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The effects of household exposure to cigarette smoke on the incidence of respiratory illness were examined among 1007 18 month old children at Lu-wan District, Shanghai City, People's Republic China. The passive smoking quantity was estimated by summing the total daily cigarette consumption of family members. No mothers who smoked were found. A significant dose-response relationship of passive smoking to hospitalization for respiratory illness during the children's first 18 months of life was found, for which no confounding factors were discovered. The relative risk was 2.4 for children living in families including people who smoked 20 or more cigarettes a day compared with those living in non-smoking families. The children who were boys or artificially (bottle) fed were more affected than those who were girls or breast fed. The cumulative incidence of bronchitis and pneumonia increased significantly with increasing cigarette smoking of family members, that did not change when sex, birth

weight, type of feeding, coal for cooking, or parental education were taken into account. Family smoking status was not found to be significantly associated with the cumulative incidence of asthma, whooping cough, sinusitis or measles.

The Effects of Passive Smoking on Respiratory Illness in Early Childhood in Shanghai, P.R.China

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INTRODUCTION

Passive smoking, also called Environmental Tobacco Smoke (ETS), is the term used to characterize the tobacco combustion substances inhaled by nonsmokers in the proximity of burning tobacco.[1] According to the National Research Council report, over 3800 compounds have been identified in tobacco smoke, many of which are known carcinogens.[2]

ETS consists of sidestream emitted from the burning tip of the cigarette and mainstream smoke, which is inhaled, filtered, and exhaled by the smoker. The vast majority of ETS is composed of sidestream smoke, which is quantitatively and qualitatively different from mainstream smoke. Typically, a nonsmoker is exposed to less smoke than an active smoker. However, the sidestream smoke is qualitatively more hazardous than mainstream smoke because of the higher temperature of combustion at the time it is formed and because sidestream smoke remains unfiltered, either by the cigarette or by the smoker's lung. Sidestream contains higher concentrations of ammonia, benzene, nicotine, carbon monoxide, and many carcinogens.[1,2] Many of these particles are of the size that makes them easily drawn deep into the lung.[4]

Exposure to ETS is commonplace. In a study of nearly 38,000 nonsmokers, 63% reported some exposure to ETS, with one-third reporting ten or more hours and 16% reporting exposure for more than 40 hours per week.[5] Nonsmokers who are exposed to tobacco smoke are believed to assume health risks similar to those of a light smoker.[6] In some studies, when biologic markers of tobacco smoke exposure are analyzed, levels of nicotine in body fluids correspond to the self-reported level of exposure.[7] Some investigators report that urinary cotinine levels in nonsmokers were strongly related to the extent of self-reported passive smoking.[8] There appeared to be a dose-response relationship among nonsmokers who lived and /or worked with smokers. The authors concluded that the deleterious effect of passive smoking was in direct relationship to the extent of exposure.

The specific effects of passive smoking on nonsmokers continues to be investigated; however, there is substantial agreement that chronic exposure to passive smoke can cause lung cancer in healthy adults, has an adverse effect on the health of children, is an irritant to the senses, can cause respiratory impairment, and may lead to cardiovascular disease.[1]

So far, many studies have reported that children of parents who smoke have more respiratory infections, more respiratory symptoms, and an increased frequency of hospitalization for bronchitis and pneumonia compared with children of parents who do not smoke. [9-12]

Not only do children who are passively exposed have more symptoms of respiratory disease, but evidence from some cohort studies suggest that parental smoking may also affect the rate of lung growth during childhood.[13,14] Thus, children of parents who smoke are not only sick more frequently from respiratory ailments but are also more likely to have impaired lung growth as they develop, which may increase the risk of chronic airflow obstruction as an adult.[15] This process may initially result from passive exposure in utero affecting the growth pattern of the fetal lung.[2]

In spite of these findings, some contradictions and questions remain. One of question is to distinguish between the effect of maternal smoking during pregnancy and the effect of passive exposure to tobacco smoke after birth. The health outcomes of maternal smoking during pregnancy, including lower birth weight, higher risk of spontaneous abortion, fetal deaths as well as pregnancy complications, have been well documented.[16]

In this study, I shall evaluate the association between admission to hospital for respiratory illness and passive smoking in infants during the first 18 months life using data from Shanghai City, Peoples's Republic of China.

