



ORIGINAL ARTICLE

# Prevalence and indoor environment risk factors of otitis among preschool children in Urumqi, China



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## KEYWORDS

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## Abstract

**Objective:** To investigate the indoor environmental risk factors to provide measures for the prevention and control of otitis in preschool children.

**Method:** In this cross-sectional study, a questionnaire survey was administered to preschool children aged 2–7 years from 60 kindergartens in six districts of Urumqi City in August 2019. Multiple regression was run to predict influence factors for otitis media in preschool children.

**Result:** A total of 8153 valid questionnaires were collected. After adjusting for age, the prevalence of otitis among preschool children in Urumqi was 13.1%. Multivariate logistic regression showed that previous antibiotic treatment, treatment with one to two antibiotics before 1 year of age, presence of walls with aqueous or latex paint, use of carpet floor bedding in rooms, newly decorated homes of mothers before pregnancy, purchase of new furniture for homes of children at 0–1 year of age, and presence of flowering plants in the residence of children at 0–1 years of age were all identified as risk factors for the development of otitis in children.

**Conclusion:** Parents should also pay attention to indoor living environments, and reduce indoor renovation in the homes of children during their growth and development, which can positively improve children's indoor living environment, thus effectively preventing otitis in preschool children.

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## Introduction

Environmental pollution contributes differentially to health hazards in different populations, in which children belong to typical susceptible groups. Compared with adults, children have a large amount of activity, a fast breathing rate, and rapid development of body structure and organs. Their respiratory, immune, and other systems are not well developed, and they are more sensitive to harmful substances in the environment.<sup>1</sup> Studies have shown that the indoor environment, renovation of dwellings, dampness inside dwellings, heating and ventilation of buildings, indoor air quality, and life habits of households are related to preschool child health.<sup>2,3</sup> Otitis is an inflammation of the ear. It is usually divided into two types (otitis externa and otitis media) and is an infectious disease secondary to the common cold in children.<sup>4</sup> Presently, studies on otitis in preschool children have focused on the effects of medication, and there are few investigations on the indoor environmental factors associated with the occurrence of otitis in preschool children. Concurrently, children's hearing organs and brains were irreversibly injured due to the lack of attention paid by parents to the prevention of acute otitis attacks. Therefore, it is necessary to extensively study the health effects of indoor environmental pollution on preschool children in China. This study was conducted from April to August 2019 and investigated residential environmental and otitis risk factors of preschool children in 60 kindergartens in Urumqi. This study aimed to explore the potential risk factors affecting the occurrence of otitis in preschool children and provide corresponding measures for the prevention of such diseases.

## Methods

### Subjects

Stratified cluster random sampling was used in this study. According to the administrative area division of Urumqi city, there are six districts (Xinshi, Shayibake, Tianshan, Shuimogou, Toutunhe, and Midong), and 8–12 kindergartens were randomly selected. This study was approved by the ethics committee of Fudan University, and all parents of the children provided written informed consent.

### Questionnaire

The contents of this questionnaire refer to those used in the International Study of Asthma and Allergies in Childhood (ISAAC)<sup>5</sup> and Dampness in buildings and health (DBH)<sup>6</sup> survey studies. The survey consisted of six parts: (1) demographic characteristics, including sex, ethnicity, educational level, and home address; (2) feeding status, including whether they were single children, whether they were breastfed, breastfeeding duration, and age at which the child attended kindergarten; (3) health of children and family members, including otitis, pneumonia, allergic rhinitis, and other diseases and related symptoms; (4) children's residential environment, including housing type, renovation, whether the furniture was newly purchased, ventilation, and smoke evacuation; (5) lifestyle habits, including animals, plants, cleaning frequency, and smoking in the residence of the

child; (6) dietary habits, including the type and frequency of meal. Before the initiation of the survey, the subject group initially contacted the Education Bureau of Urumqi City and the kindergarten gardener, and uniform professional training was provided to the teachers involved in the survey class. A questionnaire was uniformly distributed by the preschool teachers to the parents of the children in their kindergartens. The questionnaires were completed by the parents or guardians of the children when they were taken home. They were asked to fill out the questionnaire within 1 week and hand it over to the responsible teacher in the kindergarten. The teachers returned the questionnaires and sent them together to the City Education Bureau of Urumqi. All questionnaires were reviewed by more than two trained subject team members and ineligible questionnaires were excluded.

