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Housing Quality and Child Mental Health: A Longitudinal Study

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Abstract

AIMS: This study investigated the longitudinal effects of internal and external housing quality problems on child mental health outcomes, as measured by child internalizing and externalizing behavior problems. The study also aimed to elucidate the mechanisms through which housing quality problems affect child mental health by testing the mediating effects of parenting style and child self-efficacy. **METHODS**: We examined these questions across three separate studies, using publicly available longitudinal data collected at three study waves between 1994 and 2002 as part of the Project on Human Development in Chicago Neighborhoods (PHDCN) study. We used hierarchical linear modeling methods to account for the multilevel structure of the data and study design, in which time, child variables, and neighborhood context were treated as three separate levels of data. We controlled for demographic variables including cohort age, race/ethnicity, gender, and household SES. **RESULTS**: Internal and external housing quality problems were associated with higher levels of child externalizing behavior problems (EBP) over time through direct and indirect routes. There was an interaction effect between external housing quality problems (EHQP) and race/ethnicity of the child in predicting levels of child EBP. Neither internal nor external housing quality problems were associated with child internalizing behavior problems (IBP) over time. We found a mediating effect of parenting harshness on the link between internal housing quality problems (IHQP) and child EBP. Child self-efficacy also partially mediated the relationships between IHQP/EHQP and child EBP, after controlling for demographic and parental variables. **CONCLUSION**: Our findings suggest that housing quality problems may have significant direct and indirect effects on increased child externalizing problems over time, but not on child internalizing problems. Policy and clinical implications of the findings, suggestions for future research, and limitations of the study are discussed.

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Introduction

An estimated 13% of children in poverty, and 4% of those above the poverty line, live in poor quality housing in the US (Joint Center for Housing Studies, 2009). Poor housing quality has been linked to depression, anxiety and reduced general mental health among adults (Freeman & Stansfeld, 2008). However, less is known about the relationship between housing quality and mental health problems among children. The few existing studies generally show a significant relationship between poor housing quality and diminished well-being among children, but the findings regarding mental health outcomes in particular are mixed. The longitudinal nature of the relationship between housing quality and child mental health outcomes and its mechanism are not well understood.

This is an important knowledge gap because home is where children are likely to spend the majority of their time while not attending school. To illustrate, in a study using large samples from several major cities in Canada and the US, children under the age of 11 spent, on average, 71-72% of their daily time indoors at home, and 3-4% of their time outdoors at home. Canadian and US adolescents aged 11-17 years spent 61-67% of their day indoors at home, and about 2% of their time outdoors at home (Leech, Nelson, Burnett, Aaron & Raizenne, 2002; adults in both countries spent about 64% of their time indoors at home). As children spend more time at home, they are more likely to be exposed to any negative or positive influences of the immediate home environment, such as the structural quality of the home.

Effects of housing quality on children have been consistently documented in studies of housing quality and cognitive development. A large body of cross-sectional and longitudinal studies has shown a positive association between high availability of learning materials in the

home and better cognitive development, among children (Iltus, 2006). Exposure to chronic noise at home or in the neighborhood has also been associated with reduced intellectual functioning among school-aged children (Cohen et al., 1986; Wachs, 1978). Living in a crowded home in childhood was also associated with lower academic achievement in adulthood (Conley, 2001), higher rates of repeating grades during elementary and middle school (Goux & Maurin, 2005), and increased rates of behavioral problems as rated by teachers among preschool children (Maxwell, 1996). Children living in poor housing conditions have been found to experience cognitive deficits such as reduced attention and memory skills or lower academic performance compared to controls (Evans, 2004; Krieger & Higgins, 2002). Lastly, studies on child creativity showed that design features of the home environment, such as brighter lighting and greater use of warm colors than cold colors, may be related with higher creativity levels among children (McCoy & Evans, 2002). Given the significant effects physical quality of the home environment can have on children's cognitive functioning and behavior, it can be hypothesized that housing quality may also influence child mental health outcomes.

Mental health problems occur commonly among children, with over 2 out of 5 children and 1 out of 5 children in the US experiencing at least one type of mental disorder and debilitating serious mental illness, respectively, during childhood (Merikangas et al., 2010). To better understand the causes and trajectories of child mental disorders, it is necessary to expand the investigative scope beyond traditional biopsychosocial factors to incorporate the effects of the child's immediate physical surroundings, as child mental health problems are likely to result from multiple interactions between biopsychosocial and environmental factors (Bradley, 1993). Housing quality is a key environmental factor for children because it is a predominant surrounding in which children develop.

The objective of this study is to investigate how housing quality is related to mental disorders among children using a longitudinal dataset. Adequate housing is regarded as a basic human right by the United Nations Convention on the Rights of the Child (1989) and several other international human rights treaties and laws. Yet a significant proportion of children are living in poor housing conditions that put their mental and physical health at risk. Because living in poor quality housing during childhood may have lifelong consequences such as higher mortality rates in adulthood (Dedman, Gunnell, Smith & Frankel, 2001), ameliorating poor housing quality may be a potential target for early public health intervention and prevention efforts. Furthermore, housing quality can be directly changed, unlike risk factors for poor mental health such as biological or demographic factors. The ultimate objective of this research is to help develop an intervention to improve physical aspects of children's home environments to promote mental health. It would be important to better understand how physical housing quality affects child mental health to deliver effective interventions to improve or mitigate the negative effects of poor housing quality. Findings of this study could also have implications for housing policy and planning.

Background

Definition of Housing Quality

The definition of housing quality greatly varies by the context in which the term is used (e.g. academic research vs. public sector monitoring), and so far there appears to be no standard definition of housing quality. Housing quality is also referred to in the literature as *housing condition, quality of accommodation, built environment of housing, or physical home environment*. Housing quality is generally assessed using a combination of physical features of the home, including structural quality (e.g. building/interior deterioration, facade), orderliness (e.g. cleanliness, clutter), climate (e.g. dampness, heating), crowding, pollution (e.g. noise, air quality), availability of learning materials (e.g. books, toys) and safety hazards (e.g. broken window/glass, exposure to drugs/alcohol/toxic materials) of the interior and/or exterior of homes, as well as functional features such as sanitation, water, and electricity supply (Evans, Saltzman, & Cooperman, 2001). In general, housing quality refers to the quality of multiple physical features of the internal and/or external home environment.

In academic studies on housing quality and mental health, housing quality has often been assessed using a combination of housing characteristics to reflect the multidimensional nature of a dwelling (Evans, 2006; Freeman & Stansfeld, 2008). Characteristics included structural deficiencies or damage (e.g. of walls, windows or roof), dampness, mold, crowding, noise, vermin infestation, cleanliness, clutter, adequate lighting, indoor climate, availability or resources for children in the home, or the quality of the physical or social environment around the house. Evans, Wells, Chan and Saltzman (2000) developed an observational measure to comprehensively assess housing quality to mirror the complexity of dwellings, including structural quality, privacy, indoor climate, hazards, cleanliness/clutter, and availability of

children's resources. However, the measure has not been widely used.

There have been some debates about the measurement and scope of definitions of housing quality. Some researchers have argued that measures of housing quality should place more emphasis on the perceived quality of housing by the residents rather than a more objective rating of quality (Harrison, 2004). This view, however, is not reflected in the majority of the studies on housing quality and mental health that have historically focused on objective ratings of housing quality. The preference for objective measurement of housing quality may be due to the need to control for the possible confounding relationship between perceived housing quality and mental health.

Other scholars have posited that some housing features that have traditionally been considered to be physical features may in fact be psychological or behavioral in nature. For instance, Freeman and Stands Feld (2008) have argued that crowding, a psychological perception, needs to be distinguished from *density*, which is a physical condition represented by the ratio of number of persons per space/room. They cited an experimental study by Freedman (1975) that showed that crowding no longer had a negative effect on physical, mental or social processes once smell, heat, fear and discomfort were controlled for, showing that physical density per se may not be the source of distress caused by crowding. While this distinction between crowding and density warrants further attention, most studies so far have operationalized "crowding" as density (i.e. number of persons per room; Evans, 2006).

Keall, Baker, Howden-Chapman, Cunningham, and Ormandy (2010) also argued for the need to distinguish between behavioral aspects of housing quality and pure physical/built aspects of the housing. They reasoned that housing problems such as mold or lack of electricity may be caused or worsened by the inhabitant's behaviors such as not providing adequate ventilation or

paying the electricity bills on time. In such cases, mold or lack of electricity may not reflect the qualities of the housing itself, which may be problematic when such features of housing are included in measures of housing quality used for housing policy and planning, or even academic research.

In the public sector, more standardized, deficiency-focused definitions have indeed been developed for purposes of national housing needs assessment and housing policy and planning, albeit not to the stringency or specificity of that proposed by Keall et al. (2010). For instance, the American Housing Survey (AHS) by the US Department of Housing and Urban Development (HUD) includes a construct named *housing adequacy*, which is a distinct and narrower concept than housing quality due to its focus on basic physical standards such as sanitation, water, heating, and electricity supply, reflecting the minimum housing standards prescribed by the US Housing Act (1949) – "a decent home and a suitable living environment" (Eggers & Moumen, 2013a). Housing adequacy, however, does not capture the wider range of variability in housing quality, especially in developed countries such as the US where only 1.8% of the surveyed housing units tend to be severely inadequate (Eggers & Moumen, 2013b).

To address this gap, the HUD has commissioned the development of the Poor Quality Index (PQI), which consists of a larger pool of weighed AHS items to reflect both quality and defects of housing, such as electricity problems, heating problems, inside structural problems (water leakage, holes in floor, rodents, cracks, peeling paint), outside structural problems (broken windows, roof or wall damage), bathroom problems, kitchen problems, water and sewage problems, and elevator problems (Eggers and Moumen, 2013b). These measures of housing adequacy or poor housing quality (PQI) slightly differ from the measures of housing quality used in academic studies on housing and mental health, which tend to include a wider range of quality

variables such as cleanliness, clutter, lighting, availability of learning materials, crowding and noise.

In sum, a consistent definition of housing quality across disciplines is lacking. As stated by Keall et al. (2010): "Internationally, the approach to assessing housing quality could be described as fragmented, reflecting a lack of national agreement about what is important in housing quality. The USA, for example has several different housing hazard assessment protocols". Our current lack of understanding of which particular aspects of housing quality affect mental health (Evans, 2006) compounds this difficulty in devising a uniform measure of housing quality, at least for mental health research purposes.

Acknowledging both the need for a consistent definition as well as the current lack of a scientific knowledge base to come up with such a definition, this study will take the more inclusive approach in defining housing quality: The quality of the internal and external physical features of the home environment. Housing quality indictors will include noise, density, cleanliness/clutter, indoor décor (e.g. adequate lighting, availability of pictures/art works on the wall), hazard level/materials inside and outside of the home, and quality of the environment around the housing (condition of buildings on face block of the housing, cleanliness, hazards, and volume of traffic of street in front of housing). The study will include multiple indicators of housing quality to reflect overall housing quality and to remain consistent with some of the prior studies on housing quality and children's mental health for comparison purposes. The use of a more comprehensive definition of housing quality will also allow us to investigate which particular features of the housing quality are important for mental health among children.

Theoretical Models on Housing Quality and Child Mental Health Outcomes

Most research on housing quality and child mental health outcomes so far has been built upon the bioecological model of human development by Bronfenbrenner (Bronfenbrenner & Morris, 2006). The model includes four primary components that interact: *process, person, context* and *time*. At the core of the model lies process, or what is more specifically referred to as *proximal processes*: "[H]uman development takes place through processes of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate external environment. To be effective, the interaction must occur on a fairly regular basis over extended periods of time. Such enduring forms of interaction in the immediate environment are referred to as *proximal processes*" (Bronfenbrenner & Morris, 2006). The effects of proximal processes on child development are moderated by the characteristics of the person, time, and context. Context, or immediate or distal environments, is multileveled, ranging from immediate microsystems to meso, exo and macrosystems, each nested in another "like a set of Russian dolls (Bronfenbrenner, 2005)".

The child's home may be an example of setting where a microsystem unfolds: "A microsystem is a pattern of activities, social roles, and interpersonal relations experienced by the developing person in a given face-to-face setting with particular physical, social, and symbolic features that invite, permit, or inhibit engagement in sustained, progressively more complex interaction with, and activity in, the immediate environment" (Bronfenbrenner & Morris, 2006). As such, features of housing quality may influence the child either directly (e.g. by providing sources of intellectual or emotional stimulation, or sense of stability and predictability or lack thereof) and/or by influencing the proximal processes that shape the child's development.

While Bronfenrenner's theory provides grounds for hypothesizing that the housing

environment may have direct and indirect effects on child mental health in the developmental trajectory, it does not explain *how* housing quality may affect child mental health.

Leventhal and Newman (2010) proposed a conceptual model on the role of housing in child development outcomes based on a synthesis of literature from various disciplines, spanning developmental psychology to economics (see Figure 1). The model incorporates different levels of the child's contextual influences in the environment that both affect and moderate the effects of housing. The model includes physical housing quality and five other housing features in its definition of "housing": crowding, housing mobility, homeownership, subsidized housing, and housing unaffordability.

The model begins with parent and family sociodemographic factors such as poverty, as well as macrosystem forces such as discrimination, that determine the level of housing features such as housing affordability and homeownership. These housing features can in turn affect extra-familial environments such as quality of neighborhoods, schools, and social networks; family processes such as parenting stress and style; and other housing features such as crowding, which can also be intertwined with negative family processes and increase risk for health problems for the child. Lastly, child characteristics also play into the model and moderate the relationship between housing features and child outcomes. Their review of literature on housing features and child well-being provided some support for this conceptual model.

However, more empirical studies are needed to test this model, as few studies have incorporated familial processes or other child characteristics in their investigations on housing and child outcomes. Furthermore, the definition of child outcomes in this model extends beyond mental health outcomes, including other developmental domains such as physical health and academic functioning. Although they are closely related, research so far suggest different types

of child outcomes may each be associated with distinct features of housing [e.g. home environmental toxins with physical health; availability of learning materials with academic functioning (lltus, 2006; Leventhal & Newman, 2010)]. The development and empirical testing of a conceptual model that would explain the relationship between housing quality and child mental health outcomes is thus warranted.

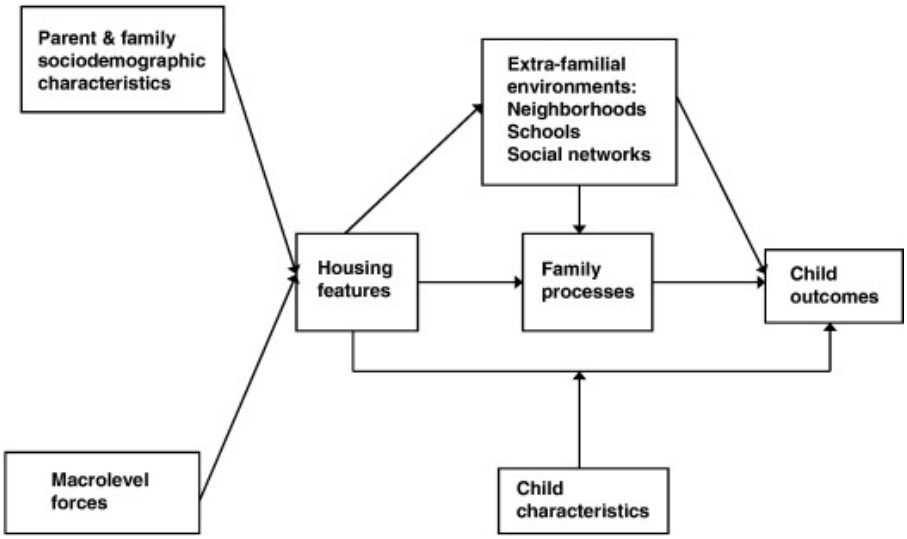


Figure 1. Conceptual Model on Housing and Child Outcomes by Leventhal and Newman (2010)

In this study, we will employ a conceptual model similar to that proposed by Leventhal and Newman (2010), but with a focus on the immediate microsystem of the child's home, in particular, housing quality (in contrast to including other housing features such as affordability, stability, or homeownership). In order to further isolate the effects of the immediate home surroundings on child mental health in our study, we will also control for neighborhood context. Based on previous research conducted in disciplines of developmental psychology, clinical psychology, and environmental psychology, our model hypothesizes that housing quality will

affect child mental health outcomes directly as well as through indirect pathways. There are two indirect pathways in the model: The first pathway is through the effect of housing quality on parenting quality, which would mediate child mental health outcomes. We hypothesize a mediating versus moderating role of parenting quality because of the critical role of parenting in child mental health outcomes, and the existing literature on the negative effects of poor housing quality on family dynamics and mental health and stress among adults. The second pathway links housing quality to a child's sense of self-efficacy, which then mediates child mental health outcomes, independent of the effects of parenting quality. We hypothesize a meditational role of self-efficacy based on the existing literature on the negative effects of various housing quality problems on child self-efficacy, which has in turn been linked with mental health outcomes. See **Figure 2** for an illustration of this model.

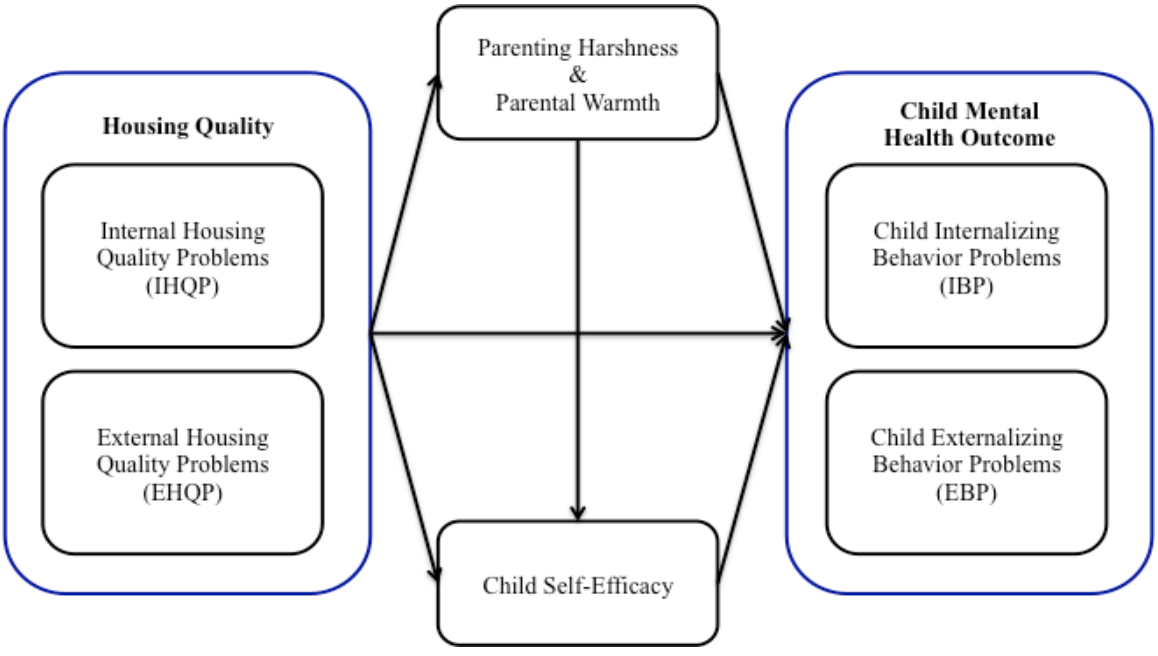


Figure 2. Conceptual Framework for this Study

The following sections will review the literature on the relationship between housing quality, parenting quality, child self-efficacy, and child mental health outcomes.

Review of Literature on Housing Quality and Child Mental Health Outcomes

Overall housing quality and child mental health outcomes. Literature on housing quality and child mental health outcomes is scarce and still growing. Seven studies were identified that investigated this relationship. Four of the seven studies reported significant associations between poor housing quality and child mental health problems after controlling for potential confounders (Blair et al., 2011; Coley et al., 2013; Evans et al., 2001; Mulligan et al., 2011). One longitudinal case study reported a decrease in child psychological distress after structural improvements in the housing through a public housing renewal project (Blackman & Harvey, 2011). One study did not find a direct association between housing quality and child mental health problems, but found an indirect effect of poor housing quality through parental stress and harsh, inconsistent, and cold parenting style on child externalizing and internalizing problems (Jocson & McLoyd, 2015). However, studies varied greatly in terms of study location (four were conducted in the US), age range, outcome variable and measures, and most of all, measures of housing quality, rendering a reliable conclusion difficult (see **Table 1** for summary of the seven studies).

Of the seven studies identified, one study did not show any associations between the physical aspects of home environment and internalizing or externalizing behaviors among young infants up to 2 years old (Rijlaarsdam et al., 2013). These findings may be specific to infants, or the context of Netherlands, where the study was conducted. The mothers included in the study were also of higher than average Socioeconomic Status (SES), and there may not have been enough variability of housing quality to show any effect on child behaviors. Nevertheless, low availability of learning materials in the home was associated with higher rates of subsequent internalizing behaviors.

Most studies used their own housing quality indices with no agreed upon definition of housing quality (see column on *Housing Quality Measure* in Table 1). Studies also used a range of outcome measures, including salivary cortisol levels as a measure of chronic stress (Blair et al., 2011); Child Behavior Checklist (CBCL), Revised Children's Manifest Anxiety Scale (RCMAS), and Social Skills Rating System (SSRS) to assess internalizing and externalizing behavior problems (Coley & Leventhal, 2013; Jocson & McLoyd, 2015; Rijlaarsdam et al., 2013); Children's Behavior Questionnaire to assess symptoms of depression, anxiety and conduct disorders (Evans et al., 2001); Connors' rating scale and semi-structured interview to measure symptoms of attention-deficit hyperactivity disorder (ADHD; Mulligan et al., 2011); and a set of items assessing behavioral indicators of psychological distress (Blackman & Harvey, 2001).

As for study design, five studies used longitudinal data (Blackman & Harvey, 2001; Blair et al., 2011; Coley & Leventhal, 2010; Rijlaarsdam et al., 2013), one of which was a case study using data gathered from families who were affected by a public housing renewal project (Blackman & Harvey, 2001). The age groups of study samples also varied greatly between studies, ranging from birth to age 17. In studies that included a wide range of age groups (e.g. infants/young children and adolescents), one found no differences between age groups in the relationship between housing quality and externalizing or internalizing behaviors (Coley & Leventhal, 2013), while another found an effect of housing quality on symptoms of ADHD in the younger sample only (Mulligan et al., 2011).