METHODS

The study area covers the whole of Lu-Wan District, which is one of ten urban districts of the Shanghai City in the People's Republic of China. Lu-Wan District, with eight neighborhoods, is in the center of Shanghai City and a commercial area. Outdoor air pollution is mostly caused by vehicular emissions.

All 1007 live babies born in the last quarter of 1983 in Lu-Wan District, Shanghai, were selected as the study population. When the survey was conducted during the period from March to June 1985, the children had reached the age one and a half years. The list of baby's names was collected from each health promotion sector of the neighborhood hospital, which notifies all births in the area as soon as they are certified and provides regular immunization coverage and other primary health care. The babies who moved out the study area in their first 18 months of life (less than 5% of study population) were not included in the study.

Questionnaires were administered in the children's homes by trained interviewers from the health promotion sectors of each neighborhood hospital in Lu-Wan District. The questionnaire probed sociodemographic information, baby's characteristics, such as sex, and birth weight; residential conditions, such as the number of rooms and the number of family members; household environmental exposure excluding passive smoking, such as gas-stove, or coal-stove; parental education and occupation; and all family members' smoking habits including father, grandparents and uncles who lived in same house.

Hospitalization and respiratory diseases were defined as an affirmative response to the following questions:

Hospitalization: "Has the child ever been hospitalized during the first 18 months of life?". If yes, ask, "How old was he/she when hospitalized?", and "What was the diagnosis?". If there was more than one episode, each was recorded.

Respiratory diseases: For bronchitis or pneumonia--" Has the child ever had bronchitis of pneumonia diagnosed by a doctor during the first 18 months of life?". If yes, ask "How old was he/she at the time of having the first attack?". Other respiratory diseases such as asthma, whooping cough measles and sinusitis were recorded in the same way.

The diagnosis on hospitalization was grouped according to the International Classification of Disease (ICD) 1975 revision into three categories: respiratory, gastroenteritis and all other diseases.

The respiratory illness in this paper refers to bronchitis and pneumonia. The reasons to choose these two diseases as an indicator for adverse health effects of passive smoking are that both diseases belong to the lower respiratory tract and are serious conditions that require admission to a hospital; thus, parents are more likely to remember these serious diseases. It is also biologically credible that passive smoking may cause respiratory disease, because many pollutants from cigarette smoke are inhaled into the lungs and are harmful to the respiratory system.

Children were classified according to the total number of cigarettes smoked daily by household members [none, 1-10 cigarettes/day, 11-20 cigarettes/day and GE(greater than) 20 cigarettes/day]. Few household smokers changed their smoking habits between the time of the child's birth and when he/she reached age 18 months. Other variables were categorized as follows: sex (male,female); birth weight (<2500g,=>2500g); feeding type [mother milk fed, artificially (bottle) fed]; father and mother's educational status (college, secondary, primary); mother's age at child's birth (<30,=>30 years); cooking fuel (coal, gas).

Primary analysis with simple frequency distributions and cross tabulations was performed to examine the potential risk factors for hospitalization and the incidence of respiratory diseases, and the characteristics which might be associated with family smoking.

The 18 months cumulative incidence was used to measure the frequency of hospitalization for respiratory diseases, gastroenteritis and all other diseases. The Mantel-Haenzel extension X^2 test was used to examine the linear trend of disease occurrence. Stratified analysis was used to evaluate and control confounding. The relative risk (RR) was used to estimate the magnitude of the association between exposure of passive smoking and respiratory illness.

For multivariate analysis, the logistic regression model was selected to test the significance of the relationship between passive smoking and respiratory illness (pneumonia and bronchitis) after controlling for the effects of potential confounding factors. The parameters of the model were estimated by the method of maximum likelihood. Variables selected for the final model by a backward elimination procedure included smoking status of family members, which was of primary interest, and factors that potentially might confound the association between passive smoking and the admission rate for respiratory illness. The Pearson chi-square test (X^2) was used to evaluate the goodness-of-fit of the logistic regression model.

RESULTS

The trained interviewers visited the eligible families and completed 1007 interviews (96% of eligible families). The remaining eligible families either changed their place of residence in the study area which could not be found or had submitted false residence registration. Among the 1007 questionnaires completed, 48% were answered by the child's mother, 22% by the father, 18% by both father and mother,and the remaining 12% by a guardian.

