

Prevention of Children's Exposure to Second-Hand Smoke : A Biochemical Feedback Intervention Focused on Stage of Behavioral Change

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Objective : To determine the impact of an intervention in which a child's urinary cotinine value is told to smoking family members on stage of behavioral change for smoking cessation, and to investigate factors that contribute to the progression of stage of behavioral change among smoking family members. **Methods :** Participants were smoking family members of children enrolled at five kindergartens in two cities in Japan between December 2009 and January 2011. The stage of behavioral change before and after the intervention and related variables were measured by self-administered questionnaires. Statistical analyses were performed using the Wilcoxon signed-rank test and multivariate logistic regression analysis. **Results :** Valid responses were obtained from 110 participants in 101 households. Before the intervention, 39 participants (35.5%) were in the first half of the pre-contemplation stage, 53 participants (48.2%) were in the latter half of the pre-contemplation stage, 18 participants (16.4%) were in the contemplation stage, and no participants (0.0%) were in the preparation stage. A significant difference in stage of behavioral change was found before and after the intervention ($z = -3.350$, $p = 0.001$). The stage of change progressed after the intervention. The lower the stage of behavioral change for smoking cessation before the intervention (odds ratio [OR] 11.90, 95% confidence interval [CI] 2.24-63.30, $p < 0.01$) or the higher a parent's anxiety regarding the children's health (OR 4.23, 95%CI 1.34-13.30, $p < 0.05$), the more the intervention led to a progression in the stage of behavioral change. **Conclusion :** A biochemical feedback intervention for smoking family members who are in the first half of the pre-contemplation stage could lead to progress in the stage of behavioral change among smokers, and this progress might lead to an increase in the number of quitters. (Kitakanto Med J 2014 ; 64 : 125~134)

Key words : kindergartener, pre-contemplation stage, urinary cotinine value

I Introduction

It is widely accepted that there is no safe or harmless level of second-hand smoke.¹ Second-hand smoke is a risk factor for sudden infant death syndrome,¹⁻⁴ otitis media,^{1,5,6} asthma,^{1,7-9} and respiratory infections,⁷⁻¹⁰ especially among children. Currently, approximately 40% of children worldwide are at risk of second-hand smoke,¹¹ mostly from family members,¹² as they cannot escape from the dangers of second-hand smoke on their own. As such, cessation of smoking by family members is important to prevent children's exposure to second-hand smoke. However,

the rate of smoking cessation by family members remains low.¹³

Stages of behavioral changes leading to smoking cessation are classified as follows: (1) the pre-contemplation stage, wherein a smoker does not wish to quit smoking, or, if he/she wishes to, does not intend to do so within a 6-month period; (2) the contemplation stage, wherein a smoker intends to quit smoking within a 6-month period; and (3) the preparation stage, wherein a smoker intends to quit smoking within 1 month. Somewhere along these stages, a smoker is expected to reach the action stage, where they would commence smoking cessation.¹⁴ According to

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a previous report,¹⁵ it is possible for smokers to progress through these stages with the appropriate intervention.

Various smoking interventions for family members have been proposed to prevent children's exposure to second-hand smoke, including the "cognitive-behavioral approach," which uses cognitive behavioral science¹⁶⁻¹⁸; "self-help materials," which provide self-study teaching materials¹⁹⁻²⁵; "individual counseling" by professionals²²⁻³¹; and "biochemical feedback," which is based on biochemical test results.³⁰⁻³² A meta-analysis¹³ showed that an appropriate combination of these methods increased the rate of smoking cessation by smoking family members to 23.1% in the intervention group compared to 18.4% in the control group.

Of the above intervention methods, the cognitive-behavioral approach, self-help materials, and individual counseling are mainly applied to smokers who are guardians of children with asthma, and to those who are typically in the contemplation and preparation stages. The intervention period usually spans 6 months to 1 year. This results in a limited number of participants in interventions, and the need for long durations of interventions.