Previous studies also varied greatly on other sample characteristics, including SES, race/ethnicity makeup, size, gender, nationality, urbanity, and pre-existing mental health conditions. One study included only children with pre-existing ADHD diagnoses, who were 83%

male (Mulligan et al., 2011). Another study conducted in a rural area in New York State included a sample that was 94% White and primarily low-to-middle income households (Evans et al., 2001). One study conducted on infants across three US cities included only persons in poverty (Coley & Leventhal, 2013).

Two studies tested the meditational or moderational role of parenting stress or parenting style on the relationship between housing quality and child mental health outcomes. Coley and Leventhal (2013) found that maternal parenting stress and psychological distress partly mediated the link between poor housing quality and child emotional and behavioral problems. Jocson and McLoyd (2015) reported that higher level of housing disorder was linked with increased parental psychological distress, which was associated with higher harshness and inconsistency in parenting style and lower parental warmth. Increased use of harsh and inconsistent parenting methods then predicted child externalizing and internalizing behaviors three years later. Neither study, however, incorporated child factors such as self-efficacy as potential mediators/moderators.

To summarize, research shows that there may be a relationship between poorer housing quality and increased child mental health problems. Findings are mixed in regards to the effects of housing quality on child internalizing and externalizing problems in particular. While two studies found direct or indirect associations between poor housing quality and elevated child mental health problems (Coley & Leventhal, 2013; Jocson & McLoyd, 2015), one study did not find any associations (Rijlaarsdam et al., 2013). Only one study incorporated neighborhood context (i.e. neighborhood disorder, Jocson & McLoyd, 2015) in analyzing the effects of housing quality on child mental health outcomes.

Table 1. Literature on Housing Quality and Mental Health Outcomes in Children

Author	Sample	Location	CS^	LG^	Outcome Measure	Housing Quality Measure	Findings	Strengths	Limitations
Child Outcome Measure: Child Internalizing and Externalizing Behavior Problems									
Coley, Leventhal, Lynch and Kull (2013)	N = 2,437; ages 2-21 years	US (Boston, MA; Chicago, IL; San Antonio, TX)		x	Internalizing and externalizing problems (CBCL)	Structural, maintenance, and environmental deficiencies (i.e. leaking roofs, broken windows, vermin, heater or stove dysfunction, peeling paint, exposed wiring); presence of unsafe or unclean environments	Poor housing quality was associated with child interanlizing and externalizing problems; maternal parenting stress and psychological stress mediated the link between housing quality and child externalizing and internalizing behaviors	Tested moderation effect of child age and the role of parental stress-related variables in the association between housing and child mental health outcomes	Housing quality measure did not include crowding, noise, etc.; sample was mostly Hispanic and African American, low- and middle-income urban families, limiting generalizability
Jocson and McLoyd (2015)	N = 852; ages 6-16 years	US (Milwaukee, WI)		x	Internalizing and externalizing problems (Revised Children's Manifest Anxiety Scale, RCMAS; Social Skills Rating System, SSRS)	Level of housing disorder incidated by presence of leaking roof, broken windows, exposed electrical wires, or vermin	Housing disorder was not directly linked with child outcomes, but through indirect effect via parental stress and negative parenting behaviors; neighborhood disorder was positively associated with child externalizing behaviors	Used structural equational modeling to assess the inter-relationship between housing, neighborhood, parental, and child factors; accounted for neighborhood disorder	Housing quality and parenting behavior measures were largely derived from self-report instruments, potentially inflating scores; limited housing quality measure
Rijlaarsdam et al. (2013)	N = 2,711; ages 1.5 and 3	Netherlands		x	Internalizing and externalizing problems [Child Behavior Checklist (CBCL)]; vocabulary	Quality of the physical and learning environment of the home, using the HOME Inventory	Lower quality learning environment of the home, but not physical environment,was associated with delayed expressive vocabulary and more internalizing problems	Used a comprehensive measure of housing quality encompassing physical and learning environment of home, and examining mental health and learning outcomes	Sample consisted of infants only; parents were mostly of middle and high socioeconomic status, limiting generalizability
Child Outcome Measure: Socioemotional Well-Being or Indicators of Stress									
Blackman and Harvey (2011)	N = 253; youth under 16 years old (study also included adults, analyzed separately)	United Kingdom		x	Psychological distress (parent report), indicated by bed wetting, being upset or crying so much to interfere with functioning, concentration difficulties, or lack of appetite; use of health services	Participation in a public housing renewal project, involving improvements on walls, footpaths, security lighting and landscaping, etc.; self-report on presence of overcrowding, dampness, draughts, vermin, and various housing defects, etc. in the home	After housing renewal, children reported reduction in psychological distress and less visits to the general physician compared to pre-renewal; housing quality problems were not linked with child psychological distress, but draught and perception of safety of the housing area was linked with distress among adults	Measured longitudinal impact of housing renewal on mental health as well as service use	Being a case study, there may be sampling bias; difference between those who participated in renewal vs. control were not tested, but rather based on descriptive data; measures were mostly based on self-report; did not measure change in internal housing quality
Blair et al. (2011)	N = 1,135; ages 0-2 years old	US (NC, PA)		x	Allostatic stress (level of salivary cortisol)	Observer report of cleanliness, number of rooms, safety of home interior, safety of area outside the home building	Poor housing quality, African American ethnicity, and low positive caregiving behavior were each associated with high cortisol levels among children; parenting quality did not mediate poverty and child stress	Used biological measure to assess impact of poor housing quality on stress level, reducing bias entailed in self-report or parent-report measures of child distress	Findings limited to infants up to 2 years old; limited housing quality measure
Evans, Saltzman and Cooperman (2001)	N = 277; children in grades 3-5	United States (US; NY)	x		Socioemotional well-being and helplessness (Children's Behavior Questionnaire; persistence test)	Availability of child resources, cleanliness/clutter, indoor climatic conditions, privacy, hazards, and structural quality	Higher housing quality was associated with better mental health and task persistence after controlling for income	Investigated child motivation as a potentail mediator of child mental health outcomes	Sample consisted of children from majority White (94%), low and middle income families
Child Outcome Measure: Symptoms of Psychiatric Disorder									
Mulligan et al. (2011)	N = 96; ages 6-17	Ireland	x		ADHD, ODD, and CD* symptoms (parent and teacher-rated scales)	Quality of the physical and learning environment of the home, using the HOME Inventory	Negative correlation was found between hyperactivity/impulsivity and quality of physical environment (R=-.358) and learning materials (r=-.39) among children under 10 years with ADHD	Comprehensive measure of physical and learning environment of home; multi-informant measurement of child outcome	Sample includes only those with previous diagnosis of ADHD; lacked heterogeneity in regards to sex

^CS = Cross-Sectional Study; LG = Longitudinal Study

*ADHD = Attention Deficit Hyperactivity Disorder; ODD = Oppositional Defiant Disorder; CD = Conduct Disorder

Individual features of housing quality and child mental health outcomes. Individual features of housing quality such as noise, crowding, and availability of learning materials were shown to have negative effects on child emotional and behavioral problems. Chronic exposure to noise at home was associated with increased psychophysiological markers of stress such as resting systolic blood pressure and overnight urinary cortisol levels (Evans, Lercher, Meis, Ising, & Kofler, 2001), increased social withdrawal (Liddell & Kruger, 1989), and higher levels of aggression, conflict, and uncooperativeness among children (Aiello et al., 1979; Ruopp et al., 1979). Crowding, or residential density, of the home was associated with increased levels of neuroticism (Murray, 1974), psychological distress (Evans, Saegert, & Harris, 2001), and behavioral problems at school (Booth & Johnson, 1975). Higher residential density and lack of electricity were associated with lower rates of condom use among female and higher number of sexual partners among male adolescents in a study in South Africa (Burns & Snow, 2012). Availability of learning materials, traditionally investigated in relation to cognitive development, was also found to predict internalizing behaviors among younger children in a longitudinal study in Netherlands (Rijlaarsdam et al., 2013).

Other aspects of housing that were studied in relation to child mental health are type of housing (e.g. high rise vs. low-rise buildings) and floor level of housing, but they are often regarded as a distinct category from housing quality. Nonetheless, such studies have shown that children who live in high-rise buildings or higher floors tend to be more socially withdrawn and report fewer play opportunities (Evans, 2006; Freeman & Stansfeld, 2008). The association between residence in high rise buildings or higher floors and diminished child well-being has been hypothesized to be due to reduced physical activity and social contact entailed in living in high rise or higher floor housings. Another hypothesized reason for the link between higher

floors and lower child mental health is the indirect effects of increased anxiety caregivers experience – and perhaps communicate to children – in fear of their children falling out the window from higher unit floors (Freeman & Standsfeld, 2008).

In all, these studies show preliminary evidence that individual and overall physical aspects of the internal and external housing quality may have direct and indirect effects on child mental health outcomes. Our empirical understanding of the potential *mechanisms* that link housing quality to child mental health outcomes remains limited. Finally, more research is needed for findings to be generalized to children and adolescents of diverse racial, SES and geographic backgrounds.

In the following sections, we will review the literature on the relationships between the various components in the conceptual model for our study, including housing quality, parenting style, child self-efficacy, and child mental health outcomes.

Housing quality and parenting style. Parents living in crowded homes are more likely to use harsh parenting methods and be less responsive toward their children than those living in less crowded homes (Bradley et al., 1994; Evans, 2001). Crowding has also been associated with less monitoring of children by parents (Gove & Hughes, 1983), strained interactions among family members (Bartlett, 1998), and higher rates of child maltreatment by caregivers (Martin & Walters, 1982). Kasl et al. (1982) found that poor housing quality as measured by level of utility services, unit maintenance and structural deficiencies was related to harsher parenting but not related to mental health of inner city minority children. Because harsh parenting is predictive of various mental disorders in childhood and adulthood (Bender et al., 2007; Afifi et al., 2012), the findings by Kasl et al. (1982) suggest the possibility that harsh parenting may be a mediator of housing quality and child mental disorder. In all, studies on the relationship between overall

housing quality and parenting quality are lacking, as most studies to date have focused on single factors such as noise or crowding.

Parenting style and child mental health outcomes. There is extensive evidence that parenting quality has a critical effect on child mental health outcomes. Poor parenting can result in mental health problems in childhood (Rapee, 1997) as well as through adulthood (Parker et al., 1999). Among studies on children, parenting behaviors have been found to influence both child internalizing problems such as depression and anxiety, and externalizing problems such as conduct disorders (Hutchings & Lane, 2005; Scott, 2012). For instance, a meta-analysis of 45 studies on parenting and childhood depression revealed that parenting behaviors explained 8% of the variance in childhood depression (McLeod, Weisz, & Wood, 2007). The authors also found that parental hostility, as well as rejection (vs. parental control), was the most consistent predictors of childhood depression. McLeod, Wood, and Weisz (2007) also conducted a meta-analysis on 47 studies examining the relationship between parenting and childhood anxiety. For childhood anxiety, parenting accounted for 4% of its variance, and it was more strongly related to parental control rather than rejection. In a more recent, comprehensive meta-analytic review of 181 studies again found consistent reports on links between parenting and internalizing disorders among youth. The authors found that low parental warmth/ parental rejection/aversiveness, high parental control/over-involvement, and high parental conflict were related to childhood depression and anxiety (Yap, Pilkington, Ryan, & Jorm, 2014).

In numerous studies, harsh parenting – in verbal or physical form –, has been consistently found to be linked with child externalizing problems (Criss et al., 2002; Kim et al., 2003; McKee et al., 2007). A meta-analysis of studies on corporal punishment and child behaviors revealed that corporal punishment was a consistent predictor of externalizing problems such as aggressive

or disruptive behaviors among children (Gershoof, 2002). Harsh parenting has also been found to be associated with risk of internalizing problems such as depression and anxiety among children and adolescents in cross-sectional and longitudinal studies (Asarnow et al., 2001; Bender et al., 2007; Silk et al., 2009). In a study using US nationally representative adult samples, Afifi et al. (2012) found that childhood exposure to harsh parenting involving physical punishment predicted increased likelihood of mood disorders, anxiety disorders, substance/alcohol dependence, and personality disorders in adulthood, after controlling for confounding factors such as sociodemographic variables and family dysfunction.

To summarize, there appear to be consistent and strong evidence regarding the relationship between parenting behaviors marked by harshness, lack of warmth, and control and child mental health outcomes, including internalizing and externalizing problems.

Self-efficacy and child mental health outcomes. Bandura (1984) defined self-efficacy as "people's judgments of their capabilities to execute given levels of performance". According to Bandura (1999), low self-efficacy may cause depression and anxiety through multiple mechanisms. First is through unfulfilled goals, whereby one sets unrealistically high goals for oneself and fails to achieve, resulting in low self-efficacy, which in turn induces depression and anxiety. The second route is through low social efficacy. Low sense of social efficacy may deter individuals from seeking social support and contact; and low social support and isolation are predictors of depression and anxiety. The third pathway is through low perceived control over ruminative thoughts. A low sense of efficacy in one's ability to manage ruminative thoughts may lead to longer duration and higher intensity and frequency of ruminative thoughts, which in turn may increase risk for depression. In regards to anxiety in particular, Bandura (1988) has also

proposed that low perceived self-efficacy may increase anxiety through reduced sense of control over potential threats.

Low levels of self-efficacy have been linked with symptoms of depression and anxiety in studies on children and adults (Comunian, 1989; Ghaderi & Rangaiah, 2011; Parada et al., 2014). In a study using longitudinal data from the Project on Human Development in Chicago Neighborhoods (PHDCN) study, self-efficacy mediated the relationship between neighborhood processes and internalizing problems among adolescents (Dupere, Leventhal & Vitaro, 2012). Self-efficacy has also been found to predict a range of psychosocial outcomes, including peer preference, academic performance, and problem behaviors, among adolescents in a longitudinal study conducted in Italy (Caprara, Barbaranelli, Pastorelli, and Cervone, 2004).

Overall, there appears to be some evidence for an association between self-efficacy and internalizing and externalizing behaviors among youth. These findings suggest that if housing quality is linked to self-efficacy, self-efficacy may be a potential mediator or moderator of the relationship between housing quality and mental health outcomes.

Housing quality and self-efficacy. Few studies have investigated the link between housing quality and self-efficacy among children. Adult studies on housing quality and mental illness, mostly depression, show that the deleterious effects of poor housing quality on mental health may be mediated by perceived control over one's home. Shenassa et al. (2007), for instance, used a large dataset from eight European countries and investigated the link between dampness and mold in the home and depression, with perceived control over one's home as a hypothesized mediator. After controlling for other housing features such as ventilation, heat, lighting and crowding, dampness and mold were associated with both depression and perceived

control. Other studies found associations between crowding and noise at home and reduced sense of control (Gove, Hughes, & Galle, 1979).

Studies on children have also shown correlations between aspects of housing quality and indicators of self-efficacy. For example, chronic crowding and noise have been found to be associated with lower task motivation or helplessness on difficult puzzles among children (Evans, Lepore, Shejwal, & Palsane, 1998; Evans et al., 2001). In one study, crowding and helplessness were related among female but not male children between ages 10 to 12 years (Evans, Bullinger, & Hygge, 1998). The mechanism through which crowding or noise affects self-efficacy may be the sense of control over one's situation; in a laboratory study on adolescents by Sherrod (1974), crowding did not elevate helplessness anymore when the subjects had control over the level of crowding. While these findings shed light on potential mechanisms through which housing quality may affect mental health, none of the studies on children have used direct measures of self-efficacy such as by self-report questionnaires. Although task motivation as measured in the aforementioned studies may be an indicator of general self-efficacy, it may be task-specific. It is therefore still unclear whether housing quality affects general self-efficacy per se, which has been linked to mental health outcomes (Parada et al., 2014).

Parenting style and self-efficacy. Parenting style has been shown to predict self-efficacy among children. In a longitudinal study on toddlers, higher levels of maternal acceptance and responsiveness, and lower intrusiveness during the first few months of infancy predicted higher self-efficacy at 17 months of age. In a study on adolescents, Muris, Schmidt, Lambrichs, & Meesters (2001) found that self-efficacy mediated the relationship between negative parenting behaviors and adolescent depression, suggesting links between negative parenting practices such

as low parental warmth, higher rejection, and higher control and self-efficacy in adolescents. In another study on children, Hilsman and Garber (1995) found that parental reactions to children's report cards affected self-efficacy of children, which in turn was related to negative mood among children. In all, existing literature suggest that parenting style may contribute to child self-efficacy, that usually have consequences for child emotional adjustment.

Neighborhood context and child mental health outcomes. There has been evidence in the literature that neighborhood characteristics may be linked to mental health and behavioral problems among children. For instance, children's perceived neighborhood quality (including physical, social and resource qualities) was associated with their self-reported depression in a study conducted in New York City (Schaefer-McDaniel, 2009). Poorer neighborhood structural quality (e.g. condition of buildings, availability of electricity, etc.) has been found to be associated with higher sexual risk behaviors among adolescents in a study conducted in South Africa (Burns & Snow, 2012).

Evidence on the interplay between housing quality and neighborhood physical quality on child mental health outcomes is scarce, as most studies have studied the effects of either housing or neighborhood quality only. Nevertheless, a recent study showed that the structural quality of the immediate neighborhood, rather than that of housing, was a stronger predictor of externalizing behaviors among children, whereas housing quality was more important for the parents (Jocson & McLoyd, 2015).

Summary of the Literature

The literature review indicates that housing quality may be linked with child mental health outcomes, through direct and indirect pathways, although the findings are somewhat mixed: Most of the few studies existing on this topic have shown significant associations

between poor housing quality and psychological and physiological indicators of stress, increased internalizing and externalizing behavior problems, and hyperactivity and impulsivity symptoms among children with ADHD. These studies mostly involved children and adolescents versus young infants, and children from low-to-middle income households. However, two of the seven studies we reviewed did not find any direct links between lower housing quality and child internalizing and externalizing problems.

There are wide methodological variations among the studies that limit specificity and generalizability of findings. We do not know which specific features of housing quality affect mental health outcomes among children, as studies have used aggregate measures of housing quality. The measures of housing quality also vary greatly in their composition, and have not distinguished between internal or external features of the housing quality. In addition, several studies employed self-report measures of housing quality, which may introduce bias into reporting the level of problems in housing. Most study samples lacked heterogeneity in demographic variables such as SES and race/ethnicity, as their data were collected as part of public intervention projects, or included children with particular psychiatric diagnoses only. The majority of studies have used longitudinal data, but have not necessarily employed longitudinal analysis methods such as multilevel modeling using three or more data time points, limiting our understanding of the longitudinal nature of the link between housing quality and child mental health outcomes. None of the seven studies has controlled for the context of the immediate neighborhood in which the housing is embedded, although one study simultaneously investigated the effects of neighborhood disorder on child mental health through structural equation modeling.

Lastly, the mechanism through which housing quality affects child mental health remains unclear. Some studies have found a meditational role of parental stress and parenting behaviors in the effects of housing quality on child internalizing and externalizing problems. No study has empirically investigated the meditational or moderational role of child characteristics on the effect of housing quality on child mental health. Our literature review on the individual links between housing quality, parenting quality, child self-efficacy, neighborhood context, and child mental health outcomes suggests that these variables may be significantly interrelated to form a pathway between housing quality and child mental health outcomes. This study will therefore investigate these relationships, and contribute to a finer understanding of the effect of housing quality on child mental health outcomes over time.

Study Aims

The objective of this study is to investigate how housing quality is related to mental health outcomes, particularly internalizing and externalizing behavior problems, among children. As our definition of housing quality includes both internal and external features of housing quality, we will investigate measures of internal and external housing quality as separate predictor variables. We distinguish between internal and external housing quality because children tend to spend more time indoors than outdoors at home (Leech et al., 2002), and therefore may be differentially affected by internal or external housing features. To our knowledge there has been no study to date that has differentially examined the impact of internal and external housing quality on child mental health outcomes.

The specific aims and hypotheses, based on our conceptual model as well as findings from previous studies, are as follows:

- **Aim 1**: To test the association between overall and individual features of housing quality and child internalizing and externalizing behavior problems
    - ***Hypothesis 1.1****:* Poorer internal and external housing quality will be associated with higher levels of internalizing and externalizing behavior problems over time.
    - ***Hypothesis 1.2****:* Some individual housing features will be significantly linked with child internalizing and externalizing behavior problems, while others are not.
- **Aim 2:** To test the mediating effect of parenting harshness and warmth on the association between housing quality and child internalizing and externalizing behavior problems
    - ***Hypothesis 2****:* Parental harshness and warmth will mediate the relationship between housing quality and child internalizing and externalizing behavior problems.
- **Aim 3:** To test the mediating effect of child self-efficacy on the association between housing quality and child internalizing and externalizing behavior problems, after controlling for the effects of parenting harshness and/or parental warmth
    - ***Hypothesis 3****:* Child self-efficacy will mediate the relationship between housing quality problems and internalizing and externalizing problems, independent of the effects of parenting harshness and/or warmth. Specifically, we hypothesize that housing quality problems are linked with decreased child self-efficacy, which in turn is related with higher levels of internalizing and externalizing behavior problems among children.

Our study consisted of three parts, each addressing one of the three aims listed above.

Study Approach

Research Design

We used a publicly available dataset that followed a prospective longitudinal cohort study design. Data from all three study waves were analyzed using quantitative methods.

Data Source & Collection

This study was approved by the Northwestern University Institutional Review Board (NU IRB) with an exempt status, on August 15, 2014. Data were then obtained from the National Archives of Criminal Justice Data (NACJD) and Interuniversity Consortium for Political Science Research (ICPSR). All data were obtained and used in de-identified form.

We used data from the Project on Human Development in Chicago Neighborhoods (PHDCN) study (Earls, Brooks-Gunn, Raudenbusch, & Sampson, 2005). The PHDCN was an interdisciplinary project to investigate the effects of social/neighborhood/family/school environment on the developmental pathway of children and adolescents in Chicago.

The PHDCN used a three-stage sampling method to reduce sampling bias by: 1) selecting a stratified probability sample (stratified by racial-ethnic mix) of 80 Chicago neighborhood clusters (NC) out of 343 neighborhoods; 2) randomly selecting block groups within each neighborhood; and 3) contacting residents in each block group and including those that met the inclusion criteria of households with children ages 6 months or less, or 3, 6, 9, 12, 15 and 18 years old to form seven cohort groups (ages 0, 3, 6, 9, 12, 15 and 18). For each of the cohort groups, between 800 and 900 subjects were recruited, consented, and interviewed for each of the seven age groups. One primary caregiver was identified per household and interviewed with their consent. Data on male caregivers were also collected if the primary caregiver was female.

Regardless of gender, the primary caregiver responded to questionnaires/interview questions on the child subjects.

