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COGNITIVE FUNCTION OF 6-YEAR OLD CHILDREN EXPOSED TO MOLD-CONTAMINATED HOMES IN EARLY POSTNATAL PERIOD. PROSPECTIVE BIRTH COHORT STUDY IN POLAND

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Abstract

In the last decade, the neurologic effects of various air pollutants have been the focus of increasing attention. The main purpose of this study was to assess the potential impact of early childhood exposure to indoor molds on the subsequent cognitive function of 6-year old children. The results of this study are based on the six-year follow-up of 277 babies born at term to mothers participating in a prospective cohort study in Krakow, Poland. The study participants are all non-smoking pregnant women who were free of chronic diseases such as diabetes and hypertension.

The presence of visible mold patches on indoor walls was monitored at regular time intervals over gestation and after birth up to the age of five. The Wechsler Intelligence Scale for Children (WISC-R) was administered to children at age 6. The exposure effect of living in mold-contaminated homes on the IQ scores of children was adjusted for major confounders, known to be important for the cognitive development of children such as maternal education, the child's gender, breastfeeding practices in infancy, the presence of older siblings and the prenatal exposure to lead and environmental tobacco smoke (ETS).

The adjusted IQ deficit attributed to longer exposures to indoor molds (> 2 years) was significantly lower on the IQ scale (beta coeff. = −9.16, 95%CI: −15.21, −3.10) and tripled the risk of low IQ scoring (OR= 3.53; 95%CI: 1.11 – 11.27) compared with references. While maternal education (beta coeff. = 0.61, 95%CI: 0.05, 1.17) and breastfeeding (beta coeff. = 4.0; 95%CI: 0.84, 7.17) showed a significant positive impact on cognitive function, prenatal ETS exposure (beta coeff. = −0.41; 95%CI: −0.79, −0.03) and the presence of older siblings (beta coefficient= −3.43; 95%CI: −5.67, −1.20) were associated with poorer cognitive function in children.

In conclusion, the results of this study draw attention to the harmful effect of early postnatal exposure to indoor molds on children cognitive development and provide additional evidence on the role of environmental determinants in human cognitive development.

Keywords

cognitive function; children; exposure to molds; breastfeeding; prospective birth cohort study

Introduction

It is well known that water infiltration from roofs, windows, water pipes, shower installations or bathtubs into buildings leads to the condensation of water droplets on walls or under carpets. This, in turn, causes mold growth, which often requires improvement and decontamination. Indoor mold growth is a very common phenomenon and, for instance, a study among white children, 9 to 11 years-old in 24 communities across North America reported the prevalence of indoor mold growth of 22% to 57%, exceeding 50% of households in five communities (1). Potentially toxic and immunogenic by-products of fungi and molds include mycotoxins (2 – 5) and fungal fragments, usually categorized as indoor air biocontaminants (6). The exposure to mycotoxins and fungal components occurs by inhalation, dermal contact and ingestion. Occupants of affected dwellings complain of headaches, various respiratory symptoms and gastrointestinal and urinary tract disorders as well as musculoskeletal impairments (1, 7 – 9).

While many epidemiologic publications describe the adverse health effects of indoor molds on respiratory health and asthma in children (10 – 18), studies on the effects of mold-contaminated home environments on mental health and brain development in early childhood are very scarce (19). As dramatic changes in brain and neurobehavioral development occur in the first years of life, this period is very sensitive to various environmental hazards. Studies in adults on the neurophysiological effects and neurobehavioral deficits associated with mycotoxins exposure have already shown that mold-exposed groups had decreased neurological functions, such as body balance, reaction time, blink reflex latency, color discrimination, or visual fields compared with controls (20 – 23). Furthermore, the exposed groups also showed depression (24) and lower scores on cognitive tests (25).

Increasing attention to children cognitive development deficit resulting from ambient air pollutants exposure prenatally and during childhood has recently emerged (26), since early cognitive development is vital for an individual's capacity to learn, adapt and exploit the opportunities available in their particular environment (27 – 29). Moreover, it was demonstrated that individuals scoring higher on intelligence tests in early childhood are usually more successful in professional carriers and achieve higher education levels and socio-economic status, which in turn may positively affect their health status.

