



Associations between home dampness-related exposures and childhood eczema among 13,335 preschool children in Shanghai, China: A cross-sectional study



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ABSTRACT

From April 2011 to April 2012, we conducted a cross-sectional study in Shanghai, China. A total of 13,335 modified ISAAC questionnaires (response rate: 85.3%) were returned by parents or guardians for 4–6 year-old children. Six dampness-related indicators (visible mold spots, visible damp stains, damp bed clothing, water damage, window pane condensation, and moldy odor) were used to evaluate home dampness-related exposures. In the present study, we applied logistic regression model to reveal associations, dose–response relationships, and statistical interaction effects of these dampness-related exposures, with childhood eczema, during lifetime since birth (ever) and in the last 12 months before the questionnaire. The dampness-related indicators were frequently reported in the perinatal and current residences. Prevalences of eczema ever and in the last 12 months were 22.9% and 13.2%, respectively. The dampness-related indicators were robustly associated and dose–response related with increased risk of eczema ever and in the last 12 months in the logistic regression analyses, with adjusted for potential confounders. Specifically, in the perinatal residence, visible mold spots or damp stains could increase 46% (OR, 95% CI: 1.46, 1.29–1.66) odds of childhood eczema (ever); in the current residence, visible mold spots and visible damp stains could increase 34% (1.34, 1.14–1.58) and 38% (1.38, 1.22–1.56) odds of childhood eczema (ever), respectively. Associations were not appreciably different between boys and girls, nor were they different between children with and without parental history of atopy. In conclusion, perinatal and current dampness-related exposures in the residence perhaps are risk factors for childhood eczema.

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1. Introduction

In recent years, the prevalence of childhood eczema in China (Zhang et al., 2013b) and many other countries (Asher et al., 2006; Duggan et al., 2012; Grize et al., 2006; Sun and Sundell, 2013; Weidinger and Novak, 2015) has been rapidly increasing. A national survey, which was conducted in ten cities of China in 2002, found that prevalence of childhood eczema among preschool children in Beijing (4.75%) was the highest, followed by Shanghai (2.78%) (Gu et al., 2004). In 2012, we found that the eczema prevalence in Beijing and Shanghai had increased to 34.7% and 23.4%, respectively (Zhang et al., 2013b).

Several studies have suggested that indoor environmental

exposures may be related to the prevalence of childhood eczema (Miyake et al., 2007; Schafer et al., 2008; Tsakok et al., 2015; Wang et al., 2015; Wegienka et al., 2015; Weinmayr et al., 2013; Weidinger and Novak, 2015; Zhang et al., 2013a, 2013b; Zhao et al., 2013). The cross-sectional studies on home environment and children's health in Sweden (Bornehag et al., 2005), Ireland (Duggan et al., 2012), Bulgaria (Naydenov et al., 2008), USA (Sun and Sundell, 2011), Korea (Choi et al., 2014), and in the Chinese cities Taiyuan (Zhao et al., 2013), Wuhan (Zhang et al., 2013a), and Chongqing (Wang et al., 2013, 2015), using a similar questionnaire, found that home dampness-related indicators (mold spots, damp stains, water damage, windows pane condensation, moldy odor) were associated with childhood eczema. However, several studies found that residential dampness-related exposures had no significant associations of with eczema in childhood (Holme et al., 2010; Pirastu et al., 2009; Tham et al., 2007) nor among young adults (Sun et al., 2011). Therefore, it is still unclear that whether home dampness-related exposures are risk factors for childhood

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eczema. More investigations are required as the recent systematic reviews on associations of environmental exposures and childhood eczema suggested (Flohr and Mann, 2014; Wegienka et al., 2015; Weidinger and Novak, 2015).

Shanghai, a city with a typical subtropical monsoon climate, is located in the Yangtze River estuary in the Chinese East Sea. Hot-moist in summer and cold-moist in winter characterize both its outdoor and indoor environments, since this city's location in China means there is no central heating. Our previous study revealed notably different situations of dampness-related indicators in residences with different building characteristics and lifestyle behaviors in Shanghai (Liu et al., 2015). These differences in Shanghai dwelling dampness give us an excellent chance to study associations between home dampness-related indicators and childhood diseases. As a part of the China, Child, Homes, Health (CCHH) study in Shanghai (Huang et al., 2013, 2015), we aim in the present study to investigate associations, dose–response relationships, and interaction effects (multiplicative and additive) of home dampness-related indicators, in the perinatal residence (at the child's birth) and/or in the current residence (at the time of the questionnaire), on eczema among 4–6 year-old children. We further examined these relations in different subgroups *via* stratifying the sampled children by sex and family history of atopy. We hypothesized that home dampness-related exposures would be related with childhood eczema.

2. Methods

2.1. The CCHH study in Shanghai

From April 2011 to April 2012, we conducted a questionnaire-based cross-sectional study (CCHH phase one) in 72 kindergartens from five districts of Shanghai, and surveyed 17,898 parents or guardians of 1–8 year-old children. We selected the surveyed kindergartens by this approach: five districts (Urban: Hong-Kou, Jing-An, and Zha-Bei; Suburban: Bao-Shan and Feng-Xian) were selected from 18 districts (10 urban districts and 8 suburbs) of Shanghai city, and then about 15 kindergartens were randomly chosen in each district. More details with respect to the chosen kindergartens in each district are described in our previous article

(Huang et al., 2015).

Questionnaires were distributed by two methods: (1) delivered to parents and recovered on-site by us in kindergartens at teacher–parents meetings in the urban districts, and (2) posted to kindergartens where teachers delivered them to parents, and then recovered them and mailed them back to us in the suburban districts. Before the survey, we introduced the CCHH study and questionnaires to parents or the kindergarten leaders and/or teachers, and a questionnaire guidance was distributed to each parent along with the questionnaire. All the data for the present study are from the questionnaire. Early published articles provide more information about the CCHH study in China (Zhang et al., 2013b) and in Shanghai (Hu et al., 2014; Huang et al., 2015; Liu et al., 2014). The study was approved by the ethical committee in the School of Public Health, Fudan University in Shanghai, China.

2.2. Definitions of exposures and outcomes

Questions for home environments were the same as for the CCHH study in other cities of China (Zhang et al., 2013b) and were similar to studies in other countries (Bornehag et al., 2004; Choi et al., 2014; Naydenov et al., 2008; Sun and Sundell, 2011; Tham et al., 2007). Table 1 shows the questions for dampness-related indicators in the perinatal and current residence in Shanghai (Table A.1 shows the questions for dampness-related indicators in Chinese version). Dampness-related exposure was defined as a “yes” answer to any of the questions mentioned in the table. Herein the perinatal residence or perinatal indicators were defined as the household at the child's birth; and the current residence or current indicators were defined as the home the surveyed child currently lives in. To investigate the dose–response relationships of home dampness-related exposures with childhood eczema, the number of dampness-related indicators in the perinatal (three indicators) and current residences (six indicators) were added so as to yield a sum, *n*, of indicators. Thus, for perinatal residence, *n* varied from zero to three, and the current residence, *n* varied from zero to 6. If both the perinatal and current residences did not report any dampness indicators, we considered these families to have had “both no” home dampness exposure; if both the perinatal and current residences reported any one of the damp indicators, we considered these families to have had “both yes”

Table 1
Questions for the home dampness-related indicators.

