

Children's health and its association with indoor environments in Danish homes and daycare centres – methods

Abstract The principle objective of the Danish research program 'Indoor Environment and Children's Health' (IECH) was to explore associations between various exposures that children experience in their indoor environments (specifically their homes and daycare centers) and their well-being and health. The targeted health endpoints were allergy, asthma, and certain respiratory symptoms. The study was designed with two stages. In the first stage, a questionnaire survey was distributed to more than 17 000 families with children between the ages of 1 and 5. The questionnaire focused on the children's health and the environments within the homes they inhabited and daycare facilities they attended. More than 11 000 questionnaires were returned. In the second stage, a subsample of 500 children was selected for more detailed studies, including an extensive set of measurements in their homes and daycare centers and a clinical examination; all clinical examinations were carried out by the same physician. In this study, the methods used for data collection within the IECH research program are presented and discussed. Furthermore, initial findings are presented regarding descriptors of the study population and selected characteristics of the children's dwellings and daycare centers.

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Practical Implications

This study outlines methods that might be followed by future investigators conducting large-scale field studies of potential connections between various indoor environmental factors and selected health endpoints. Of particular note are (i) the two-stage design – a broad questionnaire-based survey followed by a more intensive set of measurements among a subset of participants who have been selected based on their responses to the questionnaire; (ii) the case-base

approach utilized in the stage 2 in contrast to the more commonly used case-control approach; (iii) the inclusion of the children's daycare environment when conducting intensive sampling to more fully capture the children's total indoor exposure; and (iv) all clinical examinations conducted by the same physician. We recognize that future investigators are unlikely to fully duplicate the methods outlined in this study, but we hope that it provides a useful starting point in terms of factors that might be considered when designing such a study.

Introduction

This study summarizes the background, design, and methodology of the Danish research program 'Indoor Environment and Children's Health' (IECH). The program focuses on exploring associations between children's exposure to factors related to the indoor environments in their homes and daycare centers and their well-being and health, with a special focus on allergy, asthma, and other respiratory diseases. This study is largely inspired by the Swedish DBH study (Bornehag et al., 2004a), which originally was designed to study potential health effects arising from exposures related to dampness in buildings, but later shifted its emphasis toward exposure to semivolatile organic compounds and other chemicals. Our study thus belongs to a family of epidemiological studies resembling the original DBH study which has subsequently been carried out in Bulgaria (Naydenov et al., 2008) and Singapore (Tham et al., 2007). However, there are several features incorporated into our study that were not part of the earlier studies. These include a case-base rather than a case-control design in stage 2 of the study, the collection and analysis of urine samples for selected biomarkers of the children's chemical exposure (Brive et al., 2012), detailed air exchange rates based on CO₂ measurements (Bekö et al., 2010, 2011), analyses of polycyclic aromatic hydrocarbons (PAHs) in dust as a crude indicator of traffic exposure (Langer et al., 2010), analysis of nicotine in dust as an indicator of indoor smoking (Weschler et al., 2011a), and the first quantification of squalene and cholesterol in indoor dust (Weschler et al., 2011b).

The study was carried out to gather information on building characteristics and exposures to key pollutants in Danish homes and daycare centers. Such information, collected in a systematic fashion for a large number of residences, is relatively scarce. The further aim was to explore associations between children's health and exposures indoors in Denmark, exposures that may be different from those in the other countries mentioned earlier. The differences may arise from differences in building construction, but they may also arise from more subtle differences in cultural habits such as taking shoes off when entering a home (or not), the use of carpets, and differences in bedding – use of duvets vs. use of sheets and blanket. We believe that subsequent meta-analysis of the

results from all the above-mentioned studies will be valuable owing to the large contrast in exposure parameters.

Characterization of children's environmental exposure history is complicated by several factors. During pregnancy and the earliest years of life, children remain, for the most part, indoors in their homes, which then presents the most dominant exposure environment. In the case of the older child, transition from the home to the daycare center presents a new environment with more complex exposures, such as contagions, a more diverse mix of allergens, and a higher incidence rate of respiratory transmissible diseases (e.g., common cold). At this stage, the combined environmental exposure in the home and daycare center may have a considerable influence on the child's health, including the risk of developing asthma/allergy (Høst et al., 2005; Kozyrskyj et al., 2009). A complete account of children's exposures in the home, daycare center, transportation environments, shopping facilities, and other microenvironments is difficult to obtain. However, the current study attempts to characterize exposure in two of these environments, the home and daycare center. For most children, we expect that these two settings represent the majority of their total exposure. This study examines associations between these exposures and the children's health as characterized by a parental questionnaire, a parental interview, and a clinical examination.