### Statistical analyses

The primary objective of this study was to analyze the prevalence and indoor environment risk factors of otitis among preschool children.

The database was established using EpiData 3.1, and SPSS 25.0 software was used to complete the data analysis as it is suitable for the analysis of complex samples. Initially, univariate analysis was performed using  $\chi^2$  tests between independent variables and the outcome variable, variables with  $P < 0.01$  were selected to build the multivariate model. A multiple regression model was adopted with otitis among preschool children (yes or no) as a dependent variable. Each variable was selected using the "enter method." Differences with  $P < 0.05$  were considered statistically significant. The  $\alpha$  level was set at 0.05.

### Ethics approval and consent to participate

The study was conducted strictly in accordance with the Declaration of Helsinki and approved by the research ethics committee of Fudan University (protocol no. IRB00002408 & FWA00002399), all parents and class teachers of the children under investigation have signed written informed consent.

## Results

### General condition of the investigated subjects

A total of 10000 questionnaires were distributed, and 8153 valid questionnaires were returned, resulting in an 81.53% response rate, including 4180 boys (51.3%) and 3973 girls (48.7%). The youngest age was 2.00 years, and the oldest was 7.83 years, with a mean age of  $5.27 \pm 1.10$  years. Moreover, 7010 individuals were of Han ethnicity (86.0%), and 1143 individuals were of other ethnicities (14.0%). Furthermore, 4569 children were single children (56.0%), and 3584 were not a single child (44.0%).

### Prevalence of otitis

The characteristics of preschool children in Urumqi City who was diagnosed with otitis by physicians as reported by their parents are shown in Table 1. The findings showed that 1072 of 8153 children had at least one definite diagnosis of otitis

**Table 1** Characteristics of preschool children in Urumqi, China who were diagnosed with otitis by physicians ( $n = 8153$ ).

Features		Number of investigators	Number of previous cases of otitis diagnosed by physicians	Ratio(%)	$\chi^2$	$P$
Sex	Male	4180	551	13.2	0.01	0.93
	Female	3973	521	13.1		
Ethnicity	Han	7010	909	13.0	1.44	0.23
	Others	1143	163	14.3		
Age	2–4	1151	84	7.3	60.48	<0.01
	4–5	2078	235	11.3		
	5–7	4924	753	15.3		
Single child	Yes	4569	649	14.2	10.15	<0.01
	No	3584	423	11.8		
Mode of birth	Natural labour	4187	534	12.8	1.18	0.28
	Caesarean delivery	3966	538	13.6		
Premature infant	Yes	424	54	12.7	0.07	0.80
	No	7729	1018	13.2		
Birth weight	Low weight	789	126	16.0	6.31	0.04
	Normal weight	6618	846	12.8		
	Macrosomia	746	100	13.4		
Duration of breastfeeding	< 6 months	2927	415	14.2	4.24	0.04
	$\geq 6$ months	5226	657	12.6		
Permanent address	Countryside	219	44	20.1	11.0	<0.01
	Suburb	836	97	11.6		
	City	7098	931	13.1		
Previously diagnosed as allergic rhinitis by physicians	Yes	622	126	20.3	29.80	<0.01
	No	7531	946	12.6		
Previously diagnosed as pneumonia by physicians at least one time	Yes	2369	314	13.3	0.03	0.86
	No	5784	758	13.1		
Previously paroxysms of sneezing and rhinorrhoea in the absence of cold	Yes	2235	386	17.3	45.82	<0.01
	No	5918	686	11.6		
Previous antibiotic treatment	Yes	5261	814	15.5	70.14	<0.01
	No	2892	258	8.9		
Antibiotics treatment before 1 year of age	Did not receive antibiotics	5830	700	12.0	23.44	<0.01
	1–2 times	1884	303	16.1		
	2–3 times	269	43	16.0		
	More than 3 times	170	26	15.3		
Mother's highest academic qualifications	Spp and below	2943	338	11.5	15.50	<0.01
	Diploma or undergraduate	4766	659	13.8		
	Master's graduate	36	65	17.6		