Indicator	Question	Answer
(1) In the perinatal residence		
1) Visible mold spots or damp stains	Did you notice there was visible mold or damp stains on the floor, walls or ceiling in the perinatal residence at the child's birth?	Yes, often (every week) vs. Yes, sometimes vs. No, never
2) Windows pane condensation	Did you notice there was condensation or moisture occur on the inside, at the bottom, of windows in winter in the perinatal residence at the child's birth?	Yes, often (every week) vs. Yes, sometimes vs. No, never
3) Moldy odor	Have you been bothered by the moldy odor in the perinatal residence at the child's birth?	Yes, often vs. Yes, sometimes vs. No, never
(2) In the current residence		
1) Visible mold spots	Have you noticed any visible mold on the floor, walls or ceiling in the child's room?	Yes vs. No
2) Visible damp stains	Have you noticed any visible damp stains on the floor, walls or ceiling in the child's room?	Yes vs. No
3) Damp bed clothing	Have you noticed your clothing and/or bedding are damp in the last year?	Yes, often vs. Yes, sometimes vs. No, never
4) Water damage	Have there been any flooding or other kinds of water damages in your residence?	Yes, during the last year vs. Yes, before the last year vs. No, never
5) Windows pane condensation	In the winter, does condensation or moisture occur on the inside, at the bottom, of windows in the child's room?	Yes, > 25 cm vs. Yes, 5–25 cm vs. Yes, < 5 cm vs. No, never
6) Moldy odor	Have you been bothered by the moldy odor in your residence during the last 3 months?	Yes, often vs. Yes, sometimes vs. No, never

Table 2
Demographic information, household and individual characteristics, and prevalences of eczema for the surveyed children.

Items	Sample size, n (%)
Age (years-old)	
4	5561 (41.7)
5	4399 (33.0)
6	3375 (25.3)
Sex	
Boys	6536 (49.2)
Girls	6753 (50.8)
Administrative area	
Urban	7576 (56.8)
Suburban	5759 (43.2)
Ownership of the current residence	
Owner	8224 (63.2)
Renter	4795 (36.8)
Family history of atopy	
Yes	3097 (23.9)
No	9837 (76.1)
Duration of breastfeeding (months)	
≤ 6	7605 (58.2)
> 6	5456 (41.8)
Pet-keeping in the perinatal residence	
Yes	1628 (12.4)
No	11,515 (87.6)
Parental smoking	
Yes	7319 (56.5)
No	5637 (43.5)
Eczema, ever	
Yes	2856 (22.9)
No	9605 (77.1)
Eczema, in the last 12 months	
Yes	1695 (13.2)
No	11,136 (86.8)

exposures in home dampness; the same rules were used to report “only perinatal” and “only current” home dampness-related exposures. More information for home dampness-related exposures in the residences with different building characteristics has been presented in our previous articles (Hu et al., 2014; Liu et al., 2015).

Questions on the child's diseases were modified from those used in the International Study of Asthma and Allergies in Childhood (ISAAC) (Asher et al., 1995). Questions for childhood eczema in our CCHH study were as follows: (1) Eczema, ever: has your child ever had an itchy skin rash (eczema), which was coming and going for at least 6 months (yes, < 1 year-old vs. yes, 1–2 year-old vs. 3–4 year-old vs. > 4 year-old vs. No)? If the parents reported any “yes” in this question, we considered their children have had eczema (ever); (2) Eczema, in the last 12 months: has your child had eczema (itchy skin rash that comes and goes for the least 6 months) in the last 12 months (Yes vs. No)? Children were classified as having eczema (in the last 12 months) when their questionnaires were answered “Yes” in this question. Table A.1 shows the questions for these diseases in Chinese version. The original ISAAC questionnaire did not include the word “eczema” in the questions with respect to childhood eczema. In the CCHH questionnaire, we have improved these questions by adding the word “eczema” and adding a specific description that explain what is defined as “eczema” to the parents.

2.3. Covariates

We included the following factors as covariates, which were reported significant associations with childhood eczema:

administrative area (urban areas vs. suburb), age (4 vs. 5 vs. 6 year-old), sex (boys vs. girls), family history of atopy (yes vs. no), ownership of the current residence (owner vs. renter), breast-feeding (≤ 6 vs. > 6 months), furred animals/pets in the child's residence at birth (yes vs. no) and environmental tobacco smoke (ETS) (yes vs. no). Family history of atopy was defined as at least one of the child's family members (siblings, parents, or grandparents) having had at least one of the following diseases: asthma, eczema, and allergic nose or eye problems. Ownership of the current residence was considered as an indicator of higher socioeconomic status. Parental smoking was defined as at least one of the child's family members smoking in the perinatal and/or current residence. Questions for these factors are provided in a previous article (Zhang et al., 2013b).

2.4. Statistical analysis

Data were analyzed by SPSS (Version 17.0, SPSS Ltd., USA). Pearson's chi-square test was used to compare differences in eczema prevalence between subgroups with different dampness-related exposures. Bivariate and multiple logistic regression models were applied to reveal associations and dose-response relationships between home dampness-related indicators with eczema. We constructed multiple logistic regression models with one health outcome as dependent variable, one target factor as independent variable, and the potential confounders as covariates. For associations and dose-response relationships, the target factors (home dampness-related exposures by different indicators and in different combinations) were analyzed as categorical variables, with no exposure as reference categories. Crude and adjusted associations were indicated by odds ratio (OR) and adjusted odds ratio (AOR) with 95% confidence intervals (CI).

To further indicate dose-response relationships, we tested linear trends between the combined numbers of home dampness-related indicators (as normal variables) and prevalences of childhood eczema, in the logistic regression models. The same analyses were performed for boys and girls, as well as for children with and children without family history of atopy.

We also performed multiple logistic regression analyses in SPSS, with setting both the two variables that we want to test their multiplicative interaction effect on the diseases and their multiplicative item as independent variables, and setting the potential confounders as covariates: (1) to investigate possible multiplicative interaction effects of each dampness-related indicator and sex or family history of atopy on childhood eczema; and (2) to investigate possible multiplicative interaction effects of dampness-related exposures in the perinatal residence and in the current residence on childhood eczema.

We also analyzed for possible additive interaction effects of dampness-related exposures in the perinatal and current residences on childhood eczema by multiple logistic regression analysis and the delta method (Hosmer and Lemeshow, 1992). Two indices, relative excess risk due to interaction (RERI) and attributable proportion due to interaction (AP), were used to indicate the additive interaction effects. Andersson et al. (2005) created an Excel spreadsheet to calculate these indices with their CIs using the regression coefficients, standard errors, and covariance matrices given by logistic regression analyses for the two variables that we want to test their additive interaction effect on the diseases in SPSS. We used the updated version of this spreadsheet from Knol et al. (Knol et al., 2007; Knol and VanderWeele, 2012; VanderWeele and Knol, 2014) to calculate RERIs and APs and their 95% CIs. A $p < 0.05$ indicated significance in all statistical analyses.

Table 3
Associations of different dampness-related indicators and eczema.

