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Identifying potentially unhealthy housing conditions in Rosengård – a cross-sectional study in immigrant households with small children in Sweden

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Abstract

The social determinants of health form a complex and dynamic web, shaping both population and individual health and disease. The built environment and especially human dwellings influence health in many ways. Associations between factors such as dampness, mould growth, heating/insulation, and crowding on the one hand and respiratory health and infectious diseases on the other hand have been studied in several populations.

In Sweden, social and health inequalities have slowly been increasing. The linkages between them have however not been characterized in detail. In this cross-sectional study, the apartments of families of children with respiratory symptoms living in a socially disadvantaged immigrant neighbourhood in Malmö, in which the incidence of bad housing was known to be high, were assessed for potentially harmful housing-related exposures. This information was correlated with subjective questionnaire-based assessments of dampness and mould in the apartments.

While agreement between objective and subjective assessments was generally only fair, the questions performed better at excluding relevant exposures. The utility of screening questions related to housing is related to the prevalence of the exposure in the population and to the default plan of action. A case is made for interdisciplinary home visits to be the default option in families of children with respiratory symptoms.

The overall prevalence of other contributory factors that are potentially harmful to health was high in this population; potentially protective factors were distributed unevenly as well. Factors related to the built environment cannot and should not be seen in isolation, as they often co-vary with other social determinants of health. Housing is however an important pathway along which social inequalities translate into health inequalities.

In order to sustainably address health inequalities rooted in complex webs of social, economic, and behavioural determinants, the health system needs to move beyond interdisciplinary towards intersectoral cooperation.

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List of Abbreviations

ETS – Environmental Tobacco Smoke

IQR – Inter-Quartile Range

NME – Near & Middle East

PHC – Primary Healthcare Centre

SD – Standard Deviation

1. Introduction

1.1 Social determinants of health

The concept of social determinants of health (CSDH, 2008) allows for framing both individual and population health in a wider system of mutually dependent forces, which act in multiple layers and on different outcomes. The social ecological model (Stokols, 1996) describes these dynamic relationships between individuals, groups, and the environment, where the latter is seen as the totality of physical, social, and cultural factors.

The distribution of social determinants in populations usually follows socio-economic gradients, increasing the complexity of the web of causality through different pathways and exposures which often co-vary across populations. A "life-course perspective", where risk and protection factors accumulate over the course of a person's life (Weitoft et al., 2008), as well as a community-health approach, as opposed to the medical model of individual pathology (Burridge and Ormandy, 1993), are helpful when trying to disentangle this situation.

The "rainbow model" is a useful visualization of many of these relationships, and Figure 1 shows an adaptation of this with special regard to the built environment.

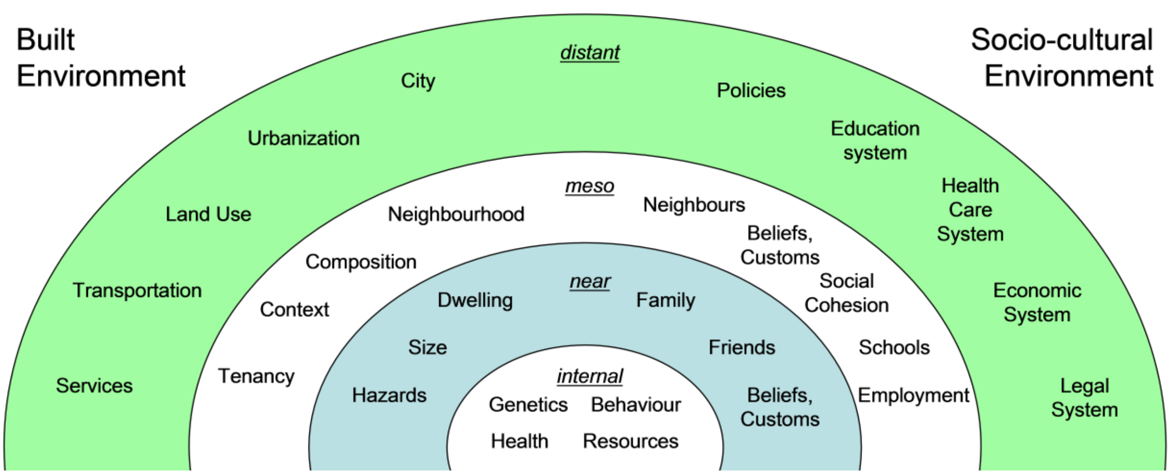


Figure 1 Levels of the socio-cultural and built environment as an illustration of the systemic social ecological model (adapted from Dahlgren and Whitehead, 1991; Northridge et al., 2003)

1.2 Housing as a social determinant of health

The built environment and especially human dwellings have long been identified as important social determinants of health on many levels (Robertson, 1919). Individual apartment characteristics, neighbourhood characteristics, and social-structural factors such as urbanization are influenced by social, cultural, behavioural, economic, and environmental parameters (Rauh et al., 2008). The relationship between these factors and health is strongly determined and influenced for example by household income, educational level, ethnicity/migrant status, and tenure type (rented vs. owner-occupier) (Braubach and Fairburn, 2010; Breysse et al., 2004; Gibson et al., 2011; Jacobs, 2011; Thomson et al., 2009; WHO, 2012). In addition, susceptibility to negative health outcomes and resilience (via such pathways as social capital (Lindström et al., 2004) and healthcare accessibility) are also unevenly distributed in the population, which together with the inequitable exposure places both individual and population health squarely in the social context (CSDH, 2008; Rauh et al., 2008).

Humans in high-income countries spend large amounts of their time indoors. This is especially true for young children, who spend most of their day in the family home or alternatively in day-care centres. It is therefore not surprising that exposures connected to the indoor environment have increasingly been acknowledged to play an important role in determining individual and community health outcomes (Stewart and Rhoden, 2006; WHO, 2011). In fact, one of the roots of Public Health lies in the "sanitary movement" in the second half of the 19th century following the realization that the abominable living conditions faced by the poor working class in England were highly injurious to their health and economic productivity, leading to state-sanctioned interventions proposing sanitation, fresh air, and less crowded living quarters (Burridge and Ormandy, 1993; Robertson, 1919; WHO, 2012).

1.3 Harmful exposures in the home environment

Potentially harmful exposures in the home environment that have been studied extensively include: dampness and mould growth; indoor air quality with factors such as environmental tobacco smoke (ETS), chemicals (lead, formaldehyde, phthalates, etc.), and ventilation; overcrowding and noise; heating and insulation; and injury hazards. The contribution of these factors depends very much on broader environmental, climatic, geographical, and cultural determinants.

1.3.1 Dampness and mould

Numerous studies and meta-analyses have explored the influence of dampness in buildings on health outcomes (Bornehag et al., 2004; Fisk et al., 2010; Mendell et al., 2011; Tischer et al., 2011). Exact pathways are difficult to delineate, but several proposed pathways have been discussed. It is well known that increased environmental humidity improves the living conditions for moulds, bacteria, and insects such as dust-mites and cockroaches, all of which can contribute to negative health outcomes via antigen production and sensitization and via metabolic products such as 1,3-beta-glucans or endotoxins. Additionally, dampness and structural water intrusion can affect and damage building materials and lead to off-gassing of chemicals (formaldehydes, phthalates) into indoor air. Overall, the cumulative weight of the evidence suggests that there are causal associations between indoor dampness and negative health outcomes (Institute of Medicine (U.S.), 2004; WHO, 2011).

Mould growth is associated strongly with indoor dampness, and is a ubiquitous problem in human dwellings. Numerous studies suggest associations and causal links between indoor mould exposure and multiple negative health outcomes (Antova et al., 2008; Bush et al., 2006; Tischer et al., 2011). Associations are especially strong for respiratory diseases such as asthma, and respiratory symptoms, such as wheezing (Fisk et al., 2010; Karvonen et al., 2009; Reponen et al., 2011). A methodological issue in common with dampness is the question of exposure assessment (Hägerhed Engman et al., 2007; Larsson et al., 2011). Self-reported assessment in questionnaires or interviews captures a longer time period, but can be biased in multiple ways. Expert assessment, on the other hand, usually provides just one snapshot of the exposure. Technical assessments such as dust collection with antigen testing, culture from dust or air samples, or measurement of metabolic products such as 1,3-beta-glucans suffer from similar issues of time-sensitivity.

1.3.2 Indoor air quality

The main determinant of indoor air quality on a population basis is still environmental tobacco smoke (ETS) (WHO, 2011). Exposure to ETS in the home environment has been associated with an increased incidence of wheezing, rhinitis, and bronchodilator therapy (Johansson et al., 2008) as well as physician-diagnosed asthma in children (Lannerö et al., 2006), and may play a role in facilitating sensitisation to indoor aero-allergens (Lannerö et al., 2008).

1.3.3 Overcrowding

Overcrowding as a classic social determinant has many different aspects of importance to health (Maani et al., 2006). Measures of crowding usually take into account the number of regular inhabitants and either the number of bedrooms or the floor space of a dwelling, and define an arbitrary threshold. Cultural differences need to be taken into account when considering what density or composition of inhabitants may be considered appropriate or not. Functional crowding can occur in the context of fuel poverty, when a family can afford to heat only one bedroom in winter and everyone is crowded together, while other bedrooms may not be used. Overcrowding is associated with the spread of infectious diseases (Jaine et al., 2011; WHO, 2011); other negative physical and mental health effects are thought to be mediated via behavioural factors of the occupants (increased moisture etc.) and stress due to noise and lack of privacy.

All of the above exposures are distributed unevenly in society. In general, families with lower socioeconomic status, lower education, lower social capital, and minority backgrounds tend to live in housing of lower quality and in neighbourhoods where such housing is concentrated. Social exclusion prevents them from accessing higher quality housing in better neighbourhoods, unless specific programs are targeted at improving mobility. Harmful housing factors are therefore a major pathway along which social inequality leads to health inequality (Northridge et al., 2003).

1.4 Childhood asthma and housing

From the list of harmful exposures related to the home environment, it is quite apparent that one of the strongest health associations and prime concerns must be respiratory health, especially of children. Not only is their exposure usually higher in terms of time spent indoors in the family home or in childcare institutions, but they are also more susceptible. Children have a different physiology from adults, e.g. proportionally much higher respiratory rates per weight; their behaviour differs (more time spent on the floor; placing objects in mouth etc.); their immune system is less mature; their metabolic capacities are less developed; and they have fewer opportunities to actively influence their environment if and when harmful exposures are perceived (Perera et al., 2006).

For several decades, the global incidence and prevalence of asthma have been rising (Lai et al., 2009; Pearce et al., 2007). While the rate of increase in high-income countries seems to be levelling off slowly, rates are rising faster in low- and middle-income countries (Pearce et al., 2007). In the complex interaction of genetics, environment, and lifestyle, two important explanatory pathways are the rising exposure to environmental toxicants (Perera et al., 2006) and the "hygiene hypothesis" (Liu, 2007). Breastfeeding, especially exclusive breastfeeding for more than 4 months, has been identified as an important protective factor against the development of childhood asthma (Kull et al., 2010; Silvers et al., 2012). Diagnostic challenges, especially in very young children, sometimes make it more appropriate to speak of "obstructive-type" airway symptoms, without committing to a definite diagnosis. Wheezing in younger children is often an epi-phenomenon of respiratory infections, while in older children, wheezing is more often associated with asthma.