Selected characteristics of the participants are shown in Table 1. Of the participants, the number of boys did not differ substantially from that of girls. The birth weights for most of participants were over 2500g. Almost three-quarters of mothers were age 30 years or younger at the time of having their child's birth. One-third of families used coal as fuel for cooking; the rest of the families used gas for cooking. Two-thirds of infants were fed by mother's milk, while rest of them were fed artificially.

The prevalence of smoking habits in family members is shown in Table 2. No mothers who were smokers were found. There were 713 smoking families, 70.8% of the total. Among these families, 212 (29.7%) of the total smoked 20 or more cigarettes per day. 274 (38.4%) of the total smoked less than 10 cigarettes per day, while 227 (31.8%) of the total smoked

Table 1--Frequency of Selected Characteristics of the Population

		No.	%
Sex	Boys	525	52.1
	Girls	482	47.9
Birth weight (g)	<2500	39	3.9
	=>2500	968	96.1
Family Smoking Status	No	294	29.2
	Yes	713	70.8
Type of Feeding	Breast	635	63.1
	Artificial	372	36.9
Maternal Age at Child's birth(yr)	<30	730	72.5
	=>30	277	27.5
Fuel for cooking	Gas	669	66.4
	Coal	338	33.6
Father's education	College	147	14.6
	Secondary or Primary	860	85.6
Mother's Education	College	126	12.6
	Secondary or Primary	881	87.5

10 to 19 cigarettes per day. On average, 14.8 cigarettes were consumed daily by smoker(s) in each smoking family. In a smoking family, it was estimated that a total of about 8,000 cigarettes were smoked during the child's first 18 months of life.

Table 2. The distribution of infants according to the number of cigarettes smoked by family member(s)

No.of Cigarettes smoked	Frequency	%
None	294	29.2
1-	134	13.3
5-	140	13.9
10-	165	16.4
15-	65	6.2
20-	89	8.8
25-	18	1.8
30-	53	5.3
35-	52	5.2
Total	1007	100.0

The cumulative incidence of hospitalization for respiratory illness in early childhood by passive smoking groups was presented in Table 3. The data showed a significantly higher cumulative incidence of respiratory illness in passive smoking group compared with non-smoking group (X^2=7.8, P<.01). Relative risk(RR) was 1.6.

Table 3. The 18 months Cumulative Incidences (CuIs) of respiratory illness in early childhood by passive smoking

Family smoking status	Yes	No	Total	RR (95%CI*)
Respiratory illness				
Cases	131	33	164	1.6
Non-cases	582	261	843	(1.2-2.2)
Total	713	294	1007	
CuI(%)	18.4	11.2	16.3	

X^2=7.8, P<.01
*95% confidence interval

The data were pooled into four groups according to the number of cigarettes smoked by the family members (Table 4). The cumulative incidence of respiratory illness requiring hospitalization of light passive smoking group was 15.0%, 18.9% for medium group, 22.2% for the heavy group compared to 11.2% for non-passive smoking group. The cumulative incidence ratios showed the same trend: 1.3 for the light passive smoking group, 1.7 for the medium group, 2.0 for the heavy group compared to the non-smoking group ($X^2_{\text{M-H extension}}$=14.51 P=0.0002).

Table 4. The 18 months Cumulative Incidences (CuIs) and Cumulative Incidence Ratios (CIRs) of respiratory illness in early childhood by family smoking status

Family smoking status (cig./day)	No.of children	Cases	CuI(%)	CIR (95%CI*)
None	294	33	11.2	1.0
1-9	274	41	15.0	1.3(.9-2.1)
10-19	227	43	18.9	1.7(1.1-2.6)
GE 20	212	47	22.2	2.0(1.3-3.0)
$X^2_{\text{M-H extension}}$		14.51		
P value			0.0002	

*95% confidence interval

It was assumed that passive smoking targets the respiratory system. Can it target on another system? To evaluate this assumption, the relation between the cumulative incidence of gastroenteritis and passive smoking amount was examined. The cumulative incidence and cumulative incidence ratio are showed on Table 5. For the light passive smoking group, the cumulative incidence ratio was 1.2, 1.0 for medium passive smoking group, 0.8 for heavy passive smoking group, compared to non-smoking group. There was no statistically significant relationship between gastroenteritis and passive smoking ($X^2_{\text{M-H extension}}$ =0.002, P=0.97).