The overall aim of the current study is to contribute to increased understanding of the associations between indoor environmental exposures and asthma/allergy. Such knowledge is needed to improve the indoor environmental conditions in homes and daycare centers and thus limit exposures that may cause or contribute to these diseases.

Methods

The study consisted of two stages of which the first was a questionnaire survey of a large group of children focusing on their health and the indoor environments within the homes they inhabit and daycare centers they attend. A subsample of these children was then selected for further investigations, including a comprehensive set of measurements in their home and daycare center and a clinical examination. A flow diagram showing the design of the study is shown in

Table 1 Selected general characteristics of the study population and their dwellings. The table shows data for the whole population and stratified on the age group of 3–5 years, the case–base group as a whole, and separately for cases and bases

Characteristic	Categories	Whole population (<i>n</i> = 11 082) %	3–5 years (<i>n</i> = 7433) %	3–5 years Odense (<i>n</i> = 2797)	Cases and bases (<i>n</i> = 498) ^a %	Cases (<i>n</i> = 200) %	Bases (<i>n</i> = 298) ^a %
Sex	Female	48.9	49.2	49.0	46.0	45.5	46.3
	Male	51.1	50.8	51.0	54.0	54.5	53.7
Age ^b	1	15.7	0	0	0	0	0
	2	16.9	0	0	2.6	3.0	2.3
	3	21.1	31.3	32.2	33.1	37.0	30.5
	4	24.0	35.7	34.8	33.9	30.5	36.2
	5	22.3	33.1	33.0	30.3	29.5	30.9
Location of dwelling	City	36.9	35.8	48.5	43.8	47.2	41.6
	Suburb	22.4	23.0	44.8	45.6	38.1	50.7
	Rural	20.1	20.6	4.1	5.9	6.1	5.7
	Village	20.2	20.2	2.4	4.5	8.6	1.7
	Other	0.4	0.4	0.2	0.2	0.0	0.3
Type of dwelling	Detached dwelling	69.5	71.2	64.8	65.8	58.5	70.9
	Semidetached dwelling	10.7	10.3	18.3	18.1	20.5	16.5
	Apartment	9.3	7.6	14.6	12.3	16.0	9.8
	Farm	8.5	8.9	1.6	2.6	2.5	2.7
	Other	1.9	1.9	0.7	1.2	2.5	0.3
Size of dwelling	<50 m ²	0.1	0	0	0	0	0
	50–69 m ²	1.2	0.7	1.3	0.6	1.5	0
	70–89 m ²	8.2	6.9	11.1	11.5	15.0	9.1
	90–109 m ²	12.1	11.3	16.1	15.7	20.0	12.8
	110–139 m ²	24.5	23.9	24.8	24.6	23.0	25.7
	>140 m ²	54.0	57.3	46.7	47.6	40.5	52.4
Construction period	Before 1940	36.6	36.9	28.6	26.4	23.3	28.4
	1941–1960	14.2	13.6	17.5	21.4	19.7	22.5
	1961–1970	14.0	13.6	18.2	17.2	17.6	17.0
	1971–1976	10.2	10.5	11.0	10.0	14.5	6.9
	1977–1983	6.6	6.6	7.4	7.3	3.6	9.7
	1984–1993	5.5	5.7	7.2	6.4	8.8	4.8
	1994–2000	3.4	3.9	2.7	1.9	3.1	1.0
	After 2000	9.5	9.3	7.4	9.5	9.3	9.7
Form of payment	Owner	81.9	83.6	75.0	76.0	66.0	82.8
	Share	1.6	1.5	3.2	2.2	3.5	1.4
	Rental	16.5	14.9	21.8	21.8	30.5	15.9

^aTwo questionnaires lost during scanning.^bAge on the January 15, 2008.

Figure 1. An overview of the study populations is shown in Table 1.