The main purpose of this study was to assess the potential impact of early life exposure to mold-contaminated home environments on cognitive function at the age of 6. The size of the effect on the IQ scores measured by the Wechsler Intelligence Scale for Children (WISC-R) was adjusted for major confounders known to be important for children cognitive development such as maternal education, the child's gender, breastfeeding practice in infancy, the presence of older siblings, prenatal exposure to lead and environmental tobacco smoke (ETS).

Material and Methods

This study is part of an ongoing, longitudinal investigation of the health effects of prenatal exposure to outdoor and indoor air pollution on infants and children in Krakow, Poland. As described previously [30], between January 2001 and February 2004, we recruited a total of 505 women between 8 and 13 weeks pregnant, who registered at prenatal healthcare clinics

in the central area of Krakow, where they had also lived for at least a year before screening. Pregnant women visiting the prenatal clinic received a letter of introduction and answered a short screening questionnaire to determine whether they met the eligibility criteria – age ≥ 18 years, non-smoking, singleton pregnancy, no current occupational exposure to known developmental toxicants, no history of illicit drug use, pregnancy-related diabetes, or hypertension. All participants received verbal and written information about the study. Ethical permission for the study was granted by the Bio-ethical Committee of Jagiellonian University Medical College. The women fully enrolled in the study had to complete prenatal questionnaires on demographic and health characteristics, take part in personal monitoring of exposure to airborne PAHs and fine particulate matter and provide a blood sample collected at delivery either from the mother and/or her newborn child. After delivery medical information was extracted from the mothers' and infants' hospital records.

The present study includes 277 term babies (>36 weeks of gestation) who completed the 6-year follow-up and underwent cognitive testing. Test of Nonverbal Intelligence (TONI-3) to the mothers at the 4th year of follow-up was performed as well. Detailed data on maternal education was used as a proxy for social class, intellectual ability and quality of parenting. Breastfeeding initiation and its duration were defined based on the answers from interviews taken at regular 3-month intervals over the postpartum period. Mothers were asked whether the infant had ever been breastfed, and, if so, the age of the baby (in months) when exclusive breastfeeding was stopped. Exclusive breastfeeding was assumed if the child received only breast milk, and no other liquids or solids with the exception of medicine, or mineral supplements. mixed feeding was assumed when the child received both breast milk and formula or only formula since birth. Data on the number of cigarettes smoked daily by all household members was used to assess environmental tobacco smoke (ETS) at home during the prenatal and postnatal periods.

The data on visible patches of mold growth on internal walls of home were regularly collected in each trimester of pregnancy and after delivery every three months in the first two years of life and every six months subsequently. The definition of mold-contaminated home was based on the responses to the following question "In the last 6 months have you noticed any problem in your home like leaky pipes, mold on walls, holes in ceilings/walls ?" If mold patches on internal walls was present, interviewer qualified the answer as positive only in the case the moldy area exceeded one square meter.

Mental development testing of children

At age 6, the WISC-R was used, which is the most widely used intelligence and neuropsychological assessment and is considered to be a valid and reliable measure of general intelligence in children (31, 32). It has also been found to be a good measure of both inductive and deductive reasoning but it also measures knowledge and skills primarily influenced by biological and socio-cultural factors. The WISC-R includes questions of general knowledge, traditional arithmetic problems, vocabulary, completion of mazes, and arrangements of blocks and pictures and yields three IQ (intelligence quotient) scores, based on an average of 100, as well as subtests and index scores. WISC-R subtests measure specific verbal and performance abilities. In the present analysis only the full WISC-R scale was used as the main health outcome. The Wechsler scales were standardized for Polish children and are meant to be representative of the Polish population. The practical standardization of these tests was done during team practice sessions with Ms. Maria Butscher, a psychologist from the Jagiellonian University Medical College, who subsequently evaluated the IQ scoring.

As maternal intelligence is a known correlate of child cognitive development (33, 34), we administered the Test of Nonverbal Intelligence (TONI-3) to the mothers at the 4th year of

follow-up. The TONI-3 is a language-free measure of general intelligence, considered to be relatively free of cultural bias (35).