Table 1 (Continued)

Features		Number of investigators	Number of previous cases of otitis diagnosed by physicians	Ratio(%)	$\chi^2$	P
Father's highest academic qualifications	Doctoral student and above	75	10	13.3	17.01	<0.01
	Spp and below	3092	362	11.7		
	Diploma or undergraduate	4656	645	13.9		
	Master's graduate	325	59	18.2		
	Doctoral student and above	80	6	7.5		

by a physician. After adjusting for age, the prevalence of otitis in preschool children in Urumqi City was 13.1%. Moreover, a higher prevalence was noted in the age group of 5–7 years, singletons, children in rural areas, children with a previous physician diagnosis of allergic rhinitis, children who previously reported symptoms of sneezing and rhinorrhoea in the absence of a cold, children with previous antibiotic exposure, children who had received antibiotics before 1 year of age, and children whose mothers' and fathers' highest qualifications were master's postgraduate students compared to their counterparts (all  $P < 0.05$ ).

### Univariate analysis of indoor environmental variables

The results of the univariate analysis of the prevalence of otitis in preschool children and indoor environmental variables in Urumqi City are shown in Table 2. The results of this analysis showed that the type of residence, the surface material of the walls, carpet floor bedding in the room, new furniture in the mother's home before pregnancy, renovation of the mother's home before pregnancy, dampness in the mother's home before pregnancy, dampness in the mother's home during pregnancy, new furniture in the homes of children at the age of 0–1 year, newly decorated homes of children at the age of 0–1 year, dampness in the homes of children at the age of 0–1 year, presence of flowering plants in the homes of children at the age of 0–1 year, presence of flowering in the current residence, passive smoking in the mother's home during pregnancy, passive smoking in the homes of children at the age of 0–1 year, passive smoking in the child's current residence, paternal smoking, and maternal smoking were the main indoor environmental factors associated with otitis in children (all  $P < 0.05$ ).

### Multivariate logistic regression

The results of the multivariate logistic regression analysis of otitis in preschool children in Urumqi City are shown in Table 3. The results of the analysis of different characteristics and univariate analysis of indoor environment variables with or without otitis as dependent variables (0 = no; 1 = yes) were introduced into the logistic regression model.

Of the 28 variables in the final residence main effect model, 14 were associated with the occurrence of rhinitis-related symptoms in children.

Ages of 4–5 years ( $OR = 1.55$ , 95%  $CI = 1.19–2.02$ ) and 5–7 years ( $OR = 2.20$ , 95%  $CI = 1.73–2.80$ ), single child ( $OR = 1.17$ , 95%  $CI = 1.02–1.35$ ), previous antibiotic exposure ( $OR = 1.50$ , 95%  $CI = 1.28–1.76$ ) and one or two episodes of antibiotic exposure before the age of 1 year ( $OR = 1.20$ , 95%  $CI = 1.03–1.40$ ), multiple apartment dwellings ( $OR = 1.30$ , 95%  $CI = 1.04–1.62$ ), and presence of wall materials with aqueous paint/latex paint ( $OR = 1.17$ , 95%  $CI = 1.01–1.36$ ) increased the risk of otitis in children. Carpet floor bedding in the rooms ( $OR = 1.37$ , 95%  $CI = 1.13–1.65$ ), renovation in the mother's home before pregnancy ( $OR = 1.34$ , 95%  $CI = 1.06–1.69$ ), new furniture in the homes of children at the age of 0–1 year ( $OR = 1.32$ , 95%  $CI = 1.00–1.74$ ), presence of flowering plants in the homes of children at the age of 0–1 year ( $OR = 1.25$ , 95%  $CI = 1.05–1.49$ ), and maternal smoking ( $OR = 2.13$ , 95%  $CI = 1.21–3.73$ ) were risk factors of otitis in children. Normal birth weight ( $OR = 0.76$ , 95%  $CI = 0.61–0.93$ ), residence in a suburban ( $OR = 0.47$ , 95%  $CI = 0.31–0.71$ ) or urban areas ( $OR = 0.50$ , 95%  $CI = 0.35–0.72$ ), and surface materials of walls ( $OR = 0.53$ , 95%  $CI = 0.33–0.88$ ) were considered as protective factors of otitis in children.