Stage 1 – questionnaire survey

In January 2008, a wide-ranging questionnaire was distributed among 17 486 families with children aged 1–5 years. The recipients were all residents of the Danish island Funen (482 310 inhabitants) with a child in this age group. The island of Funen was selected for the study as it is considered to be fairly representative of the general Danish population. A reminder was sent to 12 608 non-responding families approximately 4 weeks after the first questionnaire, and a successive reminder was sent to 8016 families 2 weeks thereafter.

Parents were asked to complete a questionnaire containing 116 questions on the health history of the index child (the oldest in the designated age group) with special emphasis on asthma/allergy symptoms, characteristics of the residence, and the child's bedroom in particular, pet keeping, food habits, and other

environmental factors. The questionnaire, which could be filled in via the Internet or on paper, resembled the ones that were used in the original DBH study in Sweden (Bornehag et al., 2004a). The questions related to the child's health were similar to those used in the ISAAC study (Asher et al., 1995). The ISAAC questionnaire has been used repeatedly in previous studies as a standardized methodology for the evaluation of asthma, rhinitis, and eczema and of environmental exposures (Gehring et al., 2008; Bornehag et al., 2004a; Naydenov et al., 2008).

The envelopes with the returned questionnaires were first inspected manually to record the family's unique ID to cancel additional reminders and to assign the child as a potential case or base in case–base study in stage 2. Then, the questionnaires were stored for subsequent delivery to the company that performed the scanning and arranged the first version of questionnaire database. Unfortunately, seven questionnaires from the 500 cases and bases that were initially recorded as being received did not

appear in the database that was received from the company. Five of these families completed a new questionnaire. Two families could not be reached when the missing questionnaires were discovered. In parallel with the scanning process, responses from the families that chose to fill in the electronic questionnaire were organized and prepared for the merge with the database of scanned questionnaires. Duplicate responses from families that filled in both the electronic and the hard copy version of the questionnaire were removed from the database. Finally, data from both sources were aligned and checked for consistency. The final database contained records for 11 082 children.

Stage 2 – nested case–base study of indoor environment risk factors in the home and daycare center

A subsample of 500 children aged 3–5 years were selected among the respondents of the questionnaire study for a more detailed investigation of the indoor environment in their dwelling and the daycare centers they attended. The 500 children were all residents of Odense (population 166 000), which is the main city of Funen, or one of its suburbs and thus represented urban, suburban, and to a minor degree rural neighborhoods. In the analysis, we chose a case–base approach that would give a risk estimate applicable to the general population (in contrast to the ‘case–control’ design, which does not allow for this type of inference). The decision to focus on the residents of Odense in the case–base design was primarily based on logistics. The selection criteria for inclusion in the nested case–base study (stage 2) were based on the initial questionnaire from stage 1. But as we wanted the same physician to examine all children participating in stage 2, we were concerned about too many dropouts if participation involved driving too long a distance to the clinic. This choice resulted in under-sampling of rural residents. The study was designed as a nested case–base investigation that included 200 children, classified as cases, who suffered from at least two of three diseases categorized as asthma, rhinoconjunctivitis, and atopic eczema. A child was labeled asthmatic if it had had more than three periods of wheezing, had been treated with asthma medicine prescribed by a doctor within the past 12 months, or had ever been diagnosed with asthma by a doctor. The label rhinoconjunctivitis was assigned to children who during the past 12 months repeatedly had suffered from a runny nose, stuffed nose, or sneezing without having a cold or who had been diagnosed with allergy or conjunctivitis by a doctor. Eczema was used with children who suffered from eczema at the elbows, back of the knees, ankles, wrists, neck, ears, or eyes, or who had been diagnosed with atopic dermatitis by a doctor. The base group consisted of 300 randomly selected children.

Exposure measurements

The exposure measurements were taken by inspectors (students and employees from the Technical University of Denmark) who visited all 500 homes and 151 daycare centers. The inspections were conducted between March and May 2008. Each potential family was phoned to schedule a time for the inspectors to visit their home. This process continued until all 500 dwellings had been inspected. The inspections were booked in 90-minute time intervals during the day. The actual inspection lasted on average 60 min. Owing to the logistical reasons and the large number of homes, the order in which the homes were inspected could not be determined in advance. However, we attempted to have a relatively even distribution of visits of cases and bases throughout the 10-week campaign.