In contrast, biochemical feedback is a simple method that relies only on biochemical test results. Therefore, this intervention, mostly using urinary cotinine values of children as an indicator of exposure to second-hand smoke, has been applied successfully, not only to guardians of children with asthma,³² but to guardians of healthy fourth-graders as well.³³ Biochemical feedback has the advantage of being able to be used in smoking family members in the pre-contemplation stage and to intervene in the short term. As an indicator of passive smoking, urinary nicotine value is used in some cases although its half-life is only several hours.³⁴ However, as for biochemical feedback, urinary cotinine value is used in general since it has longer half-life and reflects the exposure to passive smoking retroactively to a few days ago.³⁰⁻³²

Over the past 10 years, smoking cessation interventions have generally been provided to smokers in the preparation or contemplation stages, as such interventions have greater success with these groups than with smokers in the pre-contemplation stage. However, 50-60% of smokers overall,¹⁵ and 38.7% of smokers who are primary caregivers to children,³⁵ are in the pre-contemplation stage. Despite these findings, support related to smoking cessation by family members is primarily provided to individuals in the contemplation or preparation stage. Consequently, there is a need to develop an effective intervention method for smoking family members who are in the pre-contemplation

stage.

In addition, the evaluation of smoking cessation interventions tends to focus on success in smoking cessation and not on the process leading up to smoking cessation. It is assumed that an intervention that corresponds with each stage of behavioral change plays an important role in enabling smokers to proceed to the next stage.¹⁴ Therefore, there is a need for a study focusing on stages of behavioral change.

In consideration of developing a biochemical feedback intervention aimed at smoking family members in the pre-contemplation stage, the first objective of this study was to determine the impact of an intervention in which a child's urinary cotinine value is told to each smoking family member on the progression of stage of behavioral change for smoking cessation. The second objective was to investigate factors associated with the progression of stage of behavioral change among smoking family members because of the intervention.

II Methods

1. Participants and methods

To ensure that only the impact of second-hand smoke was reflected in each child's urinary cotinine value, participants in this study were defined as every smoking family member of a pre-school child who could not possibly smoke on his or her own. In addition, the preschool children were restricted to kindergarteners (3-6 years old), because kindergarteners spend nearly the same amount of time at home as at school, which determines the extent of exposure to second-hand smoke.

Between December 2009 and January 2011, all households (N=766) whose children attended one of five kindergartens located in two cities in the Kansai district of Japan (each city's population was approximately 130,000) were requested to participate in this study. Siblings who attended the same kindergarten were considered members of one household.

1) Biochemical feedback intervention

The urinary cotinine value, used as the biochemical feedback indicator, was measured using urine passed and collected on a Monday morning. This was based on the assumption that the kindergarteners would have been more frequently exposed to second-hand smoke on the preceding Saturday and Sunday. The urine was collected at home by the guardians, and the filled containers were collected upon the children's arrival at kindergarten. Thereafter, the corresponding author saved the collected urine at -20°C. The urinary cotinine value was measured using T996B841 (Cosmic Corporation, Tokyo, Japan). Further, to consider changes associated with urine flow, urinary

Result report on urinary cotinine study

Thank you very much for your participation in my study of "the condition of passive smoking in households." I would like to report the results as follows.

Urinary cotinine value ※※ ng/ml
(Reference: value \geq 10ng/ml means possible passive smoking)

Cotinine tested in this study is a substance contained in urine after nicotine in tobacco smoke is first inhaled by children and then broken down in children's body.
In some cases cotinine is not detectable due to the time of tobacco smoke inhaled. Also, it is possible the value includes outside tobacco smoke inhaled. Thus, please refer to the value as rough indicator.

I very appreciate for your participation.
As a token of appreciation, I am sending you a small gift. Please accept it.

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Fig. 1 A report on urinary cotinine value used as the biochemical feedback

creatinine value was measured at a commercially available laboratory (SRL, Inc., Tokyo, Japan) using an enzymatic assay. In this study, the urinary cotinine value adjusted for urinary creatinine level was used as an indicator of biochemical feedback. This urinary cotinine value measuring method uses Enzyme-Linked ImmunoSorbent Assay (ELISA). This method can measure many samples cheaply in a short time compared with gas chromatography-mass spectrometry. Moreover, the reliability and validity are already established.³⁶

In accordance with a previous study,³⁷ 10 ng/mgCr or more were considered indicative of possible exposure to second-hand smoke. In addition, a urinary cotinine value of less than 1.3 ng/mgCr was considered under the minimum recorded detectable sensitivity of urinary cotinine value. As the intervention, the researchers notified every participant of the urinary cotinine value and information above 5–7 weeks after urine collection (Fig. 1).