Items		Sample size, N (%)	Eczema, ever		Eczema, in the past 12 months	
			Prevalence, n (%)	AOR, 95% CI ^a	Prevalence, n (%)	AOR, 95% CI ^a
(1) In the perinatal residence						
1) Visible mold spots or damp stains	No	11,222 (86.4)	2310 (21.9)	1.00	1390 (12.8)	1.00
	Yes	1773 (13.6)	479 (29.2) [#]	1.46, 1.29–1.66	271 (16.0) [#]	1.31, 1.12–1.52
2) Windows pane condensation	No	6043 (46.7)	1119 (19.9)	1.00	653 (11.2)	1.00
	Yes	6892 (53.3)	1655 (25.4) [#]	1.25, 1.14–1.37	999 (14.9) [#]	1.26, 1.12–1.41
3) Moldy odor	No	11,201 (92.0)	2343 (22.2)	1.00	1416 (13.0)	1.00
	Yes	975 (8.0)	260 (28.8) [#]	1.46, 1.24–1.72	148 (16.1) [#]	1.32, 1.08–1.61
(2) In the current residence						
1) Visible mold spots	No	11,603 (92.2)	2442 (22.4)	1.00	1474 (13.1)	1.00
	Yes	987 (7.8)	264 (28.9) [#]	1.34, 1.14–1.58	145 (15.4) [#]	1.16, 0.95–1.41
2) Visible damp stains	No	10,728 (84.7)	2205 (21.9)	1.00	1336 (12.9)	1.00
	Yes	1939 (15.3)	529 (29.2) [#]	1.38, 1.22–1.56	303 (16.3) [#]	1.23, 1.06–1.42
3) Damp bed clothing	No	7453 (57.9)	1479 (21.1)	1.00	873 (12.1)	1.00
	Yes	5428 (42.1)	1277 (25.2) [#]	1.27, 1.15–1.39	768 (14.7) [#]	1.24, 1.11–1.39
4) Water damage	No	9820 (81.8)	1994 (21.6)	1.00	1204 (12.7)	1.00
	Yes	2185 (18.2)	583 (28.4) [#]	1.36, 1.21–1.53	347 (16.5) [#]	1.27, 1.11–1.46
5) Windows pane condensation	No	4474 (44.3)	1464 (21.1)	1.00	856 (12.0)	1.00
	Yes	5631 (55.7)	722 (28.1) [#]	1.35, 1.21–1.51	468 (17.8) [#]	1.46, 1.28–1.66
6) Moldy odor	No	8377 (69.3)	2200 (22.0)	1.00	1327 (12.9)	1.00
	Yes	3705 (30.7)	373 (28.9) [#]	1.40, 1.21–1.61	214 (15.9) [#]	1.20, 1.05–1.37
(3) The total number (n) of dampness-related indicators in perinatal residence						
n=0		5006 (42.0)	892 (19.0)	1.00	531 (11.0)	1.00
n=1		5364 (45.0)	1228 (24.1)	1.15, 0.96–1.36	746 (14.3)	1.25, 1.10–1.42
n=2		1187 (10.0)	320 (28.7)	1.55, 1.32–1.82	195 (17.0)	1.52, 1.25–1.84
n=3		354 (3.0)	110 (33.5) [#]	2.14, 1.65–2.77 [*]	59 (17.7) [#]	1.70, 1.24–2.32 [*]
(4) The total number (n) of dampness-related indicators in current residence						
n=0		1638 (20.1)	266 (17.2)	1.00	144 (9.0)	1.00
n=1		2653 (32.6)	516 (20.5)	1.15, 0.96–1.36	322 (12.4)	1.23, 0.99–1.53
n=2		2034 (25.0)	466 (24.1)	1.38, 1.15–1.65	302 (15.2)	1.58, 1.26–1.97
n=3		1064 (13.1)	275 (27.1)	1.64, 1.33–2.03	169 (16.2)	1.67, 1.29–2.16
n=4		454 (5.6)	131 (30.0)	1.98, 1.52–1.59	82 (18.4)	2.01, 1.46–2.78
n=5		222 (2.7)	73 (34.9)	2.39, 1.69–3.38	41 (19.2)	1.89, 1.23–2.91
n=6		67 (0.8)	21 (35.0) [#]	2.57, 1.40–4.69 [*]	12 (19.0) [#]	2.33, 1.13–4.81 [*]
(5) Whether there were any dampness-related indicator in the perinatal or current residence						
Both no		1284 (16.4)	199 (16.3)	1.00	114 (9.1)	1.00
Only perinatal		300 (3.8)	53 (19.0)	1.16, 0.80–1.66	24 (8.3)	0.85, 0.52–1.40
Only current		1881 (24.0)	337 (19.0)	1.18, 0.96–1.45	208 (11.4)	1.22, 0.95–1.57
Both yes		4363 (55.8)	1091 (26.1) [#]	1.55, 1.30–1.85	688 (16.1) [#]	1.59, 1.28–1.98

^a Adjusted for administrative area, sex, age, breastfeeding, family history of atopy, ownership of the current residence, furred animals/pets in the child's residence at birth, and parental smoking.

[#] *p*-Value < 0.05 in the Pearson's chi-square test.

* *p*-Value < 0.001 for liner trend test in the multiple logistic regression analysis with adjusted for the above factors.

Table 4
Multiplicative interaction effect of dampness-related exposures in the perinatal (yes vs. no) and current (yes vs. no) residence on childhood eczema.

Items	AOR, 95% CI (<i>p</i> -Value)	
	Eczema (ever)	Eczema (in the past 12 months)
Total children ^a	1.18, 0.80–1.74 (0.397)	1.57, 0.94–2.63 (0.085)
Boys ^b	1.06, 0.63–1.80 (0.830)	1.53, 0.72–3.24 (0.268)
Girls ^b	1.34, 0.76–2.38 (0.313)	1.62, 0.80–3.30 (0.182)
Children with family history of atopy ^c	1.53, 0.71–3.27 (0.275)	2.18, 0.91–5.19 (0.079)
Children without family history of atopy ^c	1.08, 0.69–1.70 (0.732)	1.42, 0.74–2.71 (0.295)

^a Adjusted for administrative area, sex, age, breastfeeding, family history of atopy, ownership of the current residence, furred animals/pets in the child's residence at birth, and parental smoking.

^b Adjusted for all factors for the total children except for sex.

^c Adjusted for all factors for the total children except for family history of atopy.

3. Results

A total of 15,266 questionnaires for 1–8 year-old preschool children were returned (response rate: 85.3%). We selected the 13,335 questionnaires for four to six year-old children for analyses because the numbers of children in other ages were small (Huang et al., 2013, 2015). Table 2 shows demographic information, household and individual characteristics, and prevalences of the studied diseases for the surveyed children. The overall prevalences of eczema (ever) and eczema (in the past 12 months) were 22.9% and 13.2%, respectively. The prevalence of eczema (ever) in girls (22.8%) was close to that in boys (23.0%). The prevalence of eczema in children with family history of atopy was much higher than in children without family history of atopy (ever: 36.5% vs. 18.5%, *p*-value < 0.001 in chi-square test; and in the past 12 months: 23.2% vs. 10.1%, *p*-value < 0.001). Dampness-related indicators were common in both perinatal and current residences; in particular, more than half of the perinatal and current residences were reported to have had condensation on windows during night in

Table 5Additive interaction effect of dampness-related exposures in the perinatal (yes vs. no) and current (yes vs. no) residence on childhood eczema ^a.