Each home was inspected by two inspectors. Four pairs of inspectors were simultaneously available 7 days a week during the measurement campaign. Their tasks were clearly stated in inspector protocols. The first inspector introduced the measurement plan to the parent; conducted a short interview; checked the home for moisture-related problems, building materials, and ventilation system; and placed the CO₂ monitor with a data-logger in the child’s bedroom. Meanwhile, the second inspector also checked the home for moisture-related problems, set out two Petri dishes for the duration of inspection, inspected the child’s bed and mattress type, collected one dust sample from the bed mattress and one from above-floor surfaces, and measured the volume of the bedroom. After returning from the inspection, the dust samples were placed in a freezer. One person revisited each home, usually 2–3 days after the inspection, to collect the CO₂ monitor. Altogether, 17 inspectors were involved in the home inspections. They were trained prior to the campaign. Every point in the two inspector protocols was introduced and thoroughly explained by an expert. Additionally, all inspectors participated in a training inspection in one home, where they practiced the roles of both inspectors.

Dwellings

In each home, the inspector filled in a detailed checklist of building characteristics and observations related to occupant habits, including the household cleaning products that were present. Dust samples were taken from the child’s bed and subsequently analyzed for five allergens [Der p1, Der f1, Mite Group 2 (dust mite), Fel d1 (cat), and Can f1 (dog)], lipopolysaccharides (LPS), and glucan.

Other dust samples were taken from horizontal surfaces above floor level and analyzed for the more abundant chemical constituents. In 2% of the homes, a second dust sample (duplicate) was collected. In 5% of

the homes (randomly chosen), a field blank was collected.

The initial focus was on five phthalate esters [diethyl phthalate (DEP), di(n-butyl) phthalate (DnBP), di(isobutyl) phthalate (DiBP), butylbenzyl phthalate (BBzP), and di(2-ethylhexyl) phthalate (DEHP)] and three polycyclic aromatic hydrocarbons (pyrene, benz[a]anthracene, and benzo[a]pyrene) (Langer et al., 2010). The phthalate esters were targeted based on prior observations of associations between certain phthalates and either asthma or allergic symptoms (Bornehag et al., 2004b; Kolarik et al., 2008). The PAHs were targeted because of the studies that have reported an association between asthma-related symptoms in children and traffic-derived PAHs (Miller et al., 2004; Perera et al., 2009). Subsequently, a number of chemicals responsible for other major peaks in the total ion chromatogram were identified and quantified. These included squalene and cholesterol (Weschler et al., 2011b), as well as nicotine, triphenyl phosphate, nonanal, decanal, 2-(2-butoxyethoxy) ethanol, and butylated hydroxytoluene (BHT).

The temperature, relative humidity, and the concentration of carbon dioxide in the bedrooms of the children were continuously measured during a period of 2–3 days using the equipment mounted by the inspectors during the home inspection.

The carbon dioxide measurements were used to infer ventilation rates (Bekö et al., 2010). We were concerned that after years of focusing on reduced energy consumption, ventilation rates in some buildings might be dangerously low. Low ventilation rates in the bedrooms will result in higher gas-phase

concentrations of volatile pollutants with indoor sources. Low ventilation rates also reduce indoor-to-outdoor transport of airborne particles and prolong the persistence of semivolatile organic compounds such as phthalate esters, brominated flame retardants, and chlorinated pesticides. Finally, low ventilation rates translate to longer residence times for airborne pollutants and more time for chemical reactions to occur among these pollutants. In this study, ventilation rates were calculated from the mass balance of occupant-generated CO₂ concentrations obtained during the periods between 21:00 and 7:00 when the child slept in the room. The occupancy of the bedrooms during each night was recorded by the parents to estimate the CO₂ emission rate during the measurement period. The calculation method used in this study provides an estimate of the total airflow into the bedroom, including airflows from adjacent spaces. As we have not measured the CO₂ concentrations in the adjacent rooms, we assumed in the calculations that the CO₂ concentration in the air coming from adjacent spaces was equal to that in the outside air. For a discussion regarding the possible errors introduced with this procedure, see Bekö et al. (2010).