### Discussion

Otitis in children is mainly caused by bacteria, of which 69.7% are gram-positive bacteria, 16.7% are gram-negative bacteria, and 13.6% are fungi.<sup>7</sup> Presently, China's medical treatment places otitis under the category of the five organ diseases, so some pediatricians have a vague understanding of it, which leads to a missed diagnosis by physicians, thus concluding that the prevalence of otitis in Chinese children is low and not paid attention to. However, according to the results of this survey, the prevalence of otitis in preschool children in Urumqi was 13.1%, which was higher than the prevalence (11.9%) of otitis among 4618 children in Urumqi investigated by Wang<sup>8</sup> in 2013. This further suggests that more attention should be paid to the prevalence of otitis in preschool children. At the onset of otitis, a vast majority of

**Table 2** Univariate analysis of otitis and indoor environmental variables in preschool children in Urumqi, China ( $n = 8153$ ).

Features	Number of investigators	Number of previous cases of otitis diagnosed by physicians	Ratio (%)	$\chi^2$	<i>P</i>
Type of residence				13.25	<0.01
Single-family houses, individual houses, joint row houses	1010	108	10.7		
Multi-family apartment	5669	796	14.0		
Others	1474	168	11.4		
Residential area				1.09	0.30
< 75 m <sup>2</sup>	1983	247	12.5		
≥ 75 m <sup>2</sup>	5916	791	13.4		
Floor material				12.52	0.05
Solid wood flooring	1449	204	14.1		
Multilayered wood flooring	545	55	10.1		
Composite flooring	1163	175	15.0		
Bamboo flooring	130	14	10.8		
Tile/stone/cement floors	4517	573	12.7		
PVC/plastic/plastic gram flooring	83	15	18.1		
Others	266	36	13.5		
Surface material of walls				32.22	<0.01
Wallpaper	3256	422	13.0		
Aqueous/latex paint	2759	426	15.4		
Oil-based paint	72	11	15.3		
Wood panels	93	13	14.0		
Lime/cement	203	19	9.4		
Powdered wall	1367	149	10.9		
Seaweed sludge	126	13	10.3		
Others	277	19	6.9		
Carpet floor bedding in the room				14.75	<0.01
Yes	960	164	17.1		
No	7193	908	12.6		
New furniture in the mother's home before pregnancy				9.96	<0.01
Yes	1853	284	15.3		
No	6300	788	12.5		
Renovation of the mother's home before pregnancy				19.53	<0.01
Yes	1264	215	17.0		
No	6889	857	12.4		
Dampness in the mother's home before pregnancy				7.82	<0.01
Yes	948	152	16.0		
No	7205	920	12.8		
New furniture in the mother's home during pregnancy				0.02	0.88
Yes	931	121	13.0		
No	7222	951	13.2		
Renovation of the mother's home during pregnancy				0.20	0.66
Yes	649	89	13.7		
No	7504	983	13.1		
Dampness in the mother's home during pregnancy				8.31	<0.01
Yes	743	123	16.6		
No	7410	949	12.8		

Table 2 (Continued)