Items	Eczema (ever)		Eczema (in the past 12 months)	
	RERI, 95% CI (p-Value)	AP, 95% CI (p-Value)	RERI, 95% CI (p-Value)	AP, 95% CI (p-Value)
Total children ^b	0.26, -0.37–0.89 (0.414)	0.17, -0.16–0.49 (0.312)	0.56, -0.34–1.46 (0.225)	0.35, 0.01–0.69 (0.044)
Boys ^c	0.14, -0.72–1.00 (0.754)	0.09, -0.40–0.58 (0.727)	0.36, -0.30–1.01 (0.284)	0.41, -0.10–0.92 (0.113)
Girls ^c	0.39, -0.52–1.31 (0.399)	0.29, -0.17–0.68 (0.234)	0.57, -0.56–1.71 (0.322)	0.38, -0.05–0.82 (0.085)
Children with family history of atopy ^d	0.44, -0.57–1.46 (0.389)	0.35, -0.16–0.85 (0.177)	0.66, -0.32–1.65 (0.187)	0.62, 0.18–1.05 (0.006)
Children without family history of atopy ^d	0.18, -0.60–0.96 (0.648)	0.11, -0.30–0.52 (0.601)	0.50, -0.89–1.88 (0.480)	0.26, -0.24–0.77 (0.309)

^a RERI: relative excess risk due to interaction; AP: attributable proportion due to interaction.^b ORs for calculation of the indices were adjusted for administrative area, sex, age, breastfeeding, family history of atopy, ownership of the current residence, furred animals/pets in the child's residence at birth, and parental smoking.^c ORs for calculation of the indices were adjusted for all factors for the total children except for sex.^d ORs for calculation of the indices were adjusted for all factors for the total children except for family history of atopy.

winter (Table 3).

Among all children (Table 3), the prevalence of eczema in children with exposures to all six home dampness-related indicators either in the perinatal or current residence were higher than in children without these exposures. The larger the number of home dampness-related indicators either in the perinatal residence or in the current residence, the higher the prevalence of eczema, except for when the sample sizes were very small. In the logistic regression analyses for all children (Table 3), dampness-related indicators either in the perinatal or current residence had significant associations with increased odds of childhood eczema; and the higher the number of home dampness-related indicators, the higher the odds of childhood eczema. The new indicator of home dampness, damp bed clothing, consistent with other indicators, had significant associations with eczema. The multiple logistic regression analyses also showed that the number (*n*) of dampness-related indicators in the perinatal and current residence had significant, positive linear-trends with the prevalence of childhood eczema ever and in the last 12 months.

Besides, we found that dampness-related exposures in the perinatal residence and in the current residence had positive multiplicative (Table 4) and additive (Table 5) interaction effects on childhood eczema (ever and in the last 12 months), although none of the indicators for the multiplicative interaction effects had statistical significance. These interaction effects were more robust on eczema (in the last 12 months) than on eczema (ever), and were more notable in girls than in boys, as well as in children with than without family history of atopy.

Furthermore, as among the total children, we found that the trends for the prevalences of childhood eczema with regard to different indicators of home-dampness related exposures were still apparent when the sampled children were stratified by sex (Table A.2) or by family history of atopy (Table A.3). In the logistic regression analyses, the associations between childhood eczema and home-dampness related exposures also were still apparent for boys and girls (Table A.4 and Table 6), and for children with and without family history of atopy (Table A.5 and Table 7).

Stratification by gender also indicated few differences between boys' and girls' eczema prevalence as related to dampness-related indicators, although it was noted that associations in perinatal residences were stronger than in the current residences for childhood eczema in the last 12 months (Tables A.4 and 6). In the presence of family history of atopy (Tables A.5 and 7), moldy odor was strongly associated with childhood eczema (ever and in the last 12 months); as was the total number (*n*) of indicators in the current residence and various combinations of home dampness in the perinatal and current residences, for eczema in the last 12 months. Most associations of home dampness-related exposures with childhood eczema among children without family history of atopy were stronger than among children with family history of

atopy (Table 7), especially the dose-response relationships of dampness-related indicators in the current residence with childhood eczema.

We also found that multiplicative interaction effect of visible mold spots or damp stains in the perinatal residence, and of moldy odor in the current residence, with sex on eczema (in the last 12 months) were significant (Table 6); as well as multiplicative interaction effect of visible mold spots or damp stains and of moldy odor in the perinatal residence, with family history of atopy on eczema (ever) were significant (Table 7).

4. Discussion

In the present study, we used parent-reported data from 13,335 preschool children and found that dampness-related exposures either in the perinatal or current residence were associated with the prevalence of childhood eczema. These findings are consistent with previous studies on home environment and childhood health in Sweden (Bornehag et al., 2005), USA (Sun and Sundell, 2011), Korea (Choi et al., 2014), and cities in China (Zhang et al., 2013a, 2013b; Zhao et al., 2013; Wang et al., 2013, 2015) for preschool children. We also found that damp bed clothing was a strong indicator of home dampness-related exposures. This is consistent with our previous findings (Hu et al., 2014) and thus we suggest that questions about damp bed clothing should be included in studies on associations between home dampness-related exposures and childhood health.

Previous CCHH studies in different cities of China have reported that those children who had family history of atopy (Zhang et al., 2013a, 2013b; Huang et al., 2015), shorter breastfeeding (Zhao et al., 2013), perinatal pet-keeping at the child's birth (Huang et al., 2013; Zhao et al., 2013), parental smoking (Liu et al., 2013), and lived in urban area (Huang et al., 2015) had higher prevalences of eczema (ever and in the last 12 months). These findings are consistent with several systematic reviews on associations between indoor exposures and childhood eczema (Flohr and Mann, 2014; Wegienka et al., 2015; Weidinger and Novak, 2015). Therefore, we considered these factors, as well as sex and age, as potential confounders in our analyses on associations between home dampness-related exposures and childhood eczema.

We cumulated indicators of home dampness-related indicators in the perinatal and current residence, and found that these numbers had robust dose-response relationships with the prevalence of childhood eczema (ever and in the past 12 months), except among children with family history of atopy in some cases. Children with dampness-related exposures in both the perinatal and current residences had the highest increased risk of childhood eczema. This suggests that home dampness-related exposures in infancy through age four to six may have additive effects on

Table 6
Association of dampness-related indicators and eczema, stratified by sex.