Childhood asthma is a classic condition with significant social and economic influences on both prevalence and disease impact (Almqvist et al., 2005; Cope et al., 2008; Currie, 2009). As one of many pathways, the associations between harmful housing conditions and the development and symptoms of childhood asthma have been shown beyond reasonable doubt (Bornehag et al., 2004; Heinrich, 2011; Holt et al., 2013; Institute of Medicine (U.S.), 2004; WHO, 2011). Equally convincing is the evidence that well-targeted, multi-trigger, multi-modal, community-based interventions with educational components have the biggest potential to reduce negative health impacts, which are not limited to asthma (Bryant-Stephens et al., 2009; Crocker et al., 2011; Dixon et al., 2009; Howden-Chapman et al., 2008; Jackson et al., 2011; Kercsmar et al., 2006; Krieger, 2010; Morgan et al., 2004; Sandel et al., 2004; WHO, 2011). A question that remains to be answered is how to best target interventions: community-wide, neighbourhood-wide, or individually? And if the latter, where and how should potential candidates be identified?

1.5 The situation in Sweden

Sweden has undergone momentous changes in many social areas since World War 2. There have been significant shifts in its demographic composition, with currently 15% of the population having been born outside of Sweden. Healthcare is delivered in a socialized system; residence in Sweden leads to automatic enrolment. Child healthcare for all children is the responsibility of specialized Child Health Centres (CHC), or Barnvårdscentralen (BVC), which are often co-located with primary healthcare centres. Scheduled visits at certain ages for immunizations and developmental assessments are supplemented by home visits and parental education groups. The uptake is generally high across socio-demographic strata, although it has been noted that the stated goal of increased attention to low-income, high-risk families is not always reached (Wallby and Hjern, 2011).

Sweden in general and Malmö in particular show distinct inequalities in children's health along social and ethnic gradients (Köhler, 2012). Children with a foreign background (either born outside of Sweden or both parents born outside of Sweden) have a five times higher risk of living in an economically disadvantaged household compared to Swedish children (Salonen, 2012). Malmö holds the dubious position of the Swedish municipality with the highest rate of child poverty: 33% of all children live in economically disadvantaged households (Salonen, 2012).

A housing crisis in the 1960s led to the implementation of the "Million Programme" (Miljonprogrammet), during which 100,000 homes were built every year between 1965 and 1974, resulting in a net increase of 650,000 units (Borgegård and Kemeny, 2004). The newly built apartments and areas were in no way uniform in quality, form or location. New production methods (e.g. standardization, prefabrication) and materials were necessary to achieve the large number of new buildings while structural quality and technical equipment were sometimes compromised in order to achieve the targets set by the state (Sundin and Willner, 2007). The types of dwellings include single family homes, small apartment blocks and larger multi-storey buildings, some in city areas where prior buildings had been demolished, some of the latter in outer areas such as Rinkeby in Stockholm and Rosengård in Malmö, which then dominated the public perception of these areas, similar to other countries (e.g. the Banlieue in France, the Projects in the UK and the US). From the very beginning, a process of social (and ethnic) segregation set in, both from the areas towards other locations as well as within the areas (Hall and Vidén, 2005; Sundin and Willner, 2007).

1.6 Slums in Sweden?

The city district of Rosengård in Malmö is one of the largest continuous areas built during the Miljonprogrammet. It is separated into several distinct parts and contains mainly apartment blocks with 3 to 9 storeys, with a smaller number of single-family homes on the periphery (see map in Appendix B). Selected population statistics for Malmö, Rosengård, and Herrgården as well as Örtagården (the neighbourhoods within Rosengård of particular interest for this study) are summarized in Table 1.

Table 1 Populations statistics for Malmö, Rosengård, Herrgården, and Örtagården (Malmö Stadskontor, 2008)

2008	Malmö	Rosengård	Herrgården	Örtagården
Inhabitants, *n*	280,801	21,904	4,878	4,702
Households, *n*	138,152	7,607	1,360	1,405
$1^{st}/2^{nd}$ generation immigrants, %	37	86	96	92
Under 16 years old, %	17	28	40	36

The number of first and second generation immigrants in the population is high, with Iraq and other Arabic countries in the near and middle East, the Balkans (former Yugoslavia, Albania), Afghanistan, and Somalia the dominant countries of origin. The proportion of children who live in poverty is 62%, and 96.5% of all children have a foreign background, which makes Rosengård the city district with the highest rates for both in Sweden (Salonen, 2012).

Previous investigations have revealed that a large number of households have a high number of children, yet these families inhabit apartments with three rooms plus kitchen and bathroom, originally designed for the "average" Swedish family of two adults and two children. The neighbourhood of Herrgården was originally planned for roughly 3,000 inhabitants, has an official population of almost 5,000, but according to estimates as many as 8,000 persons could actually be living there. Overcrowding is thus a widespread phenomenon in this part of the city (Albin et al., 2012). Fluctuation within and in and out of this area is high – it has been estimated that the entire population of just under 25,000 people in Rosengård is theoretically exchanged once every five years (Malmö Stad, n.d.).

Within Rosengård, there are marked differences in the quality and desirability of neighbourhoods and buildings. Particularly, in one part of Herrgården, a large number of apartment buildings in a single street had gone through the hands of a number of private investors, who seriously neglected upkeep and renovation of these buildings (Lind and Blomé, 2012). The quality of the buildings deteriorated over many years, and in November 2008 the attention of the public was focused by the investigative television program Uppdrag Granskning (www.svt.se/ug) depicting hitherto unimaginable squalor and decrepitude on the margin of Swedish society, with overcrowded, damp apartments covered in mould, infested by cockroaches and other vermin, non-functioning toilets, bathrooms and other facilities, etc.

A public outcry led to the involvement of the Environmental Department (Miljöförvaltningen) in November 2008, on the basis of laws and regulations stipulating that owners are responsible for preventing or remedying conditions in apartments that can negatively affect human health. Over the following two months, all apartments were inspected by building engineers. At the end of the litigation that followed, the owner was ordered to renovate all affected apartments (n=867) in the area. Other areas in Rosengård, some of them just one street away such as the neighbourhood of Örtagården, had had appropriate upkeep of buildings and did not suffer from the described exposures in such a widespread way.

1.7 Rationale for the study

Anecdotal evidence from health workers in Rosengård had suggested that children from the affected area were overrepresented in terms of respiratory diseases and healthcare use. Child health is considered to be of paramount importance for a society and must be understood in terms of its social, economic, and environmental determinants. The unexpected presence of widespread and significant harmful exposures related to the built environment in Rosengård was seen as a chance to study the problem in a sort of natural experiment.

A detailed description of the underlying study is available in Appendix A. In summary, the Division of Occupational and Environmental Medicine of Lund University, Sweden, carried out a study with the aim to research the effects which renovations in the apartments would have on respiratory and other health outcomes of children and families. Originally, only children from the intervention area (Herrgården) and a control area (Örtagården) which already had had healthcare contacts for respiratory problems, as well as their siblings, were recruited, but the sampling frame was later expanded (see Appendix A). As further discussed in the section on methodology below, it is important to carefully consider which kinds of questions can be asked at the various stages of the underlying study. This thesis is concerned only with data collected before renovations were carried out.

1.8 Research questions

The thesis presented here starts with the argument that (as discussed above) it is already known from the literature that certain factors connected to the built environment are related to health outcomes, and that in particular the relation between housing factors, such as dampness and mould, and respiratory health in children is clearly established. What is also known is that certain interventions to reduce harmful housing exposures can have a beneficial effect on health outcomes.

A gap in the current knowledge is how the underlying social inequalities are distributed in the Swedish context and what characterizes their relation to child health inequalities. Better knowledge about this context would help in understanding how to best link the children, the exposures, the interventions, and the outcomes together. Another way to describe the question would be: what is the best way to identify the children which would benefit most from interventions to reduce exposure to harmful housing conditions? Or, in other words: who should be screened, where, and when, and how?

The part of the study that forms this thesis was therefore conceptualized with the following research questions and aims in mind:
First part (primary analysis):

- Which items from the list of known potentially harmful housing characteristics can be explored as questions to be asked of the parents of children with respiratory health problems?
- What is the agreement between subjective reports of these exposures and objective assessments carried out during home visits by health communicators?

Second part (context analysis):

- Apart from factors related to the built environment, what is the distribution of other important determinants (both protective and harmful) of health in this population?
- How can the information gathered in this study be applied in the clinical context?

2. Methods and Materials

2.1 Study area

Data was collected from households in two areas in the city district of Rosengård/Malmö. The intervention area was defined as the apartment blocks in a particular street (Ramels väg 1-21 and 45-147) in Herrgården that were owned privately by an investment company that had systematically neglected their upkeep over many years. As described above, following an intervention by the Environmental Department (Miljöförvaltningen) substantial renovations were scheduled to take place in order to remedy the structural damage. The control area was defined as a number of apartment blocks in Örtagården (the neighbourhood adjacent to Herrgården), which were owned by MKB, the municipal housing company, and where such renovations were not necessary or planned. However, the housing stock and the demographic composition were generally similar. These apartment blocks (in Bennets väg, Hårds väg, Cronmans väg, and von Rosens väg, see map in Appendix B) were individually chosen by investigators familiar with the area and its inhabitants. The available background statistical data was already shown in Table 1.

2.2 Recruitment pathways

Recruitment of study participants was possible through several pathways. In early 2010, electronic patient registries going back to 2007 at the two local primary healthcare centres (PHC) serving the intervention and control areas were searched for all children between the ages of 0 and 13 years (cut-off date May 1st, 2010) with diagnoses of asthma or other respiratory diseases, that were living in the defined intervention and control areas at the time of the documented healthcare contact. The specialized asthma nurses' records were also checked, as were the enrolment lists of "asthma schools" (information sessions for families with asthmatic children) that had been held at the PHC. This identification of candidate children was carried out by the same team of investigators in both PHC with similar procedures.

All families with children on the candidate list then received written invitations from the researchers and the PHCs to participate in the study. It was explained that the study would entail a home visit, and that data would be collected on the index children (regardless of whether or not they were symptomatic at the time of the home visit) and their siblings between 0 and 13 years, and also on other family members. If no replies to the written invitations were received, the investigators attempted to contact the families by phone.

As mentioned above, the sampling frame was expanded during the study to increase enrolment, and children were identified from class-lists obtained from the local schools (see also Appendix A). All families of these children received written invitations to participate in the study. Enrolment via this pathway was not related to health parameters, and only children of school-age were identified. However, during the home visits all children between the ages of 0 and 13 living in the household were enrolled for the study. A flowchart of the enrolment pathways is shown in Figure 2.