Table 5. The 18 months Cumulative Incidences (CuIs) and Cumulative Incidence Ratios (CIRs) of gastroenteritis in early childhood by family smoking status

Family smoking status (cig./day)	No.of Children	Cases	CuI(%)	CIR (95%CI)
None	294	12	4.1	1.0
1-9	274	13	4.7	1.2(.5-3.0)
10-19	227	9	4.0	1.0(.3-3.2)
GE 20	212	7	3.3	.8(.3-2.0)
$X^2_{\text{M-H extension}}$		0.002		
P value		0.97		

In order to determine whether there was an effect modification by gender, the data were divided to estimate the cumulative incidence and cumulative incidence ratios of respiratory illness for both boys and girls, respectively. Regardless of the child's sex, the gradient relationship of cumulative incidence of respiratory illness to passive smoking amount was consistent. The more cigarettes smoked by family members, the more cases of respiratory illness there were. The cumulative incidence of respiratory illness for boys and girls were different, however. The cumulative incidence for boys was significantly higher than that of girls (u=4.08, $p<0.01$),although CIRs were very similar.

Table 6. The 18 months Cumulative Incidences (CuIs) and Cumulative Incidence Ratios (CIRs) of respiratory illness for boys and girls in early childhood by family smoking status

Family smoking status (cig./day)		None	1-9	10-19	GE 20
	No.of infants	151	140	118	116
Boys	CuI% (cases)	12.9 (19)	17.1 (24)	21.1 (25)	23.3 (27)
	CIR (95%CI)	1.0	1.4 (.8-2.5)	1.7 (1.0-2.9)	1.8 (1.1-3.0)
	No.of infants	143	134	109	96
Girls	CuI% (cases)	9.8 (14)	12.7 (17)	16.5 (18)	20.0 (20)
	CIR (95%CI)	1.0	1.3 (.7-2.6)	1.7 (.9-3.2)	2.1 (1.1-3.8)

Coal stoves and gas stoves are very popular for cooking in the kitchens in Shanghai. Both of them are an important source of indoor air pollution and thus a possible confounding factor for the observed relationship between passive smoking and respiratory illness. Because each family of subjects was either using gas or coal, the confounding of fuel only can be relatively controlled by assuming that the group of gas stove families was the "unexposed" group and the group of coal stove families was the "exposed" group, based on the general knowledge that coal stoves cause more indoor air pollution than do gas stoves.

Of the 334 coal-burning families, there were 45 cases of respiratory illness, while among 673 gas stove families , there were 119 cases, X^2 is 2.90, p=0.09. There was no large difference between these groups in the incidence of respiratory illness (Table 7).

Table 7. The relation of using gas-stove or coal-stove and respiratory illness in early childhood

Family with	Respiratory illness		total
	Cases	Non-cases	
Gas-stove	119	554	673
Coal-stove	45	289	334
Total	164	843	1007

X^2=2.90 P=0.09 CIR=.76

Table 8. The relation of using gas or coal-stove and respiratory illness in early childhood after controlling for the factor of passive smoking

Family with	Fuel	Respiratory illness		Total	RR
		Cases	Non-cases		
	coal	5	72	77	
Non-smoker	gas	21	196	217	.67
	Total	26	268	294	
	coal	40	217	257	
Smoker	gas	98	358	456	.72
	Total	138	575	713	

RR_{M-H}=0.71 (95%CI=.50-1.00) X^2_{M-H}=3.68 P=.06

Considering that the passive smoking might confound the effect of coal-burning on respiratory infections in the infants, the data were further stratified to smoking group and non-smoking group; each group was divided into two sub-groups according to the fuel used and the Relative Risks (RR) for each group were calculated (Table 8).

The RR was 0.67 for non-smoking group, 0.72 for smoking group. The adjusted RR_{M-H} was 0.71, 95% confidence interval was 0.50-1.00 (X^2_{M-H} = 3.68 p>.05). There was little difference between the crude and adjusted relative risks.

The families with coal-stoves and smokers had more cases of respiratory illness than did of families with coal-stoves without smokers (Table 9). X^2 was 4.18, $p<0.05$. The same was true for families using gas-stove (Table 10).