Items	AOR, 95% CI ^a					
	Eczema, ever			Eczema, in the past 12 months		
	Boy (N=1447)	Girl (N=1396)	p-Value ^b	Boy (N=832)	Girl (N=856)	p-Value ^b
(1) In perinatal residence (yes vs. no; no=1.00)						
1) Visible mold spots or damp stains	1.32, 1.11–1.57	1.63, 1.36–1.94	0.100	1.13, 0.91–1.40	1.50, 1.22–1.85	0.063
2) Windows pane condensation	1.18, 1.04–1.35	1.33, 1.17–1.52	0.218	1.15, 0.98–1.35	1.38, 1.18–1.62	0.095
3) Moldy odor	1.63, 1.31–2.04	1.30, 1.02–1.65	0.164	1.31, 1.00–1.73	1.35, 1.02–1.80	0.956
(2) In current residence (yes vs. no; no=1.00)						
1) Visible mold spots	1.19, 0.95–1.50	1.52, 1.21–1.92	0.141	1.01, 0.75–1.34	1.34, 1.02–1.77	0.169
2) Visible damp stains	1.32, 1.11–1.56	1.46, 1.22–1.73	0.402	1.17, 0.96–1.44	1.30, 1.06–1.60	0.517
3) Damp bed clothing	1.28, 1.13–1.46	1.25, 1.09–1.42	0.758	1.23, 1.05–1.44	1.26, 1.07–1.47	0.876
4) Water damage	1.25, 1.06–1.47	1.49, 1.26–1.75	0.146	1.22, 1.00–1.48	1.33, 1.10–1.62	0.539
5) Windows pane condensation	1.42, 1.22–1.65	1.28, 1.10–1.50	0.227	1.53, 1.27–1.84	1.39, 1.16–1.67	0.092
6) Moldy odor	1.43, 1.18–1.73	1.37, 1.12–1.68	0.889	1.35, 1.12–1.63	1.07, 0.89–1.30	0.041
(3) The total number (n) of dampness-related indicators in the perinatal residence (reference: n=0)						
n=1	1.11, 0.96–1.28	1.39, 1.20–1.61		1.11, 0.93–1.33	1.41, 1.18–1.68	
n=2	1.46, 1.16–1.83	1.68, 1.33–2.10		1.38, 1.05–1.81	1.70, 1.30–2.22	
n=3	2.03, 1.44–2.85*	2.28, 1.54–3.39*	0.273	1.25, 0.80–1.95**	2.47, 1.58–3.86*	0.041
(4) The total number (n) of dampness-related indicators in the current residence (reference: n=0)						
n=1	1.17, 0.92–1.50	1.12, 0.87–1.44		1.36, 0.99–1.87	1.13, 0.83–1.52	
n=2	1.44, 1.12–1.84	1.31, 1.01–1.71		1.96, 1.43–2.70	1.27, 0.92–1.74	
n=3	1.61, 1.21–2.16	1.67, 1.23–2.26		1.62, 1.12–2.35	1.72, 1.20–2.47	
n=4	2.41, 1.67–3.47	1.58, 1.06–2.36		2.63, 1.68–4.12	1.57, 0.98–2.52	
n=5	1.87, 1.14–3.05	3.06, 1.86–5.03		1.79, 0.96–3.34	1.87, 1.01–3.47	
n=6	2.53, 1.14–5.61*	2.66, 1.05–6.73*	0.910	2.58, 0.96–6.89*	2.03, 0.68–6.11*	0.587
(5) Whether there were dampness-related indicators in perinatal or current residence (reference: both no)						
Only perinatal	1.21, 0.74–1.97	1.08, 0.63–1.87		0.80, 0.39–1.64	0.86, 0.43–1.73	
Only current	1.29, 0.97–1.72	1.08, 0.81–1.46		1.44, 0.99–2.07	1.04, 0.73–1.49	
Both yes	1.60, 1.25–2.05*	1.50, 1.16–1.93	0.653	1.76, 1.28–2.42*	1.45, 1.07–1.96	0.906

^a Adjusted for administrative area, age, breastfeeding, family history of atopy, ownership of the current residence, furred animals/pets in the child's residence at birth, and parental smoking.

^b For multiplicative interaction effect of home dampness-related exposures and sex on childhood eczema.

* p-Value < 0.001 for liner trend test in the multiple logistic regression analysis with adjusted for the above factors, except for the specific indication.

** p-Value=0.018.

childhood eczema as proposed in some previous studies (Chen et al., 2003; Kercsmar et al., 2006; Hu et al., 2014). The inconsistent dose–response relationships between home dampness-related indicators and childhood eczema among children with family history of atopy may be due to the small sample sizes (Table A.2). Nonetheless, our findings indicate that home dampness-related exposures perhaps are risk factors for childhood eczema, as they have been shown to be for childhood asthma and allergic rhinitis (Hu et al., 2014; Mendell et al., 2011; Wang et al., 2012; Yang et al., 1997). It also suggests that the observed associations in the present study are likely to be causal, because these associations are consistent with results in the previous studies (Bornehag et al., 2005; Choi et al., 2014; Sun and Sundell, 2011; Tsakok et al., 2015; Wang et al., 2013, 2015; Zhang et al., 2013a, 2013b; Zhao et al., 2013) and we further observed robust dose–response relationships between home dampness-related exposures and childhood eczema.

The magnitude of increased odds for eczema among children with all six dampness-related exposures compared to no exposures (Table 3) was similar to (and for children without family history of atopy (Table 7) even was higher than) the increased odds of family history of atopy for eczema, ever (OR, 95% CI: 2.54, 2.32–2.78) and for eczema, in the last 12 months (2.70, 2.42–3.01). These findings also suggest that home dampness-related exposures could be strongly associated with childhood eczema as family history of atopy.

We found that dampness-related exposures in the perinatal and current residence had stronger multiplicative and additive

interaction effects on eczema in children with family history of atopy, when dampness-related exposures both in the perinatal residence and in the current residence only were stratified by two options (yes vs. no). Thus we infer that family history of atopy may strengthen the interaction effects of home dampness-related exposures on childhood eczema. On the other hand, these multiplicative and additive interaction effects are consistently positive among all children and when children were stratified by sex and family history of atopy. However, no previous studies have investigated the multiplicative and additive interaction effects of dampness-related exposures on eczema as our methods. More longitudinal studies on the causal relationships between home dampness-related exposures and childhood eczema are warranted.

Several studies have noted that home dampness-related indicators (visible mold and water damage) have a positive association with the concentration of indoor airborne fungi (Haas et al., 2007; Mahooti-Brooks et al., 2004), which in turn have been reported to be robustly associated with childhood eczema (Cipriani et al., 2014; Saunders et al., 2012; Weidinger and Novak, 2015). However, there are no established causative agents, and some studies have suggested that a single mechanism cannot explain the health effects associated with home dampness-related exposures (Mendell et al., 2011). More investigations for these potential mechanisms are needed to obtain consistent evidence.

This study had some limitations. No causal inference can be made about associations of dampness-related exposures with childhood eczema, as in all cross-sectional epidemiological

Table 7
Association of dampness-related indicators and eczema, stratified by family history of atopy ^a.