Features	Number of investigators	Number of previous cases of otitis diagnosed by physicians	Ratio (%)	$\chi^2$	P
New furniture in the homes of children at the age of 0–1 year				12.83	<0.01
Yes	782	135	17.3		
No	7371	937	12.7		
Renovation in the homes of children at the age of 0–1 year				7.37	<0.01
Yes	536	91	17.0		
No	7617	981	12.9		
dampness in the homes of children at the age of 0–1 year				4.07	0.04
Yes	670	105	15.7		
No	7483	967	12.9		
Presence of fur pets in the homes of children at the age of 0–1 year				0.05	0.83
Yes	250	34	13.6		
No	7903	1038	13.1		
Presence of flowering plants in the homes of children at the age of 0–1 year				18.75	<0.01
Yes	1867	301	16.1		
No	6286	771	12.3		
Presence of fur pets in the current residence				1.46	0.23
Yes	403	45	11.2		
No	7750	1027	13.3		
Presence of flowering plants in the current residence				8.97	<0.01
Yes	2457	365	14.9		
No	5696	707	12.4		
Frequency of sanitary cleaning of rooms				2.15	0.34
Very seldom	82	11	13.4		
Occasionally	992	145	14.6		
Often	7079	916	12.9		
Passive smoking in the mother's home during pregnancy				8.84	<0.01
Yes	2058	310	15.1		
No	6095	762	12.5		
Passive smoking in the homes of children at the age of 0–1 year				9.11	<0.01
Yes	2462	366	14.9		
No	5691	706	12.4	1204	
Passive smoking in the child's current residence				7.65	<0.01
Yes	2969	431	14.5		
No	5184	641	12.4		
Paternal smoking				5.57	0.02
Yes	2842	408	14.4		
No	5311	664	12.5		
Maternal smoking				12.61	<0.01
Yes	69	19	27.5		
No	8084	1053	13.0		