Table 9. The effect of passive smoking and using a coal-stove on respiratory illness in early childhood

	Respiratory illness		Total	RR (95%CI)
	Cases	Non-cases		
Smoking family with coal-stove	40	217	257	2.4 (1.0-5.6)
Non-smoking family with coal-stove	5	72	77	
Total	45	289	334	

X^2 =4.18 P=.04

Table 10. The effect of passive smoking and using a gas-stove on respiratory illness in early childhood

	Respiratory illness		Total	RR (95%CI)
	Cases	Non-cases		
Smoking family with gas-stove	98	358	456	2.2 (1.5-3.4)
Non-smoking family with gas-stove	21	196	217	
Total	119	554	673	

X^2 =14.09 P<.001

A lower birth weight infant may develop respiratory illness more frequently. In this study, however, of 39 infants with birth weights less than 2500 grams, there were 8 cases of respiratory illness during their first 18 months of life, while there were 156 cases out of 968 infants in the

Table 11. The relation of lower birth weight and respiratory illness in early childhood

	Respiratory illness		Total	RR (95%CI)
	Cases	Non-cases		
Lower birth weight	8	31	39	1.27(.67-2.41)
Normal birth weight	156	812	968	
Total	164	843	1007	

X^2 =.53 P=.47

normal birth weight group (x^2 = 0.53, p=.47). The relative risk was 1.34, (95% confidence interval = 0.61 to 2.95). There was no significant difference between the two groups (Table 11). The data were further stratified into the passive smoking group and non-smoking group to evaluate the possible effect of lower birth weight on the infant's respiratory illness. There still were no significant differences in the cumulative incidence of respiratory illness between the two groups. (Table 12,13)

Table 12. The relation of lower birth weight and respiratory illness in early childhood in the passive smoking group

	Respiratory illness		Total	RR (95%CI)
	Cases	Non-cases		
Lower birth weight	5	21	26	1.19(.53-2.68)
Normal birth weight	109	568	677	
Total	114	589	703	

X^2 =.18 P=.67

Table 13. The relation of lower birth weight and respiratory illness in early childhood in the non-smoking group

	Respiratory illness		Total	RR (95%CI)
	Cases	Non-cases		
Lower birth weight	3	10	13	1.43(.49-4.14)
Normal birth weight	47	244	291	
Total	50	254	304	

X^2 =.43 P=.51

In this study, artificial feeding was another important risk factor of hospitalization for respiratory illness in early childhood. More than one-third of the children were artificially fed up to ten months.

The percentages of children fed artificially in both non-smoking families and smoking families were roughly identical (39% versus 36%). However, the artificially fed group had a greater increase in the cumulative incidence of respiratory illness with increased smoking by family members than did the breast fed group.

Table 14. The 18 months Cumulative Incidence (CuI) of respiratory illness in early childhood by passive smoking and feeding type

Feeding type	Cigarettes smoked daily by family members				Total
	None	1-9	10-19	GE20	
Breast					
Cases	16	20	20	24	80
No.of infants	179	180	134	142	635
CuI(%)	8.9	11.1	14.9	16.9	12.6
Artificial					
Cases	17	21	23	23	84
No.of infants	115	94	93	70	372
CuI(%)	14.8	22.3	24.7	32.9	22.6
Total					
Cases	33	41	43	47	164
No.of infants	294	274	227	212	1007
CuI(%)	11.2	15.0	18.9	22.2	16.3

IRR_{M-H} =1.8 95%CI 1.3-2.5 X^2_{M-H} =15.06 P<.01
(Comparing breast group with artificial group after controlling the cigarettes)

The frequency of hospitalization for respiratory illness among artificially fed children was about 1.8 times higher than that among breast fed ones ($IRR_{MH} = 1.8$, $p<0.01$). Table 14 presents the cumulative incidence of hospitalization for respiratory illness during the first 18 months of life by smoking status of family members and children's feeding type. It shows that the cumulative incidence increased with increasing smoking amount by family members among these artificially fed children more rapidly than among the breast fed infants. It seemed that the artificially fed children with household exposure to cigarette smoke were more affected by respiratory illness.

Table 15 shows the CIRs of hospitalization for respiratory illness of various groups compared with breast fed children without exposure to cigarette smoke in the household, when combined passive smoking with feeding type.

The CIR in non-smoking with artificial fed group was equal to that in smoking 10-19 cigarettes daily by family members with breast fed group.