Items	AOR, 95% CI ^a					
	Eczema (ever)			Eczema (in the past 12 months)		
	Children with family history of atopy	Children without family history of atopy	p-Value ^b	Children with family history of atopy	Children without family history of atopy	p-Value ^b
(1) In perinatal residence (yes vs. no; no = 1.00)						
1) Visible mold spots or damp stains	1.64, 1.33–2.03	1.37, 1.18–1.61	0.002	1.31, 1.04–1.66	1.31, 1.07–1.59	0.182
2) Windows pane condensation	1.14, 0.97–1.35	1.30, 1.17–1.46	0.423	1.15, 0.95–1.38	1.32, 1.15–1.52	0.405
3) Moldy odor	1.64, 1.24–2.18	1.39, 1.13–1.70	0.008	1.51, 1.11–2.05	1.21, 0.93–1.58	0.006
(2) In current residence (yes vs. no; no = 1.00)						
1) Visible mold spots	1.27, 0.97–1.67	1.37, 1.12–1.68	0.309	1.11, 0.81–1.51	1.19, 0.92–1.55	0.341
2) Visible damp stains	1.32, 1.08–1.61	1.41, 1.21–1.64	0.586	1.13, 0.91–1.42	1.31, 1.08–1.58	0.474
3) Damp bed clothing	1.32, 1.13–1.55	1.24, 1.11–1.39	0.569	1.23, 1.03–1.48	1.25, 1.08–1.44	0.719
4) Water damage	1.34, 1.11–1.62	1.37, 1.18–1.58	0.594	1.21, 0.98–1.50	1.32, 1.10–1.58	0.890
5) Windows pane condensation	1.23, 1.02–1.48	1.41, 1.23–1.62	0.200	1.33, 1.08–1.64	1.54, 1.30–1.82	0.313
6) Moldy odor	1.38, 1.09–1.74	1.42, 1.29–1.69	0.871	1.14, 0.87–1.48	1.32, 1.06–1.65	0.595
(3) The total number (n) of dampness-related indicators in the perinatal residence (reference: n=0)						
n = 1	1.15, 0.95–1.38	1.28, 1.13–1.45		1.17, 0.95–1.45	1.29, 1.11–1.52	
n = 2	1.58, 1.20–2.08	1.53, 1.25–1.87		1.38, 1.01–1.87	1.63, 1.28–2.08	
n = 3	2.26, 1.47–3.47***	2.07, 1.49–2.87***	0.853	1.88, 1.19–2.98**	1.54, 1.00–2.39***	0.789
(4) The total number (n) of dampness-related indicators in the current residence (reference: n=0)						
n = 1	0.95, 0.68–1.33	1.23, 1.00–1.51		0.83, 0.57–1.22	1.48, 1.13–1.93	
n = 2	1.25, 0.90–1.74	1.43, 1.15–1.78		1.11, 0.77–1.61	1.89, 1.43–2.50	
n = 3	1.32, 0.91–1.91	1.80, 1.40–2.33		1.06, 0.70–1.61	2.14, 1.55–2.95	
n = 4	1.68, 1.05–2.70	2.14, 1.55–2.95		1.15, 0.67–1.98	2.78, 1.87–4.13	
n = 5	1.74, 0.97–3.12	2.77, 1.81–4.25		2.00, 1.08–3.72	1.70, 0.91–3.19	
n = 6	1.87, 0.66–5.33**	3.51, 1.69–7.26***	0.242	0.96, 0.26–3.63	4.59, 1.98–10.67***	0.049
(5) Whether there were dampness-related indicators in perinatal or current residence (reference: both no)						
Only perinatal	0.89, 0.60–1.33	1.31, 1.03–1.67		0.66, 0.42–1.05	1.58, 1.16–2.15	
Only current	0.89, 0.43–1.86	1.22, 0.80–1.85		0.75, 0.33–1.73	0.94, 0.50–1.74	
Both yes	1.27, 0.91–1.79**	1.66, 1.34–2.04	0.703	1.08, 0.74–1.57*	1.89, 1.44–2.48	0.368

^a Adjusted for administrative area, sex, age, breastfeeding, ownership of the current residence, furred animals/pets in the child's residence at birth, and parental smoking.

^b For multiplicative interaction effect of home dampness-related exposures and family history of atopy on childhood eczema.

* 0.01 ≤ p-Value < 0.05.

** 0.001 ≤ p-Value < 0.01.

*** p-value < 0.001 for line trend test in the multiple logistic regression analysis with adjusted for the above factors.

studies, even though our results suggest certain causal relationships. All data were obtained from parent-reported questionnaires. Some studies have found that such reports may have been confounded by reporting error and reverse causation, namely parents whose children had eczema may be more likely to report home dampness-related exposures (Larsson et al., 2011; Sun et al., 2007). There also may be recall biases regarding dampness-related exposures in the perinatal residence and eczema ever during the child's lifetime.

Nevertheless, this study also has several strengths. Firstly, this study is one of the largest cross-sectional studies on home dampness-related exposures and childhood eczema conducted in China. The high response rate also gives credibility to our results. Secondly, the questionnaire we used has been used in many previous studies (Bornehag et al., 2005; Choi et al., 2014; Tsakok et al., 2015; Wang et al., 2013; Zhao et al., 2013). Therefore, although there is potential error resulting from over-reporting those risk factors that respondents are aware of, the present study likely give a reliable picture of the dampness-related exposures and childhood eczema in Shanghai, China.

5. Conclusions

Home dampness-related exposures perhaps were risk factors

for childhood eczema, regardless of the child's sex and heredity status. The dose–response relationship that we found also suggest a potential causal relationships between home dampness-related exposures and childhood eczema. More longitudinal studies on this topic were warranted.

Competing interests

YH and LS were master students in their school when they conducted the questionnaire study with other authors, and are presently employed by the companies noted in their affiliations. These companies had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The authors have declared that no competing interests exist.

Authors' contributions

CH, WL, YH, and ZJZ conceived and designed the questionnaire; CH, WL, YH, ZJZ, and LS performed the survey; JC and WL analyzed the data, drafted and prepared the paper; JC, WL, ZJZ, and CH contributed reagents/materials/analysis tools.

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Ethics statement

The questionnaire and detailed proposal for the CCHH study in Shanghai were approved by the ethical committee in the School of Public Health, Fudan University, Shanghai, China (International Registered number: IRB00002408&FWA00002399). We thoroughly informed potential participants of the purpose, proposal details and potential concerns of the study by oral presentation or written explanation. All participants verbally consented for themselves and for the preschool children for whom they responded to questionnaires. All participants voluntarily responded to the survey. The ethical committee approved this procedure for obtaining consent.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.envres.2015.12.009>.

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Table A.1 The questionnaire for dampness-related indicators and childhood eczema in Chinese version

Item	Question	Answer
1. Home dampness-related indicators		
(1) In perinatal residence		
1) visible mold spots or damp stains	69a, <u>在孩子出生时</u> , 您是否注意到您住所的地板、墙、天花板上有明显的发霉或潮湿的污点?	☐ 是, 经常 (每周) ☐ 是, 有时 ☐ 否, 从未
2) windows pane condensation	69b, <u>在孩子出生时</u> , 您是否注意到您的住所: 冬季时, 在窗户的内侧底部有凝结或水汽现象?	☐ 是, 经常 (每周) ☐ 是, 有时 ☐ 否, 从未
3) moldy odor	70, <u>在孩子出生时</u> , 您是否被住所内的右述气味所烦扰 (发霉的气味)?	☐ 经常 ☐ 有时 ☐ 否
(2) In the current residence		
1) visible mold spots	58, 在孩子睡觉房间中的地板, 墙和天花板上, 您是否注意到有 <u>明显的发霉现象</u> ?	☐ 是 ☐ 否
2) visible damp stains	59, 在孩子睡觉的房间中的地板, 墙和天花板上, 您是否注意到有 <u>明显的潮湿现象 (湿斑、凝水、裂纹, 墙面剥落)?</u>	☐ 是 ☐ 否
3) damp bed clothing	63a, 近一年里, 您是否发现您住所内的衣物, 被褥等有受潮现象?	☐ 从未发现 ☐ 偶尔发现 ☐ 经常发现
4) water damage	64, 您的住所是否有过水泛滥或者其它由水造成的损害 (湿斑、墙皮剥落等)?	☐ 是, 在过去的一年中 ☐ 是, 一年以前 ☐ 否
5) windows pane condensation	66, 冬天, 在孩子睡觉的房间内, 窗户内侧底部是否有凝结水或水汽?	☐ 否, 从来没有 ☐ 是, 高度小于 5 厘米 ☐ 是, 5-25 厘米 ☐ 是, 高度大于 25 厘米
6) moldy odor	67, <u>最近的三个月中</u> , 您是否被住所内的这些 (一种或多种) 气味所烦扰 (发霉的气味)?	☐ 经常 ☐ 有时 ☐ 否
2. Eczema		
(1) Eczema, ever	28a, 是否有过持续 6 个月以上的皮肤瘙痒 (湿疹)?	☐ 是, 1 岁以前 ☐ 是, 1-2 岁 ☐ 是, 3-4 岁 ☐ 是, 4 岁以后 ☐ 否
(2) Eczema, in the last 12 months	28c, <u>最近十二个月</u> , 孩子是否患过湿疹?	☐ 是 ☐ 否