2) Stage of behavioral change among smoking family members

Information regarding the stage of behavioral change before the intervention for smoking family members was collected by self-administered questionnaires. Participants received a self-administered questionnaire during recruitment for participation in the study. Participants who consented to participation in the study sent their completed, self-administered questionnaires directly to the researchers.

Information regarding the stage of behavioral change following the intervention was also collected by another self-administered questionnaire; participants were asked to return this questionnaire after they had been informed of each child's urinary cotinine value.

The stage of behavioral change for smoking cessation was based on the stages developed by Prochaska and Velieer.¹⁴ To determine the stages more precisely, the pre-contemplation stage was divided into two stages. A smoker who was not interested in smoking cessation was assigned to the first half of the pre-contemplation stage, while a smoker who wished to quit smoking but did not intend to do so within 6 months was assigned to the latter half of the pre-contemplation stage.

3) Factors related to progress in the stage of behavioral change

Values of potential factors related to the progress in the stage of behavioral change were measured by self-administered questionnaires completed before the intervention. Factors included child's health, number of children in the household, attempts to prevent the child's exposure to second-hand smoke (in the house, car, and restaurants), number of years smoking, number of attempts made to quit smoking, number of cigarettes smoked per day, number of smokers in the household, number of family members who had already quit smoking, family relation of smoker to

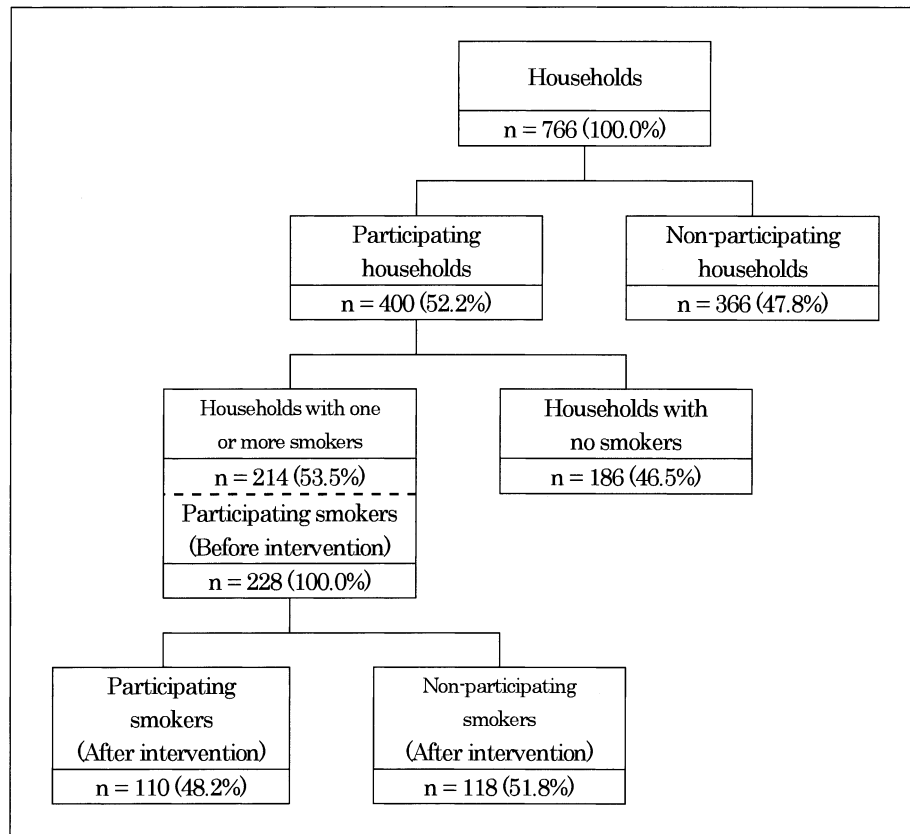


Fig. 2 Flow of participants in this study

child, and the stage of behavioral change before the intervention. The urinary cotinine value of the child was also considered a potential factor.