The PHDCN consists of three study components – the Community Survey, Systemic Social Observation, and the Longitudinal Cohort Study. We used data from the Longitudinal Cohort Study, which was conducted over 3 waves. Data for Wave 1 were collected between 1994 and 1997; Wave 2 between 1997 and 2000; and Wave 3 between 2000 and 2002. **Appendix 1.1** presents the number of participants and response rate per PHDCN study wave. To incorporate information on neighborhood context, we also used data from the PHDCN Community Survey, which was conducted in Wave 1 to assess aspects of the community as perceived by the study participants and aggregated into NC-level data.

For this study, we used data for cohorts 3, 6, 9, and 12 from all three PHDCN study waves. We outline the details of the samples used for each of the three parts of our study in the corresponding sections below.

Study Variables

Child internalizing and externalizing behavior problems. Child mental health outcomes were measured using internalizing (IBP) and externalizing behavior problem (EBP) scores on the Child Behavior Checklist/4-18 years (CBCL; Achenbach, 1991), as dependent variables in our study. Primary caregivers rated their children and adolescents on the level of child emotional and behavioral problems on items using a scale of 0-2 (0 = “not true”, 1 = “somewhat or sometimes true”, 2 = ”very true or often true”). In study wave 1, the full CBCL scale was used (113 items), and the reduced form of the CBCL (61 items) was used in waves 2 and 3. The CBCL has been shown to have high reliability (Cronbach’s alpha = .92-.94) and useful in predicting mental health outcomes among children and adolescents (Achenbach &

Rescorla, 2001). The items are aggregated to produce a total problem scale, two broad-band scales including internalizing and externalizing problem scales, and eight narrow-band subscales that fall under each internalizing and externalizing scales. For this study, we used the total raw scores for the internalizing and externalizing behavior problem scales to measure child mental health outcomes. The scores were standardized for use in this study.

The internalizing behaviors measured by this scale encompass anxious/depressed behaviors, somatic problems, withdrawal, social problems, thought problems, and attention problems. Examples of internalizing problem scale items include "has nightmares", "complains of loneliness", "bites nails", and "doesn't eat well". The externalizing behaviors problems measured by the CBCL include aggressive and delinquent behaviors. Examples of externalizing scale items include "argues a lot", "physically attacks people", and "cruel to animals".

Housing quality problems. Housing quality problems, the independent variable of this study, were measured using 15 items developed by the PHDCN staff to assess problems in physical conditions of the interior and exterior of the home environment. The items were added to the Home Observation for the Measurement of the Environment (HOME) inventory developed by Caldwell and Bradley (1984) in Wave 1 of the study. In Waves 2 and 3, items on the physical home environment were moved to another interview module of the PHDCN study, the Interviewer Assessment questionnaire.

The items were rated by the study interviewers based on observation of the subjects' home. Examples of items are: 'Home free of potential hazards?'; 'Home is clean and minimally cluttered?'; 'Rooms not overcrowded with furniture?'; 'Home not too noisy from noise in the house?'; 'Garbage, broken glass in street/sidewalk?' etc. In our study, the items were used to

form two scales indicating the level of problems in housing quality – internal housing quality problems (IHQP) and external housing quality problems (EHQP).

Appendix 1.2 presents the list of housing quality items. The IHQP score ranged from 0 to 9 (consisting of nine yes/no items), and the EHQP score ranged from 0 to 20 (consisting of six Likert-scale items). Higher scores represented more problems with housing quality, thus poorer housing quality.

Mediating variable 1: Parenting harshness and parental warmth. Parenting style was operationalized using two variables: parenting harshness and parental warmth. Both variables were created using items from the Home Observation for Measurement of the Environment (HOME) inventory/Home and Life Interview (Felton, Brooks-Gunn, Raudenbush, & Sampson, 2005) used in the PHDCN study. The HOME inventory is a widely used, semi-structured measure that combines parent report as well as interviewer observation to assess parenting practices. PHDCN study interviewers coded various yes/no items on parent behaviors toward the child based on their observations during the interview time. Because there was no aggregate subscale score for parent behaviors indicated in the dataset, we constructed parenting harshness and parental warmth variables by grouping items based on the face value of the item contents. We used face value to derive these subscales instead of statistical methods such as factor analysis because of the limited number of items that were consistently used across three study waves, due to variations in sets of items administered at each study wave.

See Appendix 1.3 for items included in each of the parenting variables. Only those items that were consistently included and worded equally across the three study waves were included. The parenting harshness variable included 3 yes/no items; higher scores represented higher

harshness. The parental warmth variable included 7 yes/no items, and higher scores represented higher warmth in how parents interacted with their children.

Mediating variable 2: Self-efficacy. Child self-efficacy was measured using the Things I Can Do If I Try survey, which was developed for the PHDCN study by the study administrators. The measure was administered in study waves 2 and 3, but not in wave 1, only to cohorts 9 and 12 (as well as cohort 15, who are not included in this study). The measure assesses child self-efficacy across five domains, including future, school, neighborhood, home and social domains, and consists 30 items, scored on a scale of 0 to 3, from Very True to Very Untrue. When aggregating the item scores, we reverse-coded items that were reverse-phrased. The total score of the self-efficacy measure ranged from 0 to 90, with higher scores representing higher self-efficacy. Appendix 1.4 presents the items of the Things I Can Do If I Try measure.

Control variables. ***Socioeconomic Status (SES).*** The PHDCN dataset includes a composite measure of SES that was computed by the PHDCN researchers through principal factor analysis, using data on annual household income, highest education level of the primary caregiver or the partner of the primary caregiver, and type of job held by the primary caregiver. We used this continuous SES variable derived by the PHDCN researchers to categorize the sample into high (top 33.33 percentile), middle (middle 33.33 percentile), and low SES (bottom 33.33 percentile) groups. We used the SES score from wave 1 only because the correlation of SES between wave 1 and wave 2 was high, $r = 0.86$ ($p < 0.001$).

Cohort. Cohort membership (3, 6, 9, or 12) was used as a categorical variable to control for age or cohort effects.

Gender. We used gender as identified in Wave 1, which was a dichotomous variable coded as female = 0 or male = 1.

Race/Ethnicity. Subjects were originally coded in the PHDCN study as Black, White, Latino, Pacific Islander, Native American, Asian, or Other. For this study, we only included subjects identified as Black, White, or Latino due to the low number of subjects in the other racial/ethnic categories, which would hinder any meaningful interpretation of results for those groups.

Neighborhood Context. In the PHDCN Community Survey dataset, there were two types of neighborhood variables that we could use control for neighborhood context – the neighborhood cluster (NC) physical disarray and SES level of the NC, which will be described in more detail below. As we did not have enough evidence from the literature to determine which of these two neighborhood factors would be more likely to be associated with child mental health outcomes, we tested both variables in our models to determine which one(s) to retain in our model tests as control variable(s). Our approach was to retain one or both of these neighborhood variables to control for neighborhood-level effects in our models if they explained a significant amount of variation in the dependent variables.

Physical disarray. We used the perceived physical disarray variable from the PHDCN Community Survey conducted in 1994 (Wave 1) to focus on the physical aspects of neighborhood quality. The variable consisted of three items that assessed the degree to which disorderly aspects of the neighborhood such as litter/broken glass, graffiti, and deserted buildings/stores were perceived to be a problem (See Appendix 1.5 for the list of items). Adult PHDCN participants responded to these items on a 3-point Likert scale. Scores for the physical disarray variable could range from 3 to 9, higher numbers indicating higher levels of perceived neighborhood physical disarray. The responses were then aggregated to the NC level.

Neighborhood cluster socioeconomic status (NC SES). NC SES refers to the SES level of the NC in which the child resides. The NC SES variable data were obtained from the PHDCN Longitudinal Cohort Study Wave 1. We used NC SES data from Wave 1 only because the correlations between NC SES levels between study waves 1 and 2 were high ($r = 0.83$, $p < .001$). As with the household SES variable described above, we categorized the NC SES variable into high (top 33.33 percentile), middle (middle 33.33 percentile), and low (bottom 33.33 percentile) SES groups. The NC SES was thus entered as a three-level categorical variable in our analyses.

Study 1

Aim of Study 1

The aim of Study 1 was to test the association between overall and individual features of internal housing quality problems (IHQP) and external housing quality problems (EHQP) and child internalizing and externalizing problems. We first hypothesized that higher IHQP and EHQP would be associated with higher levels of internalizing and externalizing problems over time (*hypothesis 1.1*). We further hypothesized that some individual features of IHQP and EHQP would be significantly associated with child internalizing and externalizing problems, while other individual IHQP and EHQP features will not be associated with child internalizing and externalizing problems (*hypothesis 1.2*).

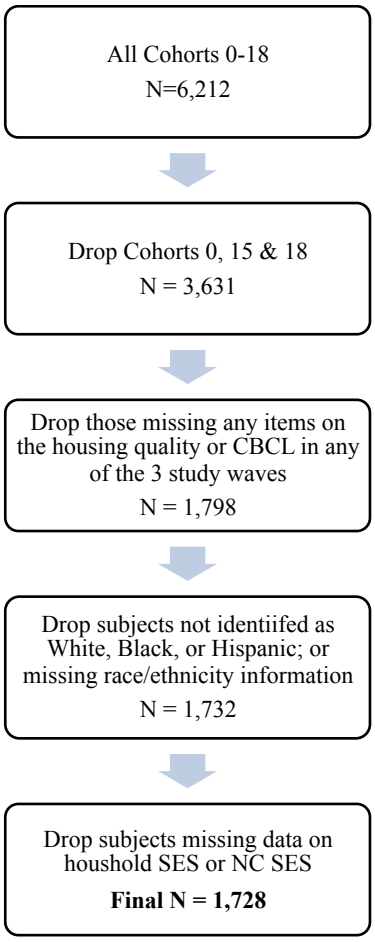
Method

Sample. We used data from the Longitudinal Cohort Study for cohorts 3, 6, 9, and 12 from all three study waves; only those who participated in all three study waves were included (N = 3,631). Cohorts 0, 15 and 18 were excluded because of differences in the measures used and/or completed across the three study waves due to aging (i.e. due to differences in items of CBCL versions given to infants vs. children and adolescents). Next, subjects with missing data for any of the housing quality items or child outcome measures (CBCL internalizing and externalizing variables) were subsequently excluded, resulting in a sample size of 1,798. Those cases were excluded because it was not possible to reliably impute missing values for the housing quality variables, as many of those variables were derived using discrete single items. For CBCL, it was the case in the PHDCN dataset that if the total internalizing or externalizing

scores were missing, the subject was missing all CBCL items, rendering imputation of missing data unreliable.

We then eliminated those subjects not identified as White, Black or Latino in regards to their race/ethnicity (Asian, N=22; Pacific Islander, N=4; Native American, N=15; or Other, N=24 in Wave 1) because the sample sizes for those groups were not large enough to draw reliable inferences. An additional subject was missing data on race/ethnicity and was dropped, resulting in a sample size of N = 1,732. Lastly, two subjects who were missing data on household SES and two subjects missing data on NC SES were excluded, resulting in a final sample of N = 1,728 for this study (See **Figure 3** for number of excluded subjects in each step).

Figure 3. Selection of sample for Study 1



We compared the subjects in our final sample to those who were excluded due to missing data on either housing quality variables or child internalizing and externalizing behavior problems (CBCL) for any differences in demographic characteristics or cohort membership (see Appendix 2.1 for results). Logistic regression results revealed that subjects from cohorts 9 and 12 were more likely to have been excluded from the final sample [Odds Ratio (OR) = 1.25, $p < .05$, 95% Confidence Interval (CI) = 1.04-1.50; and OR = 1.41, $p < 0.001$, 95% CI = 1.17-1.70, for cohort 9 and 12, respectively] than subjects from cohort 3. Excluded subjects were also significantly more likely to have moved residences between waves 1 and 2, and between waves 2 and 3 of the study (both $p < 0.001$). Those in the middle household SES group were also more likely to be excluded than those in the lower SES group (OR = 1.25, $p < 0.01$, 95% CI = 1.06-1.46). Lastly, Latino subjects were significantly less likely to be excluded from the final sample than the White subjects (OR = 0.81, $p < 0.05$, 95% CI = 0.66-0.99). We will discuss the implications of the differences in excluded and included samples on our findings in the discussion section of this manuscript.

Statistical analyses. ***Descriptive statistics*****.** Descriptive analyses were conducted to characterize the sample (N = 1,728) used in this study and obtain means and standard deviations (SD) for the study variables. As we observed lower mean internal housing quality problem scores in wave 2 compared to waves 1 and 3, we ran ANOVA tests to assess for statistically significant variations in the independent and dependent variables between study waves and/or demographic groups (i.e. by SES level and by race/ethnicity).

Next, bivariate correlation analyses were conducted to assess the relationships between demographic variables, internal and external housing quality variables, and child mental health outcomes.

Hypotheses testing: Multilevel analyses. To test hypothesis 1.1, we used three-level hierarchical linear modeling (HLM; Bryk and Raudenbush, 2002) methods to examine children's internalizing and externalizing behavior problems over time, where Level 1 is time, Level 2 is the child, and Level 3 is the NC. We used Stata 14.0 to conduct the analyses. To control for any statistically significant between-wave variations of study variables that were found during descriptive statistics analyses, the continuous variables – housing quality problems and child internalizing and externalizing problem variables – were standardized and time-centered before being entered into the HLM models.

The first step when using an HLM approach is to examine unconditional means models to determine whether there was significant within-person variance (Level 1) in internalizing and externalizing behavior problems over time that could be explained by factors other than time. Given there were non-zero within-person variances over time in internalizing or externalizing behavior problems, we next tested whether those variances were associated with within-person changes in internal and external housing quality over time, after controlling for gender, cohort, race/ethnicity, and household SES. Preliminary descriptive analyses showed significant differences in housing quality between racial/ethnic and SES groups, so we entered interaction terms (IHQP/EHQP by 3 levels of SES, and IHQP/EHQP by 3 groups of race/ethnicity) testing for interaction effects.

The next step was to test whether neighborhood characteristics (Level 3) were also associated with changes in child internalizing and externalizing problems. We entered NC-level variables, including NC SES and neighborhood physical disarray, to control for the effects of neighborhood characteristics on the relationships between IHQP/EHQP and child internalizing and externalizing problems. Because the NC physical disarray variable, but not the NC SES

variable, improved model fit when entered into each model, we only used the NC physical disarray variable to control for neighborhood context.

We next tested hypothesis 1.2, whether certain individual features of internal or external housing would be associated with changes in child internalizing and externalizing behavior problems. We conducted these tests on the models with significant relationships between IHQP or EHQP and internalizing or externalizing behavior problems over time in our tests of hypothesis 1. After testing the unconditional means model, we entered the full set of either internal or external individual housing quality variables, along with the control variables. Each individual housing quality variable was removed to identify the effect of that variable.

Final models were selected using Akaike Information Criterion (AIC; Akaike, 1974) and Bayesian Information Criterion (BIC; Schwarz, 1979) values. Smaller AIC and BIC values denote better fit and are used to compare maximum likelihood models (Burnham & Anderson, 2004).

Results

Descriptive statistics. Table 2.1. presents demographic characteristics of the sample. Approximately half of the sample consisted of Latino children (52.9%), followed by Black (32.8%), and White (14.3%). This is representative of the original over-representation of Latinos in the PHDCN dataset that reflects the demographic composition of Chicago at the time of the PHDCN data collection. The sample was otherwise almost equally divided by cohort, gender, and SES level.

Table 2.1

Sample Characteristics (N = 1,728)

Variable	N	%
Cohort		
3	512	29.6
6	489	28.3
9	373	21.6
12	354	20.5
Gender		
Female	871	50.4
Male	857	49.6
SES		
Low	608	35.2
Mid	534	30.9
High	586	33.9
Ethnicity		
White	247	14.3
Black	567	32.8
Latino	914	52.9

Table 2.2 presents means and standard deviations (SD) of scores on the continuous variable measures in our sample, before the scores were standardized for multivariate analyses. It is notable that the IHQP scores were lower in wave 2 in comparison to waves 1 and 3, across most individual IHQP features. Because this pattern was observed across SES and racial/ethnic groups in wave 2, this suppression of IHQP scores may be due to systemic bias in research administration in wave 2 rather than true change in IHQP. To control for any such systemic bias, we standardized the scores per study wave in our further analyses.

Table 2.2

Sample means and standard deviations (SD) on continuous variables (N = 1,728)

	Wave 1		Wave 2		Wave 3	
	Mean	SD	Mean	SD	Mean	SD
Internal Housing Quality						
Hazard (0-2)*	0.13	0.38	0.10	0.33	0.17	0.41
Density (0-2)	0.28	0.59	0.22	0.52	0.26	0.55
Cleanliness/Clutter (0-1)	0.11	0.31	0.09	0.29	0.12	0.32
Décor (0-2)	0.23	0.51	0.17	0.45	0.24	0.51
Noise (0-2)	0.26	0.57	0.13	0.4	0.22	0.56
External Housing Quality						
Structural Quality (0-9)	6.13	1.83	5.93	1.77	5.84	1.84

Traffic (0-5)	3.24	1.05	3.21	0.98	3.2	1.01
Cleanliness (0-3)	1.70	0.8	1.62	0.71	1.58	0.72
Hazard (0-3)	1.39	0.67	1.37	0.62	1.3	0.58
Child Internalizing Behaviors	8.22	6.63	8.05	6.99	8.32	7.45
Child Externalizing Behaviors	12.44	9.05	8.08	6.54	7.42	6.31
NC physical disarray	1.68	0.31	(not measured in waves 2 and 3)			

Note: NC = neighborhood cluster

*Minimum and Maximum Score Range for the Housing Quality Variables are Listed in Parentheses

Tables 2.3 and **2.4** present means in IHQP/EHQP, neighborhood physical disarray, and child IBP/EBP by household SES and race/ethnicity (significant differences between groups are marked with asterisks; see table footnote). Results of ANOVA tests on IHQP and EHQP scores by demographic characteristics revealed significant differences in levels of IHQP and EHQP between low, middle and high SES groups ($p < .001$), showing a reverse relationship between SES and level of housing quality problems. ANOVA test results also showed that Black subjects had significantly higher IHQP and EHQP scores than Latino and White subjects ($p < .001$). Latino subjects also had significantly higher IHQP ($p < .01$) and EHQP ($p < .001$) scores than White subjects, with the exception of IHQP scores in wave 2.

ANOVA test results on NC physical disarray revealed a reverse relationship between SES level and level of physical disarray in a NC. Latino subjects had significantly higher levels of NC physical disarray than Black and White subjects ($p < .001$); Black subjects had significantly higher levels of NC physical disarray than their White counterparts ($p < .001$). These differences were observed across all three study waves.

Table 2.3. Sample means and standard deviations (SD) on continuous variables by household SES (N = 1,728)

	Wave 1		Wave 2		Wave 3	
	Mean	SD	Mean	SD	Mean	SD
Internal Housing Quality Problems (IHQP)						
Hazard						
Low SES	0.20	0.46	0.13	0.38	0.21	0.44
Mid SES	0.13**	0.37	0.10	0.32	0.21	0.45
High SES	0.07**	0.28	0.06**	0.26	0.10**	0.29
Density						
Low SES	0.42	0.69	0.29	0.59	0.36	0.63
Mid SES	0.29**	0.57	0.23*	0.53	0.32	0.59
High SES	0.14**	0.42	0.22**	0.52	0.11**	0.36
Cleanliness/Clutter						
Low SES	0.15	0.36	0.13	0.34	0.13	0.34
Mid SES	0.12	0.32	0.09**	0.28	0.16	0.36
High SES	0.05**	0.22	0.05**	0.22	0.07**	0.26
Décor						
Low SES	0.29	0.55	0.22	0.52	0.31	0.56
Mid SES	0.25	0.53	0.17	0.46	0.27	0.52
High SES	0.15**	0.42	0.10**	0.36	0.14**	0.41
Noise						
Low SES	0.37	0.67	0.17	0.45	0.23	0.57
Mid SES	0.26**	0.58	0.13	0.40	0.28	0.61
High SES	0.13**	0.41	0.10**	0.35	0.15*	0.49
External Housing Quality Problems (EHQP)						
Structural Quality						
Low SES	6.73	1.67	6.58	1.67	6.39	1.69
Mid SES	6.34**	1.78	6.14**	1.62	6.11**	1.79
High SES	5.31**	1.73	5.07**	1.65	5.02**	1.76
Traffic						
Low SES	3.39	1.00	3.29	0.97	3.37	1.00
Mid SES	3.31	1.04	3.27	0.99	3.23*	1.01
High SES	3.02**	1.07	3.07**	0.97	2.99**	0.98
Cleanliness/Clutter						
Low SES	1.90	0.87	1.82	0.75	1.79	0.75
Mid SES	1.78**	0.80	1.69**	0.72	1.66**	0.74
High SES	1.41**	0.64	1.33**	0.55	1.30**	0.57
Hazard						
Low SES	1.47	0.73	1.49	0.71	1.42	0.66
Mid SES	1.45	0.69	1.45	0.65	1.33**	0.61
High SES	1.24**	0.53	1.18**	0.42	1.13**	0.38
Internalizing Behavior Problems (IBP)						
Low SES	9.61	7.51	9.15	7.50	9.61	8.11
Med SES	7.80	5.89	7.92	6.41	8.12	6.75
High SES	7.16	6.04	7.01	6.77	7.15	7.13
Externalizing Behavior Problems (EBP)						

Low SES	13.34	10.03	8.29	7.14	7.68	6.45
Med SES	12.65	8.62	8.28	6.29	7.75	6.15
High SES	11.31	8.24	7.66	6.17	6.86	6.29
NC physical disarray			(Not measured in waves 2 and 3)			
Low SES	1.81	0.26				
Med SES	1.71**	0.28				
High SES	1.53**	0.30				

Note: Significant differences between groups in housing quality problem variable and NC physical disarray are noted in asterisks, *$p < .05$; **$p < .01$ (Low SES is reference group)

Table 2.4. Sample means and standard deviations (SD) on continuous variables by race/ethnicity (N = 1,728)

	Wave 1		Wave 2		Wave 3	
	Mean	SD	Mean	SD	Mean	SD
Internal Housing Quality Problems (IHQP)						
Hazard						
White	0.08	0.31	0.05	0.26	0.08	0.27
Black	0.17**	0.45	0.16**	0.41	0.25**	0.46
Latino	0.12	0.34	0.06	0.27	0.15*	0.39
Density						
White	0.17	0.46	0.15	0.46	0.11	0.34
Black	0.37**	0.63	0.34**	0.62	0.34**	0.59
Latino	0.26*	0.58	0.16	0.45	0.26**	0.56
Cleanliness/Clutter						
White	0.06	0.25	0.06	0.25	0.06	0.24
Black	0.17**	0.38	0.14**	0.35	0.18**	0.38
Latino	0.08	0.26	0.06	0.24	0.10	0.30
Décor						
White	0.12	0.39	0.07	0.27	0.12	0.34
Black	0.32**	0.59	0.29**	0.59	0.37**	0.63
Latino	0.21*	0.47	0.12	0.38	0.19*	0.44
Noise						
White	0.15	0.43	0.10	0.34	0.17	0.50
Black	0.27**	0.57	0.25**	0.54	0.27*	0.57
Latino	0.27**	0.60	0.07	0.28	0.20	0.57
External Housing Quality Problems (EHQP)						
Structural Quality						
White	4.73	1.46	4.30	1.39	4.28	2.35
Black	6.68**	1.99	6.56**	1.85	6.49**	1.95
Latino	6.16**	1.60	5.98**	1.52	5.86**	1.63
Traffic						
White	2.93	1.04	2.91	1.01	2.76	0.92
Black	3.32**	1.10	3.35**	0.99	3.28**	0.98
Latino	3.28**	1.00	3.20**	0.95	3.27**	1.02
Cleanliness						
White	1.31	0.57	1.23	0.51	1.15	0.39
Black	1.91**	0.89	1.73**	0.77	1.71**	0.81

Latino	1.67**	0.75	1.65**	0.69	1.62**	0.69
Hazard						
White	1.17	0.48	1.11	0.39	1.05	0.24
Black	1.60**	0.80	1.46**	0.68	1.41**	0.70
Latino	1.32**	0.57	1.39**	0.62	1.29**	0.53
Internalizing Behavior Problems (IBP)						
White	6.88	5.76	7.05	6.99	6.84	6.44
Black	8.05	6.50	7.65	7.14	8.34	7.82
Latino	8.69	6.89	8.56	6.85	8.70	7.43
Externalizing Behavior Problems (EBP)						
White	10.87	8.53	7.57	6.06	6.39	5.49
Black	13.80	9.22	9.49	6.92	8.98	7.13
Latino	12.02	8.99	7.34	6.27	6.74	5.78
NC physical disarray			(not measured in waves 2 and 3)			
White	1.43	0.25				
Black	1.69**	0.32				
Latino	1.75**	0.27				

Note: Significant differences between groups in housing quality problem variable and NC physical disarray are noted in asterisks, *$p < .05$; **$p < .01$ (White is reference group)

Table 2.5 presents bivariate correlations between study variables across all three study waves, with the exception of race/ethnicity and gender variables. Cohort membership was more strongly related with child EBP than IBP. Older cohort membership was significantly correlated with lower externalizing behaviors. While the correlation between cohort membership and internalizing behaviors is also statistically significant, the coefficient is close to zero ($r = .04$, $p < .01$).