Table A.2 Prevalence of childhood eczema under different dampness-related indicators, stratified by sex

Items	Prevalence, n (%) ^a			
	Eczema, ever		Eczema, in the past 12 months	
	Boy	Girl	Boy	Girl
(1) In early residence				
1) visible mold spots or damp stains	238 (27.6) [#]	237 (30.7) [#]	123 (13.9)	146 (18.2) [#]
2) windows pane condensation	831 (25.0) [#]	815 (25.8) [#]	483 (14.1) [#]	511 (15.8) [#]
3) moldy odor	147 (31.1) [#]	111 (26.0)	76 (15.8) [#]	71 (16.4)
(2) In current residence				
1) visible mold spots	126 (26.8) [#]	137 (31.1)	66 (13.6)	79 (17.5) [#]
2) visible damp stains	272 (28.9) [#]	254 (29.5) [#]	149 (15.3) [#]	151 (17.1) [#]
3) damp bed clothing	647 (25.3) [#]	626 (25.1) [#]	372 (14.1) [#]	392 (15.3) [#]
4) water damage	285 (27.2) [#]	295 (29.6) [#]	165 (15.3) [#]	179 (17.5) [#]
5) windows pane condensation	374 (28.9) [#]	346 (27.3) [#]	238 (17.9) [#]	230 (17.8) [#]
6) moldy odor	192 (28.9) [#]	178 (28.8) [#]	107 (15.3) [#]	105 (16.4) [#]
(3) The total number (n) of dampness-related indicators in the early residence				
n=0	456(19.5)	435(18.5)	268(11.2)	262(10.8)
n=1	610 (23.4)	613 (24.7)	365 (13.6)	377 (14.9)
n=2	163 (28.7)	154 (28.5)	95 (16.3)	98 (17.6)
n=3	62 (33.3) [#]	48 (33.8) [#]	27 (14.4) [#]	32 (21.8) [#]
(4) The total number (n) of dampness-related indicators in the current residence				
n=0	142(17.4)	123(16.8)	68(8.2)	75(9.9)
n=1	258 (20.5)	256 (20.4)	154 (11.9)	167 (12.9)
n=2	239 (24.0)	225 (24.0)	162 (15.8)	139 (14.5)
n=3	134 (25.9)	139 (28.4)	74 (13.8)	93 (18.5)
n=4	76 (34.5)	55 (25.3)	46 (20.3)	36 (16.5)
n=5	33 (29.7)	39 (40.2)	19 (17.1)	21 (20.8)
n=6	11 (34.4) [#]	10 (35.7) [#]	6 (18.2) [#]	6 (20.0) [#]
(5) Whether there were dampness-related indicators in early or current residence				
Both no	105(16.5)	94(16.2)	54(8.4)	60(9.9)
Only early	29 (19.6)	23 (17.7)	11 (7.1)	12 (9.0)
Only current	170 (19.3)	166 (18.5)	105 (11.6)	102 (11.1)
Both yes	555 (25.8) [#]	530 (26.3) [#]	341 (15.5) [#]	343 (16.7) [#]

^a Only the prevalence among children with the exposure was presented. [#] $p < 0.05$ in the Pearson's chi-square test.

Table A.3 Prevalence of childhood eczema under different dampness-related indicators, stratified by family history of atopy

Items	Prevalence, <i>n</i> (%) ^a			
	Eczema (ever)		Eczema (in the past 12 months)	
	Children with family history of atopy	Children without family history of atopy	Children with family history of atopy	Children without family history of atopy
(1) In early residence				
1) visible mold spots or damp stains	207 (46.3) [#]	259 (22.5) [#]	124 (27.0) [#]	142 (11.9) [#]
2) windows pane condensation	678 (37.4)	930 (20.4) [#]	443 (23.9)	533 (11.4) [#]
3) moldy odor	108 (47.0) [#]	148 (22.6) [#]	71 (30.0) [#]	76 (11.4)
(2) In current residence				
1) visible mold spots	107 (42.1) [#]	150 (23.5) [#]	63 (24.6)	79 (12.0)
2) visible damp stains	225 (41.6) [#]	289 (23.4) [#]	137 (25.0)	158 (12.4) [#]
3) damp bed clothing	510 (39.1) [#]	737 (20.1) [#]	330 (24.8) [#]	423 (11.2) [#]
4) water damage	254 (40.5) [#]	315 (22.9) [#]	162 (25.2)	179 (12.7) [#]
5) windows pane condensation	310 (39.0)	399 (23.1) [#]	212 (26.2) [#]	249 (14.1) [#]
6) moldy odor	157 (43.5) [#]	208 (23.0) [#]	95 (25.5)	116 (12.2) [#]
(3) The total number (<i>n</i>) of dampness-related indicators in the early residence (reference: <i>n</i> =0)				
<i>n</i> =0	291(32.4)	585(15.8)	189(20.6)	330(8.6)
<i>n</i> =1	479 (35.6)	719 (19.7)	321 (23.4)	412 (11.0)
<i>n</i> =2	140 (43.8)	171 (22.2)	87 (26.3)	103 (13.0)
<i>n</i> =3	52 (51.0) [#]	58 (26.2) [#]	32 (31.1) [#]	27 (11.9) [#]
(4) The total number (<i>n</i>) of dampness-related indicators in the current residence (reference: <i>n</i> =0)				
<i>n</i> =0	78(32.6)	181(14.2)	55(22.4)	88(6.7)
<i>n</i> =1	176 (32.1)	333 (17.3)	114 (20.5)	202 (10.2)
<i>n</i> =2	193 (36.9)	264 (19.2)	126 (23.6)	172 (12.2)
<i>n</i> =3	120 (38.0)	150 (21.9)	72 (22.4)	95 (13.4)
<i>n</i> =4	52 (41.6)	76 (25.2)	30 (23.6)	50 (16.2)
<i>n</i> =5	31 (44.9)	41 (29.9)	24 (34.8)	16 (11.3)
<i>n</i> =6	8 (42.1) [#]	13 (32.5) [#]	3 (15.0) [#]	9 (21.4) [#]
(5) Whether there were dampness-related indicators in early or current residence (reference: both no)				
Both no	60(32.4)	136(13.4)	42(22.6)	71(6.8)
Only early	16 (34.0)	35 (15.9)	11 (20.8)	13 (5.8)
Only current	106 (29.6)	227 (16.3)	63 (17.1)	141 (9.9)
Both yes	454 (38.3)	618 (21.2) [#]	294 (24.5)	384 (12.8) [#]

^a Only the prevalence among children with the exposure was presented. [#] *p* < 0.05 in the Pearson's chi-square test.