Two Petri dishes containing different nutrients (V8 and DG18 agar) were placed in the child's bedroom for approx. 1 h during the home inspection. V8 consists mostly of vegetable juice and has a high water activity, which supplied favorable growth conditions for hydrophilic fungi. The DG18 (dichloran glycerol agar) consists of 18% glycerol and has a low water activity. This medium favors hydrophobic fungi. After exposure, the dishes were sealed,

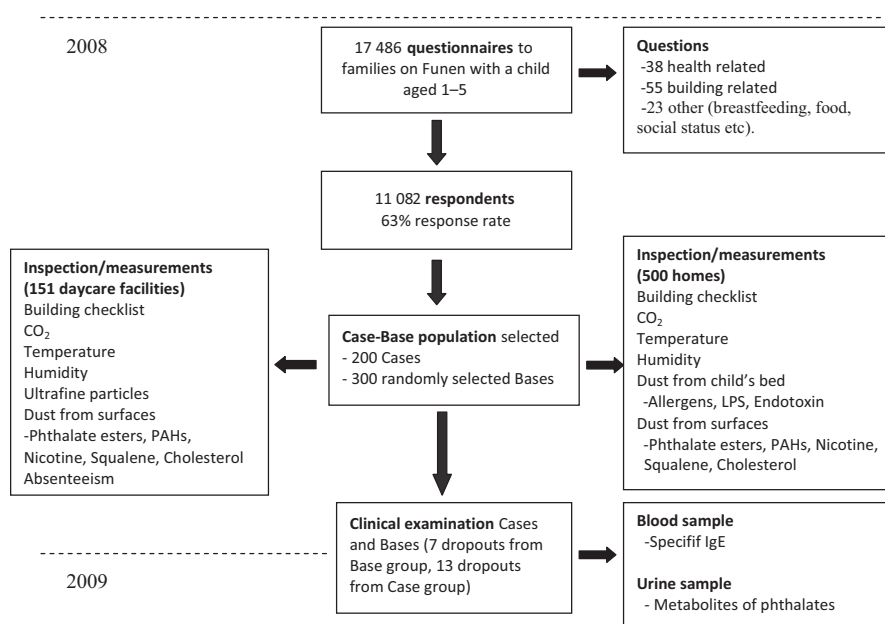


Fig. 1 Flow diagram showing the design of the study

kept under refrigerated conditions, and subsequently analyzed in the laboratory for fungal growth after incubation for 1 week.

Daycare centers

Each daycare center that was attended by one or several of the 500 children was visited by the inspectors who made observations and measurements to characterize the indoor environment. Altogether 151 daycare centers were visited. A building checklist was completed at the site, and dust samples from horizontal surfaces were collected and subsequently analyzed for the same set of chemicals as the samples collected from the children's bedrooms. Microorganisms were collected and analyzed using the same procedure as in the homes. CO₂ concentrations were measured for a minimum of 3 days. In 10 of the 151 daycare centers, the CO₂ concentrations were measured during a whole year to study the seasonal variations. The concentrations of the ultrafine particles were measured on the spot. Independently of, and prior to the commencement of the IECH research program, the Odense municipality initiated recording of absenteeism of the children in daycare centers together with the reason for the child being absent. Continuously updated versions of these data were made available to IECH and enabled analysis of the association between indoor environmental exposures in the home and daycare center and the children's absenteeism.

Clinical health examination

During the period from August to December 2008, the 500 children were called in for a clinical examination at the H.C. Andersen Children's Hospital located in Odense. The visit included an extensive questionnaire-based interview regarding atopic heredity; exposure to pets, tobacco smoke, and other environmental pollutants; and medical history. The same medical doctor conducted all clinical examinations, which included measurements of the child's weight and height, and a blood sample for subsequent IgE measurement (Callesen et al., 2012). The doctor also collected a morning urine sample intended for future analyses of phthalate metabolites (Brive et al., 2012). Specific IgE was measured by ImmunoCAP specific IgE (Phadia, Alleroed, Denmark) for six food allergens, five indoor allergens, and nine outdoor allergens including six molds. The samples were handled by the same medical laboratory technician, centrifuged daily, and stored at -23°C. Collection of urine was standardized by handing written instructions to the families on how and when to collect the urine using the distributed sample kit. The collected urine samples were stored at -23°C and subsequently shipped for analysis.

Results and discussion

In the following, some general characteristics of the study populations and their dwellings are presented.

Stage 1 – questionnaire

Altogether, 11 082 completed questionnaires were received, corresponding to an overall response rate around 63.4%; 9695 families returned the hard copy questionnaire, and 1387 families filled in the questionnaire via the Internet. Some basic characteristics of the study population and their dwellings can be found in Table 1.