Household SES was correlated with all study variables except for cohort membership. Higher household SES was associated with lower internal and external housing quality problems, lower NC physical disarray, and lower child internalizing and externalizing problems. Household SES showed a stronger correlation with EHQP ($r = -.37$, $p < .001$) and NC physical disarray ($r = -.43$, $p < .001$) than IHQP ($r = -.20$, $p < .001$). NC SES showed similar correlational patterns as household SES with most study variables; NC SES showed higher correlations with EHQP,

problems of the external housing structural quality (EHQP structural quality), and NC physical disarray than household SES.

Total IHQP and EHQP scores were positively correlated ($r = .35$, $p < .001$). Both IHQP and EHQP were positively correlated with NC physical disarray ($r = .17$ and $.45$, respectively, $p < .001$), with EHQP showing a higher correlation coefficient with the NC variable.

Child IBP and EBP variables were highly positively correlated ($r = .59$, $p < .001$). Both variables showed similar levels of correlation coefficients with all housing quality variables, with EBP showing slightly higher correlations with IHQP and some EHQP variables. Both child IBP and EBP were similarly correlated with NC physical disarray and NC SES. Household SES had a slightly higher correlation coefficient with child IBP ($r = -.14$, $p < .001$) than with child EBP ($r = -.07$, $p < .001$).

Table 2.5. Bivariate correlations between all study variables, across 3 waves [N = 5184 (1728 subjects x 3 waves)]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Cohort	1																
2. Household SES	-.03	1															
3. NC SES	-.03	.42***	1														
4. Child IBP	.04**	-.14***	-.08***	1													
5. Child EBP	-.21***	-.07***	-.08***	.59***	1												
6. IHQP-Total	.00	-.20***	-.19***	.06***	.13***	1											
7. IHQP-hazard	.03	-.12***	-.13***	.04**	.09***	.74***	1										
8. IHQP-density	-.01	-.19***	-.16***	.04**	.09***	.77***	.43***	1									
9. IHQP-clean	.00	-.12***	-.13***	.07***	.10***	.62***	.40***	.48***	1								
10. IHQP-décor	.01	-.15***	-.14***	.04**	.09***	.74***	.43***	.42***	.38***	1							
11. IHQP-noise	-.01	-.12***	-.12***	.06***	.11***	.74***	.53***	.39***	.24***	.42***	1						
12. EHQP Total	-.01	-.37***	-.46***	.07***	.11***	.35***	.25***	.28***	.25***	.28***	.21***	1					
13. EHQP Struct. Qual.	.00	-.38***	-.47***	.06***	.11***	.32***	.23***	.28***	.23***	.26***	.17***	.90***	1				
14. EHQP traffic	.01	-.16***	-.17***	.02	.03*	.12***	.08***	.09***	.04**	.08***	.13***	.56***	.28***	1			
15. EHQP hazard	-.01	-.21***	-.30***	.07***	.08***	.28***	.19***	.21***	.23***	.26***	.14***	.71***	.53***	.18***	1		
16. EHQP clean	-.02	-.31***	-.38***	.07***	.09***	.35***	.25***	.27***	.26***	.29***	.20***	.81***	.64***	.25***	.72***	1	
17. NC Physical Disarray	.00	-.43***	-.78***	.08***	.07***	.17***	.12***	.15***	.14***	.13***	.08***	.45***	.44***	.19***	.28***	.38***	1

Note: SES = Socioeconomic Status; NC = Neighborhood Cluster; IBP = Internalizing Behavior Problems; EBP = Externalizing Behavior Problems; IHQP = Internal Housing Quality Problems; EHQP = External Housing Quality Problems; Struc. Qual. = Structural Quality

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Results of test of hypothesis 1.1. Tables 2.6 to **2.9** present the HLM test results for hypothesis 1.1. Each of the four pairs of associations, between IHQP/EHQP and child IBP/EBP, were tested. We next elaborate on the results of each of the four associations.

Internal housing quality problems (IHQP) and child internalizing behavior problems (IBP; Table 2.6). We first tested the unconditional growth model to examine whether there were significant variations in child internalizing behavior problems over time (see Column 2 in **Table 2.6**). Results indicated significant non-zero variance in child internalizing behavior problems over time (Residual = 0.43, 95% CI = 0.40-0.46, Singer & Willett, 2003) and thus we progressed to testing subsequent levels of the model. We next tested whether changes in IHQP were associated with changes in child IBP over time (Model 1). Results showed a small but significant association between changes in IHQP and child IBP. For every unit increase in IHQP, there was an increase of 0.026 standard deviations in child internalizing problems over time ($p < 0.05$). This association remained significant after controlling for cohort membership (Model 2). However, when household SES was entered into the equation (Model 3), the association between IHQP and child IBP was no longer statistically significant. Entering the remaining control variables – race/ethnicity, gender, and NC physical disarray – did not improve the model fit (see Model 4, 5, and 6). Model 3 demonstrated the best model fit as indicated by lowest AIC and BIC values. Therefore, we concluded that after controlling for cohort and household SES, IHQP did not have a significant association with child IBP over time.

Table 2. 6.
HLM Results: Internal Housing Quality Problems (IHQP) and Child Internalizing Behavior Problems (IBP)

	UM^	Level 2					Level 3
		Model 1	Model 2	**Model 3**	Model 4	Model 5	Model 6
Regression coefficients (fixed effects)							
Intercept	2.97e-10 (.019)	.000 (.012)	.032 (.036)	**.220 (.044)*** **	.127 (.073)	.140 (.076)	.151 (.076)*
IHQP		.026 (.012)*	.026 (.012)*	**.017 (.012)**	.018 (.013)	.018 (.013)	.017 (.013)
Cohort							
3 (Ref.)							
6			-.133 (.051)**	**-.145 (.050)****	-.145 (.050)**	-.144 (.050)**	-.146 (.050)**
9			-.053 (.055)	**-.064 (.054)**	-.067 (.054)	-.066 (.054)	-.067 (.053)
12			.084 (.056)	**.067 (.055)**	.068 (.055)	.069 (.055)	.070 (.055)
Household SES							
Low (Ref.)							
Middle				**-.215 (.047)*** **	-.201 (.048)***	-.200 (.048)***	-.192 (.048)***
High				**-.330 (.046)*** **	-.292 (.051)***	-.292 (.051)***	-.269 (.053)***
Race/Ethnicity							
White (Ref.)							
Black					.061 (.063)	.059 (.063)	.039 (.065)
Hispanic					.106 (.063)	.104 (.063)	.081 (.064)
Gender							
Male (Ref.)							
Female						-.027 (.038)	-.029 (.038)
NC Disarray							.033 (.021)
Variance components (random effects)							
Residual	.429 (.015)	.430 (.015)	.430 (.015)	**.430 (.015)**	.430 (.015)	.430 (.015)	.430 (.015)
95% CI	*.402-.459*						
Intercept	.514 (.023)	.511 (.023)	.505 (.023)	**.487 (.022)**	.486 (.022)	.486 (.022)	.485 (.022)
95% CI	*.471-.561*						
Slope	.084 (.013)	.084 (.013)	.084 (.013)	**.084 (.013)**	.084 (.013)	.084 (.013)	.084 (.013)
95% CI	*.062-.112*						
Covariance	.022 (.011)	.022 (.011)	.024 (.011)	**.026 (.011)**	.026 (.011)	.026 (.011)	.026 (.011)
95% CI	*.001-.042*						
Model sumary							
Deviance statistic	13,528.17	13,523.85	13,507.75	**13,455.77**	13,452.64	13,452.15	13,449.79
df	0	1	4	**6**	8	9	10
Wald Chi-Square	N.A.	4.34*	20.65***	**74.22*** **	77.51***	77.99***	80.42***
AIC	13,538.17	13,535.85	13,525.75	**13,477.77**	13,478.64	13,480.15	13,479.79
BIC	13,570.94	13,575.17	13,584.73	**13,549.85**	13,563.83	13,571.89	13,578.09

Note 1: Standard errors listed in parentheses

Note 2: **Bold =** best-fit model based on AIC and BIC values.

Note 3: UM = unconditional model; Ref. = reference group; NC = Neighborhood Cluster

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Internal housing quality problems (IHQP) and child externalizing behavior problems (EBP; Table 2.7). We first tested the unconditional growth model to determine whether there was adequate variation in child EBP over time to warrant further examination (see Column 2 in **Table 2.7**). Results of the unconditional growth model indicated that there was, so we progressed to testing subsequent models. In Model 1, change in IHQP is associated with change in child EBP over time. Results showed a significant association between change in IHQP and change in child EBP. For every unit increase in IHQP, there was an increase of 0.042 standard deviations in child EBP over time ($p < 0.001$). This association remained significant after controlling for cohort membership (Model 2), household SES (Model 3), race/ethnicity (Model 4), gender (Model 5), and NC physical disarray (Model 6). Models 5 and 6 demonstrated similar model fit in regards to AIC and BIC values. Although Model 5 had one less independent variable in the equation, and hence would be the more parsimonious explanation, we chose Model 6 as the final model for this study, as it contains all the control variables of theoretical relevance in our study, i.e. NC disarray.

We further tested for any interaction effects between IHQP and household SES or IHQP and race/ethnicity in relation to changes in child EBP. Adding the interaction terms to Model 6 showed significant interaction effects of both race/ethnicity and household SES with IHQP in predicting child behavioral problems, but did not improve the fit of the models (See Appendix 2.2 for the output results). We therefore chose Model 6 as our final model and concluded that an increase in IHQP was significantly associated with higher child EBP over time, after controlling for cohort, household SES, race/ethnicity, gender, and NC physical disarray.

Table 2. 7.

HLM Results: Internal Housing Quality Problems (IHQP) and Child Externalizing Behavior Problems (EBP)

	UM^	Level 2					**Level 3**
		Model 1	Model 2	Model 3	Model 4	Model 5	**Model 6**
Regression coefficients (fixed effects)							
Intercept	-3.07e-09 (.020)	.000 (.020)	.158 (.037)***	.220 (.047)***	.189 (.077)*	.118 (.079)	**.135 (.079)**
IHQP		.042 (.011)***	.043 (.011)***	.039 (.011)**	.032 (.011)**	.031 (.011)**	**.029 (.012)***
Cohort							
3 (Ref.)							
6			-.177 (.053)**	-.180 (.053)**	-.174 (.052)**	-.177 (.052)**	**-.180 (.052)****
9			-.268 (.057)***	-.270 (.057)***	-.253 (.056)***	-.255 (.056)***	**-.256 (.056)*****
12			-.243 (.058)***	-.247 (.058)***	-.252 (.057)***	-.255 (.057)***	**-.254 (.057)*****
Household SES							
Low (Ref.)							
Middle				-.037 (.050)	-.091 (.050)	-.095 (.050)	**-.080 (.050)**
High				-.145 (.049)**	-.195 (.053)***	-.197 (.053)***	**-.159 (.055)****
Race/Ethnicity							
White (Ref.)							
Black					.262 (.066)***	.272 (.066)***	**.237 (.067)*****
Hispanic					-.048 (.065)	-.039 (.065)	**-.078 (.067)**
Gender							
Female (Ref.)							
Male						.135 (.040)**	**.131 (.040)****
NC Disarray							**.056 (.022)***
Variance components (random effects)							
Residual	.326 (.011)	.327 (.011)	.327 (.011)	.326 (.011)	.326 (.011)	.326 (.011)	**.326 (.011)**
95% CI	*.305-.348*	*.306-.349*	*.306-.349*	*.305-.349*	*.305-.349*	*.305-.349*	***.305-.349***
Intercept	.616 (.025)	.607 (.025)	.598 (.024)	.595 (.024)	.576 (.024)	.572 (.023)	**.569 (.023)**
95% CI	*.569-.666*	*.560-.657*	*.552-.648*	*.549-.644*	*.531-.624*	*.527-.620*	***.525-.617***
Slope	.087 (.010)	.087 (.010)	.087 (.010)	.087 (.010)	.087 (.010)	.087 (.010)	**.087 (.010)**
95% CI	*.069-.109*	*.069-.110*	*.069-.110*	*.069-.110*	*.069-.109*	*.069-.109*	***.069-.109***
Covariance	.009 (.010)	.011 (.010)	.025 (.011)	.026 (.011)	.021 (.010)	.022 (.010)	**.022 (.010)**
95% CI	*-.011-.029*	*-.009-.031*	*.004-.046*	*.006-.047*	*.001-.042*	*.002-.042*	***.001-.042***
Model sumary							
Deviance statistic	12,915.18	12,915.18	12,901.88	12,875.65	12,818.27	12,806.69	**12,800.35**
df	0	1	4	6	8	9	**10**
Wald Chi-Square	N.A.	13.48***	42.74***	52.81***	101.47***	113.92***	**120.60*****
AIC	12,925.18	12,925.18	12,913.88	12,893.65	12,844.27	12,834.69	**12,830.35**
BIC	12,957.95	12,957.95	12,953.20	12,952.63	12,929.46	12,926.43	**12,928.65**

Note 1: Standard errors listed in parentheses

Note 2: **Bold =** best-fit model based on AIC and BIC values.

Note 3: UM = unconditional model; Ref. = reference group; NC = Neighborhood Cluster

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

External housing quality problems (EHQP) and child internalizing behavior problems (IBP; Table 2.8). As we had already found considerable variance in child IBP over time, we progressed to testing subsequent levels of the model (see **Table 2.8**). Model 1 tested whether changes in EHQP was associated with changes in child IBP over time. Model 1 results showed a significant association between change in EHQP and change in child IBP. For every unit increase in EHQP, there was an 0.040 standard deviations increase in child IBP over time ($p < 0.01$). This association remained significant after controlling for cohort membership (Model 2; $p < .001$). Model 2 also showed that cohort 6 had a negative slope in relation to cohort 3 in the rate of change in IBP over time. The other cohorts were not significantly different from cohort 3.

In Model 3, household SES was entered as an additional control variable. Controlling for household SES rendered the association between EHQP and child IBP no longer significant. The middle and high household SES groups had significantly lower rate of change in IBP than the low household SES group ($p < .001$) Additionally controlling for race/ethnicity, NC SES, gender, or NC physical disarray in subsequent models did not change the lack of association between EHQP and child IBP. Based on the lowest AIC and BIC values, we determined that Model 3 demonstrated the best model fit.

We further tested for any interaction effects between EHQP and household SES in predicting changes in child IBP. Adding the interaction term 'EHQP by household SES' to Model 3 did not improve the model fit, hence the term was discarded (see Appendix 2.3 for the model test results).

We, therefore, concluded that there was no significant association between EHQP and child internalizing problems over time, after controlling for cohort membership and household SES.

Table 2. 8.
HLM Results: External Housing Quality Problems (EHQP) and Child Internalizing Behavior Problems (IBP)

	UM^	Level 2					Level 3
		Model 1	Model 2	**Model 3**	Model 4	Model 5	Model 6
Regression coefficients (fixed effects)							
Intercept	2.97e-10 (.019)	.000 (.019)	.032 (.036)	**.217 (.045)*** **	.134 (.073)	.148 (.076)	.156 (.076)*
EHQP		.040 (.014)**	.040 (.014)**	**.019 (.014)**	.018 (.014)	.018 (.014)	.014 (.015)
Cohort							
3 (Ref.)							
6			-.133 (.051)**	**-.144 (.050)****	-.145 (.050)**	-.144 (.050)**	-.145 (.050)**
9			-.055 (.055)	**-.065 (.054)**	-.068 (.054)	-.076 (.054)	-.067 (.054)
12			.082 (.056)	**.066 (.055)**	.067 (.055)	.068 (.055)	.069 (.055)
Household SES							
Low (Ref.)							
Middle				**-.213 (.047)*** **	-.200 (.048)***	-.200 (.048)***	-.193 (.048)***
High				**-.323 (.047)*** **	-.289 (.051)***	-.288 (.051)***	-.270 (.053)***
Race/Ethnicity							
White (Ref.)							
Black					.051 (.064)	.049 (.064)	.035 (.065)
Hispanic					.096 (.063)	.094 (.063)	.076 (.064)
Gender							
Male (Ref.)							
Female						-.027 (.038)	-.029 (.038)
NC Disarray							.030 (.022)
Variance components (random effects)							
Residual	.429 (.015)	.430 (.015)	.430 (.015)	**.429 (.015)**	.429 (.015)	.429 (.015)	.429 (.015)
95% CI	*.402-.459*	*.402-.459*	*.402-.459*	***.402-.459***	*.402-.459*	*.402-.459*	*.402-.459*
Intercept	.514 (.023)	.509 (.023)	.504 (.023)	**.488 (.022)**	.487 (.022)	.487 (.022)	.486 (.022)
95% CI	*.471-.561*	*.467-.556*	*.462-.550*	***.447-.533***	*.446-.532*	*.445-.532*	*.445-.531*
Slope	.084 (.013)	.084 (.013)	.084 (.013)	**.084 (.013)**	.084 (.013)	.084 (.013)	.084 (.013)
95% CI	*.062-.112*	*.063-.112*	*.063-.112*	***.062-.112***	*.062-.112*	*.062-.112*	*.062-.112*
Covariance	.022 (.011)	.021 (.011)	.023 (.011)	**.026 (.011)**	.026 (.011)	.026 (.011)	.025 (.011)
95% CI	*.001-.042*	*.0004-.042*	*.001-.045*	***.004-.047***	*.004-.048*	*.004-.047*	*.004-.047*
Model sumary							
Deviance statistic	13,528.17	13,519.64	13,503.83	**13,455.78**	13,453.10	13,452.61	13,450.73
df	0	1	4	**6**	8	9	10
Wald Chi-Square	N.A.	8.58**	24.59***	**74.11*****	76.91***	77.40***	79.33***
AIC	13,538.17	13,531.64	13,521.83	**13,477.78**	13,479.10	13,480.61	13,480.73
BIC	13,570.94	13,570.96	13,580.81	**13,549.86**	13,564.29	13,572.35	13,579.03

Note 1: Standard errors listed in parentheses
Note 2: **Bold =** best-fit model based on AIC and BIC values.
Note 3: UM = unconditional model; Ref. = reference group; NC = Neighborhood Cluster
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

External housing quality problems (EHQP) and child externalizing behavior problems (EBP; Table 2.9). As we had already found considerable variation in child EBP over time in our sample, we progressed to testing subsequent levels of the model (see **Table 2.9**). Model 1 tested whether changes in EHQP was associated with changes in child EBP over time. Model 1 results showed significant associations between changes in EHQP and child EBP. For every unit

increase in EHQP, there was a .033 standard deviations increase in child EBP over time ($p <$ 0.01). This association remained significant after controlling for cohort membership (Model 2, p < .01). Model 2 also showed that all cohorts 6, 9, and 12 had significantly lower slopes than cohort 3 in the rate of change in EBP over time.

The association between EHQP and child EBP remained significant after additionally controlling for household SES (Model 3, $p < 0.001$). The high SES group displayed a significantly slower rate of increase in EBP compared to the low SES group ($p < 0.01$). The association between EHQP and child EBP became insignificant, however, when race/ethnicity was added to the model (Model 4, $p < 0.001$). The Black subjects had a significantly higher rate of increase in child EBP over time than White subjects ($p < 0.001$). Further controlling for gender (Model 5) and NC physical disarray (Model 6) improved the model fit based on decrease in AIC and BIC values, but the association between EHQP and child EBP remained insignificant. Male subjects had a higher slope of change in EBP than female subjects (Model 5, $p < .01$); one unit increase in NC physical disarray was associated with a .057 standard deviations increase in child EBP over time (Model 6, $p < .05$).

We further tested for any interaction effects between EHQP and household SES (EHQP by SES) or between EHQP and race/ethnicity (EHQP by race/ethnicity) to determine if those interaction terms were associated with changes in child EBP by adding each those interaction terms to the Model 6 equation. Adding the EHQP by race/ethnicity interaction effects, as shown in Model 7 on Table 2.9, rendered a goodness of fit comparable to that of Model 6. There was a statistically significant association between EHQP and child EBP in Model 7, in that poorer EHQP was linked to increased EBP over time, after controlling for the EHQP by race/ethnicity interaction effects ($p < 0.01$).

