.26–24.28	16–27	
Urine concentration of cotinine, ng/mL*	Control	Abs. change, %		5.53		0.028
		Before intervention	21.24 $\pm$ 5.33	19.35–23.13	4–26	
		3 Years after intervention	22.76 $\pm$ 2.83	21.75–23.76	16–26	
		Abs. change, %		7.16		
FeNO level in the exhaled air, ppb*	Active	Before intervention	4.482 $\pm$ 1.262	2.943–6.827	0.353–272.191	0.001
		3 Years after intervention	1.717 $\pm$ 1.219	1.122–2.627	0.000–90.810	
		Abs. change, %		–61.69		
		Before intervention	2.459 $\pm$ 1.030	1.706–3.543	0.200–33.005	
FEV ₁ best/pred., %	Control	3 Years after intervention	2.795 $\pm$ 1.575	1.518–5.148	0.000–851.360	0.822
		Abs. change, %		13.66		
		Before intervention	20.89 $\pm$ 0.62	17.00–25.68	8.40–198.00	
		3 Years after intervention	21.92 $\pm$ 0.52	18.44–26.06	9.00–127.00	
No. cigarettes smoked daily	Active	Abs. change, %		4.93		0.053
		Before intervention	15.79 $\pm$ 0.72	12.24–20.35	2.50–137.00	
		3 Years after intervention	21.80 $\pm$ 0.75	16.68–28.48	3.70–169.00	
		Abs. change, %		38.06		
FEV ₁ best/pred., %	Control	Before intervention	102.21 $\pm$ 16.17	96.82–107.61	72–140	0.802
		3 Years after intervention	101.59 $\pm$ 6.98	99.27–103.92	86–120	
		Abs. change, %		–0.61		
		Before intervention	99.55 $\pm$ 15.50	94.05–105.04	65–124	
No. cigarettes smoked daily	Active	3 Years after intervention	99.92 $\pm$ 11.07	95.99–103.84	75–130	0.861
		Abs. change, %		0.37		
		Before intervention	29.21 $\pm$ 17.21	23.48–34.95	6–80	
		3 Years after intervention	20.44 $\pm$ 13.55	15.08–25.80	5–45	
No. cigarettes smoked daily	Control	Abs. change, %		–30.02		0.180
		Before intervention	27.09 $\pm$ 18.69	20.35–33.83	3–75	
		3 Years after intervention	26.21 $\pm$ 22.30	17.72–34.69	4–90	
		Abs. change, %		–3.25		

CACT = Childhood Asthma Control Test; SD = standard deviation; CI = confidence interval; FeNO = fractional exhaled nitric oxide, FEV₁% = percentage of pre-dicted forced expiratory volume in 1 second; Abs = absolute.

*Geometric mean was displayed.

#Repeated measurements in a specific study group.

§Between-group differences in a multifactor analyses.

that active intervention decreased ETS exposure in our patients.

Our results were in accordance with the observations from two Cochrane analyses⁴ of recently examined interventions that aimed to reduce the exposure of children to ETS. Motivational interviewing or intensive counseling provided in clinical settings seemed to be more effective, whereas interventions on parental education only (leaflet distribution) that focused on reducing children's ETS did not prove to be effective,²⁴ which convinced us to include an educational module into routinely performed visits in the active group in the Allergy Outpatients Clinic.

Interventions may yield important benefits for children with asthma.²⁵ Hansen *et al.*²⁶ found that parents who did not receive parental education exposed their children to second-hand smoke more often than those who did receive parental education. Furthermore, children with parents who have an allergy were exposed to tobacco smoke to a lower extent than children with parents without allergies.²⁶ In our study, all the patients had allergic asthma, which could be an additional motivating factor.

The features that differentiate the effective interventions from those without clear evidence of effectiveness remain unclear. Studies that showed a significant effect used a range of interventions: in-person counseling or motivational interviewing, telephone counseling, multi-component education-based interventions, and a school-based strategy.^{27–29} Observations indicate that a “face-to-face” intervention is the most reliable method that has been established right now.³⁰ The regular visits in our Allergy Outpatient Clinic and educational efforts taken by allergists resulted in quitting smoking entirely by 27% of the parents in the active group. It seems that the development of an individual tobacco intervention could provide a greater chance of changing parental habits in terms of decreasing children's exposure to second-hand smoking.

Although our research has shown that parents are susceptible to interventions for smoking cessation, it is still questionable how long the positive effect may last. Six-month smoking quitting rates are as low as 10% for minimum interventions and up to 26% for high intensity counseling with nicotine replacement therapy.³¹ Previous studies showed that many smokers who successfully quit, relapse after 1 year of abstinence.^{32,33} Nohlert *et al.*³⁴ reported that abstinence from smoking by a 12-month follow-up could significantly predict people's smoking status in the long term, whereas Ockene *et al.*³³ suggested that a follow-up period of 1 or 2 years would be more appropriate.

Results of our study indicated that intervention and re-education done on a regular basis for a couple of years by physicians familiar with their patients is a valuable assistance that supports smokers in their fight

with addiction. The limitation of our study was the small sample size. A lack of significant differences in the cotinine level in urine between the groups may indicate that the intervention failed, and it was a major weakness of our study; however, it may be connected with a higher baseline level of cotinine in the active group and other included confounders. The strongest correlation was observed for a patient's age, father's age, and father's level of education. The added value of our study was the extended duration of contact over 3 years as opposed to just 1 year in a similar study, which also demonstrated the same results.³⁵

A study design that uses a longer follow-up period and biochemical validations is recommended.³⁶ The most important test that evaluated our type of intervention was the urine laboratory test to check the cotinine level, which is a good biomarker of nicotine intoxication.^{19,20} We decided to use the urine cotinine to assess ETS exposure objectively. Self-reported smoking may be a potential source of bias. A systematic review done by Connor Gorber *et al.*³⁷ revealed a tendency of underestimation of self-reported smoking, especially when smoking is seen as undesirable. This study showed that an individual intervention can be effective and can decrease the number of cigarettes smoked in homes and cotinine levels in children, which thus improved their asthma treatment.

CONCLUSION

The influence of ETS on children's asthma is widely known. There was strong statistical evidence that our intervention performed in parents was effective in our children with asthma. These results encourage educational programs to increase people's knowledge of the possible damage caused by ETS and offer parents who smoke regular assistance.

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