Table A.4 Association of home dampness-related indicators and childhood eczema, stratified by sex

Items	Odds ratio, 95% confidence interval			
	Eczema, ever		Eczema, in the past 12 months	
	Boy	Girl	Boy	Girl
(1) In early residence (yes vs. no; no=1.00)				
1) visible mold spots or damp stains	1.34, 1.14-1.58	1.61, 1.36-1.90	1.11, 0.90-1.37	1.51, 1.24-1.83
2) windows pane condensation	1.30, 1.16-1.47	1.44, 1.27-1.63	1.28, 1.11-1.49	1.50, 1.29-1.74
3) moldy odor	1.61, 1.31-1.98	1.22, 0.97-1.52	1.30, 1.00-1.68	1.27, 0.97-1.65
(2) In current residence (yes vs. no; no=1.00)				
1) visible mold spots	1.24, 1.00-1.54	1.59, 1.29-1.97	1.07, 0.81-1.40	1.37, 1.06-1.77
2) visible damp stains	1.43, 1.23-1.67	1.52, 1.29-1.78	1.26, 1.04-1.53	1.36, 1.12-1.65
3) damp bed clothing	1.25, 1.11-1.41	1.27, 1.12-1.43	1.21, 1.04-1.40	1.29, 1.12-1.50
4) water damage	1.33, 1.14-1.55	1.57, 1.34-1.83	1.28, 1.06-1.54	1.44, 1.20-1.72
5) windows pane condensation	1.57, 1.36-1.82	1.36, 1.17-1.58	1.72, 1.44-2.04	1.50, 1.26-1.79
6) moldy odor	1.46, 1.22-1.75	1.42, 1.18-1.71	1.27, 1.02-1.59	1.27, 1.02-1.59
(3) The total number (n) of dampness-related indicators in the early residence (reference: n=0)				
n=1	1.08, 0.95-1.22	1.23, 1.09-1.40	1.13, 0.97-1.31	1.22, 1.05-1.42
n=2	1.43, 1.18-1.73	1.41, 1.16-1.72	1.36, 1.07-1.72	1.42, 1.12-1.79
n=3	1.74, 1.28-2.38*	1.78, 1.25-2.53*	1.14, 0.76-1.73*	1.81, 1.21-2.70*
(4) The total number (n) of dampness-related indicators in the current residence (reference: n=0)				
n=1	0.84, 0.71-0.98	0.83, 0.70-0.98	0.86, 0.71-1.06	0.88, 0.73-1.08
n=2	1.11, 0.94-1.32	1.12, 0.94-1.33	1.36, 1.12-1.67	1.07, 0.87-1.31
n=3	1.23, 0.99-1.52	1.43, 1.16-1.77	1.08, 0.83-1.40	1.49, 1.17-1.91
n=4	1.88, 1.41-2.51	1.18, 0.86-1.61	1.76, 1.26-2.47	1.24, 0.86-1.80
n=5	1.47, 0.97-2.22	2.37, 1.57-3.58	1.39, 0.84-2.30	1.65, 1.01-2.69
n=6	1.80, 0.87-3.75*	1.92, 0.88-4.17*	1.49, 0.61-3.62*	1.55, 0.63-3.82*
(5) Whether there were dampness-related indicators in early or current residence (reference: both no)				
Only early	1.23, 0.78-1.94	1.12, 0.68-1.84	0.84, 0.43-1.64	0.90, 0.47-1.73
Only current	1.21, 0.93-1.58	1.18, 0.90-1.56	1.44, 1.02-2.03	1.14, 0.81-1.59
Both yes	1.76, 1.40-2.21	1.85, 1.46-2.36	2.01, 1.48-2.71	1.82, 1.36-2.44

* p -value < 0.001 for liner trend test in the logistic regression analysis.

Table A.5 Association of home dampness-related indicators and childhood eczema, stratified by family history of atopy^a

Items	Odds ratio, 95% confidence interval			
	Eczema (ever)		Eczema (in the past 12 months)	
	Children with family history of atopy	Children without family history of atopy	Children with family history of atopy	Children without family history of atopy
(1) In early residence (yes vs. no; no=1.00)				
1) visible mold spots or damp stains	1.64, 1.34-2.01	1.34, 1.15-1.55	1.28, 1.02-1.61	1.24, 1.03-1.50
2) windows pane condensation	1.14, 0.97-1.33	1.30, 1.17-1.45	1.14, 0.96-1.37	1.32, 1.15-1.51
3) moldy odor	1.62, 1.23-2.13	1.34, 1.10-1.62	1.46, 1.09-1.96	1.16, 0.90-1.49
(2) In current residence (yes vs. no; no=1.00)				
1) visible mold spots	1.31, 1.01-1.70	1.38, 1.14-1.67	1.09, 0.81-1.47	1.21, 0.95-1.54
2) visible damp stains	1.29, 1.07-1.56	1.42, 1.23-1.65	1.12, 0.90-1.39	1.29, 1.07-1.54
3) damp bed clothing	1.27, 1.09-1.48	1.20, 1.08-1.34	1.21, 1.01-1.43	1.23, 1.07-1.41
4) water damage	1.27, 1.06-1.53	1.40, 1.21-1.61	1.16, 0.95-1.43	1.34, 1.13-1.60
5) windows pane condensation	1.17, 0.98-1.40	1.46, 1.27-1.66	1.27, 1.04-1.56	1.59, 1.35-1.87
6) moldy odor	1.40, 1.12-1.75	1.38, 1.17-1.63	1.14, 0.89-1.47	1.27, 1.03-1.57
(3) The total number (n) of dampness-related indicators in the early residence (reference: n=0)				
n=1	0.96, 0.82-1.13	1.17, 1.05-1.31	1.04, 0.87-1.24	1.18, 1.02-1.35
n=2	1.44, 1.14-1.83	1.30, 1.08-1.55	1.22, 0.94-1.59	1.37, 1.10-1.70
n=3	1.89, 1.27-2.81*	1.60, 1.18-2.18*	1.53, 1.00-2.35*	1.21, 0.80-1.82*
(4) The total number (n) of dampness-related indicators in the current residence (reference: n=0)				
n=1	0.79, 0.64-0.98	0.89, 0.77-1.02	0.84, 0.66-1.07	0.92, 0.77-1.10
n=2	1.07, 0.87-1.32	1.07, 0.92-1.25	1.08, 0.85-1.37	1.22, 1.01-1.47
n=3	1.12, 0.87-1.44	1.28, 1.06-1.56	0.98, 0.74-1.31	1.35, 1.07-1.70
n=4	1.30, 0.90-1.88	1.53, 1.17-2.00	1.06, 0.70-1.62	1.66, 1.21-2.28
n=5	1.49, 0.92-2.41	1.93, 1.33-2.79	1.87, 1.13-3.11	1.07, 0.63-1.81
n=6	1.31, 0.52-3.27*	2.14, 1.10-4.17*	0.60, 0.18-2.06	2.29, 1.09-4.82*
(5) Whether there were dampness-related indicators in early or current residence (reference: both no)				
Only early	1.08, 0.55-2.12	1.22, 0.82-1.83	0.90, 0.43-1.90	0.85, 0.46-1.56
Only current	0.88, 0.60-1.29	1.26, 1.00-1.59	0.71, 0.46-1.09	1.51, 1.12-2.03
both yes	1.30, 0.93-1.80	1.73, 1.42-2.12	1.11, 0.77-1.61	2.02, 1.55-2.63

* p -value < 0.001 for liner trend test in the logistic regression analysis.