In terms of attempts to prevent the child's exposure to second-hand smoke, the following situations were regarded as not considering the child's exposure to second-hand smoke: smoking in the house ("smoke in the house"), smoking in the car ("smoke in the car"), and smoking in restaurants ("choose a smoking section" or "do not care").

2. Statistical analysis

The difference in stage of behavioral change among smoking family members before and after the intervention was tested by the Wilcoxon signed-ranks test.

To examine factors that led to a progression in the stage of behavioral change among smoking family members, respondents were classified into two groups according to the presence or absence of progression in the stage of behavioral change for smoking cessation due to the intervention. Then, the relation was tested by the chi-square test between the classification and each potential factor. Subsequently, forced entry multivariate logistic regression analysis was conducted using potential factors significantly related to the classification as independent variables and the presence or

absence of progress as the dependent variable. P values < 0.05 were considered statistically significant. SPSS PASW Statistics 18 (SPSS Japan Inc., Tokyo, Japan) was used for statistical analysis.

3. Ethical considerations

Study participants were asked to read both a letter of explanation concerning the study and a request to participate carefully. If they agreed to participate in the study, they were then asked to send a signed consent form and self-administered questionnaire back to the researchers. The letter indicated that the participants could withdraw their consent anytime, even after consenting to participate. Our contact information was provided in the letter. In this study, guardians' consent was also obtained, since the urine of children aged 3-6 years was part of the data. In addition, the participants received stationery for the participating child as compensation for participation. This study was performed with the approval of the ethics committee of Nara Medical University.

III Results

In the survey that was conducted with 766 households before the intervention, responses were obtained from 400 households (52.2%); 214 households (53.5% of households that responded) included smoking fam-

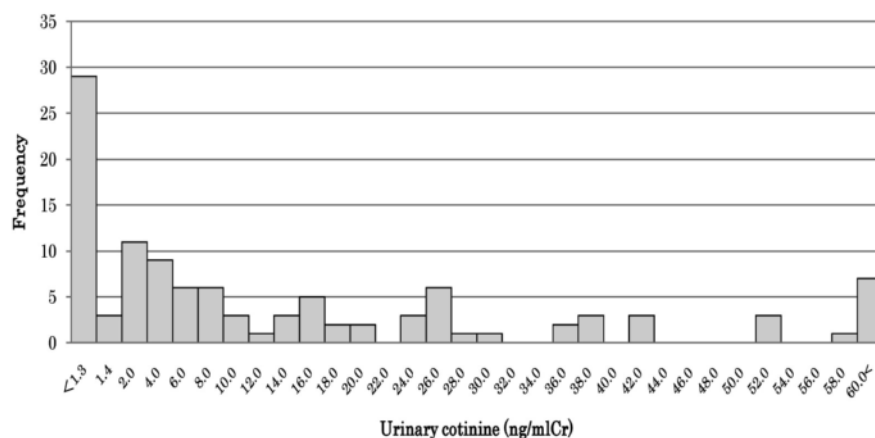


Fig. 3 Distribution of urinary cotinine values of the children (n = 110)

Table 1 Stages of behavioral change among smoking family members before and after the intervention

Before intervention	After intervention									
	First half of pre-contemplation stage		Latter half of pre-contemplation stage		Contemplation stage		Preparation stage		Total	
	n	%	n	%	n	%	n	%	n	%
First half of pre-contemplation stage	18	46.2	15	38.5	4	10.3	2	5.1	39	35.5
Latter half of pre-contemplation stage	7	13.2	31	58.5	12	22.6	3	5.7	53	48.2
Contemplation stage	2	11.1	5	27.8	9	50.0	2	11.1	18	16.4
Preparation stage	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	27	24.5	51	46.4	25	22.7	7	6.4	110	100.0

Progressed after the intervention (n=38)

Wilcoxon signed-ranks test : $z = -3.350$, $p = 0.001$

ily members. Valid responses were obtained from 228 of the smoking family members. Of these respondents, 110 participants in 101 households (48.2% of smoking family members) took part in the survey after the intervention (Fig. 2).