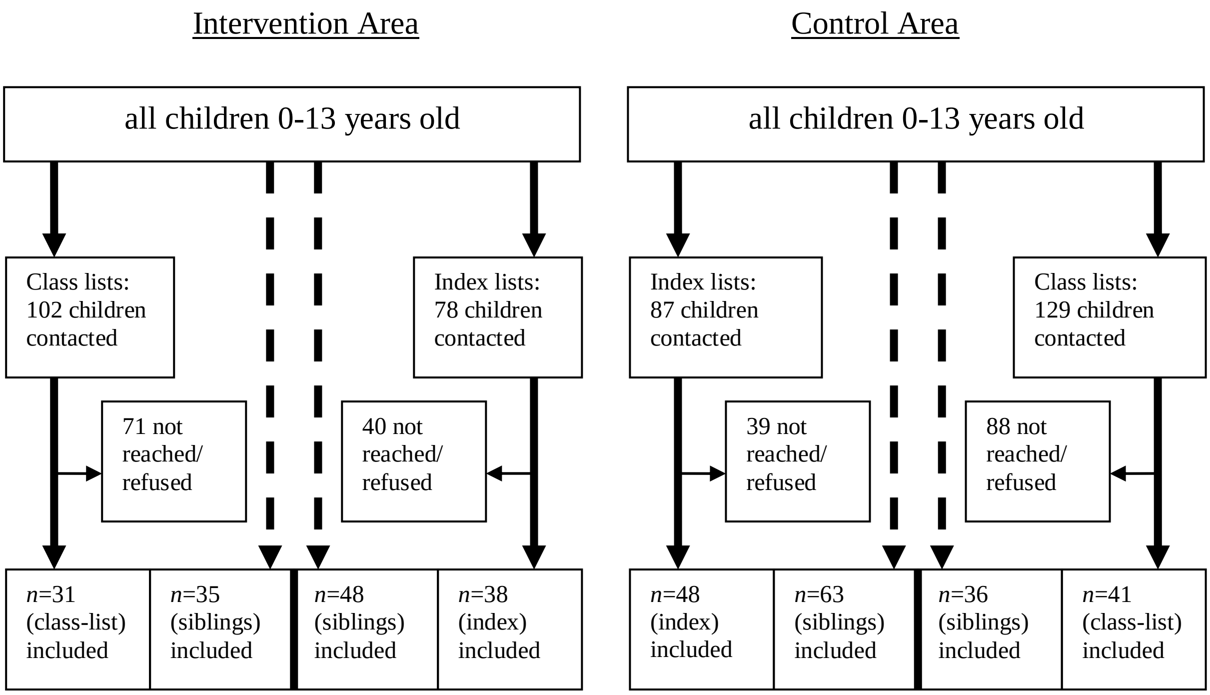


Figure 2 Flowchart of participating children entering the study (total *n*=340 children: 86 index children, 111 siblings of index children, 72 class-list children, and 71 siblings of class-list children)

2.3 Data collection

If families chose to participate, a home visit was scheduled during which health communicators fluent in the family's native language visited the apartment. Training of these health communicators was organized jointly, and visits were undertaken by relatively stable pairs of communicators. All visits were carried out between 27.05.2010 and 29.05.2011.

Information was primarily collected on all children between the ages of 0 and 13 years of age who lived in these apartments, but when possible, a minimum demographic dataset on all other inhabitants was also obtained. While the data on children between 0 and 13 years forms the base of this study, data on older siblings, parents, and other persons living in the household was collected in order to inform the analysis of exposures in the home environment (crowding, ETS, etc.).

At the start of the home visit, informed written consent (in the native language of the family) for participation in the study was sought from the parents. Ethical approval for the study was granted by the Regional Ethical Review Board through Lund University (Registration number 2010/212).

The scheduled home visits for all families were used to complete several questionnaires that were discussed with the parents and filled out by the health communicators. Translations for all questionnaires to the preferred family language were available for the parents to look at, but the filled-out versions that were collected were all in Swedish.

2.3.1 Questionnaire 1 (Demographic information, physical apartment characteristics, subjective exposure assessment, and information about lifestyles and behaviours)

The items of major interest for the primary analysis were the subjective observations of the family about exposures related to the built environment. Families were asked whether they had noticed any visible signs of moisture damage, any visible mould growth, or any discernible mould odour in their apartment over the last three months.

The first questionnaire then included demographic information about all inhabitants of the apartment (family members and others), namely age, sex, status in the family, and place of birth as well as further questions on health, socio-economic status, and duration of residence. Further items dealt with lifestyles and behaviours: smoking habits of occupants, indoor smoking, use of waterpipes or incense, presence of pets, and presence of pests such as cockroaches. Lastly, the size of the apartment (number of rooms excluding bathroom and kitchen) together with the number of inhabitants and their demographic information was used to calculate the crowding index for the household. The Swedish formula (www.scb.se) calculates the number of inhabitants divided by the number of bedrooms in the apartment (total number of rooms minus the kitchen and minus one living room). More than two inhabitants per bedroom define a crowded household.

2.3.2 Questionnaire 2 (Health information for children)

The second questionnaire was available in two versions, for children 0-2 years of age and children 2-13 years of age. One questionnaire was completed for each child in that range that lived in the apartment. The main focus of these questionnaires was on respiratory, allergic, and dermal symptoms, using questions from the Children´s Environmental Health Survey in 2003 (Sverige Socialstyrelsen et al., 2005). The mothers were also asked about duration of exclusive and total breastfeeding for all children.

2.3.3 Visual assessment (assessment of exposure in the home environment)

A standardized visual assessment of multiple areas of all homes was carried out at the time of the home visit by the health communicators, who had undergone training in home assessment. This information was of importance for the primary analysis of this thesis, in which subjective and objective assessment were compared. Documented in the form of a checklist, the assessment scored the extent of moisture damages, visible mould, and mouldy odour in all rooms to which access was granted.

2.4 Data sets for analysis

The primary analysis for the purposes of this thesis involves data gathered from the families of index children. In the second part of the thesis, a summarizing description of the situation in Rosengård is carried out utilizing the full data set of index children, class-list children, their respective siblings, and other household members.

2.5 Analytical framework

The underlying study in its original design had been conceptualized as a prospective intervention study looking at the effect of renovations on respiratory health in vulnerable children, relying on data collected at two separate points in time. The analysis presented in this thesis incorporates only the data from before the intervention, representing a cross-sectional approach. Children for the underlying study were selected on the basis of either: a) having had a health care contact for a respiratory problem (index children); b) residence, in a random fashion and without relation to health (class-list children); or c) being a sibling of either an index- or a class-list child, presumably sharing numerous exposure and contributory factors by living in the same household.

It is apparent that these selection criteria preclude an analysis of causality between housing factors and health outcomes, both for comparisons between intervention and control area (due to their heterogenous distribution of exposures) and between index families and class-list families. Rather, this question will be addressed once the post-renovation data has been analysed and put in relation with the data presented here, at which point in time the results of the underlying study will be reported.

The primary analysis revolves around the agreement between subjective and objective assessment of housing variables. Answers to the subjective assessment can be imagined as screening questions that parents of symptomatic children are asked in the PHC, where positive answers would trigger the organization of a home visit. If only this were the case, the number of true positives and false positives could be determined, which would yield information about the specificity of the test (proportion of true positives among all positives). Through the study design, where all households are assessed, regardless of their answers, we can also determine the sensitivity of the test (proportion of true negatives among all negatives). These analyses will inform the discussion around the clinical utility of the questions.

2.6 Statistical analysis

Descriptive data analysis includes frequencies for categorical data and means, medians, ranges, and standard deviations for numerical data. Cross-tabulation was performed for categorical data, with chi-squared tests (and Fisher's exact test where appropriate) for comparisons. Where appropriate, numerical data were compared between groups with independent t-tests or one-way ANOVA. A p-value of less than 0.05 was considered significant. When p-values exceeded 0.200, they were reported as >0.200. Agreement between subjective and objective assessments was analyzed with Cohen's kappa as well as observed proportional agreement and proportional agreements in positive and negative cases, respectively (Cicchetti and Feinstein, 1990). All statistical analyses were performed with IBM SPSS Statistics Version 20.0 (IBM Corporation, Armonk (NY), USA), except proportional agreement measures, which were calculated by hand.

3. Results

3.1 Source population and study population – primary analysis

Population statistics for Malmö show that in 2008, the number of apartment units was 1,360 in Herrgården and 1,405 in Örtagården (Malmö Stadskontor, 2008). The number of apartments in Herrgården that were owned by the investment company and that were the subject of the investigation by the Environmental Department was 867. The official number of inhabitants in Herrgården and Örtagården was approximately 9,500, of which 3,700 were children between the ages of 0 and 16. The number of children between 0 and 13 years at the time of the study was estimated to be at least 3,000.

The list of children with health care contacts due to respiratory illness from the two PHC in the area included 165 children: 78 children (from 64 families) which lived in the intervention area and 87 (from 80 families) in the control area. Sixty percent of the children were boys, the mean age was 4.9 ± 3.3 years (range 0.34 – 12.87); mean age was comparable between the genders. There were no differences between the intervention and control area with regard to gender distribution and mean age.

The available demographic data showed that the children with health care contacts that participated in the study (n=86) were of comparable age to the children which could not be reached or whose families declined to participate in the study (n=79). The proportions of boys and girls were almost identical. No other data on ethnic background, socioeconomic status, etc., was available for the non-participating children.

3.1.1 Individual level

The primary analysis is concerned with the index children and the subjective and objective assessments of potentially harmful exposures related to the apartments they were living in. Overall, 86 index children were enrolled. Mean ages and proportions amongst the genders were comparable, as can be seen in Table 2. Only one index child had been born outside of Sweden.

Table 2 Age and gender of index children, by area of residence

	Intervention area *n* = 38	Control area *n* = 48
Mean age (+/- SD) (years)	5.1 (2.8)	5.3 (3.7)
Sex (male), %	61	63

Of the 86 index children, 24 were from Lebanese families, 22 from Iraqi families, 15 from Somali families, 11 from other Near and Middle East families, 7 from families from Ex-Yugoslavia, and 7 from other families. In the intervention area, most index children were from Iraqi families, while in the control area, the most common ethnic background was Lebanese.

The enrolment of index children was dependent on the children having had a health care contact in the past in relation to a respiratory illness or symptoms. This information was available for all 86 index children. The majority of children had "asthma" as their diagnosis (n=56; 21 of which in the intervention area, and 35 of which in the control area). An additional 8 children had "infection-triggered asthma" as diagnosis, while for 5 children the diagnosis was "asthmatic or obstructive bronchitis". Finally, in 17 children the diagnosis had been "acute bronchitis". It was noted that the diagnostic codes depended very much on the primary health care centre in which the children had been seen: while asthma was diagnosed in both, "infection-triggered asthma" and "asthmatic or obstructive bronchitis" were diagnosed exclusively in the PHC serving the control area, while "acute bronchitis" was diagnosed exclusively in the PHC serving the intervention area.

In view of these differences and the inherent diagnostic uncertainty regarding childhood asthma, it may be more appropriate to summarize these health care contacts as indicating obstructive-type respiratory symptoms that were severe enough to seek attention in the health care centre, rather than assuming a specific diagnosis implying a disease aetiology or phenotype.

3.1.2 Household level

In total, 70 families with one or more index children were enrolled, 30 of which lived in the intervention area and 40 in the control area. Six families in the intervention area and six families in the control area each had two index children, and one family each in the intervention and control area had three index children.

3.1.2.1 Self-reported exposures

Self-reports about exposures in their apartments were available from all families with index children. According to the health communicators, the questions were generally well understood and parents could give clear answers. The proportions of positive individual answers regarding moisture damage, visible mould growth, and mould odour in the apartment were generally high. When combined (any or all of the three components), two out of three families had positive answers. Proportions were numerically higher in the intervention than in the control area. The difference reached statistical significance for mould growth and the combined variable (Table 3). When stratifying the analysis in the form of a crude severity measure (one exposure vs. two vs. all three exposures), there was a trend for a higher proportion of the households in the intervention area reporting multiple exposures in combination.

Table 3 Self-reported exposures by household for index families (% positive answers); p-value (2-sided significance) for comparison between intervention and control area, derived from chi-squared test (Fisher's exact test); * denotes statistical significance

	Intervention area (*n*=30)	Control area (*n*=40)	p-value
Visible moisture damage (A), *n* (%)	19 (66)	16 (41)	0.054
Visible mould growth (B), *n* (%)	18 (60)	9 (23)	0.003*
Mould odour (C), *n* (%)	16 (55)	14 (35)	0.140
A or B or C, *n* (%)	8 (27)	11 (28)	> 0.200
A+B or A+C or B+C, *n* (%)	6 (20)	5 (13)	> 0.200
A+B+C, *n* (%)	11 (37)	6 (15)	0.050
Combined (any of the above), *n* (%)	25 (83)	22 (55)	0.020*

3.1.2.2 Objective assessment during home visit (Checklist)

During the home visits, health communicators asked the families for permission to inspect all rooms in the apartment for visible signs of dampness or mould and for mould odour. The overall incidence must be described as high. As expected in terms of the selection criteria, there were significant differences between the intervention and control area in the proportions of apartments with any dampness visible, any mould growth visible, any smell of mould, and a combined variable (any or all of the above). The results of these objective assessments for the index families are shown in Table 4.