Dosimetry of cord blood lead

A cord blood sample (30–35 ml) at delivery was drawn into vacutainer tube and treated with ethylene diamine tetra-acetate (EDTA). Whole blood lead concentrations were determined at the Centers for Disease Control and Prevention (CDC) using inductively coupled plasma mass spectrometry CLIA'88 method (36).

Statistical data analysis

In the descriptive analysis, the distribution of various parameters related to the women and newborns under study reflected by indoor mold exposure was considered. Chi-square statistics (nominal variables) and analysis of variance (numerical variables) tested differences between subgroups. The relationship between IQ scores of children and the exposure to indoor molds was evaluated by linear multivariable regression models. The models computed regression coefficients of the dependent variable (intelligence IQ scores) on the main predictor variable (indoor molds) accounting for potential confounders or modifiers (gender of child, maternal education, parity, breastfeeding practice and ETS). As the correlation coefficients between cognitive scores achieved by children and maternal education (number of schooling years) and maternal IQ assessed by TONI test did not differ, we have chosen to consider only maternal education as a proxy for maternal intellectual ability and quality of parental care. In addition, the multivariable logistic regression model was used to estimate the risk of low IQ scoring attributable to indoor molds. All statistical analyses were performed with STATA 11.1 version software for Windows.

Results

The group of children who completed the 6-year follow-up consisted of 277 babies born at term. Out of the whole sample, 52 children (18.8 %) lived for shorter periods (<=2 years) and 15 (5.4%) for longer periods than 2 years in mold-contaminated homes. General characteristics of the study subgroups defined by the exposure levels of indoor molds did not differ significantly except for the cognitive function level achieved at age 6 (Table 1). Children who lived for longer periods in mold-contaminated dwellings scored about 10 points lower than those with no exposure. As the characteristics of the subjects included in the present analysis did not reveal significant differences compared with the group of children who dropped out of the study, except for the exclusive breastfeeding practices, we may assume that the material included in the analysis was representative of the population sample recruited initially (Table 2).

The children under study showed a mean IQ score (full scale) of 120.9 points (95%CI: 119.5 – 122.3) and prenatal exposure to indoor molds was not associated with IQ scores achieved by children (nonparametric trend $z = -0.73$, $p = 0.468$). Table 3 presents trends of crude (unadjusted) mean IQ scores with 95% confidence intervals by the postnatal exposure to indoor molds. It does show that children who were exposed for longer periods to indoor molds had a significant cognitive deficit of about 10 points on WISC IQ scales. Figure 1 shows that the IQ scores distribution was markedly shifted to lower values, especially in the group of children who were exposed to indoor molds for longer period.

The IQ scores positively correlated with maternal years of schooling (Spearman rho = 0.232, $p = 0.0001$) and duration of exclusive breastfeeding (rho = 0.211, $p = 0.0003$); there was a negative association between IQ cores and the number of cigarettes smoked daily at home (rho = −0.158, $p = 0.0067$) and with the number of older siblings (rho = −0.164, $p = 0.0047$).

Cord blood lead level, which may be treated as a measure of lead exposure of fetus over the gestation period, was very low (mean = 1,40 ug/dL; 95%CI: 1.33 – 1.48 ug/dL) and did not correlate significantly with IQ scores (rho = −0.07, p = 0.216).

Children of mothers with higher education level had higher IQ scores compared with those of mothers with lower education. Figure 2 presents the predicted regression lines for IQ scores related to maternal education (years of schooling) and the presence of indoor molds. It does show that the cognitive function values were lower for children who lived for longer periods in mold contaminated homes and this was observed at each level of maternal education.

Multivariable linear regression model for the IQ scores was used to adjust the size of the effect attributed to mold-contaminated indoor environments for all confounding variables, which in the stepwise regression analysis were associated with the dependent variable at alpha = 0.1. The size of the effect attributed to longer duration of postnatal mold exposure (> 2 years) in terms of IQ scores was significant (beta coeff. = −9.16, 95%CI: −15.21, −3.10) (Table 4). Although slightly attenuated, the effect of the exposure remained significant after the inclusion of maternal education, exclusive breastfeeding and other cofactors. From the confounders inserted in the regression models, maternal education (beta coeff. = 0.61, 95%CI: 0.05, 1.17) and breastfeeding for 6 months or longer (beta coeff. = 4.0; 95%CI: 0.84, 7.17) showed a significant positive impact on cognitive function. The data also confirmed that prenatal ETS exposure (beta coeff. = −0.41; 95%CI: −0.79, −0.03) and the presence of older siblings (beta coefficient= −3.43; 95%CI: −5.67, −1.20) were associated with poorer cognitive function in children.