There was a significant interaction effect between EHQP and race/ethnicity, whereby the association between EHQP and child EBP differed by racial/ethnic group. For White subjects, one unit increase in EHQP was linked to a 0.143 standard deviations increase in child EBP over time. In contrast, for Black subjects, a unit increase in EHQP was associated with -0.138 standard deviation decrease in child EBP over time. In the overall model equation, however, this interaction effect was mostly canceled out by the positive regression coefficient associated with Black racial membership (regression coefficient = 0.138) in the equation. This indicates that EHQP was not associated with change in child EBP among Black youth.

Among Latino subjects, a unit increase in EHQP was associated with a -0.162 standard deviations decrease in child EBP over time. Given that Latino racial/ethnic membership was linked with a significantly lower rate of change in EBP compared to Whites (regression coefficient = -0.187, Model 7), this interaction coefficient (of -0.162) further decreases the slope of change in EBP among Latinos. In the overall model equation, being a Latino youth was associated with a decrease in EBP in relation to an increase in EHQP over time.

Adding the interaction effects of EHQP by SES to Model 6 did not improve the model fit, hence that model was discarded (see Appendix 2.4 for model test results).

We therefore concluded that among Non-Latino White youth, higher EHQP was associated with an increase in EBP over time, after controlling for the effects of cohort membership, household SES, gender, and level of NC physical disarray (Model 7). EHQP was not associated with change in EBP among Black youth. Among the Latino youth, higher EHQP was associated with decrease in EBP over time.

Table 2. 9.
HLM Results: External Housing Quality Problems (EHQP) and Child Externalizing Behavior Problems (EBP)

	UM	Level 2					Level 3	**Interaction**
		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	**Model 7**
Regression coefficients (fixed effects)								
Intercept	-3.07e-09 (.020)	.000 (.020)	.158 (.037)***	.219 (.047)***	.197 (.077)*	.125 (.079)	.141 (.080)	**.246 (.086)****
EHQP		.033 (.013)*	.035 (.013)**	.027 (.013)*	.014 (.013)	.013 (.013)	.006 (.014)	**.144 (.044)****
Cohort								
3 (Ref.)								
6			-.176 (.053)**	-.179 (.053)**	-.173 (.052)**	-.176 (.052)**	-.180 (.052)**	**-.181 (0.052)****
9			-.268 (.057)***	-.271 (.057)***	-.253 (.056)***	-.255 (.056)***	-.256 (.056)***	**-.259 (.056)*****
12			-.243 (.058)***	-.247 (.058)***	-.251 (.057)***	-.254 (.057)***	-.253 (.057)***	**-.254 (.057)*****
Household SES								
Low (Ref.)								
Middle				-.036 (.050)	-.094 (.050)	-.098 (.050)	-.084 (.050)	**-.089 (.050)**
High				-.141 (.050)**	-.201 (.054)***	-.203 (.053)***	-.168 (.055)**	**-.167 (.055)****
Race/Ethnicity								
White (Ref.)								
Black					.261 (.067)***	.270 (.067)***	.241 (.068)***	**.138 (.074)**
Hispanic					-.058 (.066)	-.048 (.066)	-.085 (.067)	**-.187 (.074)***
White x EHQP (Ref.)								
Black x EQHP								**-.138 (.048)****
Hispanic x EHQP								**-.162 (.047)****
Gender								
Male (Ref.)								
Female						.136 (.040)**	.132 (.040)**	**.134 (.040)****
NC Disarray							.057 (.023)*	**.055 (.023)***
Variance components (random effects)								
Residual	.326 (.011)	.326 (.011)	.326 (.011)	.326 (.011)	.326 (.011)	.326 (.011)	.326 (.011)	**.325 (.011)**
95% CI	*.305-.348*	*.305-.348*	*.305-.348*	*.305-.348*	*.305-.348*	*.305-.348*	*.305-.348*	**.304-.347**
Intercept	.616 (.025)	.610 (.025)	.601 (.025)	.598 (.024)	.579 (.024)	.575 (.024)	.573 (.023)	**.572 (.023)**
95% CI	*.569-.666*	*.563-.660*	*.554-.651*	*.553-.648*	*.535-.628*	*.530-.623*	*.528-.621*	**.527-.619**
Slope	.087 (.010)	.088 (.010)	.088 (.010)	.088 (.010)	.088 (.010)	.088 (.010)	.087 (.010)	**.087 (.010)**
95% CI	*.069-.109*	*.070-.111*	*.071-.111*	*.070-.110*	*.070-.110*	*.070-.110*	*.069-.110*	**.069-.109**
Covariance	.009 (.010)	.009 (.010)	.023 (.011)	.025 (.011)	.020 (.010)	.021 (.010)	.020 (.010)	**.020 (.010)**
95% CI	*-.011-.029*	*-.011-.029*	*.002-.044*	*.004-.045*	*-.0004-.040*	*.0001-.041*	*-.00003-.041*	**-.0004-.040**
Model sumary								
Deviance statistic	12,915.18	12,908.55	12,882.37	12,879.24	12,828.33	12,816.88	12,810.45	**12,794.94**
df	0	1	4	6	8	9	10	**12**
Wald Chi-Square	N.A.	6.71**	35.26***	44.28***	94.25***	106.71***	113.39***	**125.19*****
AIC	12,925.18	12,920.55	12,900.37	12,899.24	12,852.33	12,842.88	12,838.45	**12,828.94**
BIC	12,957.95	12,959.87	12,959.35	12,964.77	12,930.97	12,928.08	12,930.20	**12,940.35**

Note 1: Standard errors listed in parentheses
Note 2: **Bold =** best-fit model based on AIC and BIC values.
Note 3: UM = unconditional model; Ref. = reference group; NC = Neighborhood Cluster
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Summary of results for hypothesis test 1.1. Results from testing Hypothesis 1.1 revealed that internal and external housing quality problems were both significantly associated with changes in child externalizing behaviors over time, after controlling for demographic and neighborhood characteristics. No associations were found between housing quality problems and child internalizing behavior problems. External housing quality problems were associated with an increase in child externalizing problems among White subjects, whereas among Latinos, increase in external housing quality problems were associated with decreased child externalizing problems. See **Table 2.10** for a summary of the results.

Table 2.10. Summary of Study 1.1 (*Hypothesis 1.1*)

	Housing Quality Problems	
	Internal (IHQP)	External (EHQP)
Externalizing Behavior Problems (EBP)	One unit increase in IHQP associated with 0.042 standard deviations (SD) *increase* in EBP	• One unit increase in IHQP associated with 0.143 SD *increase* in EBP among White subjects • Significant interaction between IHQP and race/ethnicity: One unit increase in IHQP associated with 0.138 and 0.162 SD *decrease* in EBP among Black and Latino subjects, respectively
Internalizing Behavior Problems (IBP)	*NS*	*NS*

Note 1: *NS* = not significant
Note 2: Results are after controlling for cohort, household SES, race/ethnicity, gender, and NC physical disorder.

Results of Test of Hypothesis 1.2. We next tested which individual features of internal and external housing were particularly predictive of child EBP, using the models selected during our test of hypothesis 1.1. To test this, we eliminated one individual feature at a time from each of the aggregate housing quality variables (e.g. eliminate the clutter items from the Total IHQP

variable, or eliminate the traffic item from the Total EHQP variable), and entered the modified variable into the equation to examine any changes in the significance in the association between housing quality and child EBP. If the elimination of an individual housing quality feature altered the effect of housing quality on child EBP, we concluded that the eliminated variable contributed significantly to the overall association of housing quality with child EBP. We did not test the effects of individual housing quality problem features on child IBP, because no associations between IHQP/EQHP and child IBP were found in the testing of hypothesis 1.1.

Individual features of internal housing quality problems (IHQP) and child externalizing behavior problems (EBP). We tested the individual effects of IHQP items (hazard, density, cleanliness/clutter, design, and noise) by removing each item from the Total IHQP (TIHQP) measure. That is, we excluded each IHQP item from the TIHQP measure and ran the model to assess for change in the coefficient of the TIHQP measure.

Results indicated that, of the 5 sets of IHQP items, the removal of noise and cleanliness/clutter items contributed the most to reducing the overall association of TIHQP with child EBP (see **Table 2.11**). When noise or cleanliness/clutter were removed from the TIHQP variable (Models 2 and 3), the regression coefficient predicting the relationship between TIHQP and change in child EBP decreased to a larger degree than when other individual features (e.g. design, density, or hazard) had been removed. The regression coefficients still remained statistically significant at the $p < 0.05$ levels. When both noise and cleanliness/clutter features were removed from the IHQP variable, the association between TIHQP and child EBP became statistically insignificant ($p = 0.07$). We therefore concluded that internal noise and cleanliness/clutter may be most associated with change in child behavioral problems over time,

controlling for cohort membership, household SES, race/ethnicity, gender, and NC physical disarray.

Table 2. 11.
HLM Results: Individual Internal Housing Quality Problems (IHQP)Variables and Child Externalizing Behavior Problems (EBP)

	Initial Model	Test of Individual IHQP Features					
		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Regression coefficients (fixed effects)							
Intercept	.135 (.079)	.135 (.079)	.136 (.079)	.136 (.079)	.134 (.079)	.136 (.079)	.137 (.079)
IHQP	.029 (.012)*						
Cohort							
3 (Ref.)							
6	-.180 (.052)**	-.180 (.052)**	-.180 (.052)**	-.180 (.052)**	-.180 (.052)**	-.180 (.052)**	-.180 (.052)**
9	-.256 (.056)***	-.256 (.056)***	-.256 (.056)***	-.257 (.056)***	-.256 (.056)***	-.256 (.056)***	-.256 (.056)***
12	-.254 (.057)***	-.254 (.057)***	-.254 (.057)***	-.254 (.057)***	-.254 (.057)***	-.254 (.057)***	-.254 (.057)***
Household SES							
Low (Ref.)							
Middle	-.080 (.050)	-.080 (.050)	-.081 (.050)	-.080 (.050)	-.080 (.050)	-.081 (.050)	-.081 (.050)
High	-.159 (.055)**	-.158 (.055)**	-.160 (.055)**	-.160 (.055)**	-.158 (.055)**	-.160 (.055)**	-.162 (.055)**
Race/Ethnicity							
White (Ref.)							
Black	.237 (.067)***	.237 (.067)***	.237 (.067)***	.238 (.067)***	.239 (.067)***	.238 (.067)***	.239 (.067)***
Hispanic	-.078 (.067)	-.078 (.067)	-.079 (.067)	-.079 (.067)	-.077 (.067)	-.079 (.067)	-.080 (.067)
Gender							
Female (Ref.)							
Male	.131 (.040)**	.131 (.040)**	.131 (.040)**	.131 (.040)**	.132 (.040)**	.132 (.040)**	.132 (.040)**
NC Disarray	.056 (.022)*	.056 (.022)*	.056 (.022)*	.057 (.022)*	.056 (.022)*	.056 (.022)*	.057 (.022)*
TIHQ without Hazard items		.030 (.012)*					
TIHQ without Density items			.029 (.011)*				
THIQ without Cleanliness/Clutter items				.026 (.011)*			
THIQ without Décor items					.031 (.011)**		
THIQ without Noise items						.025 (.012)*	
THIQ without Noise & Cleanliness/Clutter							.021 (.011)
Variance components (random effects)							
Residual	.326 (.011)	.325 (.011)	.326 (.011)	.326 (.011)	.326 (.011)	.326 (.011)	.326 (.011)
95% CI	*.305-.349*	*.305-.349*	*.305-.349*	*.305-.349*	*.305-.349*	*.305-.349*	*.305-.348*
Intercept	.569 (.023)	.569 (.023)	.569 (.023)	.570 (.023)	.569 (.023)	.569 (.023)	.571 (.023)
95% CI	*.525-.617*	*.525-.617*	*.525-.617*	*.526-.618*	*.525-.617*	*.526-.618*	*.527-.619*
Slope	.087 (.010)	.087 (.010)	.087 (.010)	.087 (.010)	.087 (.010)	.087 (.010)	.087 (.010)
95% CI	*.069-.109*	*.069-.109*	*.069-.109*	*.069-.110*	*.069-.109*	*.069-.110*	*.069-.110*
Covariance	.022 (.010)	.022 (.010)	.022 (.010)	.022 (.010)	.022 (.010)	.022 (.010)	.021 (.010)
95% CI	*.001-.042*	*.001-.042*	*.001-.042*	*.001-.042*	*.001-.042*	*.001-.042*	*.001-.042*
Model sumary							
Deviance statistic	12,800.35	12,800.23	12,800.34	12,801.41	12,799.48	12,802.17	12,803.46
df	10	10.00	10.00	10.00	10	10.00	10.00
Wald Chi-Square	120.60***	120.66***	120.59***	119.43***	121.51***	119.43***	117.15***
AIC	12,830.35	12,830.23	12,830.34	12,831.41	12,829.48	12,832.17	12,833.46
BIC	12,928.65	12,928.53	12,928.64	12,929.71	12,927.78	12,930.47	12,931.76

Note 1: Standard errors listed in parentheses
Note 2: UM = unconditional model; Ref. = reference group; NC = Neighborhood Cluster
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Individual features of external housing quality problems (EHQP) and child externalizing behavior problems (EBP). We used the same methods as above to test the effects of individual EHQP features on child externalizing behaviors, i.e. structural quality, traffic, cleanliness, and hazard of the immediate external environment of the housing. Each revised variable was entered into the model selected to test hypothesis 1.1, for EHQP and child externalizing behaviors.

Results did not show any notable change in the regression coefficients (**Table 2.12**). It was therefore concluded that there is no single external housing feature that uniquely accounts for a notable amount of the association between EHQP and change in child EBP over time. Rather, EHQP features have an aggregate effect on child EBP, which may also be explained by the high correlation between the individual features (with the exception of traffic, the bivariate correlation coefficients among the external housing features across three study waves – condition of external structural quality, hazard, and cleanliness – ranged between 0.53 and 0.72, $p < 0.001$).

Table 2. 12.

HLM Results: Individual External Housing Quality Problems (EHQP) Variables and Child Externalizing Behavior Problems (EBP)

	Initial Model	Test of Individual EHQP Features			
		Model 1	Model 2	Model 3	Model 4
Regression coefficients (fixed effects)					
Intercept	.246 (.086)**	.193 (.082)*	.247 (.087)**	.240 (.085)**	.246 (.086)**
EHQP	.144 (.044)**				
Cohort					
3 (Ref.)					
6	-.181 (.052)**	-.180 (.052)**	-.182 (.052)***	-.181 (.052)**	-.180 (.052)**
9	-.259 (.056)***	-.258 (.056)***	-.259 (.056)***	-.259 (.056)***	-.259 (.056)***
12	-.254 (.057)***	-.253 (.057)***	-.256 (.057)***	-.253 (.057)***	-.254 (.057)***
Household SES					
Low (Ref.)					
Middle	-.089 (.050)	-.087 (.050)	-.089 (.050)	-.088 (.050)	-.090 (.050)
High	-.167 (.055)**	-.169 (.055)**	-.165 (.055)**	-.168 (.055)**	-.169 (.055)**
Race/Ethnicity					
White (Ref.)					
Black	.138 (.074)	.192 (.070)**	.132 (.076)	.144 (.074)	.140 (.074)
Hispanic	-.187 (.074)*	-.135 (.070)	-.188 (.075)*	-.181 (.073)*	-.187 (.074)*
White x EHQP (Ref.)					
Black x EQHP	-.138 (.048)**				
Hispanic x EHQP	-.162 (.047)**				
Gender					
Female (Ref.)					
Male	.134 (.040)**	.134 (.040)**	.134 (.040)**	.134 (.040)**	.134 (.040)**
NC Disarray	.055 (.023)*	.057 (.023)*	.053 (.023)*	.055 (.023)*	.056 (.023)*
TEHQ without Struct. Qual. Items (TEHQSQ)		.102 (.038)**			
TEHQSQ x White (Ref.)					
TEHQSQ x Black		-.104 (.042)*			
TEHQSQ x Hispanic		-.111 (.041)**			
TEHQ without Traffic items (TEHQT)			.149 (.049)**		
TEHQT x White (Ref.)					
TEHQT x Black			-.132 (.052)*		
TEHQT x Hispanic			-.169 (.052)**		
TEHQ without Cleanliness items (TEHQC)				.133 (.041)**	
TEHQC x White (Ref.)					
TEHQC x Black				-.129 (.046)**	
TEHQC x Hispanic				-.149 (.045)**	
TEHQ without Hazard items (TEHQH)					.136 (.042)**
TEHQH x White (Ref.)					
TEHQH x Black					-.137 (.047)**
TEHQH x White					-.156 (.046)**
Variance components (random effects)					
Residual	.325 (.011)	.325 (.011)	.325 (.011)	.325 (.011)	.325 (.011)
95% CI	.304-.347	*.304-.348*	*.304-.347*	*.304-.347*	*.304-.347*
Intercept	.572 (.023)	.573 (.023)	.571 (.023)	.571 (.023)	.572 (.023)
95% CI	.527-.619	*.528-.620*	*.527-.619*	*.527-.619*	*.528-.620*
Slope	.087 (.010)	.086 (.010)	.088 (.010)	.087 (.010)	.087 (.010)
95% CI	.069-.109	*.069-.109*	*.070-.110*	*.069-.109*	*.069-.109*
Covariance	.020 (.010)	.020 (.010)	.020 (.010)	.020 (.010)	.020 (.010)
95% CI	-.0004-.040	*-.0001-.041*	*-.0002-.041*	*-.0005-.040*	*-.001-.040*
Model sumary					
Deviance statistic	12,794.94	12,799.19	12,795.56	12,795.54	12,795.28
df	12	12	12	12	12
Wald Chi-Square	125.19***	120.84***	124.74***	124.61***	124.77***
AIC	12,828.94	12,833.19	12,829.56	12,829.54	12,829.28
BIC	12,940.35	12,944.60	12,940.96	12,940.94	12,940.69

Note 1: Standard errors listed in parentheses

Note 2: UM = unconditional model; Ref. = reference group; NC = Neighborhood Cluster

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Summary of hypothesis test 1.2. Our tests partially supported our hypothesis that some individual features of IHQP or EHQP may be more associated with child EBP. Some features of IHQP, namely noise and cleanliness/clutter, accounted for larger amount of change in child EBP over time. Tests of the effects of individual EHQP features did not yield any significant results in regards to any differential contribution of each feature in predicting changes in child EBP.

Study 2

Study Aim

Study 1 showed that internal and external housing quality problems (IHQP and EHQP) were significantly associated with an increase or decrease in child externalizing behavior problems (EBP) over time, but not with any change in child internalizing behavior problems (IBP). The aim for Study 2 was to further refine the findings from Study 1 by testing the extent to which parenting harshness and warmth mediate the significant association IHQP and EHQP and child EBP. We hypothesized that parenting harshness and parental warmth will mediate the relationship between IHQP/EQHP and child EBP.

Method

Sample. For Study 2, we used the same sample as for Study 1 but excluded subjects who had missing data on any of the items used to form the two separate parenting variables of interest in this study. All subjects with missing items were excluded because a majority of those who were missing one or more items on the parenting variables was missing all of the items that form either of the parenting variables, thus rendering imputation methods inadequate (see Appendix 3.1). Six and eight percent of the initial sample of 1,728 were missing at least one harsh parenting or parenting warmth item(s), respectively, across the three PHDCN study waves. As we excluded subjects who were missing either or both of the two parenting variables (10% of the initial sample) in any of the three study waves, the final sample for Study 2 consisted of 1,551 subjects.

We ran logistic regression analyses to compare the final study sample and the excluded subjects on demographic variables (see Appendix 3.2 for results). Results revealed that cohort 12

was significantly more likely to have been excluded than cohort 3 ($p < 0.01$). Black subjects were more likely to be excluded than Latino subjects from the final sample ($p < 0.01$). There were no differences in gender or SES levels between the final study sample and excluded subjects.

Variables. The same independent, dependent, and control variables as Study 1 were used in Study 2, with the addition of the parenting variables as mediating variables – parenting harshness and parental warmth (see "Study Approach" section in the Introduction chapter of this manuscript for more information on these variables).

Analysis. We used three-level HLM methods to test the mediating effects of parenting harshness and warmth on the relationship between IHQP/EHQP and children's EBP over time. We tested the moderating/mediating effects only on the final models selected in Study 1 that had shown significant associations between housing quality and child outcome variables. Thus, we tested whether parenting harshness or warmth mediated the longitudinal relationship between: 1) IHQP and child EBP, and 2) EHQP and child EBP.

In the HLM model, time (Level 1) was nested within children (Level 2), who were nested within NCs (Level 3) as in Study 1. Parenting harshness and parental warmth variables were each entered separately, then together, into the final models selected from Study 1 to test for their mediating effects.

To determine whether the parenting variables had any mediating effects, we examined changes in both the model fit and in the association between the predictor and outcome variable as the parenting variables were entered into the models.

Results

Descriptive results. Table 3. 1 presents sample characteristics. The sample characteristics remained almost unchanged from Study 1 in regards to subject distribution across the cohort, gender, race/ethnicity and household SES categories.

Table 3. 1. Sample Characteristics (N = 1,551)

Variable	N	%
Cohort		
3	471	30.4
6	451	29.1
9	329	21.2
12	300	19.3
Gender		
Female	781	50.4
Male	770	49.7
SES		
Low	551	35.5
Mid	474	30.6
High	526	33.9
Ethnicity		
White	225	14.5
Black	489	31.5
Latino	837	54.0

Table 3. 2 presents sample means and standard deviations (SD) for continuous variables, including parenting harshness and parental warmth. As in Study 1, mean scores for IHQP and individual IHQP features tend to be lower in wave 2 compared to waves 1 and 3, whereas such pattern is not noted among EHQP variables. Child EBP mean scores decrease over time, more visibly between waves 1 and 2 than between waves 2 and 3. Parenting harshness mean scores noticeably drop between waves 1 and 2, and remain similar between waves 2 and 3. Parental warmth mean scores gradually increase between waves 1 and 3, although at a steeper rate between waves 2 and 3.