Table 4 Objectively assessed exposures by household for index families (% positive of valid answers); p-value (2-sided significance) for comparison of intervention and control area, derived from chi-squared test (Fisher's exact test); * denotes statistical significance

	Intervention area (n=30)	Control area (n=40)	p-value
Kitchen – dampness, *n* (%)	7 (23)	6 (15)	> 0.200
Kitchen – mould, *n* (%)	6 (20)	5 (13)	> 0.200
Kitchen – odour, *n* (%)	6 (20)	3 (8)	0.158
Bathroom – dampness, *n* (%)	9 (32)	6 (15)	0.140
Bathroom – mould, *n* (%)	5 (18)	2 (5)	0.115
Bathroom – odour, *n* (%)	5 (18)	6 (15)	> 0.200
Toilet – dampness, *n* (%)	7 (26)	2 (7)	0.142
Toilet – mould, *n* (%)	4 (15)	1 (4)	> 0.200
Toilet – odour, *n* (%)	7 (26)	2 (7)	0.142
Any bedroom – dampness, *n* (%)	6 (20)	7 (18)	> 0.200
Any bedroom – mould, *n* (%)	3 (10)	3 (8)	> 0.200
Any bedroom – odour, *n* (%)	4 (13)	3 (8)	> 0.200
Anywhere in apt. – dampness, *n* (%)	19 (63)	11 (28)	0.004*
Anywhere in apt. – mould, *n* (%)	14 (47)	6 (15)	0.007*
Anywhere in apt. – odour, *n* (%)	15 (50)	10 (25)	0.044*
Combined variable (any of the above) , *n* (%)	23 (77)	16 (40)	0.003*

3.1.2.3 Agreement between subjective and objective assessments of household exposure

Testing the relationship between subjective (questionnaire) and objective (home visit) assessments of dampness, mould growth, and mould odour per household revealed generally poor to fair levels of agreement, when considering Cohen's kappa only (all results summarized in Table 7 a on page 29).

For dampness, 56% of evaluations agreed, with Cohen's kappa of 0.121. For mould growth and mould odour, agreement was reached in 70% and 65%, respectively, and Cohen's kappa was 0.237 and 0.097, respectively. For the combined variables (any subjective vs. any objective exposure), which more closely resemble a clinical screening situation where any mention of subjective exposure would trigger a home visit, and any objective exposure discovered during a home visit would have made it worthwhile, Cohen's kappa was 0.346, and the observed proportional agreement was 75%.

Twelve index families lived in apartments that had already undergone major renovations in the six months before the home visit. To see whether this fact influenced the assessments, these 12 families were excluded from the analysis. Cohen's kappa for the combined variable rose insignificantly to 0.359, and p_o dropped to 69%.

The description of agreement between two observations depends on their prevalence; one way to deal with the apparent paradox of low kappa and relatively high agreement is to consider the proportional agreement in positive (p_{pos}) and negative (p_{neg}) cases. As can be seen in table 7 a (on page 29), for the individual exposures, p_{neg} tends to be higher, which indicates that the screening test is better at ruling out the presence of exposures than confirming it. Interestingly, for the combined variable, this is reversed.

For all three assessments, it was noted that "false positives" (subjective assessment positive, but not borne out by objective assessment) were more frequent than "false negatives". Considering the different time frames (snapshot for the objective assessment, three months for the subjective description), this is not unexpected. Sensitivities and specificities are summarised in Table 7 a on page 29.

3.2 Description of study population – Contextual (secondary) analysis

The secondary analysis is concerned with a summarizing description of the context and distribution of various exposures and other characteristics in the whole population for which data was collected before the intervention in the underlying study.

3.2.1 Individual level

As part of the underlying study, the expansion of the sampling frame via class-lists (see Appendix A) yielded 143 further children (66 in the intervention area and 77 in the control area). Amongst the class-list children, the age difference between those that ultimately participated (n=72) and those that did not (n=159) was not significant (8.7 vs. 9.0 yrs); the proportions of the sexes were similar.

In summary, 340 children between the ages of 0 and 13 were included in the underlying study. Figure 2 on page 14 shows a flowchart of the enrolment pathways. Demographic details about the enrolled children are shown in Table 5.

Table 5 Demographic details of 340 children enrolled in the study

	Index children *n* = 86	Siblings of index children *n* = 111	Class-list children *n* = 72	Siblings of class-list children *n* = 71	Total *n* = 340
Mean age (+/- SD) (years)	5.2 (3.3)	6.7 (3.6)	9.0 (1.6)	6.3 (4.2)	6.7 (3.6)
Sex (male), %	62	44	51	58	53
Born outside of Sweden, *n* (%)	1 (1)	9 (8)	20 (28)	13 (18)	43 (13)

The place of birth was known for all children: 80% of all children from the intervention area and 94% of all children from the control area were born in Sweden. All parents had been born outside of Sweden.

The age distribution of children by year is shown in Figure 3. Index children tended to be younger than the other groups. The older age of class-list children is partly explained through the sampling process via school lists.

The distribution of national origin among the families of index children was described above; for the 72 class-list children, the numbers were: Iraq 26, ex-Yugoslavia 18, Lebanon 13, NME and Other 7 each, and Somalia 1.

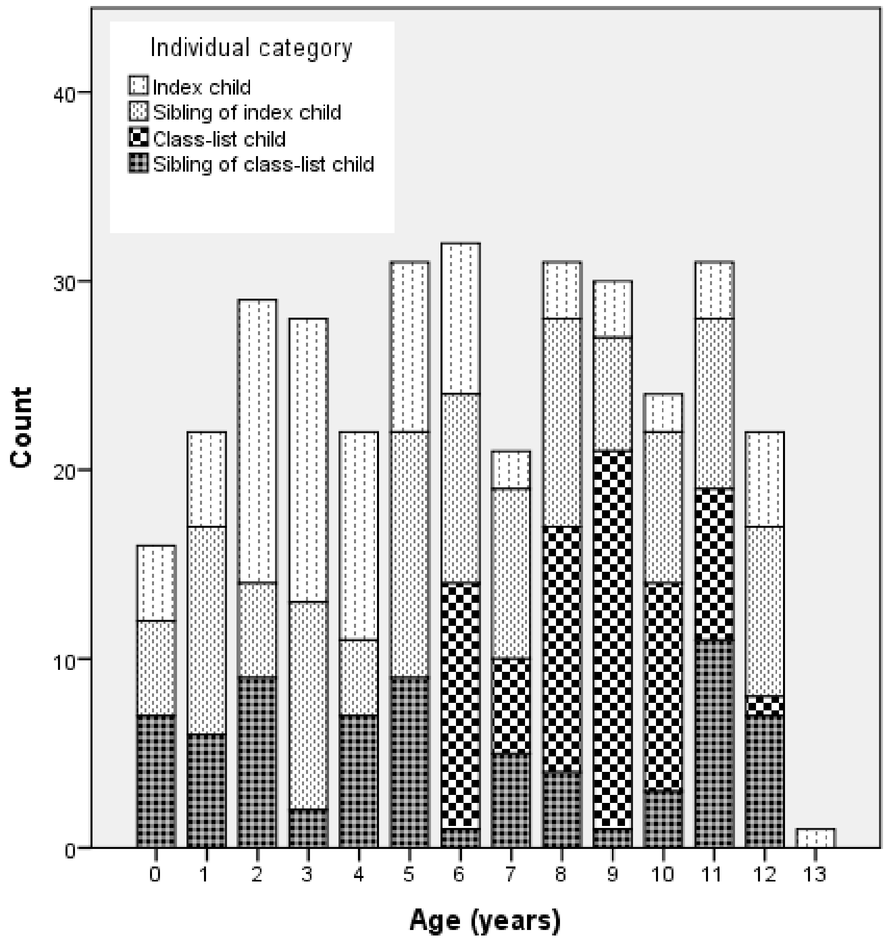


Figure 3 Distribution of 340 children by age (year) and category

Data on breast-feeding was available for 325/340 children (12 children were still being breast-fed, and data for 3 children was missing). Ninety percent of all children had been breast-fed at least in part. Total breast-feeding mean duration was 9.6 months (median 9 months, inter-quartile range (IQR) 3-13). Total breast-feeding for at least one year was reported in 43% of children. 19% of children had been exclusively breast-fed for at least 6 months. There were significant differences in breast-feeding practices between families from different ethnic backgrounds, with families from Iraq and Somalia having longer exclusive and total breast-feeding durations (data not shown).

3.2.2 Household level

Sixty families with class-list children were enrolled, of which 23 lived in the intervention area and 37 in the control area. Together with the index families mentioned above, this means that in summary, 130 families took part in the study (53 families from the intervention area and 77 families from the control area). Home visits to all families were spread out over a period of one year. The distribution of visits as shown in Figure 4 demonstrates that index families were visited first, and class-list families after the expansion of the sampling frame.

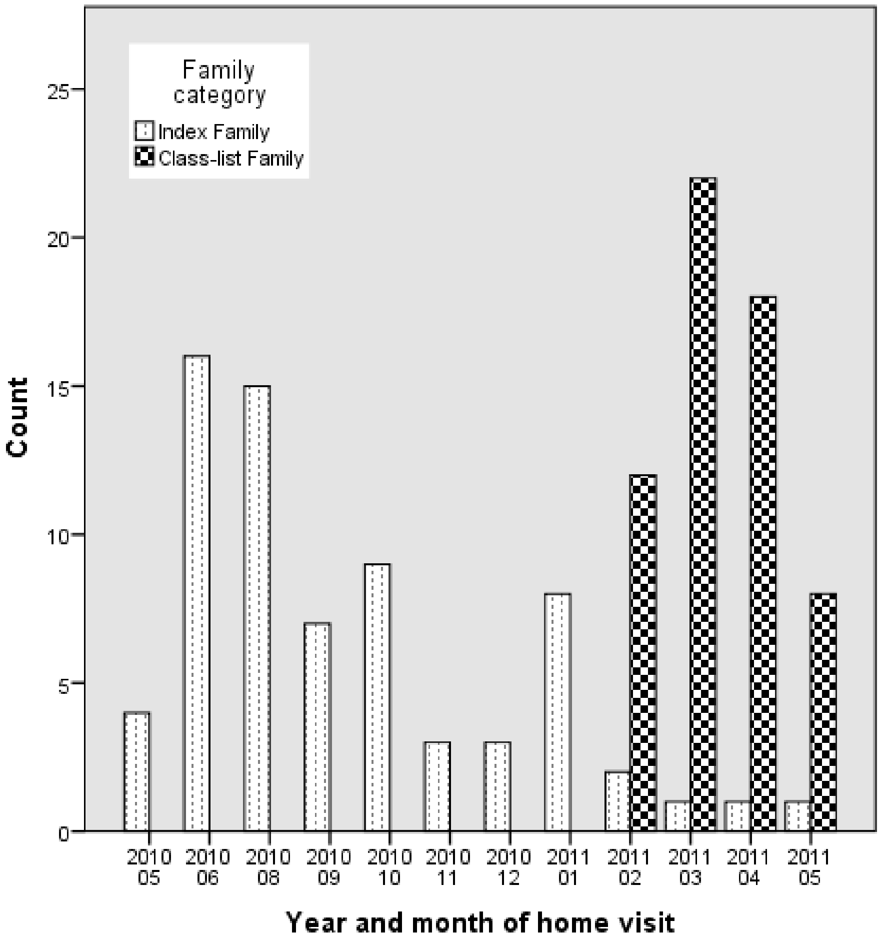


Figure 4 Monthly number of visits to families with index children and with class-list children

Eleven families had more than one class-list child: six families with two class-list children were from the intervention area and four from the control area, and one family from the intervention area had three class-list children.