Finally, we estimated the risk of low IQ scoring of 6-year-old children related to mold-contaminated home environment adjusted for the major confounders (exclusive of breastfeeding and maternal education). In the latter analysis, the IQ low scoring was defined as the IQ values below the 25th percentile of the given distribution (less than 113 points). The results showed that longer exposure to indoor molds tripled the risk of low IQ scoring (OR= 3.53; 95%CI: 1.11 – 11.27) compared with the group with no exposure.

Discussion

To our knowledge, this is the first cognitive epidemiologic study performed in early childhood aiming at assessing the relationship between mold-contaminated home environments and children cognitive function. The study's results revealed that not prenatal but only postnatal exposure to mold-contaminated homes was associated with a deficit of cognitive function in children compared with the reference group. Although the association between mold-contaminated indoor environments and the cognitive function of children was attenuated in the multivariable regression model after accounting for maternal education and other major confounders, the effect remained highly significant. Moreover, it was demonstrated that the negative effect of indoor molds on children's IQ was consistent and stable at each level of maternal education, which is a good proxy for maternal cognitive capacity.

Clinical neurological abnormalities caused by mycotoxins from molds have earlier been described in adults. For instance, in a review of a substantial number of adult patients with necropsy-proven central nervous system aspergillosis, the most common central nervous system lesions were subcortical hemorrhagic infarcts in the cerebral hemispheres or cerebellum, and the most common entry of Aspergillus into the central nervous system was the lower respiratory tract (37). In another neuropathological review, it was revealed that the pathologic characteristic of neurologic aspergillosis cases was fungal invasion into blood

vessel walls with subsequent necrosis and thrombosis spreading into the surrounding tissue (38). In a small clinical study on neuropsychological performance, it was found that patients exposed to molds presented a variety of symptoms such as fatigue, respiratory problems, recurring bloody noses, nausea, frequent sore throats, and headaches (22). Moreover, the mold-exposed patients were impaired on a number of cognitive measures, with the most consistent deficits in visuospatial learning, visuospatial memory, verb fluency, learning, and psychomotor speed. Yet another clinical study examined 119 patients with symptoms of neurotoxicity related to well-documented mold exposure (20). These patients complained of fatigue, memory loss, cognitive function loss, headaches, tremors, numbness and tingling, blurred vision, tinnitus, and muscle weakness. Ninety-nine of these patients had abnormal findings in neurophysiological testing.

Neurophysiological testing carried out in a group of hospitalized children confirmed that exposure to toxic molds can affect their neurological and behavioral status (19). Brainstem Auditory Evoked Response (BAER), electroencephalogram (EEG), Visual Evoked Potential (VEP), and Somato-Sensory Evoked Potential (SSEP) were used to test neurological abnormalities. Abnormal EEG and frontotemporal theta wave activity in mold-exposed subjects seemed to indicate diffuse changes consistent with metabolic encephalopathies. A significant delay in waveform V occurred in the majority of patients, representing a dysfunctional cognitive process and conductive hearing loss in both ears.

The underlying biomechanism of the harmful effect of mold exposure on human cognitive function is not yet completely understood. Fungal biochemical products include mycotoxins, enzymes, solvents, volatile organic compounds (2 – 6) and other by-products. Fungal particles smaller than 10 μm in diameter can be inhaled, mycotoxins may contaminate indoor dust, leading to inhalation and absorption by children. Larger fungal spores that are inhaled in the nasal cavities may also play an important role, however, inhalation and particle deposition in children's lung depends on their body size and breathing pattern (39, 40).

Inflammation and oxidative stress have been believed to be the basic mechanisms through which mold-polluted air may adversely impact the nervous system. The central nervous system in the early postnatal period is especially susceptible to oxidative stress from environmental toxins because the newborn's brain barrier is not yet fully developed (41). Furthermore, it was suggested that mold pollutants may cause systemic inflammation in peripheral tissues, a process that gives rise to higher levels of circulating cytokines in the blood stream (42). These inflammatory factors entering the nervous system through diffusion and active transport (43) could cause inflammation to the cerebro-vascular system and alter the cellular make-up of innate immune cells.