**Table 3** Multivariate logistic regression analysis of otitis in preschool children in Urumqi, China ( $n = 8153$ ).

Features	$\beta$	S-x	Wald $\chi^2$	P	OR	95% CI
Age						
2–4			52.329	<0.001		
4–5	0.440	0.135	10.606	0.001	1.552	1.191–2.023
5–7	0.790	0.122	41.682	<0.001	2.204	1.734–2.802
Single child	0.158	0.071	4.966	0.026	1.171	1.019–1.345
Birth weight						
Low weight			6.844	0.033		
Normal weight	–0.281	0.107	6.843	0.009	0.755	0.612–0.932
Macrosomia	–0.243	0.149	2.665	0.103	0.784	0.586–1.050
Duration of breastfeeding	–0.075	0.070	1.161	0.281	0.928	0.810–1.063
Permanent address						
Countryside			14.792	0.001		
Suburb	–0.756	0.210	12.942	<0.001	0.469	0.311–0.709
City	–0.692	0.185	14.036	<0.001	0.501	0.349–0.719
Previous diagnosis of allergic rhinitis by physicians	0.225	0.118	3.659	0.056	1.252	0.994–1.577
Previously paroxysms of sneezing and rhinorrhoea in the absence of cold	0.242	0.078	9.646	0.002	1.273	1.093–1.483
Antibiotic treatment before the age of 1 year	0.405	0.082	24.444	<0.001	1.499	1.277–1.759
Antibiotic treatment before the age of 1 year						
Did not receive antibiotics			5.507	0.138		
1–2 times	0.180	0.079	5.217	0.022	1.197	1.026–1.397
2–3 times	0.083	0.177	0.218	0.640	1.086	0.768–1.536
More than 3 times	–0.050	0.227	0.048	0.826	0.951	0.610–1.484
Mother's highest academic qualification						
Mother's highest academic qualification			2.224	0.527		
Diploma or undergraduate	0.043	0.096	0.199	0.656	1.044	0.865–1.259
Master's graduate	0.232	0.180	1.667	0.197	1.261	0.887–1.794
Doctoral student and above	0.386	0.413	0.874	0.350	1.471	0.655–3.301
Father's highest academic qualification						
Father's highest academic qualification			7.133	0.068		
Diploma or undergraduate	0.065	0.093	0.485	0.486	1.067	0.889–1.282
Master's graduate	0.346	0.185	3.473	0.062	1.413	0.982–2.032
Doctoral student and above	–0.778	0.499	2.426	0.119	0.459	0.173–1.222
Type of residence						
Single family houses, individual houses, or joint row houses			6.310	0.043		
Multi-family apartment	0.261	0.112	5.394	0.020	1.298	1.042–1.618
Others	0.133	0.135	0.967	0.325	1.142	0.877–1.487
Surface material of walls						
Wallpaper			16.644	0.020		
Aqueous/latex paint	0.160	0.077	4.384	0.036	1.174	1.010–1.364
Oil-based paint	0.212	0.349	0.371	0.543	1.237	0.624–2.451
Wood panels	0.132	0.323	0.166	0.683	1.141	0.606–2.149
Lime/cement	–0.197	0.252	0.611	0.434	0.821	0.501–1.346
Powdered wall	–0.103	0.106	0.948	0.330	0.902	0.734–1.110
Seaweed sludge	–0.178	0.304	0.343	0.558	0.837	0.461–1.519
Others	–0.627	0.252	6.168	0.013	0.534	0.326–0.876
Carpet floor bedding in the room	0.312	0.098	10.238	0.001	1.366	1.129–1.654
New furniture in the mother's home before pregnancy	–0.078	0.107	0.539	0.463	0.925	0.750–1.140
Renovation in the mother's home before pregnancy	0.292	0.119	6.018	0.014	1.34	1.061–1.692
Dampness in the mother's home before pregnancy	0.015	0.141	0.011	0.916	1.015	0.770–1.338
Dampness in the mother's home during pregnancy	0.147	0.170	0.741	0.389	1.158	0.829–1.617
New furniture in the homes of children at the age of 0–1 year	0.278	0.142	3.851	0.049	1.321	1.001–1.744
Renovation in the homes of children at the age of 0–1 year	–0.03	0.172	0.031	0.860	0.97	0.693–1.358
Dampness in the homes of children at the age of 0–1 year	–0.065	0.156	0.175	0.675	0.937	0.691–1.271

Table 3 (Continued)

Features	$\beta$	S-x	Wald $\chi^2$	P	OR	95% CI
Presence of flowering plants in the homes of children at the age of 0–1 year	0.226	0.088	6.542	0.011	1.253	1.054–1.489
Presence of lowering plants in the current residence	0.048	0.083	0.333	0.564	1.049	0.892–1.234
Passive smoking in the mother's home during pregnancy	0.041	0.125	0.106	0.745	1.041	0.816–1.330
Passive smoking in the homes of children at the age of 0–1 year	0.048	0.130	0.138	0.710	1.049	0.814–1.354
Passive smoking in the current residence	0.075	0.122	0.382	0.536	1.078	0.849–1.369
Paternal smoking	–0.023	0.127	0.034	0.855	0.977	0.762–1.252
Maternal smoking	0.755	0.287	6.91	0.009	2.127	1.212–3.733
Constant	–2.619	0.263	99.338	<0.001	0.073	

physicians provide antibiotic therapy. In a study by Trinh et al.,<sup>9</sup> the antibiotic prescription rate for otitis was 68–80 per 100 visits. Several international guidelines recommend antibiotics for children aged < 2 years with acute otitis media. However, in older children, only cases of high fever and severe ear pain require antibiotics. Overuse and inappropriate use of antibiotics are the main reasons for the emergence of antibiotic resistance.<sup>10,11</sup> Among them, aminoglycoside antibiotics, such as streptomycin and gentamicin, have good efficacy against diseases caused by bacteria. However, its prolonged use causes its accumulation in the inner ear lymph nodes, causing the death of hair cells in the inner ear and irreversible ototoxic effects.<sup>12</sup> The results of the present study also showed that the prevalence of otitis was 6.6% higher in children who had been treated with antibiotics than in those who had not. It was speculated that the non-standard use or abuse of antibiotics in the early years changed the susceptibility of pathogenic otitis bacteria to antibiotics, resulting in lower resistance and higher prevalence of otitis in preschool children.