The ethnic/geographic origin of the families could be determined for all 130 households. In the intervention area, half of the families were from Iraq, followed in frequency by Lebanon and other Near and Middle East countries. In the control area, the highest number of families was from Lebanon, followed closely by former Yugoslavia, and then Iraq and Somalia. No families were from Sweden, and only two families were from EU-countries (Italy and Slovakia).

Data on duration of residence in the current apartment was available for all families; however, data on duration of previous residence (if any) in other areas in Sweden, and overall duration of residence in the country were less readily available, and had to be inferred at times. None of the comparisons between groups showed a meaningful difference. Judging from the best available data, the mean overall duration of residence in Sweden for all families was approximately 10 ± 4 years. The analysis of individual household level data regarding mobility revealed that most of the 53 families living in the intervention area tended to have lived only there, mostly settling there upon arrival in Sweden. Low educational attainment of the mother (usually the primary caretaker of the children) was seen in nearly half of all families.

Dwelling sizes, occupant numbers, and crowding

The median number of rooms per apartment was 3, and the median number of inhabitants in households was 5. These values were the same for index families and class-list families. Integration of apartment size and number of inhabitants yields a measure for crowding. Almost two thirds (65%) of the 130 households in this study were considered to live under crowded conditions according to the Swedish definition. The proportions of index and class-list families living in crowded households were 69% and 60% , respectively. These differences were not significant. When analysing the data by area of residence, the proportions of crowded households in the intervention and control areas were 75% and 57%, respectively. This difference was significant (Fisher's exact test p-value 0.040). Index families and class-list families had the same proportion of crowded living conditions in both the intervention and control area (data not shown).

3.2.2.1 Self-assessment (Questionnaire 1)

Families were asked to indicate whether they had observed any visible moisture damage, any visible mould growth, and any noticeable mould odour in their apartment in the last 3 months before the home visit. For the index families, these self-reported exposures were already described above in Table 3. Class-list families reported incidences of these exposures in their apartment that were not statistically different from the incidences reported by index families. When combining the information from all families, it was again noted that there were rather marked differences between the intervention and control area (as expected by the selection criteria); in the combined analysis, both self-reported moisture damage, mould growth, and the combined variable were significantly more frequent in the intervention area.

As part of the underlying study, all families were also asked about smoking habits and smoking policies of inhabitants, use of waterpipes, use of incense, and current or previous presence of cockroaches in the apartment. Answers to these questions by intervention/control area are shown in a table in Appendix C. The overall prevalence of positive answers was relatively high. Variables related to lifestyle (smoking) showed significant differences between index and class-list families, while variables relating to apartment characteristics (cockroach infestation) showed significant differences between intervention and control area. Interestingly, incense use does not vary as a typical lifestyle variable, but rather as an area variable, suggesting that it is an indicator variable for a third factor relating to the socioeconomic characteristics of households living in the different areas.

Household exposures for children

When analysing exposure of the 340 children in the study to the above variables, it was seen that 33% of all children between 0 and 13 years of age were exposed to ETS in their home environment, with marked differences between country of origin: ETS exposure for children from Somali families was 11%, whereas this percentage was 46% in children from Ex-Yugoslavian families. Children from index families were exposed to ETS in 24% of cases, while for children from class-list families this proportion was 46% ($p<0.001$*).

In total, 15% of all children had smoking mothers, ranging from 0% in Somali families to 28% in families from Ex-Yugoslavia. There were very marked differences in mothers' smoking habits between index and class-list families, with much lower incidences in the former (4% vs. 29%; $p<0.001$*).

It is likely that both these exposure differences with regard to parents' lifestyle choices are examples of disease-related exposure modification (reverse causation). They may also reflect the success of anti-smoking messages delivered through the health-care system.

3.2.2.2 Objective assessment during home visit (Checklist)

During the home visits, health communicators asked the families for permission to inspect all rooms in the apartment for visible signs of dampness or mould and for mould odour. As expected in terms of the selection criteria, there were significant differences between the intervention and control area in the proportions of apartments with any dampness visible, any mould growth visible, any smell of mould, and the combined variable. The results of these objective assessments are shown in Table 6.

Table 6 Objectively assessed exposures by household (% of valid answers); p-value for comparison of intervention and control area, derived from chi-squared test (Fisher's exact test); * denotes statistical significance

	Intervention area (*n*=53)	Control area (*n*=77)	p-value
Kitchen – dampness, *n* (%)	15 (28)	9 (12)	0.022*
Kitchen – mould, *n* (%)	7 (13)	7 (9)	> 0.200
Kitchen – odour, *n* (%)	7 (13)	6 (8)	> 0.200
Bathroom – dampness, *n* (%)	16 (31)	9 (12)	0.011*
Bathroom – mould, *n* (%)	8 (16)	3 (4)	0.026*
Bathroom – odour, *n* (%)	10 (20)	10 (13)	> 0.200
Toilet – dampness, *n* (%)	10 (21)	3 (8)	0.129
Toilet – mould, *n* (%)	4 (9)	1 (3)	> 0.200
Toilet – odour, *n* (%)	9 (19)	4 (10)	> 0.200
Any bedroom – dampness, *n* (%)	17 (32)	13 (17)	0.057
Any bedroom – mould, *n* (%)	6 (11)	5 (7)	> 0.200
Any bedroom – odour, *n* (%)	5 (9)	6 (8)	> 0.200
Anywhere in apt. – dampness, *n* (%)	37 (70)	18 (23)	<0.001*
Anywhere in apt. – mould, *n* (%)	21 (40)	10 (13)	0.001*
Anywhere in apt. – odour, *n* (%)	21 (40)	17 (22)	0.049*
Combined (any of the above), *n* (%)	42 (79)	27 (35)	<0.001*

Within both the intervention and control areas separately and overall, there were no significant differences between index families and class-list families with regards to objectively assessed household exposures (data not shown), with the exception of a higher proportion of damp bedrooms in class-list households in the intervention area and overall (p=0.041 and 0.036, respectively)

3.2.2.3 Agreement between subjective and objective assessments of household exposure

The results for the index families were reported above (see *3.1.2.3)*. When testing the relationship between subjective (questionnaire) and objective (home visit) assessments of dampness, mould growth, mould odour, and the combined variable per household, class-list families had generally better, but still only fair to moderate levels of agreement. The data concerning agreement of measures, as well as calculated sensitivities and specificities for the questions, for the whole population is presented in Table 7 a.

Table 7 a Level of agreement between subjective and objective measures of home exposures for the whole population and subdivided by family category. p_o: observed proportional agreement; p_{pos}: proportional agreement in positive cases; p_{neg}: proportional agreement in negative cases.

Intervention and control area	Index families *n* = 70	Class-list families *n* = 60	All families *n* = 130
Dampness			
• p_o (%)	56	75	65
• p_{pos} / p_{neg} (%)	53 / 58	59 / 91	61 / 68
• Cohen's kappa	0.121	0.482	0.287
• Sensitivity / Specificity	0.59 / 0.54	0.72 / 0.76	0.65 / 0.64
Mould growth			
• p_o (%)	70	71	71
• p_{pos} / p_{neg} (%)	55 / 77	41 / 81	50 / 79
• Cohen's kappa	0.237	0.335	0.301
• Sensitivity / Specificity	0.65 / 0.72	0.55 / 0.75	0.61 / 0.73
Mould odour			
• p_o (%)	65	62	64
• p_{pos} / p_{neg} (%)	56 / 71	34 / 73	47 / 72
• Cohen's kappa	0.097	0.276	0.206
• Sensitivity / Specificity	0.63 / 0.67	0.46 / 0.66	0.57 / 0.66
Combined variable			
• p_o (%)	69	72	75
• p_{pos} / p_{neg} (%)	74 / 59	73 / 70	74 / 65
• Cohen's kappa	0.346	0.433	0.391
• Sensitivity / Specificity	0.82 / 0.52	0.77 / 0.67	0.80 / 0.59

Again, for all three assessments, it was noted that "false positives" (subjective assessment positive, but not borne out by objective assessment) were more frequent than "false negatives". Dampness in the apartment was more often over-reported (false positive) as well as under-reported (false negative) by index families than by class-list families; the opposite was true for mould growth and mould odour.

Analysing the data from only the control area can be used to approximate the situation in a "normal" area with representative demographics and building characteristics that could be expected in similar contexts in Sweden. Agreement between objective and subjective assessment seemed to be higher overall, with Cohen's kappa mostly in the moderate range. Once more, with p_{pos} lower than p_{neg}, exposures could be ruled out better than be confirmed. The index families performed better with regard to identifying mould growth and mould odour than the control families. This relation had been the opposite in the full population sample, which had included the intervention area. The results are shown in Table 7 b.

Table 7 b Level of agreement between subjective and objective measures of home exposures in the control area only, and subdivided by family category. p_o: observed proportional agreement; p_{pos}: proportional agreement in positive cases; p_{neg}: proportional agreement in negative cases.

Control area only	Index families *n* = 40	Class-list families *n* = 37	All families *n* = 77
Dampness			
• p_o (%)	62	75	69
• p_{pos} / p_{neg} (%)	44 / 71	50 / 86	47 / 79
• Cohen's kappa	0.165	0.360	0.258
• Sensitivity / Specificity	0.55 / 0.64	0.57 / 0.83	0.56 / 0.74
Mould growth			
• p_o (%)	88	86	87
• p_{pos} / p_{neg} (%)	67 / 92	55 / 92	62 / 92
• Cohen's kappa	0.593	0.471	0.541
• Sensitivity / Specificity	0.83 / 0.88	0.75 / 0.88	0.80 / 0.88
Mould odour			
• p_o (%)	80	68	74
• p_{pos} / p_{neg} (%)	80 / 86	40 / 41	55 / 82
• Cohen's kappa	0.529	0.204	0.377
• Sensitivity / Specificity	0.80 / 0.80	0.57 / 0.70	0.71 / 0.75
Combined variable			
• p_o (%)	70	70	70
• p_{pos} / p_{neg} (%)	68 / 71	59 / 77	65 / 74
• Cohen's kappa	0.412	0.371	0.400
• Sensitivity / Specificity	0.81 / 0.63	0.73 / 0.69	0.78 / 0.66

3.2.3 Children's health outcomes (Questionnaire 2)

Parent-reported health and respiratory symptoms were available for almost all children. When parents were asked about general health status, for 77% of all children the answer was "very good" or "good", while for 23% the answers ranged from "fair" to "very poor". Index children had a significantly lower proportion of "very good" or "good" general health (64%; p=0.002) compared to their siblings (84%), class-list children (86%) or siblings of class-list children (76%). More than one quarter of all children had been taken for an unplanned healthcare visit in the preceeding three months.

4. Discussion

4.1 Key findings

In this study, which formed the first part of an underlying intervention study in a socially disadvantaged immigrant neighbourhood in Malmö, a total of 86 children with respiratory health problems as well as 254 other children from a total of 130 households were analysed. The proportion of households with subjective and objective reports of potentially harmful exposures (dampness, mould) was relatively high overall, with households in the intervention area reporting these in over half of all cases. Agreement between subjective and objective assessments was fair to moderate, with no clear biases between families with sick children and those without.