1. Second-hand smoke and potential factors

Urinary cotinine values less than 10 ng/mgCr were recorded for 64 children (58.2%), and urinary cotinine values of 10 ng/mgCr or more were recorded for 46 children (41.8%); these indicated probable exposure to second-hand smoke (Fig. 3). Eighteen respondents (16.4%) felt anxious about the child's health. The number of children per household ranged from one to four (mean = 2.2; SD = 0.7).

The number of respondents who did not attempt to prevent the child's exposure to second-hand smoke in their house, car, and restaurants was 50 (45.5%), 48 (43.6%), and 37 (33.6%), respectively.

The respondents had been smoking for the past 1 to 50 years (mean = 20.1; SD = 8.0), and 55 smoking respondents (50.0%) had been smoking for 20 years or more. The number of attempts at smoking cessation ranged from 0 to 10 (mean = 1.2; SD = 2.1), and 62 respondents (56.4%) had previously tried to quit smoking. The number of cigarettes smoked per day ranged

from 3 to 40 (mean = 18.0; SD = 7.8) and 49 respondents (44.5%) smoked 20 cigarettes or more per day. There was statistically significant correlation between the number of cigarettes smoked and children's urinary cotinine value ($r = 0.27$, $p < 0.01$).

The number of smokers in the family ranged from one to three persons (mean = 1.2; SD = 0.5), and 19 respondents (17.3%) indicated that their family had two or more smokers. The number of family members who persisted with smoking cessation ranged from 0 to 2 persons (mean = 0.3; SD = 0.5), and 25 respondents (22.7%) had family members who persisted with smoking cessation. With regard to the relations between the kindergarteners and their respective respondents, 11 (10.0%) of the family members were the kindergarteners' mothers, 90 (81.8%) were their fathers, and 9 (8.2%) were their grandfathers.

2. Factors related to progress in the stage of behavioral change

Table 1 shows the stages of behavioral change for smoking cessation before the intervention: 39 participants (35.5%), 53 participants (48.2%), 18 participants (16.4%), and no participants (0.0%) were in the first half of the pre-contemplation stage, the latter half of the pre-contemplation stage, the contemplation stage,

Table 2 Relationship between progress in stages of behavioral change and related variables (n=110)

Variables	Changes in the stage of behavioral change				χ^2 value	p value	
	Progressed (n=38)		Constant or regressed (n=72)				
	n	%	n	%			
The child							
Urinary cotinine level							
< 10ng/mgCr	22	34.4	42	65.6	0.00	0.965	
≥10ng/mgCr	16	34.8	30	65.2			
Health of the child							
Good	28	30.4	64	69.6	4.20	0.040 *	
Of concern	10	55.6	8	44.4			
Number of children							
1	3	21.4	11	78.6	1.22	0.372	
≥2	35	36.5	61	63.5			
Attempts to prevent child's exposure to second-hand smoke							
At home	Yes	17	28.3	43	71.7	2.25	0.133
	No	21	42.0	29	58.0		
In car	Yes	16	27.1	43	72.9	5.73	0.057
	No	22	45.8	26	54.2		
	No car	3	100.0	0	0.0		
In restaurants	Yes	21	28.8	52	71.2	3.21	0.073
	No	17	45.9	20	54.1		
Smoking history							
Duration of smoking							
≥20 years		21	38.2	34	61.8	0.64	0.423
<20 years		17	30.9	38	69.1		
Experiences of smoking cessation							
Some		24	38.7	38	61.3	1.09	0.297
None		14	29.2	34	70.8		
Number of cigarettes smoked per day							
≥20		16	32.7	33	67.3	0.14	0.708
<20		22	36.1	39	63.9		
In the household							
Number of other smokers							
None		30	33.0	61	67.0	0.58	0.446
Some		8	42.1	11	57.9		
Number of complete quitters							
None		33	38.8	52	61.2	3.03	0.082
Some		5	20.0	20	80.0		
Smoker's relation to the child							
Mother		6	54.5	5	45.5	2.61	0.271
Father		30	33.3	60	66.7		
Other		2	22.2	7	77.8		
Stage of behavioral change (before intervention)							
First half of pre-contemplation stage		21	53.8	18	46.2	11.71	0.003 **
Latter half of pre-contemplation stage		15	28.3	38	71.7		
Contemplation stage		2	11.1	16	88.9		

Chi square test *p<0.05, **p<0.01

and the preparation stage, respectively. After the intervention, 27 participants (24.5%), 51 participants (46.4%), 25 participants (22.7%), and 7 participants (6.4%) were in these respective stages. Wilcoxon signed-ranks test showed a significant difference in the stage of behavioral change before and after the intervention ($z = -3.350$, $p = 0.001$), with progress in the stage of behavioral change after the intervention. Specifically, 53.8% of participants who were in the

first half of the pre-contemplation stage before the intervention showed progress in the stage of behavioral change, and some reached the preparation stage.