Table 3.2. Sample means and standard deviations (SD) on continuous variables (N = 1,551)

	Wave 1		Wave 2		Wave 3	
	Mean	SD	Mean	SD	Mean	SD
IHQP	1.03	1.69	0.69	1.47	0.99	1.73
Hazard (0-2)*	0.13	0.38	0.09	0.32	0.17	0.40
Density (0-2)	0.29	0.59	0.22	0.52	0.26	0.55
Cleanliness/Clutter (0-1)	0.11	0.31	0.09	0.29	0.12	0.32
Décor (0-2)	0.23	0.51	0.16	0.44	0.23	0.50
Noise (0-2)	0.26	0.57	0.13	0.40	0.22	0.56
EHQP	12.45	3.41	12.13	3.12	11.90	3.18
Structural Quality (0-9)	6.13	1.83	5.93	1.76	5.82	1.84
Traffic (0-5)	3.22	1.05	3.22	0.98	3.20	1.02
Cleanliness (0-3)	1.70	0.80	1.61	0.71	1.58	0.72
Hazard (0-3)	1.39	0.67	1.37	0.62	1.30	0.58
Child IBP	8.31	6.64	8.03	6.91	8.29	7.40
Child EBP	12.49	9.07	8.04	6.49	7.32	6.20
Parenting Warmth (0-7)	5.34	1.65	4.59	1.93	6.20	2.90
Parenting Harshness (0-3)	0.28	0.76	0.07	0.31	0.06	0.29
NC physical disarray (0-9)	1.68	0.30	(Not measured in waves 2 and 3)			

*Minimum and maximum score range for the housing quality variables are listed in parentheses.

Table 3.3 presents mean values for parenting warmth and harshness by household SES levels and race/ethnicity. Caregivers in the high SES group showed significantly lower mean parenting harshness scores in wave 1 compared to those in the low SES group, but otherwise, no differences between SES groups were noted in parenting harshness across study waves. In regards to parental warmth, there was a linear trend between higher SES and higher mean warmth scores. High SES group showed the highest parental warmth scores across study waves, followed by the middle SES group, who showed significantly higher warmth scores compared to the low SES group. In regards to race/ethnicity, Black caregivers were rated higher on parenting harshness in waves 1 and 3, compared to White caregivers. Latino caregivers were rated significantly lower on parental warmth than Whites in waves 1 and 3; Black caregivers were rated lower on parental warmth than White caregivers in wave 1 only.

Table 3.3. Parenting warmth and harshness means and standard deviations (SD) by household SES and race/ethnicity (N = 1,551)

	Wave 1		Wave 2		Wave 3	
	Mean	SD	Mean	SD	Mean	SD
Parenting warmth						
By SES						
Low SES	5.08	1.83	4.30	2.04	5.75	2.96
Middle SES	5.38*	1.65	4.61*	1.89	6.28*	2.92
High SES	5.59**	1.40	4.87**	1.79	6.60**	2.75
By race/ethnicity						
White	5.66	1.31	4.70	1.73	6.71	2.62
Black	5.16**	1.69	4.81	1.84	6.26	3.00
Latino	5.36*	1.65	4.59	1.93	6.20**	2.90
Parenting harshness						
By SES						
Low SES	0.31	0.81	0.06	0.29	0.06	0.29
Middle SES	0.38	0.87	0.08	0.35	0.08	0.35
High SES	0.17**	0.56	0.06	0.27	0.05	0.23
By race/ethnicity						
White	0.15	0.51	0.08	0.33	0.04	0.26
Black	0.38**	0.80	0.11	0.36	0.11**	0.36
Latino	0.26*	0.78	0.04	0.26	0.04	0.24

Note: Significant differences between SES and racial/ethnic groups in are noted in asterisks, *$p < .05$; **$p < .01$ (Low SES is reference group for SES group comparisons; White is the reference group for race/ethnicity group comparisons)

Table 3.4 presents bivariate correlations between the study variables across three study waves. Parenting harshness was negatively correlated with age of cohort and household SES level, indicating lower harshness among caregivers of older cohorts and of higher SES, and vice versa. Parenting harshness was positively related with both child internalizing and externalizing problems (r = 0.09 and 0.21, respectively, $p < .001$). Parenting harshness was positively correlated with total IHQP score as well as all individual features of IHQP (r = .10-.30, $p < .001$), and with NC physical disarray (r = .05, $p < .001$). Parenting harshness was positively correlated with the total EHQP score as well as most individual features of EHQP, except for traffic (r = .06-.08, $p < .001$); the coefficients were lower than those between IHQP variables and parenting harshness.

Parental warmth was positively correlated with household SES level, indicating higher warmth among caregivers of higher SES, and vice versa. Parental warmth was negatively related with both child internalizing and externalizing problems (r = -.04 and .08, respectively, $p < .001$). Parental warmth was negatively associated with the total IHQP score as well as all individual features of IHQP (r = -.07- -.12, $p < .001$), and with NC physical disarray (r = -.07, $p < .001$). Similarly, parental warmth was negatively correlated with total EHQP scores and individual features of EHQP (r = -.08-.11, $p < .001$).

Table 3.4. Bivariate correlations between all study variables, across 3 waves [N = 4,653 (1,551 subjects x 3 waves)]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Cohort	1																	
2. Household SES	-0.01	1																
3. Child IBP	0.04*	-0.15***	1															
4. Child EBP	-0.23***	-0.07***	0.58***	1														
5. Parental Warmth	0.01	0.13***	-0.04**	-0.08***	1													
6. Parenting Harshness	-0.15***	-0.06***	0.09***	0.21***		1												
7. IHQP-Total	-0.01	-0.20***	0.06***	0.13***	-0.12***	0.25***	1											
8. IHQP-hazard	0.02	-0.13***	0.04**	0.08***	-0.07***	0.22***	0.74***	1										
9. IHQP-density	-0.01	-0.19***	0.04**	0.09***	-0.10***	0.10***	0.77***	0.43***	1									
10. IHQP-clean	0.00	-0.13***	0.06***	0.10***	-0.08***	0.12***	0.63***	0.40***	0.47***	1								
11. IHQP-décor	-0.01	-0.15***	0.04*	0.09***	-0.10***	0.17***	0.74***	0.43***	0.42***	0.38***	1							
12. IHQP-noise	-0.01	-0.12***	0.05***	0.11***	-0.09***	0.30***	0.74***	0.53***	0.39***	0.25***	0.42***	1						
13. EHQP Total	-0.01	-0.37***	0.08***	0.12***	-0.10***	0.08***	0.35***	0.25***	0.28***	0.24***	0.29***	0.21***	1					
14. EHQP Struct. Qual.	-0.01	-0.38***	0.07***	0.12***	-0.10***	0.08***	0.32***	0.22***	0.28***	0.22***	0.26***	0.17***	0.90***	1				
15. EHQP traffic	0.01	-0.16***	0.04*	0.03*	-0.01	0.03	0.12***	0.08***	0.09***	0.05**	0.08***	0.13***	0.56***	0.28***	1			
16. EHQP hazard	-0.01	-0.21***	0.08***	0.09***	-0.08***	0.06***	0.27***	0.19***	0.20***	0.23***	0.26***	0.14***	0.71***	0.53***	0.18***	1		
17. EHQP clean	-0.03	-0.30***	0.07***	0.10***	-0.11***	0.08***	0.35***	0.26***	0.27***	0.26***	0.29***	0.20***	0.81***	0.64***	0.25***	0.73***	1	
18. NC Physical Disarray	-0.01	-0.43***	0.10***	0.08***	-0.07***	0.05**	0.17***	0.12***	0.15***	0.13***	0.12***	0.09***	0.45***	0.44***	0.19***	0.28***	0.38***	1

Note: SES = Socioeconomic Status; NC = Neighborhood Cluster; IBP = Internalizing Behavior Problems; EBP = Externalizing Behavior Problems; IHQP = Internal Housing Quality Problems; EHQP = External Housing Quality Problems; Struc. Qual. = Structural Quality

Results of test of hypothesis 2. Tables 3.5 and **3.6** show the HLM results for hypothesis 2, which hypothesized a mediating role of parenting harshness and parental warmth on the relationship between housing quality and child mental health outcomes. We tested the mediating effect of parenting harshness and parental warmth in the relationship between 1) IHQP and child EBP, and 2) EHQP and child EBP, as those showed significant associations in our previous study (Study 1). We tested these effects controlling for demographic variables and neighborhood context, including cohort membership, household SES, race/ethnicity, gender, and NC physical disarray. We present the test results for each association next.

Effect of parenting harshness and parental warmth on the association between internal housing quality problems (IHQP) and child externalizing behavior problems (EBP; Table 3.5). We started our test by adding the parental warmth variable into the final model selected in Study 1 for the association between IHQP and child EBP (Model 1 in Table 3.5). Entering the parental warmth variable into the model did not improve the fit of the model (i.e., AIC and BIC values increased slightly), and the association between IHQP and child EBP remained statistically significant (Model 2).

Next, we entered the parenting harshness variable into the final model from Study 1 and omitted the parenting warmth variable. Entering parenting harshness, in contrast with parental warmth, improved the model fit and also rendered the association between IHQP and child EBP no longer statistically significant, reducing the IHQP coefficient from 0.030 to 0.015 (Model 3). This reduction in the association between IHQP and child EBP upon entering the parenting harshness variable may indicate a mediating role of parenting harshness, supporting our mediation hypothesis. Entering both the parental warmth and parenting harshness variables simultaneously into the model did not improve the model fit, and the association between IHQP

and child EBP remained insignificant (Model 4). Because it had the best fit statistics of the 4 models tested, we chose Model 3 as our final model, which supports the hypothesis that parenting harshness may mediate the relationship between IHQP and child EBP over time.

These results suggest that parenting harshness, but not parental warmth, may partially mediate the relationship between higher IHQP and increased child EBP, after controlling for cohort, household SES, race/ethnicity, gender, and neighborhood physical disarray.

Table 3. 5.

HLM Results: Mediating Effect of Parenting Harshness and Parental Warmth on the Relationship between Internal Housing Quality Problems (IHQP) and Child Externalizing Behavior Problems (EBP)

	Base Model	Mediation Models		
	Model 1	**Model 2**	Model 3	Model 4
Regression coefficients (fixed effects)				
Intercept	.135 (.083)	**.127 (.082)**	.137 (.083)	.128 (.082)
IHQP	.030 (.012)*	**.015 (.012)**	.028 (.012)*	.014 (.013)
Parenting Harshness		**.075 (.011)*** **		.074 (.012)***
Parental Warmth			-.014 (.011)	-.009 (.011)
Cohort				
3 (Ref.)				
6	-.193 (.054)***	**-.180 (.054)****	-.193 (.054)***	-.181 (.053)**
9	-.248 (.059)***	**-.235 (.058)*** **	-.252 (.059)***	-.238 (.059)***
12	-.301 (.061)***	**-.279 (.060)*** **	-.304 (.061)***	-.282 (.060)***
Household SES				
Low (Ref.)				
Middle	-.061 (.053)	**-.066 (.052)**	-.060 (.053)	-.065 (.052)
High	-.126 (.058)*	**-.125 (.057)***	-.124 (.058)*	-.123 (.057)*
Race/Ethnicity				
White (Ref.)				
Black	.236 (.070)**	**.230 (.070)****	.236 (.070)**	.230 (.070)**
Hispanic	-.077 (.070)	**-.074 (.069)**	-.078 (.070)	-.074 (.069)
Gender				
Female (Ref.)				
Male	.121 (.042)**	**.118 (.041)****	.120 (.042)**	.117 (.041)**
NC Disarray	.071 (.023)**	**.070 (.023)****	.071 (.023)**	.070 (.023)**
Variance components (random effects)				
Residual	.334 (.012)	**.335 (.012)**	.334 (.012)	.335 (.012)
95% CI	*.311-.358*	***.312-.359***	*.311-.358*	*.312-.359*
Intercept	.560 (.024)	**.549 (.024)**	.558 (.024)	.547 (.024)
95% CI	*.514-.610*	***.502-.597***	*.512-.608*	*.501-.596*
Slope	.087 (.011)	**.083 (.011)**	.088 (.011)	.084 (.011)
95% CI	*.068-.111*	***.065-.108***	*.069-.112*	*.065-.108*
Covariance	.024 (.011)	**.021 (.011)**	.024 (.011)	.021 (.011)
95% CI	*.002-.045*	***-.0002-.042***	*.002-.045*	*-.0002-.042*
Model sumary				
Deviance statistic	11,531.75	**11,489.93**	11,530.37	11,489.34
df	10	**11**	11	12
Wald Chi-Square	114.03***	**157.73*** **	115.72***	158.54***
AIC	11,561.75	**11,521.93**	11,562.37	11,523.34
BIC	11,658.43	**11,625.06**	11,665.50	11,632.91

Note 1: Standard errors listed in parentheses

Note 2: **Bold =** best-fit model based on AIC and BIC values.

Note 3: Ref. = reference group; NC = Neighborhood Cluster

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Effects of parenting harshness and parental warmth on the association between external housing quality problems (EHQP) and child externalizing behavior problems (EBP). We began this analysis by adding the parenting warmth variable to the final model selected in Study 1 that focused on the association between EHQP and child EBP (Model 1 on **Table 3.6**). Entering the parental warmth variable into the model did not improve the fit of the model (i.e. AIC and BIC values increased slightly), and the association between EHQP and child EBP remained statistically significant and almost unchanged (Model 2).

Next, we entered the parenting harshness variable into the final model from Study 1 and omitted the parenting warmth variable (Model 3). The model containing parenting harshness had better model fit than either Model 1 or Model 2, and the association between EHQP and child EBP also remained significant. Furthermore, the regression coefficient for this association (0.157) remained almost identical to that of Model 1 (0.153). Entering both the parental warmth and parenting harshness variables simultaneously into the model did not improve the model fit, and the association between EHQP and child EBP remained significant (Model 4). Therefore we chose Model 3 as our best-fit final model, which showed that parenting harshness had an additive effect on increasing child EBP, above and beyond the effects of EHQP, after controlling for cohort, household SES, race/ethnicity, the interaction effects of race/ethnicity and EHQP, gender, and NC physical disarray.

The finding that addition of the parenting harshness or parental warmth variables did not impact the relationship between EHQP and child EBP over time do not fully support our initial hypothesis about the meditational role of parenting style on the relationship between housing quality and child mental health.

Table 3. 6.
HLM Results: Mediating Effect of Parenting Harshness and Parental Warmth on the Relationship between External Housing Quality Problems (EHQP) and Child Externalizing Behavior Problems (EBP)

	Base Model	Mediation Models		
	Model 1	**Model 2**	Model 3	Model 4
Regression coefficients (fixed effects)				
Intercept	.247 (.090)**	**.231 (.089)***	.248 (.090)**	.232 (.089)**
EHQP	.153 (.047)**	**.144 (.047)****	.152 (.047)**	.143 (.047)**
Parenting Harshness		**.076 (.011)*****		.075 (.011)***
Parental Warmth			-.017 (.011)	-.010 (.011)
Cohort				
3 (Ref.)				
6	-.193 (0.055)***	**-.180 (.053)****	-.195 (.054)***	-.181 (.053)**
9	-.252 (.059)***	**-.239 (.058)*****	-.257 (.059)***	-.243 (.058)***
12	-.301 (.061)***	**-.280 (.060)*****	-.306 (.061)***	-.283 (.060)***
Household SES				
Low (Ref.)				
Middle	-.069 (.053)	**-.071 (.052)**	-.067 (.053)	-.070 (.052)
High	-.132 (.058)*	**-.125 (.057)***	-.127 (.058)*	-.122 (.057)*
Race/Ethnicity				
White (Ref.)				
Black	.129 (.078)	**.126 (.077)**	.129 (.078)	.126 (.077)
Hispanic	-.187 (.077)*	**-.175 (.077)***	-.187 (.077)*	-.175 (.077)*
White x EHQP (Ref.)				
Black x EQHP	-.130 (.052)*	**-.126 (.052)***	-.128 (.052)*	-.125 (.052)*
Hispanic x EHQP	-.166 (.051)**	**-.158 (.051)****	-.167 (.051)**	-.158 (.051)**
Gender				
Female (Ref.)				
Male	.124 (.042)**	**.120 (.041)****	.123 (.042)**	.120 (.041)**
NC Disarray	.066 (.024)**	**.064 (.024)****	.066 (.024)**	.064 (.024)**
Variance components (random effects)				
Residual	.332 (.012)	**.334 (.012)**	.332 (.012)	.333 (.012)
95% CI	.310-.356	***.311-.358***	*.310-.356*	*.311-.358*
Intercept	.561 (.024)	**.547 (.024)**	.558 (.024)	.545 (.024)
95% CI	.515-.611	***.501-.596***	*.512-.608*	*.500-.595*
Slope	.088 (.011)	**.084 (.011)**	.088 (.011)	.084 (.011)
95% CI	.069-.112	***.065-.108***	*.069-.113*	*.065-.109*
Covariance	.022 (.011)	**.020 (.011)**	.022 (.011)	.020 (.011)
95% CI	.0002-.043	***-.001-.041***	*.0002-.043*	*-.001-.041*
Model sumary				
Deviance statistic	11,525.77	**11,480.93**	11,523.61	11,480.09
df	12	**13**	13	14
Wald Chi-Square	119.49***	**166.81*****	122.11***	167.95***
AIC	11,559.77	**11,516.93**	11,559.61	11,518.09
BIC	11,669.34	**11,632.94**	11,675.62	11,640.55

Note 1: Standard errors listed in parentheses
Note 2: **Bold =** best-fit model based on AIC and BIC values.
Note 3: Ref. = reference group; NC = Neighborhood Cluster
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Summary of hypothesis test 2. Our findings suggest that parenting harshness, but not parental warmth, may partially mediate the relationship between IHQP and increased child EBP. Neither parenting harshness nor parental warmth had an effect on the association between EHQP and child EBP. These findings partially support our hypothesis about the meditational role of parenting style on the relationship between housing quality problems and child mental health outcomes.

Study 3

Study Aim

The aim for Study 3 was to test the mediating role of self-efficacy on the association between housing quality and child internalizing and externalizing behavior problems. We hypothesized that the effect of housing quality problems on child internalizing and externalizing behavior problems would be mediated by levels of child self-efficacy. Specifically, high levels of housing quality problems would be related to lower child self-efficacy, which in turn relates to higher levels of child internalizing and externalizing behavior problems, after controlling demographic variables and effects of parenting style.

Method

Sample. For Study 3, we began with the same sample as in Study 1 (N = 1,728), but excluded cohorts 3 and 6 because the variable of interest for Study 3, self-efficacy, was not measured in those cohorts in the original PHDCN study, resulting in the analytic sample being limited to cohorts 9 and 12 (N = 727). Next, those with missing data on any of the self-efficacy items were excluded (N = 66, or 9% of the 727). These subjects were excluded because in Wave 3, 67% of those with missing data were missing all items of the self-efficacy variable, rendering missing data imputation inadequate. The final sample for this study consisted of 661 subjects.

We ran logistic regression analyses to compare the final study sample and the excluded subjects on demographic variables (see Appendix 4.1. for result tables). Results revealed that males were more likely to be excluded than females ($p < 0.05$). There were no differences in race/ethnicity, SES, or cohort membership between the final study sample and excluded subjects.

Variables. The same independent, dependent, and control variables as Study 2 were used in Study 3, with the addition of the child self-efficacy variable as a mediating variable (see

"Study Approach" section in the Background chapter of this manuscript for more information on the study variables).

Analysis. We used two-level HLM methods to test the mediating effects of child self-efficacy on the relationship between housing quality and children's internalizing and externalizing behavior problems over time, over and above the effects of parenting harshness or warmth. We tested the mediating effects only on the final models selected in Study 1 that had shown significant associations between housing quality and child outcome variables. Thus, we tested whether child self-efficacy mediated the longitudinal relationship between: 1) Internal housing quality problems (IHQP) and child externalizing behavior problems (EBP), and 2) external housing quality problems (EHQP) and child externalizing behavior problems (EBP), after controlling for the effects of parenting harshness and parental warmth.

In the HLM model, time (Level 1) was nested within children (Level 2), who were nested within NCs (Level 3) as in Study 1 and 2. The self-efficacy variable was entered at Level 2 of the final models selected in Study 1. To determine whether the self-efficacy variable had any mediating effects, we examined changes in both the model fit (using the AIC and BIC values) and the associations between the predictor and outcome variables as the self-efficacy variable was entered into the models.

Results

Descriptive results. Table 4.1. presents sample characteristics. As discussed in the introduction section, the sample for Study 3 only included cohorts 9 and 12 because they were the only cohorts in our initial sample at Study 1 with data on self-efficacy. The sample was almost evenly distributed in regards to cohort and gender. There were more subjects from low and high SES groups (37.7% and 35%, respectively) than the middle SES group (27.4%). In

regards to race/ethnicity, the sample distribution was similar to the original sample, with over half of the sample consisting of Latino subjects, followed by Black and Non-Latino White subjects (31.5% and 14.5%, respectively).

Table 4.1. Sample Characteristics (N = 661)

Variable	N	%
Cohort		
9	341	51.6
12	320	48.4
Gender		
Female	339	51.3
Male	322	48.7
SES		
Low	249	37.7
Med	181	27.4
High	231	35.0
Ethnicity		
White	96	14.5
Black	208	31.5
Latino	339	54.0

Table 4.2. presents sample means and standard deviations (SDs) for the continuous variables used in this study. As in Studies 1 and 2, mean total IHQP and individual IHQP subscale scores were lower in wave 2 compared to waves 1 and 3. EHQP scores did not follow this pattern; mean total and individual EHQP subscale scores showed a gradual decline from wave 1 to 3. Child IBP scores increased over time, whereas child EBP scores were highest at wave 1, decreased in wave 2, and remained so with a minimal increase in wave 3. Child self-efficacy scores – which were measured only in waves 2 and 3 in the PHDCN study – slightly decreased between waves 2 and 3 (by 1%). Parenting harshness scores were highest in wave 1, then noticeably dropped in wave 2, and remained so with a small increase in wave 3.

Table 4.2. Sample means and standard deviations (SD) on continuous variables (N = 661)

	Wave 1		Wave 2		Wave 3	
	Mean	SD	Mean	SD	Mean	SD
Internal Housing Quality Problems (IHQP)	1.03	1.68	0.64	1.39	1.00	1.71
Hazard	0.14	0.40	0.08	0.28	0.17	0.41
Density	0.29	0.60	0.20	0.49	0.27	0.55
Cleanliness/Clutter	0.10	0.31	0.07	0.26	0.11	0.31
Décor	0.23	0.51	0.17	0.47	0.22	0.47
Noise	0.26	0.57	0.12	0.40	0.23	0.58
External Housing Quality Problems (EHQP)	12.55	3.48	12.21	3.12	12.05	3.15
Structural Quality	6.19	1.85	5.99	1.77	5.90	1.81
Traffic	3.22	1.04	3.23	0.95	3.28	1.00
Cleanliness	1.72	0.82	1.61	0.69	1.58	0.73
Hazard	1.41	0.68	1.38	0.62	1.28	0.55
Child Internalizing Behavior Problems (IBP)	7.44	6.43	8.46	7.16	9.20	7.92
Child Externalizing Behavior Problems (EBP)	10.19	8.16	7.39	6.54	7.49	6.59
Child Self-Efficacy	(Not measured in Wave 1)		76.72	9.24	75.90	9.61
Parenting Harshness	0.21	0.66	0.03	0.25	0.05	0.26
NC physical disarray	1.68	0 .30	(Not measured in waves 2 and 3)			

Table 4.3. presents means in self-efficacy by household SES levels and race/ethnicity. Mean child self-efficacy increased with each level of SES in wave 2, in that youth in both high and middle SES groups showed significantly higher self-efficacy than youth in the low SES group. In wave 3, the high SES group showed significantly higher self-efficacy than the low or middle SES groups. In regards to racial/ethnic differences, Black and Latino youth showed significantly lower self-efficacy scores than Latino youth in waves 2 and 3.