The distribution of other social determinants of health was uneven, but overall exposure to potentially harmful factors was high. The proportion of children living in crowded households ranged from 90% in Iraqi families to 54% in families from Ex-Yugoslavia. Some behavioural factors such as ETS exposure and breastfeeding practices differed by ethnic composition; structural factors such as cockroach infestation differed by area; and socio-economic factors such as employment, education, and mobility differed by both area and ethnic composition. Confirming the complex web of causation shaping health and disease, there were no clear differences between families with sick children and those without, a notable exception being lower ETS exposure in the former, which is likely due to disease-related exposure modification.

4.2 Primary analysis

Comparing the subjective and objective assessment of exposures in the home environment, the primary analysis showed that there is generally only fair agreement between the two. The higher proportional agreement of negative cases suggests that these questions are better suited to ruling out an exposure. This confirms findings from the literature in Sweden (Hägerhed Engman et al., 2007) and Finland (Haverinen-Shaughnessy et al., 2005). In the Swedish study, questionnaire responses were validated with home visits by building engineers who were blinded to the health information from the underlying study (Dampness in Buildings and Health, DBH). While agreement on technical aspects was good, it was low on assessment of mould and dampness. In this study, the questions were also better at excluding problems (Hägerhed Engman et al., 2007). In the Finnish study, homes of families with asthmatic children were visited after questionnaires had been filled out. Agreements were in a similar range to the data presented here, again with higher values for p_{neg} (Haverinen-Shaughnessy et al., 2005).

The intended use of the questions about home exposures would be in screening symptomatic children who have come into contact with the health care system (Paulson and Sandel, 2011). If any positive answer to the screening questions triggers a home visit aimed at verifying the information and implementing steps to intervene, the main concern must be not to miss any households with pertinent exposures (false negatives), rather than to worry about visiting households where exposures cannot be confirmed (false positives).

It must be noted that there is no "gold standard" or more reliable method of exposure assessment. Attempts at measuring mould spore concentrations and identifying relationships to either visual assessments of mould and dampness or to health outcomes were not successful (Holme et al., 2010). The health communicators who visited the families in Rosengård were not trained building inspectors, and their assessment provides a snapshot at one point in time, while the families' assessments cover a longer period of time during which they could observe their apartment. It is possible that the media attention and the impending renovation biased answers towards reporting more severe exposure, and it is possible that this could affect the families with sicker children differentially, leading to overreporting due to recall bias. On the other hand, the objective assessment that was carried out during the home visits could also be biased by hearing the stories and complaints of the family at the same time (observer bias), as it would have been impractical to try to blind the visiting health communicators to the actual health issues.

4.3 Context analysis

The underlying study aims to understand children's respiratory health in the social context (Spencer, 2003). Even from the data that was available in this study, it is apparent that the complexity makes it rather unlikely that one single facet of social determinants will explain a large part of the variance in health outcomes, certainly on an individual level, but presumably also on the population level.

Overall, in the population studied here, there is a high prevalence of living conditions, socio-economic conditions, and behaviours that are potentially harmful to children's health. The distribution of these is heterogenous both among the index families and the class-list families, as well as in the intervention area and the control area. As an example, overall exposure to environmental tobacco smoke is high. Many protective factors such as breastfeeding are also distributed unevenly. Numerous other factors that could be protective or harmful have not been measured in this study: social integration, social cohesion, social capital, residential stability, health literacy, health care access, health care utilization all influence the health of families, both objective and self-rated (Lindén-Boström et al., 2010).

Although the stratified numbers in this study are relatively small, there is a possible suggestion that certain population subsegments exhibit different patterns or constellations of potentially harmful and protective characteristics. How recently the family immigrated, ethnic origin, and degree of assimilation into the Swedish culture, via Swedish language skills and the ability to navigate the social system, may play an important role. In certain ethnic groups, smoking among females may be traditionally very unusual, and long exclusive breast-feeding may be the norm, but educational levels and health literacy may be low, translating into persistently low socio-economic status. In other groups, maternal smoking may be much more common, breast-feeding may not be practiced, but educational levels, social mobility, and access to better housing resources may be higher. This cumulative impact of multiple environmental conditions, behaviours, and personal attributes including genetics needs to be kept in mind when assessing the component factors.

Housing is a possibly particularly harmful pathway along which social inequalities cause health inequalities. While fixing housing problems does not fix the root cause of the problem of social inequality, it at least improves the concrete situation, which in the clinical context of caring for the individual patient is desirable. Even so, all other contributing factors need to also be considered, even if they lie outside the direct expertise of the clinician.

The example of child health in Rosengård shows an interesting phenomenon: over time, an informal network of engaged and concerned stakeholders has emerged, which spans several disciplines and institutions. This coalition of interested parties was instrumental in pushing the issue of child health inequalities for the particularly vulnerable local population onto the political agenda, when the opportunity arose. The local, ad-hoc nature of this network makes it responsive and flexible, but there are caveats. The lack of institutionalisation and broader political support makes the network vulnerable, and its continued existence and function is dependent on the presence of these "local champions" of the cause of child health. In the background interviews that were conducted with several parties, the exchange of information between stakeholders, and especially between parts of the health care system, was repeatedly mentioned as a crucial problem. Further analysis of this phenomenon is unfortunately beyond the scope of this thesis.

4.4 Further Methodological Considerations

4.4.1 Strengths of the study

This is, to our knowledge, the first study in Sweden that has explicitly recruited immigrant children and their families living in a deprived neighbourhood, to determine the prevalence of bad housing conditions and ultimately their contribution to negative child health outcomes. The underlying study uses the opportunity of the renovations as a natural experiment in a real-world setting, and the data obtained from the primary health care centres also reflects the reality of care available and delivered to this population.

The home visits were carried out by researchers and health communicators that were intimately familiar with the area, the people, and their cultures, and who were often able to talk to them in their own native language. The home visits were generally well accepted and even welcomed by the affected families. Considering the high mobility of the inhabitants and the less than optimal registration data, a relatively high proportion of families were ultimately reached and participated, again thanks to the persistent efforts of the researchers.

A number of items in the questionnaires were derived from other widely used research tools, such as the Swedish Environmental Health Survey (see above), which will allow comparisons of data from the underlying study with a population sample. The combination of several different assessment modes (subjective, interviewer-led questionnaires, visual inspection during home visits) allows for triangulation of results and methods.

The study covered numerous diverse areas of social determinants of health on many different levels (near, middle, distant), reflecting the complex systemic nature of the outcomes in question. The challenge is to not become over-inclusive and then paralysed by the complex analysis. The thesis presented here therefore examines a certain aspect, and aims to put it into a meaningful context.

4.4.2 Limitations of the study

Selection of participants

The selection of index children was carried out through identification of children with documented contacts in the health-care records. It was known that not all children living in the area were actually enrolled in the two local PHCs; some families sought care at other primary healthcare institutions in other parts of Malmö. The exact number, and whether this differentially affected sicker or healthier children, was not known. It was seen that there were differing diagnostic codes and possibly differing diagnostic standards in the two primary healthcare centres, which could affect the comparability of selected children.

Crude comparisons between the participating children and those whose parents had declined or could not be reached did not show major demographic differences. It is however quite possible that families with sicker children were more motivated (and, depending on their economic circumstances, able) to move away from an area that they possibly perceived as unhealthy, thereby selecting less severely affected children remaining in the area ("healthy stayers"). Similarly, families of class-list children may have been more eager to participate in the study if their children had health issues, thereby selecting more severely affected children than would have been present in a true random sample.

Selecting children and their siblings from the same household raises issues of shared exposure and shared genetic determinants. In view of the narrow scope of analyses (concentrating on household units) carried out in this thesis, it was not necessary to make further attempts to take this potential source of bias into account.

Assessment of exposure

The home visits to families were carried out over a period of one year. Households in the intervention and control areas were visited in comparable distributions over this time (data not shown), but, as can be inferred from the study design, this is not true for index and class-list families (refer to Figure 4 in Results). This may have introduced a bias in the subjective and objective assessment of mould and dampness, in addition to the already mentioned issue of objective visual assessment providing a snap-shot image, in contrast to the self-assessment which covers a longer period of time.

Self-reporting of smoking behaviour could be biased, with answers being influenced by "social desirability", leading to an underestimation of ETS exposure for children. There are several other aspects of exposure that were not covered in the present study: no data on methods, habits, and adequacy of ventilation in the apartments was acquired, neither was outside air pollution (from road traffic) taken into account.

A major limitation is that there was no data on where the children actually spent the majority of their time. Enrolment in day care from an early age is very common in Sweden, but no data was acquired on which children from the study population actually did spend what part of their day in what other dwellings. The number of older siblings was difficult to determine in many families due to social circumstances and study design.

4.5 Generalisability of the study

The population examined here and their living conditions are different from the "general population" of Sweden, but certainly not unique. The Miljonprogrammet and the subsequent move of the state out of the housing market has left a legacy of buildings and neighbourhoods which are nearing the point of requiring major repair, reconstruction, or other disposition (Hall and Vidén, 2005; Johnson, 2010). Disadvantaged and segregated neighbourhoods exist in all three large cities in Sweden (Stockholm, Gothenburg, and Malmö) and in several smaller ones. The populations in these neighbourhoods are faced with generally comparable overarching issues of socioeconomic deprivation, social exclusion, ethnic segregation, migrant backgrounds and questions of cultural assimilation, health care access and utilisation, etc. The results reported here could therefore be of help in the local analysis of other marginalised populations in Sweden, but possibly also in other high-income countries with comparable societal organisation, mainly in Western Europe.

5. Conclusion & Recommendations

On a population level, the associations between factors such as dampness, mould growth, heating/insulation, and crowding on the one hand and respiratory health and infectious diseases, on the other hand, have been studied in many populations, especially in children. On the individual level, however, firm causal associations are more difficult to prove.

In the clinical context, health professionals are faced every day with individuals whose presentation they suspect to be influenced by important factors that are outside the classical medical domain. When taking their history, asking questions about social determinants offers valuable and relevant information, but only if this additional knowledge can be translated into action.

In the first part of the analysis, it was demonstrated that it is feasible to acquire information about apartment characteristics from parents of children with respiratory diseases. In particular, in this population of immigrants to Sweden, the use of health communicators ensured that questions were properly understood. While the agreement between subjective and objective assessments was generally only fair, questions about dampness and mould performed better in ruling out such exposures.

This supports a change in what role home visits play in the clinical care of children. Home visits in the care of young children with respiratory symptoms should be the default option as part of the best standard of practice. Only if there is a clear indication from the screening questions as well as the wider examination and history that home exposures play no major role should the home visit be waived.

But even if no clearly actionable structural problems are identified during a home visit, such a visit will never be a waste of time, as health education and support can and should always be a part of it. This can best be achieved by having home visits carried out by community health workers familiar with the area and the social and cultural needs of the population, which receive additional training in the assessment of common environmental indoor exposures. Components of the home visit can include a basic structural housing assessment, education, evaluation of health care access and literacy, counselling regarding behavioural modification such as smoking interventions, and improvement of linkage to social services.

Any areas of concern should be acted on and fed forward via a clear pathway into stable, local, intersectoral networks comprised of health professionals, community health workers, environmental departments, housing departments, social departments, and community organizations. In the context of housing, these can, if appropriate, organize a proper technical assessment and initiate interventions to fix problematic areas.

The overall prevalence of other potentially harmful factors in this population was high; both these and potentially protective factors were distributed unevenly. Factors related to the built environment cannot and should not be seen in isolation, as they often co-vary with other social determinants of health. Housing is however an important pathway along which social inequalities translate into health inequalities.

A strength of the study is the comprehensive set of data that was gathered in this socially and economically disadvantaged population. The underlying study will shed more light on the actual effect of the renovations on child health outcomes. The underlying study will, through its rich data, be well equipped to go beyond the reductionist correlation between only housing factors and health, acknowledging the real world of complex causal webs.