To investigate selection bias in the questionnaire study, 316 families among the non-responders were randomly selected for a brief telephone interview. Of these, 225 were reached by telephone, 25 of whom refused to answer any question at all. The other 200 families were asked to respond to five questions selected among the 116 items in the questionnaire. There were no differences in the prevalence of symptoms between responding and non-responding families [wheezing ever $\chi^2(1, n = 11\ 223) = 0.19, P = 0.66$; doctor diagnosed asthma $\chi^2(1, n = 11\ 086) = 1.52, P = 0.22$; eczema ever $\chi^2(1, n = 11\ 032) = 0.12, P = 0.73$]. Nor was there any significant difference between responders and non-responders in the prevalence of suspected mold growth in the dwelling ($\chi^2(1, n = 11\ 154) = 1.36, P = 0.24$). However, the type of dwelling differed between the two groups ($\chi^2(4, n = 11\ 230) = 12.57, P = 0.014$), mostly because the rate of families living in apartments was somewhat higher among the 316 non-responders (16% vs. 9.3%).

Table 2 shows selected characteristics of the residences for the total population of responding families as well as for cases and bases together and separately. Although only 12.9% of homes were built after 1994, approximately one-third of all families have slots in their window frames or diffusers in their walls indicating that there is some awareness of the need for having a means to ventilate the home. To our surprise, a noticeable fraction of families lacked proper exhaust from the kitchen (29%) and bathrooms (43.8%). In contrast to the findings in the Swedish study (Bornehag et al., 2004a), almost no Danish families had PVC flooring in the child's bedroom, but had either lacquered or non-lacquered wooden or parquet floors or wall-to-wall carpets. Figure 2 shows the prevalence of asthma, eczema, and hay fever/rhinitis among the total population ($n = 11\ 082$). As noted earlier, a child was labeled asthmatic if it met one of the several criteria; using this broad classification, 41.6% of the children were labeled asthmatic. A specific question addressed asthma previously diagnosed by a doctor. 11.2% of all families reported this to be the case.

Table 2 Selected residence characteristics for all 11 082 children, for the 498 selected cases and bases, and for the 200 cases and 298 bases separately

Home characteristic	Categories	Whole population (<i>n</i> = 11 082)%	Cases and bases (<i>n</i> = 498) ^a %	Cases (<i>n</i> = 200) %	Bases (<i>n</i> = 298) ^a %
Ventilation in residence	Window slots/wall diffusers	31.8	40.2	39.0	40.9
	Window opening	96.5	97.4	97.5	97.3
	Exhaust hood kitchen	71.0	72.1	69.5	73.8
	Bathroom exhaust	56.2	57.2	54.0	59.4
	Mechanical vent. sys.	4.0	3.6	3.0	4.0
	Other	2.2	1.4	1.0	1.7
Floor covering child's bedroom	Linoleum	0.8	0.2	0	0.3
	PVC	0.9	0.8	2.0	0
	Laquered wood or parquet	28.2	32.9	38.5	29.2
	Non-lacquered wood or parquet	33.4	39.0	35.0	41.6
	Quarry tiles or stone	0.5	0.8	1.0	0.7
	Wall-to-wall carpet	34.8	26.5	24.5	27.9
	Cork	0.2	0.2	0	0.3
	Other	1.7	1.6	2.0	1.3
Renovation owing to moisture or mold	Yes	9.4	11.7	16.2	8.8
	No	86.3	83.2	76.8	87.5
	Don't know	4.3	4.3	7.1	3.7
Visible mold	In home	29.1	33.1	37.2	30.3
	In child's bedroom	5.2	7.0	10	5
Visible moisture	In home	24.7	28.1	34.0	24.2
	In child's bedroom	3.7	4.4	7.5	2.5
Condensation on window pane (>5 cm)	In home	11.1	15.3	20.7	11.7
	In child's bedroom	11.4	16.4	21.5	12.9

^aTwo questionnaires lost during scanning.