Table 15. The 18 months Cumulative Incidence Ratios (CIRs) of various groups compared with the breast-fed children without passive smoking

Cigarettes smoked daily by family member	Feeding type	CIR
None	Breast	1.0
	Artificial	1.7
1-9	Breast	1.3
	Artificial	2.5
10-19	Breast	1.7
	Artificial	2.8
GE 20	Breast	1.9
	Artificial	3.7

Analysis using a multiple logistic regression model did not show any interactive effects when passive smoking was combined with baby's sex, feeding type, birth weight, mother and father's education, maternal age at birth, or type of fuel on hospitalization for respiratory illness using a multiplicative scale. The Goodness-of-fit of this model did not differ significantly from "perfect model" (X^2 = 46.79, P=0.48). The model fits the data well. Table 16 details the

Table 16. Unadjusted and adjusted Relative Risks(RRs) of respiratory illness in early childhood by family smoking status

Family smoking status	Unadjusted RRs(95%CI)	adjusted* RRs(95%CI)
None	1.0	1.0
1-9	1.3 (.9-2.1)	1.6 (.9-2.6)
10-19	1.7 (1.1-2.6)	2.0 (1.2-3.3)
GE 20	2.0 (1.3-3.0)	2.4 (1.4-4.0)

* adjusted for baby's sex, feeding type, birth weight, parents'education status, maternal age at birth and fuel used for cooking.

smoking group compared with the non-smoking group before and after adjusting for baby's sex, feeding type, birth weight, mother and father's education status, maternal age at birth, fuel used for cooking. The mother and father's education, gas used for cooking, maternal age at birth did not substantially influence the baby's respiratory illness and were eliminated from the final model in the variable selecting procedure.

For these children, the 18-month cumulative incidence of other respiratory diseases including asthma, sinusitis, whooping cough and measles were higher in smoking families than those in non-smoking families, but the associations between passive smoking and these diseases were not statistically significant. Table 17 shows the cumulative incidences by family smoking status.

Table 17. Crude 18-month Cumulative Incidence (CuI) of some respiratory diseases among the children by family smoking status

Respiratory diseases	Non-smoking families (n=294)		Smoking families (n=713)	
	Cases	CuI	Cases	CuI
Asthma	14	.048	40	.056
Sinusitis	4	.014	14	.020
Whooping cough	1	.003	4	.005
Measles	1	.003	3	.004

DISCUSSION

This study has evaluated the effects of household exposure to cigarette smoke on the incidence of respiratory diseases in children during their first 18 months of life.

In China, in order to curb the growth of population, the government gives many benefits to the young couple who just have one child. One of these benefits is an one year paid leaving of work for mothers after they give birth to take care of their children. Most of children in this study were cared by their mothers. Children spent most of their first 18 months of life at home.

The results of this study showed that passive smoking was significantly associated with the incidence of bronchitis and pneumonia. The cumulative incidence of these diseases increased with the increasing amount of cigarettes smoked by family members. The excess risk appeared to be independent of mother's age at birth, parent's educational status, type of fuel, type of feeding, birth weight, and sex of infant. For heavy passive smoking group (GE 20 cig/day), the risk of bronchitis and pneumonia was 2.4 times greater than the risk for the children in the non-smoking families. These results are consistent with the findings of many other studies.[10,17] Forastiere and coworkers found that children exposed to any passive smoking increased of having night cough, snoring and respiratory infections during the first 2 year of life.[12] A

New Zealand study reported parental smoking had progressive, more serious and clinically significant effects on children's pulmonary function.[9] Weitzman reported an odds ratio for asthma of 2.1 shown by a multivariate logistic regression among children whose mother smoked one-half pack of cigarettes or more per day compared with children of non-smoking mothers.[18] Many community-based, longitudinal, epidemiologic studies that have used a variety of different end points generally have found an increased risk of acute respiratory illness morbidity. Among infants and children aged two year or younger, an increased occurrence of episodes of bronchitis/pneumonia (with or without hospitalization, excess risk 1.4 to 2.6) and increased occurrence of tracheitis and laryngitis have been reported.[19] These effects have been strongest for episodes in the first year of life and more consistently associated with maternal smoking. Colley et al. and Fergusson et al. found the relationship between the incidence of bronchitis or pneumonia in the first year of life and parental smoking was greater than that over the age of one year.[10,17] It seems that during the early months of life, the child is most vulnerable and thereby more susceptible to severe respiratory illness if exposed to household cigarette. Many studies have well documented the detrimental effects of in utero exposure to maternal smoking on health outcomes.[20] The influence of maternal smoking is complicated, and it is difficult to separate the effects of passive smoking after birth from the effects of maternal smoking during pregnancy in some previous studies.[18] This study offers more new evidence of the real effects on children's health of household exposure to cigarette smoke after birth, while excluding the effect of maternal smoking during pregnancy.