Further research should be aimed at integrating the ample knowledge gained from academic research into clinical practice. The availability of successful intervention studies means that we really must move from further large-scale cross-sectional studies to actual local interventions that have clinical utility and feasibility. Piloting a home-visit program targeted at families of children who have come into contact with the health system e.g. with respiratory ailments could be a first step, with rigorous evaluation of the outcomes, acceptability, costs and benefits of such an approach.

References

Albin, M., Jakobsson, K., Djurfeldt, A., 2012. Miljöns betydelse för sociala skillnader in hälsa. Malmö Stad, Malmö.

Almqvist, C., Pershagen, G., Wickman, M., 2005. Low socioeconomic status as a risk factor for asthma, rhinitis and sensitization at 4 years in a birth cohort. Clinical and Experimental Allergy 35, 612–618.

Antova, T., Pattenden, S., Brunekreef, B., Heinrich, J., Rudnai, P., Forastiere, F., Luttmann-Gibson, H., Grize, L., Katsnelson, B., Moshammer, H., Nikiforov, B., Slachtova, H., Slotova, K., Zlotkowska, R., Fletcher, T., 2008. Exposure to indoor mould and children's respiratory health in the PATY study. Journal of Epidemiology & Community Health 62, 708–714.

Borgegård, L.-E., Kemeny, J., 2004. Sweden: High-rise housing for a low-density country, in: Turkington, I.R., van Kempen, R., Wassenberg, E. (Eds.), High-rise Housing in Europe: Current Trends and Future Prospects. Delft University Press, Delft, pp. 31–48.

Bornehag, C.G., Sundell, J., Bonini, S., Custovic, A., Malmberg, P., Skerfving, S., Sigsgaard, T., Verhoeff, A., 2004. Dampness in buildings as a risk factor for health effects, EUROEXPO: a multidisciplinary review of the literature (1998-2000) on dampness and mite exposure in buildings and health effects. Indoor Air 14, 243–257.

Braubach, M., Fairburn, J., 2010. Social inequities in environmental risks associated with housing and residential location - a review of evidence. The European Journal of Public Health 20, 36–42.

Breysse, P., Farr, N., Galke, W., Lanphear, B., Morley, R., Bergofsky, L., 2004. The relationship between housing and health: children at risk. Environmental Health Perspectives 112, 1583–1588.

Bryant-Stephens, T., Kurian, C., Guo, R., Zhao, H., 2009. Impact of a household environmental intervention delivered by lay health workers on asthma symptom control in urban, disadvantaged children with asthma. American Journal of Public Health 99, S657–S665.

Burridge, R., Ormandy, D. (Eds.), 1993. Unhealthy housing: research, remedies, and reform, 1st ed. E. & F.N. Spon, London, New York.

Bush, R.K., Portnoy, J.M., Saxon, A., Terr, A.I., Wood, R.A., 2006. The medical effects of mold exposure. Journal of Allergy and Clinical Immunology 117, 326–333.

Cicchetti, D.V., Feinstein, A.R., 1990. High agreement but low kappa: II. Resolving the paradoxes. Journal of Clinical Epidemiology 43, 551–558.

Cope, S.F., Ungar, W.J., Glazier, R.H., 2008. Socioeconomic factors and asthma control in children. Pediatric Pulmonology 43, 745–752.

Crocker, D.D., Kinyota, S., Dumitru, G.G., Ligon, C.B., Herman, E.J., Ferdinands, J.M., Hopkins, D.P., Lawrence, B.M., Sipe, T.A., 2011. Effectiveness of home-based, multi-trigger, multicomponent interventions with an environmental focus for reducing asthma morbidity. American Journal of Preventive Medicine 41, S5–S32.

CSDH, 2008. Closing the gap in a generation: health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health. World Health Organization, Geneva.

Currie, J., 2009. Healthy, wealthy, and wise: Socioeconomic status, poor health in childhood, and human capital development. Journal of Economic Literature 47, 87–122.

Dahlgren, G., Whitehead, M., 1991. Policies and strategies to promote social equity in health. Institute for Future Studies, Stockholm.

Dixon, S.L., Fowler, C., Harris, J., Moffat, S., Martinez, Y., Walton, H., Ruiz, B., Jacobs, D.E., 2009. An examination of interventions to reduce respiratory health and injury hazards in homes of low-income families. Environmental Research 109, 123–130.

Fisk, W.J., Eliseeva, E.A., Mendell, M.J., 2010. Association of residential dampness and mold with respiratory tract infections and bronchitis: a meta-analysis. Environmental Health 9 (72).

Gibson, M., Petticrew, M., Bambra, C., Sowden, A.J., Wright, K.E., Whitehead, M., 2011. Housing and health inequalities: A synthesis of systematic reviews of interventions aimed at different pathways linking housing and health. Health & Place 17, 175–184.

Goodyear, R.K., Fabian, A., Hay, J., 2011. Finding the crowding index that works best for New Zealand (Statistics New Zealand Working Paper 11-04). Statistics New Zealand, Wellington, NZ.

Hägerhed Engman, L.H., Bornehag, C.-G., Sundell, J., 2007. How valid are parents' questionnaire responses regarding building characteristics, mouldy odour, and signs of moisture problems in Swedish homes? Scandinavian Journal of Public Health 35, 125–132.

Hall, T., Vidén, S., 2005. The Million Homes Programme: a review of the great Swedish planning project. Planning Perspectives 20, 301–328.

Haverinen-Shaughnessy, U., Hyvärinen, A., Pekkanen, J., Nevalainen, A., Husman, T., Korppi, M., Halla-Aho, J., Koivisto, J., Moschandreas, D., 2005. Occurrence and characteristics of moisture damage in residential buildings as a function of occupant and engineer observations. Indoor and Built Environment 14, 133–140.

Heinrich, J., 2011. Influence of indoor factors in dwellings on the development of childhood asthma. International Journal of Hygiene and Environmental Health 214, 1–25.

Holme, J., Hägerhed-Engman, L., Mattsson, J., Sundell, J., Bornehag, C.-G., 2010. Culturable mold in indoor air and its association with moisture-related problems and asthma and allergy among Swedish children. Indoor Air 20, 329–340.

Holt, E.W., Theall, K.P., Rabito, F.A., 2013. Individual, Housing, and Neighborhood Correlates of Asthma among Young Urban Children. Journal of Urban Health 90, 116–129.

Howden-Chapman, P., Pierse, N., Nicholls, S., Gillespie-Bennett, J., Viggers, H., Cunningham, M., Phipps, R., Boulic, M., Fjallstrom, P., Free, S., Chapman, R., Lloyd, B., Wickens, K., Shields, D., Baker, M., Cunningham, C., Woodward, A., Bullen, C., Crane, J., 2008. Effects of improved home heating on asthma in community dwelling children: randomised controlled trial. BMJ 337, a1411–a1411.

Institute of Medicine (U.S.), 2004. Damp indoor spaces and health. National Academies Press, Washington, DC.

Jackson, G., Thornley, S., Woolston, J., Papa, D., Bernacchi, A., Moore, T., 2011. Reduced acute hospitalisation with the healthy housing programme. Journal of Epidemiology & Community Health 65, 588–593.

Jacobs, D.E., 2011. Environmental health disparities in housing. American Journal of Public Health 101, S115–S122.

Jaine, R., Baker, M., Venugopal, K., 2011. Acute rheumatic fever associated with household crowding in a developed country. The Pediatric Infectious Disease Journal 30, 315–319.

Johansson, A.K., Ludvigsson, J., Hermansson, G., 2008. Adverse health effects related to tobacco smoke exposure in a cohort of three-year olds. Acta Paediatrica 97, 354–357.

Johnson, G., 2010. Affordable housing. Position statements for Stockholm. Office of Regional Planning, Stockholm City Council, Stockholm.

Karvonen, A.M., Hyvarinen, A., Roponen, M., Hoffmann, M., Korppi, M., Remes, S., von Mutius, E., Nevalainen, A., Pekkanen, J., 2009. Confirmed moisture damage at home,

respiratory symptoms and atopy in early life: A birth-cohort study. Pediatrics 124, e329–e338.
Kercsmar, C.M., Dearborn, D.G., Schluchter, M., Xue, L., Kirchner, H.L., Sobolewski, J., Greenberg, S.J., Vesper, S.J., Allan, T., 2006. Reduction in asthma morbidity in children as a result of home remediation aimed at moisture sources. Environmental Health Perspectives 114, 1574–1580.
Köhler, M., 2012. Barn i Malmö. Skilda livsvillkor ger ojämlik hälsa. Malmö Stad, Malmö.
Krieger, J.W., 2010. Home is where the triggers are: Increasing asthma control by improving the home environment. Pediatric Allergy, Immunology, and Pulmonology 23, 139–145.
Kull, I., Melen, E., Alm, J., Hallberg, J., Svartengren, M., van Hage, M., Pershagen, G., Wickman, M., Bergström, A., 2010. Breast-feeding in relation to asthma, lung function, and sensitization in young schoolchildren. Journal of Allergy and Clinical Immunology 125, 1013–1019.
Lai, C.K.W., Beasley, R., Crane, J., Foliaki, S., Shah, J., Weiland, S., the ISAAC Phase Three Study Group, 2009. Global variation in the prevalence and severity of asthma symptoms: Phase Three of the International Study of Asthma and Allergies in Childhood (ISAAC). Thorax 64, 476–483.
Lannerö, E., Wickman, M., Pershagen, G., Nordvall, L., 2006. Maternal smoking during pregnancy increases the risk of recurrent wheezing during the first years of life (BAMSE). Respiratory Research 7, 3.
Lannerö, E., Wickman, M., van Hage, M., Bergström, A., Pershagen, G., Nordvall, L., 2008. Exposure to environmental tobacco smoke and sensitisation in children. Thorax 63, 172–176.
Larsson, M., Hägerhed-Engman, L., Moniruzzaman, S., Janson, S., Sundell, J., Bornehag, C.-G., 2011. Can we trust cross-sectional studies when studying the risk of moisture-related problems indoor for asthma in children? International Journal of Environmental Health Research 21, 237–247.
Lind, H., Blomé, G., 2012. Slumlords in the Swedish welfare state: how is it possible? International Journal of Housing Markets and Analysis 5, 196–210.
Lindén-Boström, M., Persson, C., Eriksson, C., 2010. Neighbourhood characteristics, social capital and self-rated health-A population-based survey in Sweden. BMC Public Health 10, 628.
Lindström, M., Moghaddassi, M., Merlo, J., 2004. Individual self-reported health, social participation and neighbourhood: a multilevel analysis in Malmö, Sweden. Preventive Medicine 39, 135–141.
Liu, A.H., 2007. Hygiene theory and allergy and asthma prevention. Paediatric and Perinatal Epidemiology 21, 2–7.
Maani, S.A., Vaithianathan, R., Wolfe, B.L., 2006. Inequality and health: Is housing crowding the link? (No. 06-09), Motu Working Paper. Motu Economic and Public Policy Research, Wellington.
Malmö Stad, n.d. Fakta om Rosengård.
Malmö Stadskontor, 2008. Områdesfakta för Malmö 2008. Avdelningen för strategisk utveckling, Malmö Stadskontor, Malmö.
Mendell, M.J., Mirer, A.G., Cheung, K., Tong, M., Douwes, J., 2011. Respiratory and allergic health effects of dampness, mold, and dampness-related agents: A review of the epidemiologic evidence. Environmental Health Perspectives 119, 748–756.
Morgan, W.J., Crain, E.F., Gruchalla, R.S., O’Connor, G.T., Kattan, M., Evans III, R., Stout, J., Malindzak, G., Smartt, E., Plaut, M., others, 2004. Results of a home-based environmental intervention among urban children with asthma. New England Journal of Medicine 351, 1068–1080.