The negative effect of ambient air quality on children's cognitive development has been assessed in several epidemiologic studies in New York City, China and Poland. A series of studies initiated by Perera et al. (44) mainly considered the effects of prenatal exposure to airborne polycyclic aromatic hydrocarbons (PAHs) on cognitive development. Personal airborne PAHs measurements were collected during pregnancy and during the child's first years of life. The Bayley Scales of Infant Development-Revised was used to assess children's mental and psychomotor development at age 3. The study in New York City disclosed that children in the upper quartile of PAHs exposure scored 5.7 points lower on the mental development index at age 3 than those in the lowest quartile of exposure to PAHs. The OR of cognitive developmental delay for the high PAHs exposure group amounted to 2.9 (95%CI: 1.33–6.25). Tang et al. (45) also evaluated the associations between prenatal ambient PAH exposure, lead, and mercury on cognitive functions measured by the Gesell Developmental Schedules at age 2 among children in China. After

adjusting for potential confounders, increased PAH-DNA adducts were associated with decreased motor development quotients. The odds ratio of motor developmental delay was 1.91 (95%CI: 1.22–2.97) per 0.1 unit increase in PAH-DNA adducts. Wang et al. (46) examined the health effects of traffic-related air pollution on neurobehavioral functions among third-grade children. After adjusting for the children's demographic, early childhood factors and indoor air pollution, traffic-related ambient air pollution exposure was significantly associated with poorer performance on the visual simple reaction time-preferred hand (OR=1.67, p=0.044), digit symbol (OR=1.38, P=0.019) and sign register (OR=1.94, P<0.001).

The results of these studies were very recently confirmed by Edwards et al. (47). The study used the Raven Coloured Progressive Matrices, a nonverbal test of reasoning ability, to evaluate the effects on child intelligence of prenatal PAH exposure estimated by personal air monitoring during pregnancy. The effects were adjusted for potential confounders including socio-demographic factors and prenatal exposure to ETS. High prenatal exposure to PAHs was associated with decreased child IQ at age 5. In the context of the latter studies we have to mention that a significant negative effect of prenatal ETS on cognitive ability of 6-year olds demonstrated in our study could have resulted from the exposure to PAH compounds occurring in tobacco smoke.

At present there is no definitive and clear explanation for the positive association between maternal education and neurocognitive development of children, which has been shown in our study. Educational level of mothers is not only a proxy of socio-economic status of the family, but it may be an indicator of other relevant factors such as maternal behavior, life style, dietary habits before and during pregnancy, all of which are important for the study of the effects of breastfeeding practices on infant's health. With the exception of breastfeeding, none of the above-mentioned variables were considered in our analysis. Less educated mothers are possibly not as responsive to their infants' needs as better educated mothers or they may present some less favorable behavior during early childhood. Children living in a poor socio-economic environment are more likely to be exposed to environmental hazards and the adverse effects may be more pronounced in lower compared to higher socioeconomic groups. Studies carried out by Bellinger et al. (48) suggest that social context also modifies the effects of chemical neurotoxins. For example, material hardship has been demonstrated to modify the neurotoxic effects of tobacco smoke in children in the study done by Rauh et al. (49). The way in which maternal behavior may affect the development of children was discussed in a recently published paper by Surkan et al. (50).

Interestingly, the presence of older siblings at home showed a negative impact on mental development of the children in our study. The number of children at home may be a proxy not only for socio–environmental factors operating in early childhood, but also for a higher risk of viral infections introduced into the household by older siblings, which in turn may effect children's neurodevelopment. On the other hand, maternal attention being spread over a couple of children may mean that mothers are less responsive to each child's particular needs. However, lower cognitive function in older siblings may be a manifestation of the well-known higher IQ among the first born children. In this respect, the results of our study call for more research efforts aiming at explaining the other factors hidden behind proxy measures for the quality of maternal care of babies.