In terms of change in stage of behavioral change, 38 participants (34.5%) showed progress in the stage after the intervention, whereas 72 participants (65.5%) showed no change or regression after the intervention. Significant relations were only found between these two groups and "the child's health" ($p < 0.05$) or "the

Table 3 Multivariate logistic regression model of progress in stages of behavioral change

	Odds ratio	95% confidence interval	
Stage of behavioral change (before intervention)			
First half of pre-contemplation stage	11.90	2.24-63.30	* *
Latter half of pre-contemplation stage	3.19	0.62-16.34	
Contemplation†			
Health of the child			
Good†			
Of concern	4.23	1.34-13.30	*

† Reference group *p<0.05, **p<0.01

stage of behavioral change for smoking cessation before the intervention” ($p<0.01$) (Table 2).

Multivariate logistic regression analysis was conducted with these two potential factors as independent variables. The lower “the stage of behavioral change regarding smoking cessation before the intervention” (odds ratio [OR] 11.90, 95% confidence interval (CI) 2.24-63.30, $p<0.01$) and the higher the anxiety of a parent regarding “the child’s health” (OR 4.23, 95% CI 1.34-13.30, $p<0.05$), the greater the progress in the stages of behavioral change as a result of the intervention (Table 3).

IV Discussion

1. Impact of biochemical feedback intervention on stage of behavioral change

In this study, the progression in stage of behavioral change presumably resulted from the biochemical feedback intervention, in which smoking family members were informed of their child’s urinary cotinine value. In conventional intervention studies, biochemical feedback has been combined with individual counseling or other intervention methods and has often been used as an additional form of intervention.³⁰⁻³² Nonetheless, as shown in this study, biochemical feedback can, on its own, lead to a progression in stage of behavioral change.

Interventions aimed at smoking cessation in the interests of children have been thought to cause conflict between the roles of parents and smokers. A previous study³⁸ showed that an intervention that causes role conflict might lead smokers to enter the preparation stage. In this study, an intervention using only biochemical feedback information also seemed to cause role conflicts, which might have led to a progression in the stage of behavioral change.

In previous studies, interventions were often performed without an understanding of the stages of behavioral changes for smoking cessation. There was also no knowledge of the mechanism behind the association of the use of the intervention with smoking

cessation. It is possible that the mechanism leading to successful smoking cessation due to progression in the stage of behavioral change and the associated intervention may be better understood in the future. This would presumably result in a higher possibility of identifying effective stages of behavioral change for each intervention.

2. Factors that lead to progression in stage of behavioral change

Two factors led to progression in stage of behavioral change in this study. First, among smoking family members who did not wish to quit smoking, which meant they were at the lowest stage of behavioral change for smoking cessation, stages of behavioral change significantly progressed with biochemical feedback. Prochaska et al. reported that depending on the stage of the smoking cessation process, appropriate intervention methods could alter the stage of behavioral change in addictive behavior, such as smoking.¹⁵ Regarding the progress from the pre-contemplation stage, they emphasized consciousness-raising, dramatic relief, and environmental re-evaluation. It was thought that the biochemical feedback in the present study had two meanings: consciousness-raising to provide information regarding the problem by indicating the child’s urinary cotinine value; and environmental re-evaluation, leading to a re-evaluation of the impact of smoking behavior on the environment on the basis of the child’s urinary cotinine value. It has been reported that smokers tend to underestimate the impact of second-hand smoke on children.³⁹ Furthermore, parents who have asthmatic children tend to underestimate the impact of second-hand smoke.³⁵ It is therefore likely that, in general, parents also underestimate the true impact of second-hand smoke. Consequently, an intervention using urinary cotinine values enables parents to accurately recognize the actual impact of second-hand smoke on their children, with the potential to result in consciousness-raising, particularly among smokers who had previously not considered

quitting smoking. However, for the progress of stages of behavioral change among smoking family members who are in the contemplation stage, there is a possibility of no effects, when an intervention is the sole use of biochemical feedback, as in this study. But effective intervention methods for smokers in the contemplation stage have been established, including biochemical feedback. Therefore, the use of these established methods is expected to result in progress in the behavioral change stages among smoking family members who are in the contemplation stage.