Stage 2 – case–base study

Selection of cases was based on parental reports of seven questionnaire items collapsed into three groups, each used to indicate whether a child possibly suffered from asthma, hay fever/rhinitis, or eczema. The case population was recruited for the case–base study from the group of children who

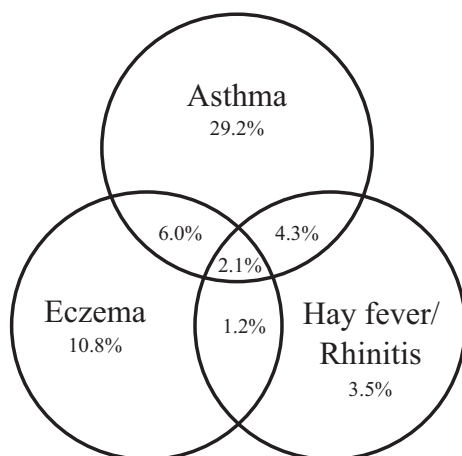


Fig. 2 The prevalence of asthma, eczema, and hay fever/rhinitis among the entire study population (*n* = 11 082). The classification is based on questionnaire data using the ISAAC inclusion criteria. The numbers in the non-overlapping parts of the circles indicate the percentages of children having only one specific disease

reported at least two disease indicators, who were in the age range of 3–5 years, and who lived in or near the city of Odense. As the number of children labeled as cases initially was lower than 200, it was decided to supplement the case group with six randomly selected 2-year old children suffering from the same diseases as the cases. Bases were selected randomly among the total population of children in this age range living in the same area. The younger cases were matched by seven 2-year old children randomly selected for the base group. Some basic characteristics of the case–base population and their dwellings can be found in Table 1. More cases than bases recorded moisture-related problems in their home; they more often had had their home renovated owing to moisture [χ^2 (1, *n* = 469) = 7.05, *P* < 0.008], had visible mold in the child's bedroom [χ^2 (1, *n* = 486) = 4.4, *P* < 0.035], and had visible moisture in the child's bedroom [χ^2 (1, *n* = 484) = 7.30, *P* < 0.007] or condensation (> 5 cm) on the window [χ^2 (1, *n* = 314) = 5.4, *P* = 0.021].

The daycare centers were built between 1865 and 2002, with 38% built between 1970 and 1980. Eighty-seven percent of the daycares were traditional Danish brick buildings; 40% of the buildings had a flat roof; 57% of the buildings had mechanical exhaust; and 34% had balanced ventilation. Forty-nine percent of the daycare centers had experienced water damage in the last 3 years prior to the inspection. A summary of the measurements taken and of the occupant density and absence rate is presented in Table 3.

Table 3 Distribution of measurements taken and of the occupant densities and absence rates in the 151 daycare centers

	Percentiles				
	5%	25%	50%	75%	95%
CO ₂ , average (ppm)	534	617	724	890	1214
CO ₂ , 20 min max (ppm)	989	1329	1733	2290	3013
Temperature _{average} (°C)	20	21	22	23	25
Temperature _{20 min max} (°C)	22	24	26	28	31
Relative humidity _{average} (%)	28	33	38	44	48
Ultrafine particles _{average} (number/cm ³)	2260	4306	6423	11 239	36 407
Fungi _{total} V8 (colony forming units)	2	5	10	23	129
Fungi _{total} DG18 (colony forming units)	1	5	11	22	125
Occupant density (person/m ²)	0.055	0.104	0.126	0.150	0.203
Absence (days/child/opening day)	0.017	0.026	0.032	0.039	0.056

Comparison between the questionnaire and case–base population

While the questionnaire survey covered the entire Island of Funen (an area of 2984 km²), the vast majority of children in the case–base investigation were located in or near the main city of Odense (area 304 km²). This is reflected in the type and location of their dwellings; more families in the case–base investigation reported living in apartments in a city or suburb compared with the responses in the general questionnaire survey. To compare demographic data between the two groups, data from the questionnaire survey completed for all children in the age range of 3–

5 years, corresponding to the age range of the case–base group, have been included in the table. Table 2 indicates a difference in the prevalence of window slots and wall diffusers between the whole population and the cases/bases, which possibly can be ascribed to differences in the distribution of type and location of the residences.

Conclusions

The aim of the current study has been to outline the methods used for data collection within the IECH research program. The acquired data are relevant to the children's environmental exposures and health status. The initial findings presented herein describe the study population and characteristics of their dwellings and daycare centers. The next step in the ongoing analyses will be to examine the potential associations between these parameters and various health endpoints as reported by parents and determined from the clinical examinations.

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