So far, how to estimate the actual amount of exposure by passive smokers to cigarette smoke remains a point at issue. For the active smoker, the question about number of years as a smoker and usual daily consumption provide fairly accurate indicators of exposure to tobacco smoke; exposure to passive smoke, however, is not as easily quantified. Most studies of long-term health consequences of passive smoking have relied on the smoking status of parents or their household member as the basis for defining exposure status. In this study, it was found that the exact number of cigarettes smoked at home by each family member was very difficult to ascertain, recall bias seems inevitable. Thus the total daily cigarette consumption was used to estimate the actual amount of exposure by passive smokers. Most of smokers in this study were children's fathers, the rest were grandparents and uncles who lived with children's family in the same house. Usually children spent nights and weekends with their fathers. The number of cigarettes smoked at home was just part of total daily cigarette consumption. From this point, the results of this study are fairly conservative.

In fact, the level of exposure hinges not only on the total number of cigarettes smoked daily, but also on the toxic component content of smoke, household ventilation, the volume of enclosed space, time spent indoors, etc. With regard to constituents 'tar' is a major portion of the total particulate matter of cigarette smoke. It was reported that weighted mean 'tar' yield of a cigarette in China is about 28 milligrams and that this has not changed in the recent years.[21] High 'tar' cigarette smoke might cause more severe indoor air pollution and would be more hazardous to health, especially for young children in Shanghai City, who spend most of their time in the relatively small residential room space. The average residential area per capita was 5.4 square meters for the families included in the study.

In questionnaire studies, respondent bias may be considerable. Schenker et al. reported[22] that the incidence of bronchitis or pneumonia was reported less frequently by fathers and other people such as grandparents than by mothers. He considered it to be because fathers were less likely to observe the child's illness and less likely to be involved in the child's treatment. But there was no significant difference in episodes of inpatient admission questionnaires reported by different people. He suggested that fathers or other people may be aware of their children's more severe episodes of illness but not of less serious diseases. In China, especially in big cities like Shanghai, there is a well-established medical care network. Because of the "one child" policy and half-priced medicare for children, parents pay great care to their children. Children can usually get their medicare in the very early stage of diseases when they get ill. Each patient has a kept-by-yourself file of disease. Thus, it is relatively easy to track the diseases the children get.

This study showed a high cumulative incidence of pneumonia and bronchitis in Shanghai City, analogous to the surveillance data from Beijing and Nanning.[23] The incidence rate of acute respiratory infection among child under the age of 12 years found in the Beijing surveillance data was 199.7% which was made up of 92.7% upper respiratory infections and 7.3% lower respiratory infection. In addition, the rate for infants and younger children was higher than that for school age children. Data from the city of Nanning, in southern China, showed the same trend for children under the age of seven years.

Results of present study showed a gender difference in the relationship between the respiratory illness and parental smoking: boys were more affected than girls. Fernando Martinez reported boys had a higher rate of bronchial responsiveness than that of girls.[14] But Tager pointed out that girls seemed to be more affected in lung function than boys.[24] Overall, there does not seem to be a consistent sex-specific pattern in the effects of passive smoking on respiratory diseases.

Many studies have shown significant difference in the prevalence of respiratory disease incidence in the children living with or without gas and coal stoves.[25,26] The cooking condition in Shanghai is special; because there is no electric stove, residents in the city use either gas stove or coal stove. Both of these stoves are sources of indoor air pollution. According to data from previous investigation, the indoor air quality in the families using coal stove is worse than that of families using gas stove.[27] But in this study, it did not show that children from the families using coal stove had higher a prevalence of respiratory diseases than children from the families using gas stove.

This study showed the joint effect of passive smoking and artificial feeding on incidence of the respiratory illness requiring hospitalization during the first 18 months of life; that was passive smoking worked together with artificial feeding producing a stronger detrimental effect than that of passive smoking with breast feeding. The 18 months cumulative incidence of respiratory illness was 8.9% in infants with breast-feeding, nonsmoking family vs 32.9% in infants with artificial feeding, heavily smoking family. The cumulative incidence ratio was 3.70 comparing these two groups. The detrimental effect in non-smoking with artificial fed group was equal to that in smoking 10-19 cigarettes daily by family members with breast fed group when compared to non-smoking with breast fed group, CIRs were 1.7 for both groups.