Weakness of the study results from the small size of the study sample and the lack of precise information on location of mold patches in home. Moreover, we performed no environmental sampling of molds for toxigenic typing or toxicity testing. However, a strength of our study is the cohort design, assessing house mold exposure by regular interviews with mothers at regular 6-month intervals preceding the outcome measurement

and control for several major confounding covariates. In addition, a set of relevant confounders of the relationship between mold exposure and cognitive development of children such as chronic diseases of mothers or maternal active tobacco smoking, have been removed through entry criteria to our study. In earlier studies, information on mold exposure was often obtained retrospectively at the time of health outcome measurements, which is prone to information bias. The assessment of the cognitive development of children was carried out by the trained staff using the Polish version of the Wechsler-R intelligence, adapted and standardized by the Polish Psychological Society.

Concluding, the findings provided an additional evidence that indoor molds exposure in early childhood might impair children's cognitive ability, especially in children who were exposed over longer periods. However, further studies are needed to confirm observed relationship, which could have resulted from some other co-exposure not controlled in this study.

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Highlights

1. The results of this study draw attention to the importance of the harmful effects of early postnatal exposure to indoor molds on children cognitive development
2. The study provides additional evidence on the role of environmental determinants on human cognitive development in early childhood.
3. The results should be used for programming public health prevention measures.

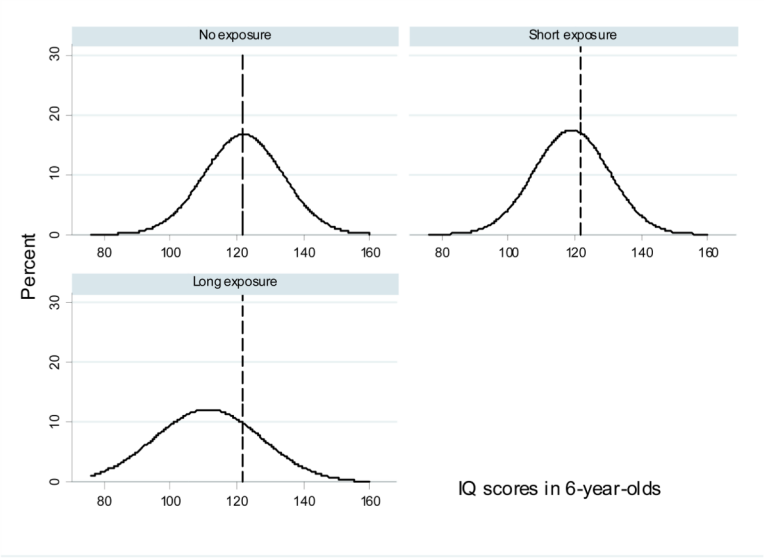

Figure 1.
Distribution of IQ scores in 6-year-old children by mold exposure duration in early childhood. Dash vertical line represents the mean score in the group of children with no exposure (121.8 points)