Table 4.3. Child self-efficacy means and standard deviations (SD) by household SES and race/ethnicity (N = 661)

	Wave 2		Wave 3	
	Mean	SD	Mean	SD
Child Self-Efficacy				
By SES				
Low SES	74.14	9.37	74.79	9.97
Middle SES	76.83**	9.05	74.56	9.87
High SES	79.42**	8.47	78.15**	8.61

By race/ethnicity				
White	80.42	7.55	78.40	8.77
Black	77.68*	8.75	75.35*	8.88
Latino	75.17**	9.59	75.55*	10.15

Note: Significant differences between SES and racial/ethnic groups in are noted in asterisks, *$p < .05$; **$p < .01$ (Low SES is reference group for SES group comparisons; White is the reference group for race/ethnicity group comparisons)

Table 4.4 presents bivariate correlations between the study variables across three study waves. Child self-efficacy was negatively correlated with child EBP and IBP scores (r = -.17 and -.18, respectively, p < .001). Contrary to the findings in the literature, child self-efficacy was not significantly related to parenting harshness in our sample (r = -.04, *ns*). Child self-efficacy showed small but significant negative correlations with most IHQP (r = -.07 to -.11, $p < .05$ to .001) and EHQP variables (r = -.08 to -.13, $p < .01$ to .001), with the exception of internal housing cleanliness problems (*IHQP clean*) and traffic outside the home (*EQHP traffic*). Child self-efficacy was not significantly correlated with level of NC physical disarray.

Cohort age was positively correlated with child IBP (r = .10, $p < .001$) whereas child EBP decreased with cohort age (r = -.12, $p < .001$). Household SES was correlated with all study variables except for cohort age and child EBP. Higher household SES was associated with lower child IBP scores (r = -.12, $p < .001$). The housing quality problem variables were all negatively correlated with household SES, with higher levels of bivariate correlation coefficients between household SES and EHQP variables (r = -.18-.37, $p < .001$) than those between household SES and IHQP (r = -.09-.17, $p < .001$).

Table 4.4. Bivariate correlations between all study variables, across 3 waves [N = 1,983 (661 subjects x 3 waves)]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Cohort	1																	
2. Household SES	-0.01	1																
3. Child IBP	0.10***	-0.12***	1															
4. Child EBP	-0.12***	-0.03	0.57***	1														
5. Child Self-Efficacy	-0.02	0.21***	-0.18***	-0.17***	1													
6. Parenting Harshness	-0.14***	-0.05*	0.03	0.11***	-0.04	1												
7. IHQP-Total	0.00	-0.17***	0.04	0.12***	-0.11***	0.25***	1											
8. IHQP-hazard	0.03	-0.09***	0.04	0.09***	-0.90***	0.25***	0.72***	1										
9. IHQP-density	-0.01	-0.17***	0.03	0.10***	-0.10***	0.11***	0.77***	0.42***	1									
10. IHQP-clean	0.03	-0.11***	0.08**	0.12***	-0.03	0.08***	0.62***	0.38***	0.49***	1								
11. IHQP-décor	0.00	-0.11***	0.00	0.06**	-0.08***	0.15***	0.72***	0.38***	0.40***	0.35***	1							
12. IHQP-noise	-0.03	-0.11***	0.03	0.08***	-0.07*	0.30***	0.74***	0.49***	0.39***	0.23***	0.41***	1						
13. EHQP Total	-0.04	-0.37***	0.04	0.07*	-0.13***	0.05*	0.35***	0.25***	0.29***	0.26***	0.28***	0.21***	1					
14. EHQP Struct. Qual.	-0.03	-0.37***	0.04	0.08***	-0.13***	0.05*	0.32***	0.22***	0.28***	0.24***	0.24***	0.17***	0.90***	1				
15. EHQP traffic	0.01	-0.18***	0.03	0.03	-0.04	0.04	0.15***	0.12***	0.10***	0.04	0.10***	0.15***	0.57***	0.31***	1			
16. EHQP hazard	-0.05*	-0.19***	0.01	0.03	-0.08**	0.02	0.28***	0.19***	0.21***	0.26***	0.25***	0.14***	0.72***	0.55***	0.19***	1		
17. EHQP clean	-0.08***	-0.31***	0.01	0.04	-0.11***	0.04	0.35***	0.25***	0.27***	0.27***	0.28***	0.18***	0.80***	0.65***	0.26***	0.72***	1	
18. NC Physical Disorder	-0.03	-0.42***	0.06**	0.03	-0.08	0.04	0.15***	0.11***	0.12***	0.13***	0.13***	0.06**	0.46***	0.46***	0.19***	0.29***	0.38***	1

Note: SES = Socioeconomic Status; NC = Neighborhood Cluster; IBP = Internalizing Behavior Problems; EBP = Externalizing Behavior Problems; IHQP = Internal Housing Quality Problems; EHQP = External Housing Quality Problems; Struc. Qual. = Structural Quality

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Results of Test of Hypothesis 3. Tables 4.5 and **4.6** show the HLM test results for hypothesis 3, which hypothesized a mediating role of child self-efficacy on the relationship between housing quality and child mental health outcomes. We tested the mediating effect of child self-efficacy in the relationship between 1) IHQP and child EBP, and 2) EHQP and child EBP. We present the test results for each association next.

Effect of child self-efficacy on the association between internal housing quality problems (IHQP) and child externalizing behavior problems (EBP). We started our test first by testing the final model selected in Study 1 (Model 1, see Table 4.5) on our current sample for Study 3, as this sample included only those from cohorts 9 and 12. Results showed that there was no significant association between IHQP and child EBP for the current sample, after controlling for cohort, household SES, race/ethnicity, gender, and NC physical disarray. Entering the child self-efficacy variable improved the model fit (Model 2), and child self-efficacy showed a significant negative association with child EBP, but the association between IHQP and child EBP remained insignificant. This result suggests an indirect-only mediation (Zhao, Lynch, & Chen, 2010), whereby IHQP has a negative association with child self-efficacy levels, which in turn is negatively associated with child EBP. There was no direct effect of IHQP on child EBP. This pattern of associations remained the same after parenting harshness was entered as a control variable in Model 3.

Table 4. 5. HLM Results: Mediating Effect of Child Self-Efficacy on the Relationship between Internal Housing Quality Problems (IHQP) and Child Externalizing Behavior Problems (EBP)

	Base Model	Mediation Model	
	Model 1	Model 2	**Model 3**
Regression coefficients (fixed effects)			
Intercept	.062 (.122)	.091 (.127)	**.076 (.127)**
IHQP	.013 (.018)	.026 (.023)	**.024 (.023)**
Child Self-Efficacy		-.081 (.024)**	**-.083 (.024)****
Parenting Harshness			**.048 (.021)***
Cohort			
9 (Ref.)			
12	-.042 (.065)	.013 (.068)	**.018 (.069)**
Household SES			
Low (Ref.)			
Middle	.025 (.086)	.037 (.090)	**.036 (.090)**
High	-.093 (.089)	-.081 (.093)	**-.100 (.093)**
Race/Ethnicity			
White (Ref.)			
Black	.207 (.109)	.188 (.114)	**.216 (.114)**
Hispanic	-.168 (.108)	-.237 (.113)*	**-.218 (.113)**
Sex			
Female (Ref.)			
Male	.019 (.066)	-.020 (.068)	**-.012 (.069)**
NC Disorder	.032 (.037)	.026 (.038)	**.021 (.038)**
Variance components (random effects)			
Residual	.334 (.018)	.127 (6.911)	**.123 (5.970)**
95% CI	*.300-.372*	*6.94e-48 - 2.33e+45*	***5.78e-43 - 2.62e+40***
Intercept	.590 (.039)	.913 (6.911)	**.842 (5.970)**
95% CI	*.518-.672*	*4.74e-08 - 1.40e+07*	***7.70e-07 - 919384***
Slope	.063 (.016)	.442 (13.821)	**.423 (11.940)**
95% CI	*.039-.103*	*1.01e-27 - 1.93e+26*	***3.89e-25 - 4.60e+23***
Covariance	.003 (.016)	-.224 (6.911)	**-.246 (5.970)**
95% CI	*-.029-.034*	*-13.768-13.321*	***-11.948-11.455***
Model sumary			
Deviance statistic	4,883.02	3,333.36	**3,241.30**
df	8	9	**10**
Wald Chi-Square	28.76***	46.00***	**54.79*****
AIC	4,909.02	3,361.36	**3,271.30**
BIC	4,981.73	3,433.97	**3,348.79**

Note 1: Standard errors listed in parentheses
Note 2: **Bold =** best-fit model based on AIC and BIC values.
Note 3: Ref. = reference group; NC = Neighborhood Cluster
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Effect of child self efficacy on the association between external housing quality problems (EHQP) and child externalizing behavior problems (EBP). We started our test first by testing the final model selected in Study 1 (Model 1, see **Table 4.6**) on our current sample for Study 3. Results showed that there was an association between EHQP and child EBP that approached statistical significance ($p = 0.055$) for the current sample, after controlling for cohort, household SES, race/ethnicity, interaction between race/ethnicity and EHQP, gender, and neighborhood physical disarray.

Next, we added the child self-efficacy variable into the model to test for mediation effects. Adding child self-efficacy into the model improved the model fit (Model 2), and both EHQP ($p < 0.05$) and child self-efficacy ($p < 0.01$) were significantly linked with child EBP, with opposite directions of association. Moreover, the addition of child self-efficacy into the model increased the regression coefficient between EHQP and child EBP (from 0.142 to 0.212). The results suggest a complementary mediation, or partial mediation, effect of child self-efficacy in the link between EHQP and child EBP (Zhao et al., 2010), as there are significant indirect and direct effects of EQHP on child EBP, and the direction of the effects are the same.

Entering parenting harshness as a control variable in the next model (Model 3) improved the model fit, and the complementary mediation effect of child self-efficacy on the relationship between EHQP and child EBP remained. Parenting harshness was significantly associated with child EBP in this model, as were EHQP and child self-efficacy. Given the goodness of fit, we chose Model 3 as our best-fit final model.

These findings support our hypothesis that child self-efficacy may mediate the relationship between EHQP and child EBP, above and beyond of the effects of parenting

harshness, cohort, household SES, race/ethnicity, the interaction effects of race/ethnicity and EHQP, gender, and NC physical disarray.

Summary of hypothesis test 3. Our tests supported our hypothesis that child self-efficacy would mediate the link between housing quality and child mental health outcomes. Specifically, we found that higher IHQP had an indirect effect on increased child EBP through decreased child self-efficacy, but no direct effect. We found direct effects of EHQP on child EBP, as well as indirect effects of EHQP on child EBP through complementary mediation by child self-efficacy. The results showed that child self-efficacy may mediate the relationship between EHQP and child EBP, after controlling for parenting harshness, cohort, household SES, race/ethnicity, the interaction effects of race/ethnicity and EHQP, gender, and NC physical disarray. IHQP and child EBP were not significantly associated in this sample.

Table 4.6. HLM Results: Mediating Effect of Child Self-Efficacy on the Relationship between External Housing Quality Problems (EHQP) and Child Externalizing Behavior Problems (EBP)

	Base Model	Mediation Models	
	Model 1	Model 2	**Model 3**
Regression coefficients (fixed effects)			
Intercept	.161 (.131)	.243 (.142)	**.229 (.141)**
EHQP	.132 (.069)	.212 (.085)*	**.208 (.084)***
Child Self-Efficacy		-.080 (.024)**	**-.082 (.024)****
Parenting Harshness			**.047 (.021)***
Cohort			
9 (Ref.)			
12	-.040 (.066)	.011 (.068)	**.016 (.069)**
Household SES			
Low (Ref.)			
Middle	.015 (.086)	.023 (.090)	**.024 (.090)**
High	-.097 (.089)	-.076 (.094)	**-.098 (.094)**
Race/Ethnicity			
White (Ref.)			
Black	.117 (.119)	.034 (.129)	**.065 (.129)**
Hispanic	-.263 (.118)*	-.383 (.128)**	**-.365 (.128)****
White x EHQP (Ref.)			
Black x EQHP	-.134 (.076)	-.154 (.094)	**-.172 (.093)**
Hispanic x EHQP	-.153 (.075)*	-.239 (.092)**	**-.235 (.091)***
Sex			
Female (Ref.)			
Male	.018 (.066)	-.024 (.068)	**-.015 (.069)**
NC Disorder	.030 (.037)	.015 (.039)	**.013 (.039)**
Variance components (random effects)			
Residual	.333 (.018)	.126 (6.543)	**.122 (5.570)**
95% CI	*.299-.371*	*8.96e-46 - 1.78e+43*	***1.79e-40 - 8.31e+37***
Intercept	.592 (.039)	.816 (6.543)	**.843 (5.570)**
95% CI	*.520-.674*	*1.21e-07 - 5501764*	***2.02e-06 - 352352.8***
Slope	.062 (.016)	.434 (13.086)	**.416 (11.139)**
95% CI	*.038-.102*	*9.13e-27 - 2.06e+25*	***6.80e-24 - 2.55e+22***
Covariance	.002 (.016)	-.222 (6.543)	**-.244 (5.570)**
95% CI	*-.029-.033*	*-13.045-12.602*	***-11.160-10.672***
Model sumary			
Deviance statistic	4,879.30	3,325.97	**3,234.99**
df	10	11	**12**
Wald Chi-Square	32.45***	53.17***	**60.85*****
AIC	4,909.30	3,357.97	**3,268.99**
BIC	4,993.19	3,440.96	**3,356.80**

Note 1: Standard errors listed in parentheses
Note 2: **Bold =** best-fit model based on AIC and BIC values.
Note 3: Ref. = reference group; NC = Neighborhood Cluster
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Discussion

This study investigated the longitudinal effects of internal and external housing quality problems on child mental health outcomes, as measured by child internalizing and externalizing behavior problems. The study also aimed to elucidate the mechanisms through which housing quality problems affect child mental health by testing the mediating effects of parenting style and child self-efficacy. We examined these questions across three separate studies (Studies 1, 2, and 3 in this manuscript), using secondary longitudinal data collected at three time points between 1994 and 2002 as part of the Project on Human Development in Chicago Neighborhoods (PHDCN) study. We used hierarchical linear modeling methods to account for the multilevel structure of the data and study design, in which time, child variables, and neighborhood context were treated as three separate levels of data. While we controlled for demographic variables such as cohort age, race/ethnicity, gender, household SES by entering one control variable at a time in the model testing, we chose the models with the best fit indicators as our final models for hypothesis testing.

Summary and Interpretation of Results

Study 1

In study 1, we hypothesized that both internal and external housing quality problems would be associated with higher levels of child internalizing and externalizing behavior problems over time, after controlling for demographic factors such as cohort age, race/ethnicity, gender, household SES, as well as the larger housing context as measured by level of NC physical disarray.

Our results partially supported our hypothesis, in that EHQP and IHQP were associated with child EBP over time. The results did not support our hypothesis that EHQP or IHQP would be related to increased child IBP. The findings on the positive association between IHQP/EHQP and child EBP are partially in line with those reported by Coley et al. (2013), who found positive relationships between poor overall housing quality and both child EBP and IBP. The direction of our findings are also consistent with other studies that have reported positive associations between poor housing quality and increased child stress levels (Blair et al., 2011), worse child socioemotional well-being (Evans et al., 2001), and higher levels of impulsivity/hyperactivity symptoms among younger children with ADHD (Mulligan et al., 2011). Our finding about the lack of association between IHQP and child IBP or EBP is in line with previous studies that have not found any direct relationships between housing quality problems and child IBP or EBP (Jocson & McLoyd, 2015; Rijlaarsdam et al., 2013). However, a direct comparison of our findings to existing studies is limited because none of the studies distinguished between internal and external housing quality problems. Furthermore, several previous studies measured housing quality using more structural/systemic aspects such as heating, leaking roofs, exposed wiring, and vermin, which are not included in our study.

Interestingly, we found an interaction effect between race/ethnicity and EHQP, in that EHQP was associated with different rates and directions of change in child EBP depending on the race/ethnicity of the child: higher EHQP was linked to increased child EBP scores among White subjects, supporting part of our initial hypothesis that there would be a positive association between EHQP and child EBP. The opposite pattern was found among Latino subjects, for whom an increase in EHQP was associated with a decrease in child EBP, which

contradicts our initial hypothesis. There was no association between EHQP and child EBP among Black subjects.

The finding that EHQP was differentially associated with child EBP between racial/ethnic groups has not been previously reported in the literature, as most studies have used homogeneous samples or not reported interaction effects. That these interaction effects remained significant after controlling for other demographic factors such as household SES or NC physical disarray – which also may account for the larger neighborhood context and resource level, as NC physical disarray is highly correlated with NC SES – suggest that there may be sociocultural processes or characteristics that contribute to the racial/ethnic group differences. One possibility is that high EHQP among Latino youth may be linked with other factors that may reduce or protect against child EBP, such as recency of immigration or closer parental supervision. There have been studies showing a link between immigration status or immigration-related factors and housing quality problems. For instance, studies have shown that immigrants with more years of living in the US are more likely to live in advantaged neighborhoods and have fewer structural housing quality problems than more recent immigrants, and vice versa (Clark, 2003; Rosenbaum & Friedman, 2006). Less culturally assimilated immigrant Latino families were more likely to have crowding problems and less likely to have own their own homes (Krivo, 1995). Another study found poorer structural housing quality and more crowding at home was more common among undocumented Mexican and Central American immigrants in the US than among native Whites (Hall & Greenman, 2013).

Recency of immigration and lower levels of assimilation to the US/Western culture have been linked with fewer child behavioral problems. For example, studies have shown that first-generation immigrant youth tend to exhibit lower levels of externalizing problems than second-

or third-generation immigrant youth, and spend more time with their caregivers than their peers during weekdays, which may lead to higher levels of parental supervision (Gonzales et al., 2008; Moon & Hofferth, 2015). Cultural characteristics of traditionally Latino families such as collectivism (Markus & Kitayama, 1991), which places emphasis on interpersonal harmony, family cohesion, and obedience to parents, may serve as protective factors against behavior problems (Le & Stockdale, 2005); these features may be more salient among youth from more recent immigrant families. Altogether, there is some support based on findings from previous studies that higher EHQP scores among Latino youth in our sample may be a proxy for the recency of immigration status, which may also be indicative of higher parental supervision, endorsement of traditional collectivistic cultural values, and lower likelihood of developing externalizing behaviors. Although this hypothesis may explain our findings, future studies controlling for immigration status in the analyses are needed to clarify our findings.

It is also notable that for Black study subjects, EHQP did not have an effect on behavioral problems (EBP). The finding is also noteworthy because in our sample, the Black study subjects had the highest levels of housing quality problems compared to White and Latino subjects; which is consistent with existing reports of Black families having worse housing quality conditions than native Whites or undocumented Latinos in the general US population (Hall & Greenman, 2013). It is likely that for Black subjects in our sample, factors other than housing quality may play an important role in the development of child EBP. For instance, Black racial membership in the US has been associated with chronic exposure to social stressors such as experience of racial discrimination and perceived racism (Seaton, Caldwell, Sellers, & Jackson, 2008) and lower access to healthcare and less receipt of quality health care (Fiscella, Franks, & Gold, 2000). Experience of racial discrimination and perceived racism among Black populations

have been extensively linked to deleterious long-term physical and mental health outcomes among youth and adults (Black, Johnson, & VanHoose, 2014; Clark, Anderson, & Williams, 1999; Pascoe & Richman, 2009; Williams, Neighbors, & Jackson, 2003). These contextual factors may play more significant roles in child mental health outcomes among Black youth, eclipsing the potential negative effects of EHQP.

We also tested the relationship between individual housing quality features and child mental health outcomes (hypothesis 1.2). We hypothesized that there would be some housing quality features that would meaningfully explain the variation in child IBP and EBP over time. We found that for internal housing quality, problems with noise and cleanliness/clutter together accounted for most of the significant association between IHQP and child EBP, whereas other features of IHQP such as décor, density, and hazard did not significantly impact the relationship. As for external housing quality, there was no single problem feature that had a particularly strong association with child EBP; rather, the effects of EHQP appeared to have a collective impact.

These findings are somewhat in line with previous findings from the literature, in which higher level of noise in the home was associated with poorer child mental health and behavioral outcomes (Evans et al., 2001). To our knowledge, the relationship between problems with cleanliness or cluttering and child mental health outcomes has not been studied on its own; cleanliness/clutter has usually been included as a larger overall housing quality measure in multiple studies. Therefore, we do not know if this finding is consistent with previous literature but contributes to the knowledge base about specific drivers of the effects of internal housing quality on child mental health outcomes. This finding would also be important in designing interventions to enhance housing quality with the aim of improving child outcomes, which we will discuss in later sections of this chapter.

Study 2

In Study 2, we tested the mediating effects of parenting harshness and parental warmth on the relationship between housing quality problems and child EBP. We hypothesized that both parenting harshness and parental warmth would mediate the relationship between housing quality problems and child EBP. Our results partially supported this hypothesis: Only parenting harshness mediated the relationship between IHQP and child EBP. As for the relationship between EQHP and child EBP, parenting harshness did not have a mediating effect, but rather added to the overall model in explaining variation in child EBP, independent of the effects of EHQP. In other words, the impact of internal housing quality on child externalizing behavior problems was mediated by parenting harshness, in that higher levels of IHQP led to higher levels of parenting harshness, which was then also positively related with increased child EBP. On the other hand, external housing quality appeared to have a direct effect on child EBP: Higher EHQP was associated with increased child EBP over time, independent of the direct effects of parenting harshness on child EBP.