Many studies have reported an increased risk of respiratory infection associated with artificial feeding.[28,29] The study by Watkins et al. found that high-risk infants, such as lower birth weight ones, appeared to benefit more from breast feeding.[30] The estimated incidence of respiratory infection in artificially fed infants, predicted by fitting a general interactive model to the data, ranged from 42 percent in boys with more than two siblings, whose parents smoked to 4.9 percent in girls with no siblings, nonsmoking parents smoked. In the breast-fed infants, the comparable estimates were 12 percent predicted attributable risk reduction for high-risk infants and 2 percent for low-risk infants. These estimates reflect the interaction between type of feeding and mixed effects of sex, siblings, and parents smoking status. Woodward et at. reported that relative odds of respiratory proneness with maternal smoking were seven times higher among children who were never breast fed than among those who were breast fed.[31]

For epidemiologic studies of the health effects of infant feeding, various potential sources of bias may be considerable. In this study, all infants were classified dichotomously. The breast-feeding group consisted of infants who were completely breast-fed during the first ten months of life, some who received only a few feedings of mother's milk, and others who fit between these two extremes. Thus, the effect of artificial feeding on the hospitalization for respiratory illness may be underestimated. Dichotomously classification of infant feeding in this study was necessary to keep the number of each subgroup sufficiently large for analysis.

Many study studies have explored the possible mechanism of the protective effect of breast feeding and the detrimental effect of passive smoking on health outcomes. [32,33] Breast milk is considered the best infant food due to its cleanliness, nutrition and content of a number of anti-infectious agents which make infants able to resist the invasion of certain pathogenic agents.

Premature children may be more vulnerable to get diseases than mature ones. In this study, the proportion of premature children in whole study population was not direct available. Because lower birth weight is very common in premature children, the information about the health effect of passive smoking on lower birth weight children may partially reflect those of premature children. There were only 3.9 % lower birth weight children (Birth Weight< 2,500 g) in the whole study population. The cumulative incidence in lower birth weight children was not significantly higher than those of normal birth weight children. Therefore, the factor of lower birth weight did not confound the relation of passive smoking and respiratory illness on children in this study.

This survey was done in 1985. Since then the economy and life style in China have been greatly changed because of "Open

Policy" in recent ten years. Smoking in young women is becoming a fashion while smoking rate in male adults is still stable. Under this circumstance, passive smoking has not been improved but worse. The health effects of passive smoking on infants need to be studied further, especially on the infants whose mothers are smokers.

CONCLUSIONS

The aggregate of the data across all of this study leads to the inescapable conclusion that passive smoking poses a health risk to infants. Nonetheless, certain conclusions and recommendations to people, the parents of infants and children seem justified:

1) Use of cigarettes in the home will increase the possibility of a child's experiencing a respiratory illness episode that requires hospitalization. Parents should be counseled not to smoke or to permit anyone else to smoke when the infant is present and should make every effort to quit smoking and to prohibit visitors from smoking in the home.

2) The infants with artificial feeding are more vulnerable to the passive smoking. These families should be urged to create a smoke-free home environment for their children.

3) Use of cigarettes in the home may lead to an increased chance of the infants having chronic respiratory symptoms such as whooping cough and phlegm. The long-term health consequences of the occurrence of such symptoms are still unknown. Efforts to create a smoke-free home environment in relation to the risk of chronic symptoms should be stressed in families with a familial history of chronic respiratory diseases especially of obstructive airways diseases.

4) Boys may be more susceptible to passive smoking than

girls. The mechanism of increased susceptibility to passive smoking is still unknown. This area needs to be studied further.

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APPENDIX

Appendix

Annual Concentration of Various Pollutants at Lu-Wan District Monitoring Setting in 1985.

Pollutants	Concentration (ug/m^3)
Suspended particulate matter	225
Sulphur dioxide	41
Nitrogen dioxide	64
Respiratory particulate (<10u)	189
Sulphate	4.67
Cadmium	.05
Chromium	.01
Nickel	.03
Lead	.21