The impact of the indoor environment on human health has gained much attention from the international community,<sup>13–15</sup> especially for preschool children whose various organs and systems of the body are not yet developmentally mature. With the increase in living standards of the Chinese residents, there is also an increasing variety of furniture and new synthetic materials in dwellings, with a consequent exposure problem of chemical components. Shin et al.<sup>16</sup> showed that formaldehyde can enter the body through the skin and eye contact, inducing the expression of inflammatory factors and mucins in human ear epithelial cells, thereby increasing the probability of developing otitis in children. Formaldehyde in residential environments mainly originates from decorating with artificial sheets, furniture, cellophane, and various types of wall materials. The results of the present study similarly showed that the purchase of new furniture and renovation in the mother's home before pregnancy and the purchase of new furniture and renovation in the homes of children at the age of 0–1 year were both associated with the development of otitis in preschool children. Concurrently, summer in Urumqi, Xinjiang, has long promoted a high-temperature environment, and the indoor temperature increases, as does the rate of formaldehyde release. A high-temperature environment is more conducive to the breeding and reproduction of fungi, which

further expands the exposure risk of preschool children. Indoor decorative materials have been repeatedly associated with the occurrence of respiratory diseases in children.<sup>2,17,18</sup> The results of this study showed that floor material, wall surface material, and carpet placement in a room were associated with otitis occurrence in children. It is presumed that newly purchased furniture and renovation materials in dwellings have some volatilization of chemical composition. Prolonged environmental exposure leads to impairment of the respiratory and immune systems of children, who are more susceptible to invasive bacterial infections that induce otitis.

Several review studies<sup>19,20</sup> have shown that exposure to mold and dampness in the home residential environment is an important indoor environmental risk factor. Dampness in dwellings promotes the breeding of indoor microbes, of which bacteria and mold are the most common. Bacteria can affect the child's immune system, and molds can be harmful to human health by suspending them in the air. Prolonged indoor dampness also leads to heavy multiplication of dust mites, which in turn triggers disease reactions, such as allergic rhinitis, in children.<sup>21</sup> Moreover, pests raised in damp dwellings, such as mice and cockroaches, carry pathogenic bacteria. Preschool children have a stronger desire to explore the world spirit, and a larger range of indoor activities, and have greater exposure to these causative factors than adults who remain indoors for longer periods. However, the results of the present study found that dampness in the home before versus during pregnancy of mothers was not a risk factor for the development of otitis media in preschool children.

This study has some limitations. Because this study did not consider risk factors for outdoor and child exposure in preschool and used a cross-sectional survey with poor causal ability, the results may have been biased. Otitis includes otitis externa and otitis media, which are further divided into acute and chronic otitis media. As defined above, one of these phenomena and the occurrence of otitis were considered. Therefore, the calculated prevalence of otitis in this study was higher than that in any of the abovementioned studies. Elucidation of specific risk factors for the development of otitis in preschool children should be confirmed by population-based cohort studies to allow further observation of environmental and developmental relationships with disease development in childhood.



## Conclusion

The prevalence of otitis in preschool children is high, and it has a certain association with indoor environmental factors. Residence renovation, tide, and humidity during pregnancy are all risk factors for the development of otitis in preschool children. The diagnosis of otitis in children should be added to the consideration of environmental factors when they come to relevant units such as hospitals, and parents should also pay attention to the indoor living environment. Reduction of indoor renovation of the dwellings of children during their growth and development and regular vector abatement of the dwellings actively improve children's indoor living environments, thereby effectively preventing otitis in preschool children.

## Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to the data belonging to the School of Public Health of Fudan University but are available from the corresponding author upon reasonable request.

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## Conflicts of interest

The authors declare no conflicts of interest.

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