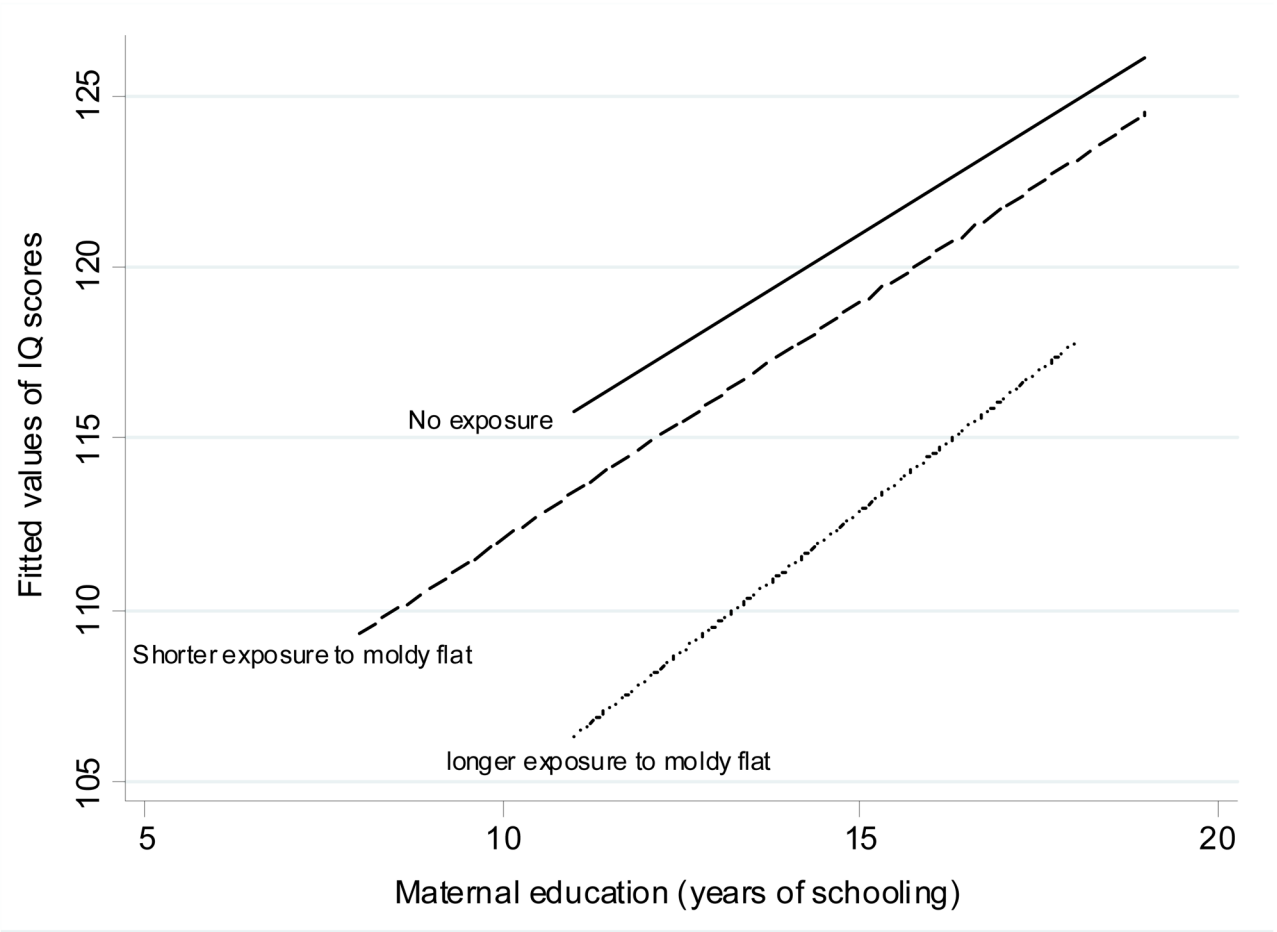

Figure 2.
Fitted values of IQ scores of 6 –year old children (WISC full scale) grouped by maternal education and exposure to mold-contaminated homes in early childhood

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Table 1

Characteristics of the study sample over the follow-up and the exposure to mold-contaminated homes

Variables		Total N=277	Exposure to molds			
			No exposure N=210	Short exposure N=52	Long exposure N=15	P for difference
Maternal age:						
	mean	27.76	27.91	27.52	26.47	0.2400
	SD	3.402	3.342	3.702	3.021	
Maternal education(years of schooling)						
	mean	15.69	15.86	15.58	13.73	0.0115
	SD	2.687	2.580	2.946	2.604	
Parity:						
1	n (%)	177 (63.9)	142 (67.6)	28 (53.8)	7 (46.7)	0.0649
≥ 2	n (%)	100 (36.1)	68 (32.4)	24 (46.2)	8 (53.3)	
Gender:						
Boys	n (%)	138 (49.8)	109 (51.9)	20 (38.5)	9 (60.0)	0.1596
Girls	n (%)	139 (50.2)	101 (48.1)	32 (61.5)	6 (40.0)	
Gestational age: (weeks) > 36						
	mean	39.53	39.50	39.62	39.67	0.7245
	SD	1.144	1.158	1.207	0.617	
Birth weight (g):						
	mean	3434.1	3441.0	3368.7	3564.0	0.2734
	SD	432.24	430.66	472.05	260.82	
Length at birth (cm):						
	mean	54.9	54.9	54.6	55.3	0.5651
	SD	2.61	2.63	2.72	1.94	
Head circumference (cm):						
	mean	33.9	33.9	33.8	34.3	0.4423
	SD	1.40	1.35	1.60	1.45	