Second, for smoking family members who were, in some ways, anxious about their children's health, the stage of behavioral change progressed significantly. A randomized intervention study involving parents and guardians of asthmatic children revealed that a complex intervention including biofeedback led to greater smoking cessation, as the children were at high risk of developing asthma.³² The results of the present study showed that biofeedback alone linked anxiety regarding children's health with a progression in stage of behavioral change, again confirming that the recognition of anxiety regarding children's health plays a major role in smoking cessation. A previous report³⁴ indicated that parents who had children with uncontrolled asthma or who thought that a child's symptoms decreased due to smoking cessation, and not those who were simply concerned about the child's health, were motivated to quit smoking. The present study conducted on general kindergarteners revealed that biochemical feedback led to progression in the stages of behavioral change among parents who were worried about their child's health.

Third, the urinary cotinine value of children, which is possibly attributable to the progression of stage of behavioral change, did not have significant correlation with the progression of stage of behavioral change of smoking family members. This result suggests that smoking family members have certain levels of recognition of the condition of second hand smoke of their children before intervention and that positive result of second hand smoke in urinary cotinine value may not directly related to the progression of stage of behavioral change.⁴⁰ The method of this study using biochemical feedback consisted of sampling urine and urinary cotinine value report; thus, it is thought that the participation in this intervention itself may have caused the progression of stage of behavioral change. Further investigation is needed to know a background of this result.

3. Future prospects and application to practice

To apply an intervention aimed at smoking cessation to smoking family members, it is necessary to

focus on the interests of children not only from the viewpoint of smoking cessation but also from the viewpoint of progressing along the stages of behavioral change. Based on the results of this study, our method could be particularly effective for use on smoking family members who are in the first half of the pre-contemplation stage.

According to a meta-analysis¹³ of interventions aimed at smoking parents of young children, the intervention for smoking cessation and prevention of second-hand smoke was effective among parents who had children aged 4 or older. Thus, interventions for parents with school-age children (kindergarten or higher) are more likely to be effective. Consequently, based on the results of this study, a reduction in the number of smoking family members who are in the pre-contemplation stage can be expected by incorporating a measurement of children's urinary cotinine value in periodical health examinations in kindergartens. This seems feasible in Japan, because periodical health examinations, including urinalysis, are implemented in all Japanese kindergartens every year due to the School Health and Safety Act. In addition, for smoking family members who reached the contemplation or the preparation stage after the intervention, an established intervention might facilitate smoking cessation. Therefore, it is necessary to establish a system of intervention specifically for smoking family members who are in both the contemplation stage and the preparation stage.

Findings obtained from this study were obtained due to dividing the pre-contemplation stage into two categories. Presumably, a classification of the pre-contemplation stages into two categories would enable the effectiveness of future studies on smoking cessation.

V Limitations

In this study, it is necessary to consider non-response bias, as the number of participants after the intervention decreased by nearly half (48.2%, 110 participants). In addition, careful consideration is needed for the generalization of these results, as the sampling method was not random, and this study used a pretest-posttest design without a control group.

Although smokers in the pre-contemplation stage usually represent 50–60% of smokers,¹⁵ this group comprised 83.7% of participants in this study before the intervention. Therefore, smokers in the pre-contemplation stage might be over-represented in this study. Many smokers who had continued smoking despite having young children may have remained in the pre-contemplation stage because of failure to quit smoking, given the fact that they were in the lower stages of behavioral change. However, this study

might have attracted smokers who, in any case, were not interested in quitting, and it might have been difficult for smokers in the preparation stage to participate in this study, due to the possible assumption that they would be forced to quit smoking.

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Conflict of Interest

None of the authors have any conflicts of interest associated with this study.

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