Northridge, M.E., Sclar, E.D., Biswas, P., 2003. Sorting out the connections between the built environment and health: a conceptual framework for navigating pathways and planning healthy cities. Journal of Urban Health 80, 556–568.

Paulson, J., Sandel, M., 2011. Healthy homes: the role of health care professionals, in: Morley, R., Mickalide, A., Mack, K.A. (Eds.), Healthy & Safe Homes: Research, Practice, & Policy. American Public Health Association, Washington, DC, pp. 91–120.

Pearce, N., Ait-Khaled, N., Beasley, R., Mallol, J., Keil, U., Mitchell, E., Robertson, C., and the ISAAC Phase Three Study Group, 2007. Worldwide trends in the prevalence of asthma symptoms: phase III of the International Study of Asthma and Allergies in Childhood (ISAAC). Thorax 62, 758–766.

Perera, F., Viswanathan, S., Whyatt, R., Tang, D., Miller, R.L., Rauh, V., 2006. Children's environmental health research - Highlights from the Columbia Center for Children's Environmental Health. Annals of the New York Academy of Sciences 1076, 15–28.

Rauh, V.A., Landrigan, P.J., Claudio, L., 2008. Housing and health: intersection of poverty and environmental exposures. Annals of the New York Academy of Sciences 1136, 276–288.

Reponen, T., Vesper, S., Levin, L., Johansson, E., Ryan, P., Burkle, J., Grinshpun, S.A., Zheng, S., Bernstein, D.I., Lockey, J., 2011. High environmental relative moldiness index during infancy as a predictor of asthma at 7 years of age. Annals of Allergy, Asthma & Immunology 107, 120–126.

Robertson, J., 1919. Housing and the public health. Cassell and Company, Ltd., London.

Salonen, T., 2012. Barns ekonomiska utsatthet. Årsrapport 2012:2. Rädda Barnen, Stockholm.

Sandel, M., Phelan, K., Wright, R., Hynes, H.P., Lanphear, B.P.P., 2004. The effects of housing interventions on child health. Pediatric Annals 33, 474–481.

Silvers, K.M., Frampton, C.M., Wickens, K., Pattemore, P.K., Ingham, T., Fishwick, D., Crane, J., Town, G.I., Epton, M.J., 2012. Breastfeeding protects against current asthma up to 6 years of age. The Journal of Pediatrics 160, 991–996.e1.

Spencer, N., 2003. Social, economic, and political determinants of child health. Pediatrics 112, 704–706.

Stewart, J., Rhoden, M., 2006. Children, housing and health. International Journal of Sociology and Social Policy 26, 326–341.

Stokols, D., 1996. Translating social ecological theory into guidelines for community health promotion. American Journal of Health Promotion 10, 282–298.

Sundin, J., Willner, S., 2007. Social change and health in Sweden: 250 years of politics and practice. Swedish National Institute of Public Health, Stockholm.

Sverige Socialstyrelsen, Karolinska institutet - Institutet för miljömedicin, Stockholms län - Landstinget - Miljömedicinska enheten, 2005. Environmental health report 2005: extended summary. The National Board of Health and Welfare (Socialstyrelsen): Institute of Environmental Medicine, Stockholms läns landsting (Stockholm Centre for Public Health), Stockholm.

Thomson, H., Thomas, S., Sellstrom, E., Petticrew, M., 2009. The health impacts of housing improvement: a systematic review of intervention studies from 1887 to 2007. American Journal of Public Health 99, S681–S692.

Tischer, C.G., Hohmann, C., Thiering, E., Herbarth, O., Müller, A., Henderson, J., Granell, R., Fantini, M.P., Luciano, L., Bergström, A., Kull, I., Link, E., von Berg, A., Kuehni, C.E., Strippoli, M.-P.F., Gehring, U., Wijga, A., Eller, E., Bindslev-Jensen, C., Keil, T., Heinrich, J., as part of the ENRIECO consortium, 2011. Meta-analysis of mould and dampness exposure on asthma and allergy in eight European birth cohorts: an ENRIECO initiative. Allergy 66, 1570–1579.

Wallby, T., Hjern, A., 2011. Child health care uptake among low-income and immigrant families in a Swedish county. Acta Paediatrica 100, 1495–1503.
Weitoft, G.R., Hjern, A., Batljan, I., Vinnerljung, B., 2008. Health and social outcomes among children in low-income families and families receiving social assistance—A Swedish national cohort study. Social Science & Medicine 66, 14–30.
WHO, 2011. Environmental burden of disease associated with inadequate housing. A method guide to the quantification of health effects of selected housing risks in the WHO European Region. World Health Organization Regional Office for Europe, Copenhagen.
WHO, 2012. Environmental health inequalities in Europe. World Health Organization Regional Office for Europe, Copenhagen.

Appendix A

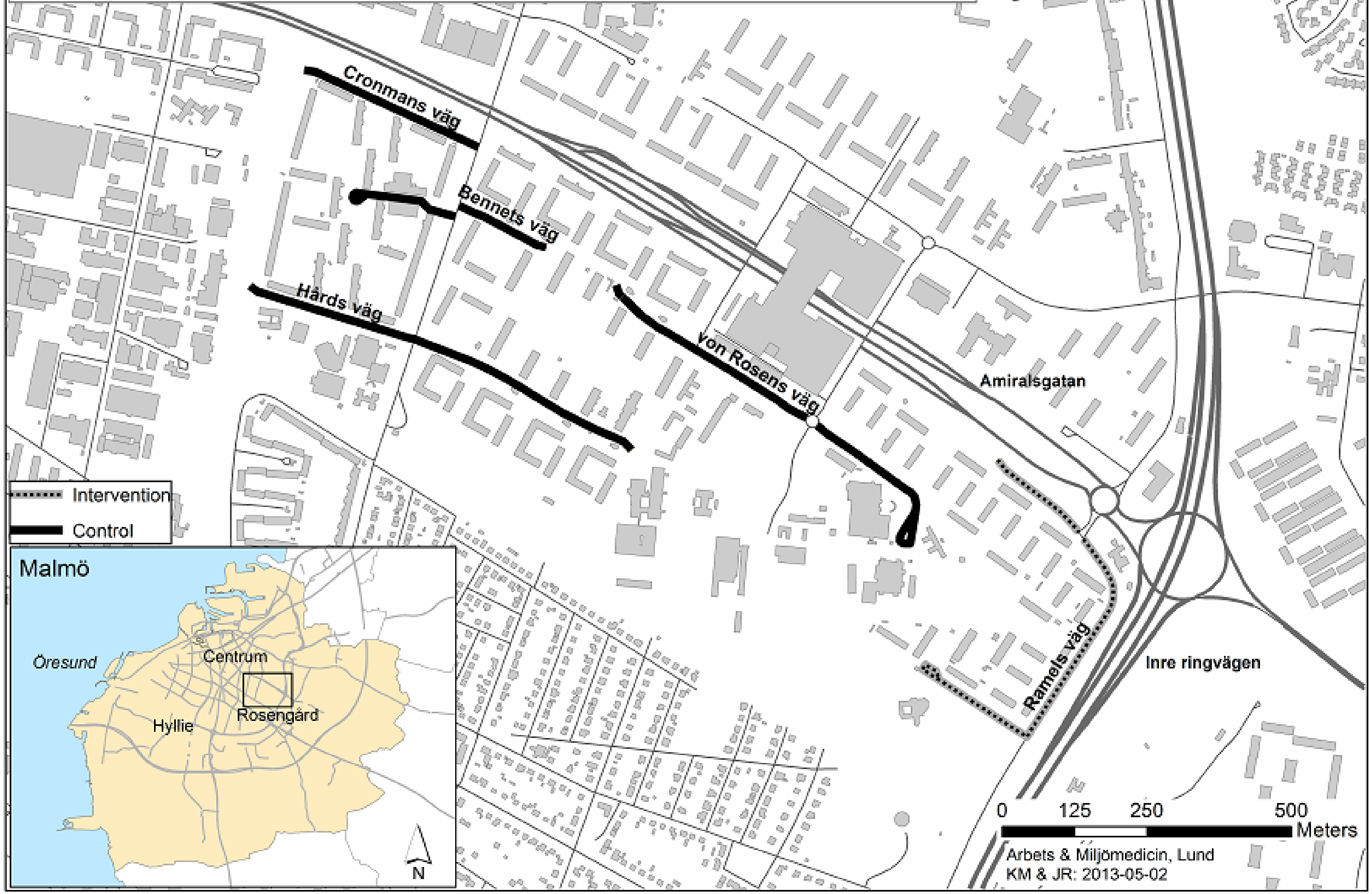
Description of the underlying study: background, design, methods, plan for analysis

The Division of Occupational and Environmental Medicine of Lund University, Sweden, developed and implemented a study with the aim to research the effects which renovations in apartments with multiple structural problems would have on respiratory and other health outcomes of children and families living in these apartments in Rosengård, a disadvantaged neighbourhood in the city of Malmö. Data collection was scheduled before and after the interventions. In the original study design, it was planned to recruit a population of children which already had had health care contacts for respiratory problems in the past, and then also include their siblings living in the same apartments.

The data collection for the initial part of the study was carried out mostly before renovations started in the individual apartments, but scheduling difficulties meant that in a few households renovations had already been carried out. As part of the underlying study, follow-up data was collected from all households after the renovations were carried out. This second round of data collection was wrapped up in early 2013, but the data is not used for the analysis presented in this thesis, which is only concerned with the data collected before the renovations.

Several months into the underlying study, it became apparent to the research team that the recruitment process was slow and that there were difficulties in reaching and recruiting many of the children from the index lists. In order to enrol a higher number children in the study, the recruitment framework was expanded. In order to have comparable exposure and sociodemographic characteristics, class lists for children between 6 and 11 years (class grades 0, 2, 3, 4, and 5) were pragmatically obtained from the local school, and all children currently domiciled in the intervention and control areas (see map in Appendix B) were marked. Data collection then proceeded in the same manner as for the index children (detailed description in Methods & Materials).

Appendix B: Overview of study area (section of Rosengård)



Appendix C

Table Self-reported exposures (lifestyle, behaviour, pests) by family category; p-value for comparison between index families and class-list families, derived from chi-squared test (Fisher's exact test); further subdivision into intervention (I) and control area (C) for each family category; * denotes statistical significance

	Index families (*n*=70)	Class-list families (*n*= 60)	p-value
Any household smoking, *n* (%)	18 (26) I: 10 (33) C: 8 (20) (p > 0.200)	30 (50) I: 10 (44) C: 20 (54) (p > 0.200)	0.006*
Mother smoking, *n* (%)	4 (6) I: 2 (7) C: 2 (5) (p > 0.200)	19 (32) I: 4 (17) C: 15 (41) (p = 0.088)	< 0.001*
Any use of waterpipe, *n* (%)	7 (10) I: 2 (7) C: 5 (13) (p > 0.200)	4 (7) I: 2 (9) C: 2 (5) (p > 0.200)	> 0.200
Any use of incense, *n* (%)	23 (33) I: 16 (53) C: 7 (18) (p = 0.002*)	20 (33) I: 13 (57) C: 7 (19) (p = 0.004*)	> 0.200
Current presence of cockroaches, *n* (%)	13 (19) I: 10 (33) C: 3 (8) (p = 0.011*)	7 (12) I: 5 (23) C: 2 (6) (p = 0.095)	> 0.200
Ever presence of cockroaches, *n* (%)	27 (39) I: 23 (77) C: 4 (10) (p < 0.001*)	21 (35) I: 16 (70) C: 5 (14) (p < 0.001*)	> 0.200

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