Variables		Total N=277	Exposure to molds			
			No exposure N=210	Short exposure N=52	Long exposure N=15	P for difference
Breastfeeding exclusive≥ 6 months n (%)		153 (55.2)	114 (54.3)	30 (57.7)	9 (60.0)	0.8431
WISC-R IQ at age 6:						
IQ verbal scale	mean	119.31	120.58	116.64	110.87	0.0015
	SD	11.827	11.279	11.739	15.137	
IQ non-verbal scale	mean	118.07	118.92	117.81	107.07	0.0050
	SD	13.726	13.302	13.262	17.061	
IQ full scale	mean	120.64	121.82	118.94	110.00	0.0006
	SD	12.132	11.657	11.361	15.807	

Table 2

Characteristics of the children who completed the 6-year follow-up and those who failed to complete the follow-up

Variables		Total N= 484	Follow–up completed N=277	Follow–up not completed N=207	P for difference
Maternal age					
	mean	27.55	27.76	27.27	0.1317
	SD	3.580	3.402	3.795	
Maternal education(years of schooling)					
	mean	15.56	15.69	15.40	0.2475
	SD	2.759	2.687	2.850	
Parity:					
1	n (%)	307 (63.4)	177 (63.9)	130 (62.8)	0.8788
≥ 2	n (%)	177 (36.6)	100 (36.1)	77 (37.2)	
Gender:					
Boys	n (%)	248 (51.2)	138 (49.8)	110 (53.1)	0.5279
Girls	n (%)	236 (48.8)	139 (50.2)	97 (46.9)	
Gestational age: (weeks) > 36					
	mean	39.54	39.53	39.55	0.8848
	SD	1.141	1.144	1.139	
Birth weight (g):					
	mean	3443.0	3434.1	3455.0	0.6015
	SD	435.90	432.24	441.51	
Length at birth (cm):					
	mean	54.8	54.9	54.6	0.1681
	SD	2.62	2.61	2.62	
Head circumference (cm):					
	mean	33.9	33.9	33.9	0.9079
	SD	1.39	1.40	1.38	

Variables		Total N= 484	Follow–up completed N=277	Follow–up not completed N=207	P for difference
Breastfeeding exclusive ≥ 6 months n (%)		244 (50.4)	153 (55.2)	91 (44.0)	0.0182

Table 3

Trends for cognitive function in children measured at age 6 and mold-contaminated home exposure

IQ scores	Exposure to molds at home			Nonparametric test for trend
	No exposure N = 210	Short exposure* N = 52	Long exposure** N = 15	
IQ verbal scale	120.6 119.0–122.1)	116.6 (113.4–119.9)	110.9 (102.5–119.2)	Z = −3.13 P = 0.002
IQ non-verbal scale	113.9 (117.1–120.7)	117.8 (114.1–121.5)	107.1 (97.6–116.5)	Z = −2.82 P = 0.005
IQ full scale	121.8(120.2–123.4)	118.9(115.8–122.1)	110.0 (101.2–118.8)	Z = −3.28 P = 0.001

* <= 2 years

** > 2 years

Table 4

Effect of the exposure to mold-contaminated homes on cognitive ability of children (WISC – R full scale) at age 6 adjusted for potential confounders. Multivariable linear regression model (N = 277, R-squared = 0.17)

Predictors	**Coef.**	**t**	**P>t**	**[95% Conf.**	**Interval]**
Maternal education(years of schooling)	0.61	2.14	0.033	0.05	1.17
Gender of child (girls)	1.26	0.92	0.359	−1.44	3.95
Prenatal ETS *	−0.41	−2.13	0.034	−0.789	−0.03
Parity **	−3.43	−3.02	0.003	−5.67	−1.20
Exclusive breastfeeding					
<24 weeks	1.10	0.50	0.614	−3.20	5.41
>24 weeks	4.00	2.49	0.013	0.84	7.17
Mold-contaminated home (duration of exposure)					
<=2 years	−2.26	−1.28	0.203	−5.74	1.22
> 2 years	−9.16	−2.98	0.003	−15.21	−3.10
_cons	114.46	23.39	0.000	104.83	124.09

* prenatal ETS = weighted number of cigarettes smoked daily at home

** parity = 0 no older siblings, 1 = at least one older sibling