Overall, these findings indicate that IHQP has an indirect effect on child EBP through its effect on parenting behaviors, whereas EHQP has a direct effect on child EBP. These findings are in line with previous research by Jocson and McLoyd (2015), who have found that poor housing quality had an indirect effect on increased levels of child internalizing and externalizing behavior problems through parental stress and harsh/inconsistent parenting behaviors, whereas neighborhood disorder had a direct effect on increased child externalizing disorders.

The psychosocial mechanism through which EHQP has a direct effect on increased youth externalizing disorders is not yet known, but our findings from Study 3 on the mediating effects of child self-efficacy on the relationship between EHQP and child EBP may partly explain this

association. It could also be hypothesized that higher EHQP is a proxy for other contextual factors of the housing neighborhood such as higher exposure to community violence/delinquent peers or lack of adult supervision and guidance, which may increase the likelihood of child EBP (Fagan, Wright, & Pinchevsky, 2015; Linares, Heeren, Bronfman, Zuckerman, Augustyn, & Tronick, 2001; Salzinger, Feldman, Stockhammer, & Hood, 2002). It is notable that this direct effect of EHQP on child EBP was significant even after controlling for neighborhood contextual factors such as NC physical disarray, which may control for the larger neighborhood level of disorder or resource level. EHQP may also represent to youth a sense of socioeconomic inequality or helplessness, which may contribute to increased externalizing problems.

Parental warmth did not have any mediating effect on the relationship between IHQP/EHQP and child EBP. This finding is also consistent with the results reported by Jocson and McLoyd (2015), who also did not find associations between parental warmth and level of child internalizing or externalizing behaviors. However, the lack of parenting warmth effect on child IBP or EBP is inconsistent with previous meta-analytic literature on parenting and internalizing disorders, in which low parental warmth was associated with higher levels of internalizing disorders such as depression and anxiety (Yap, Pilkington, Ryan, & Jorm, 2014).

The lack of association in our study may be due to the way parental warmth was measured and operationalized. The parental warmth variable was composed of items that were rated by PHDCN survey interviewers based on their observation of the parent-child interaction during the interview. The PHDCN items measured presence of affectionate behaviors the caregiver displayed in the interaction with the child such as use of positive voice, praise, encouragement, and endearment/diminutive. It is possible that the presence of the observer/interviewer may have induced some social desirability bias (Mick, 1996) and

influenced the way the caregivers interacted with the children so as to convey a desirable impression to the interviewer, inflating the actual daily level of warmth they display to the children. In fact, the high mean scores of parental warmth across study waves may indicate this possibility of a social desirability bias, which in turn may have had a ceiling effect on the measurement of the variable. This may have then driven the weak correlation between parental warmth and child IBP and EBP. Nonetheless, it is notable that parental warmth was negatively associated with all the housing quality variables except for external traffic, although to a lesser degree than parenting harshness.

The positive relationship between higher IHQP and parenting harshness may be explained by a third variable, such as increased parent stress or parental mental health problems. If so, the association may also be bidirectional, in that parental harshness may be an indicator of higher level of stress or mental health problems, which may negatively impact the level of upkeep of internal home environment such as level of cleanliness or clutter via reduced emotional, physical, or financial capacities. Nevertheless, some internal housing features such as noise are less likely to be in a parent's control and thus likely to have a unidirectional impact on parenting harshness. A counter argument to that would be that noise may also be a modifiable housing feature by way of parental control, as our IHQP noise measure included noise from inside the home such as radio, children's shouting, or television sounds. Future research could differentiate between noise from inside versus outside the home to clarify the directionality of the relationship between housing quality and parenting behaviors.

Study 3

In Study 3, we tested the mediating effects of child self-efficacy on the relationship between IHQP/EHQP and child EBP among cohorts 9 and 12 of the sample. The findings

supported our hypothesis that child self-efficacy would mediate the relationships between IHQP/EQHP and child EBP. In particular, IHQP had an indirect effect on child EBP whereas EQHP had both direct and indirect effects on child EBP. Internal housing quality problems (IHQP) were negatively associated with level of child self-efficacy, which was in turn negatively associated with child EBP. This indirect effect remained significant after controlling for demographic factors as well as parenting harshness. There was no direct association between IHQP and child EBP in this sample. IHQP may not have had a direct effect on EBP in this sample because of the higher age of the cohort sample used in Study 3, who may spend less time at home and interact less with their caregivers, thereby being less exposed to the effects of IHQP and related elevations in parenting harshness.

We found both direct and indirect effects of EHQP on child EBP. Child self-efficacy had a complementary, or partial, mediation effect on the relationship between EHQP and child EBP, after controlling for demographic variables and parenting harshness. This complementary, or partial, mediation effect of child self-efficacy suggests that there may be other mediators besides parenting harshness and child self-efficacy that may explain the relationship between EQHP and child EBP (Zhao et al., 2010).

In both the indirect effects of IHQP and EQHP on child EBP, housing quality problems had were negatively correlated with child self-efficacy, in that higher housing quality problems were associated with significantly lower child self-efficacy, and vice versa. Low child self-efficacy was then associated with higher levels of child EBP. This mediating effect of child self-efficacy suggests that child self-efficacy may be a point of intervention in reducing the harmful effects of housing quality problems on child EBP.

Limitations of the Study

There are some limitations of this study. First, because the study did not use an experimental design, study findings are associational not causal, even with the longitudinal design of the study and data source. Nonetheless, the use of hierarchical linear modeling methods allowed us to account for change over time in the study variables by setting time as a Level 1 in the model and using the change slopes in testing our hypotheses.

Second, a large number of the subjects from the original PHDCN dataset were eliminated from our study sample due to missing data on housing quality and/or child outcome measures. There were some demographic differences in the included vs. excluded samples in Study 1, in that excluded subjects were more likely to be from older cohorts (9 and 12) compared to cohort 3, more likely to be from the middle SES group than the lower SES group, and less likely to be Latino than White. In Study 2, cohort 12 was more likely to be excluded from the study sample than cohort 3, and Black subjects were more likely to be excluded than Latino or White subjects. In Study 3, males were more likely to be excluded than females in the final study sample. These differences between included and excluded samples may be a function of attrition such as due to child subjects aging and ensuing moving out of home, or higher residential instability or lower motivation for study participation among the middle SES group, certain racial/ethnic groups, or males. The data may also be missing due to limitations in home visits by interviewers to conduct the housing quality ratings (i.e. administration of the HOME measure or Interviewer Impressions section of the PHDCN survey), or lack of caregivers in the home to complete the CBCL measures to assess child IBP and EBP. We could not empirically test these assumptions due to lack of such information on the original PHDCN dataset. Despite these differences, the sample was relatively evenly distributed among cohort, gender, and SES groups, in the final samples for

each study. Furthermore, we controlled for these demographic variables in our study to minimize sampling bias, and still found significant associations between housing quality problems and child EBP.

Also in relation to sampling, over 80% of our sample consisted of Latino and Black subjects, which may limit generalizability our findings to other racial/ethnic groups. This sample composition is reflective of the original demographic composition of the Chicago neighborhoods the PHDCN studied. The PHDCN study used a stratified probability sampling method to reduce as much bias as possible of 342 Chicago neighborhoods and 80 neighborhood clusters (NC), to account for all strata of SES and race/ethnicity. Despite this sampling method, there were fewer Whites in low and middle SES groups in the sample, as those groups tended to live in the suburban areas that fell outside the study limits (Sampson, 2012). We attempted to adjust for this limitation by testing interaction effects of housing quality with SES and race/ethnicity, and indeed found differing results for the three racial/ethnic groups in regards to the effects of EHQP on child EBP. Race/ethnicity and SES were also controlled for in each HLM model we tested, and significant findings confirming or disconfirming our hypotheses still emerged. Moreover, the high representation of two racial/ethnic groups may not necessarily be a methodological limitation, but rather a point of strength in the dataset and this study, in that the findings have relevance to the communities studied. As noted earlier, racial/ethnic minority and recent immigrant households in the US have been found to have higher levels of housing quality problems (Hall & Greenman, 2013; Krivo, 1995), and studies focusing on populations most likely to be affected housing quality issues may be useful in building effective and pertinent housing policies, programs and services.

A third type of limitation lies in the measurement of the housing quality variables. The housing quality variables used in this study lacked some structural housing factors such as heating, plumbing, electricity, water, and heat, which were included in previous studies of housing quality and definitions used in public policy research on housing quality (e.g. Evans et al., 2001; Coley & Leventhal, 2013). This may limit direct comparison of results. Moreover, some of the housing quality items (e.g. IHQP cleanliness/clutter item, "House or apartment is clean; all visible rooms of the home are reasonably clean and minimally cluttered.") may have been subject to the bias of the rater, in this case the interview administrator. Nevertheless, the housing quality variables used in this study make unique contributions to the literature in that they focus on housing quality features that are immediately changeable, such as lighting, availability of art/photos on the wall, cleanliness, clutter, and hazard material availability. Lastly, the internal and external housing quality problems analyzed in this study were assessed over 15 years ago, and it is possible that the housing quality issues have transformed since, for better or worse. Such significant changes in the communities studied may impact the applicability of the study findings.

Policy Implications

There are several potential policy implications of these study findings. The effects housing quality problems on increased levels of child EBP found in our study, in line with similar findings from prior studies, suggest collaboration between public health and housing departments and agencies to promote child mental health. Collaborations between public health and housing agencies have been in place for over a decade by agencies such as U. S. Department of Housing and Urban Development (HUD), Center for Disease Control (CDC), U.S.

Environmental Health Agency (EPA), and the National Center for Healthy Housing. However, such efforts have mainly focused on protecting physical health and safety, by reducing child exposure to toxins (e.g. lead) or other safety hazards (e.g. moisture/leaks, contamination, pests, or ventilation; U.S. HUD, 2012), with little if no mention of mental health issues.

Our study adds to the growing evidence base for the longitudinal effect of poor housing quality on child mental health problems, and calls for inclusion of mental health promotion as part of the goals of public housing and health policy and program goals. Furthermore, existing public efforts to improve housing quality through monitoring, data collection, housing code enforcement, or training of public health and housing practitioners (e.g. Housing Checkup program by the National Center for Healthy Housing; National Healthy Homes Training Center and Network by Health Housing Solutions) could expand their housing quality definitions and criteria to include non-structural/systemic features of housing such as those used in our study.

Our study findings may help build cost-effective public or private housing quality intervention efforts that differ from existing public programs targeting large structural or systemic deficits such as heating, electricity, plumbing, ventilation or vermin. The majority of the housing quality variables used in this study, such as level of cleanliness/clutter, noise, or availability of hazardous materials, may be more readily modifiable through direct services and/or small-scale funding.

For example, families with children with behavioral problems may benefit from public support/services in reducing clutter and improving cleanliness of the indoor environment. It is likely that caregivers of children with behavioral problems may already be at heightened stress with limited financial, physical and emotional resources to adequately address problems with clutter and cleanliness of the indoor housing. Programs that support organization of homes with

children with behavioral problems among low-income families may have a positive impact on parenting behaviors, such as reduced parental stress and harshness, thereby preventing the worsening of or improving behavioral problems in children.

Public housing support could also include interventions to reduce noise in the home, or offering guidance and funding to support installation of noise-reducing materials in the home such as soundproofing or noise cancellation devices, or enforced windows to block outside noise. Algorithms in allocating public housing to families with young children could also take into account level of noise (e.g. apartment proximity to a train track or an airport) of the housing to reduce the likelihood of those families being placed in noisy homes or areas. Doing so could potentially reduce both parent and child stress levels and improve long-term mental health and developmental outcomes of youth on a public level.

Clinical Implications

There are also clinical implications associated with our study findings. Our results from the mediation analysis suggest that particular child and parental aspects may be potential points of intervention in preventing the negative impact of poor housing quality on increased child EBP. For instance, interventions to reduce parental stress and harsh parenting practices may help lower the negative effects of IHQP on child EBP. Psychological interventions to increase child self-efficacy may also help buffer against the negative effects of EHQP on development of EBP among adolescents.

Clinician awareness that housing quality is linked with child mental health outcomes may increase the likelihood that a clinician would make adequate referrals or provide resources for the children and their families with housing quality problems as part of an overall treatment plan.

The knowledge could also help clinicians aid parents in developing adequate home organization or child supervision strategies. In fact, our study found that the particular IHQPs that contributed most to increased child EBP were noise and clutter/cleanliness in the home. These are aspects of housing – especially clutter or cleanliness – may be amenable to improvement through behavioral interventions for parents such as organizational skills training.

Suggestions for Future Research

There are several questions that were generated by the findings of this study that future studies could address. Future research could further elucidate the mediating effects of parenting harshness and the causality between IHQP and child EBP by controlling for parental stress, mental health, or number of children in the home. In doing so, studies could also differentiate between housing quality variables that are more immediately modifiable by the parent, such as internal level of noise, versus those that are more outside one's control, such as noise from outside the home.

The mechanism through which EHQP directly impacts child EBP is yet unclear. Future studies could test the relationship between EHQP and other predictors of EBP, such as level of peer engagement, exposure to violence/delinquency, perception of societal/economic/racial inequality (which may be influenced by how youth perceive structural or other external housing quality problems) or patterns of activity in the housing and neighborhood.

Another interesting yet novel finding in our study that may warrant further research is the interaction effect between EHQP and race/ethnicity in relation to child EBP outcomes. Although there have been reports of racial/ethnic differences in housing quality (Friedman & Rosenbaum, 2004; Hall & Greenman, 2013; Sampson, 2012; Quillian, 2012), to our knowledge, there have

not been studies focusing on the differential effects of poor housing quality on child mental health outcomes. Coley et al. (2013) used a study sample consisting mostly of Black and Latino subjects and found positive associations between poor housing quality and child IBP and EBP, but did not report on any racial/ethnic interaction effects or differences. Future studies could examine more in depth the mechanisms behind the observed racial/ethnic differences in the effect of EHQP on child EBP: Our findings that higher EHQP was associated with lower child EBP in the Latino study participants, and that EHQP was not significantly linked with child EBP among Black study participants, contrast with reports from existing literature. A positive relationship between poor housing quality and higher externalizing behaviors was only found among White study participants in our study. A finer understanding of these group differences would be important so that public housing policies and public environmental health efforts are informed by data that are relevant to the population served.

Conclusion

This study has shown that internal and external housing quality problems may increase the likelihood of child externalizing behavior problems over time through direct and indirect routes. There were significant associations between IHQP/EHQP and child EBP, after controlling for demographic variables that may influence housing quality level as well as EBP outcomes, such as household SES, gender, race/ethnicity, and neighborhood physical disarray, a proxy measure of neighborhood SES.

We found an interaction effect between EHQP and race/ethnicity of the child, in which higher EHQP was associated with an increase in child EBP among the White youth in the study and with a decrease in child EBP among Latino study participants. EHQP was not associated

with EBP outcomes among Black study participants. Future studies could further elucidate these differences among racial/ethnic groups

Neither internal nor external housing quality problems were associated with child internalizing problems over time. This lack of association with child IBP has been reported in the literature previously, and may be explained by the weaker associations between the mediating factors and child IBP in our sample, such as between parenting harshness or self-efficacy with IBP. The lack of association between child self-efficacy and child IBP in our study may also be a function of the sample primarily consisting of adolescents, who may be less subject to the effects of parenting style than their younger children. An alternative possibility to explain this lack of finding is that child IBP may be more strongly influenced by other factors that were not measured for this study.

This study contributed to refining our understanding of the mechanisms of the effects of housing quality on child mental health by finding that parenting harshness mediates the relationship between IHQP and child EBP, and that child self-efficacy mediates the relationship between housing quality problems and child EBP. We also found that higher EHQP may have a direct impact on increased child EBP, above and beyond the effects of child self-efficacy or parenting harshness. There may be other intermediary mechanisms through which EHQP impacts child EBP beside decreased self-efficacy, which should be explored in future studies. This is one of the few studies in this area of research that controlled for, or examined simultaneously, the effects of neighborhood context in the relationship between housing quality and child mental health outcomes, and our study demonstrates the importance of housing quality in child development. Our findings are consistent with some findings from previous research on this topic. This is a burgeoning area of research with few existing studies, and comparisons

between studies are limited by large variations in how studies defined housing quality problems, sample characteristics, and geographic locations.

Our findings are unique in that we explored which particular housing features accounted for the association between housing quality and child EBP. Previous studies have either studied housing quality as an aggregate variable or single housing quality features only (e.g. noise, density, etc.). We found that noise and clutter/cleanliness levels were the most important features of IHQP in relation to development of child EBP over time. These features may be cost-effective targets of public health interventions for families with children relative to more structural or systemic issues of housing that are equally important yet may require more time and resources to modify. Clinical interventions to reduce parenting harshness and increase child self-efficacy among families living in poor housing conditions may also be another way to buffer the deleterious effects of housing quality problems on child mental health outcomes. Future studies could further explore the relationship between EHQP and EBP among adolescents, who may spend more time outside the home or be under less supervision and influence by their caregivers.

Our examination and findings about the role of the immediate exterior of the housing, as defined in this study as EHQP, contributes to the overall knowledge base, as it has rarely been included in previous studies. The external aspect of the housing may be important to explore because it may be a significant component of how residents experience their dwelling. For instance, in a qualitative interview study conducted in the United Kingdom (UK) with 32 inner city residents, Whitley, Prince and Cargo (2005) found a new potential unit of analysis that could be meaningful for studies on housing and mental health called a “residential bubble.” A residential bubble extends to just outside one’s dwelling, including the neighbors and shared public space immediately surrounding the housing (e.g. streets in front of/bordering the housing,

which is equivalent to one the individual EHQP variables used in this study, *structural quality*). The parameters of the total EQHP variable of this study fits into this description of a residential bubble, contributing to the literature on housing quality and child mental health.

The findings of our study could inform public policy and service efforts to improve housing quality for families with children with the aim of enhancing overall public mental health. Public health and housing/environmental health agencies and governments could coordinate development of services and interventions to improve housing quality, especially by focusing on those that are found to have more substantial impact on child mental health outcomes such as those identified in our study.

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Appendix 1. Additional Information on Dataset and Measures

Appendix 1.1. Number of child participants in each cohort group per study wave in the original PDHCN dataset

	Wave 1			Wave 2			Wave 3		
Cohort Group	**Eligible N**	**Response Rate %**	**Final N**	**Eligible N**	**Response Rate %**	**Final N**	**Eligible N**	**Response Rate %**	**Final N**
3	1,309	76.6	**1,003**	1,003	87.5	**878**	1,002	80.5	**807**
6	1,307	75	**980**	979	88	**862**	979	80.6	**789**
9	1,091	75.9	**828**	828	85.6	**709**	828	77.5	**642**
12	1,103	74.3	**820**	820	86.2	**707**	820	74.9	**614**
15	972	71.6	**696**	694	82.7	**574**	691	71.3	**493**
Total	5,782		**4,327**	4,324		**3,730**	4,320		**3,345**

Appendix 1.2. List of Housing Quality Problems Items

Item	Housing Quality Variable (Score Range)	Response Options
Internal Housing Quality Problems items (IHQP): ***Total Score Range 0 - 9***		
House or apartment is free of potentially dangerous structural or health hazards. (exposed outlets, broken windows, windows without screens or guards, leaking radiator, pots hanging over edge of stove.)	*Hazard (0-2)*	Yes/No (1/0)
There are no obvious signs of recent alcohol or nonprescription drug consumption in the home. (drug paraphernalia, beer cans, liquor bottles)		
House or apartment has at least 100 square feet of living space per person	*Density (0-2)*	
In terms of available floor space, the rooms are not overcrowded with furniture.		
House or apartment is clean; all visible rooms of the home are reasonably clean and minimally cluttered.	*Cleanliness/Clutter (0-1)*	
The interior of the house or apartment is not dark or perceptually monotonous.	*Décor (0-2)*	
House or apartment has at least two pictures or other types of art work on the walls.		
House or apartment is not overly noisy - from noise in the house. (television, shouts of children, radio)	*Noise (0-2)*	
House or apartment is not overly noisy - from noise outside the house. (train, cars, people, music)		
External Housing Quality Problems items (EHQP): ***Total Score Range 0 - 20***		
How would you rate the general condition of most of the housing units or other buildings in the face-block?	*Structural Quality (0-9)*	Well kept, fair condition, poor condition, badly deteriorated (0, 1, 2, 3)
Do any of the fronts of residential or commercial units have metal security blinds, gates, or iron bars or grills?		None, some, at least half, most (0, 1, 2, 3)
How would you rate the condition of the street in the faceblock?		Very good, moderate, fair, poor (0, 1, 2, 3)
How would you rate the volume of traffic on the face-block?	*Traffic (0-5)*	No traffic, very light, light, moderate, heavy, very heavy (0, 1, 2, 3, 4, 5)
Is there garbage, litter, or broken glass (except beer/liquor bottles) in the street or on the sidewalk?	*Cleanliness (0-3)*	None, yes a lot, yes quite a bit, yes everywhere (0, 1, 2, 3)
Are there drug-related paraphernalia, condoms, beer or liquor containers or packaging, cigarette butts or discarded cigarette packages in the street or on the sidewalk?	*Hazard (0-3)*	None, yes not a lot, yes quite a bit, yes everywhere (0, 1, 2, 3)

Appendix 1.3 List of Parenting Warmth and Harshness Items

Parenting Harshness Items
Caregiver does not should at subject during visit
Caregiver does not express annoyance with subject
Caregiver does not slap/spank subject
Parental Warmth Items
Caregiver voice positive speaking of/to subject?
Caregiver answers subject's questions verbally?
Caregiver praises subject behavior/qualities twice?
Caregiver encourages subject to contribute?
Caregiver responds positively to interviewer praise of subject?
Caregiver uses subject endearment/diminutive at least twice?
Caregiver caresses/kisses/cuddles subject once?

**Some items were reverse-coded so that higher scores represent higher harshness or warmth*

Appendix 1. 4. Items from the Things I Can Do If I Try measure

1	can understand math
2	can always find friend to do things with
3	can do things safely with friends in neighborhood
4	cannot get parents to listen
5	cannot figure out answers in school
6	have control over own future
7	hard to get people own age to like them
8	cannot do work expected in school
9	cannot avoid gangs in neighborhood
10	can get parents to do things they like
11	cannot make life better
12	can understand what they read
13	can get people own age to listen to them
14	cannot do well in school
15	cannot avoid being scared on way to school
16	can become successful
17	can get help from parents
18	can finish assignments/homework
19	have trouble making new friends
20	feel safe alone in neighborhood
21	can talk with parents about bad things
22	can make school better for self
23	can be safe within few blocks of home
24	can be self with parents
25	can get adults to listen to them
26	can go far in the world
27	cannot avoid fights in neighborhood
28	can make things better at home with parents
29	have trouble getting help for problem
30	cannot make self happy in future

Appendix 1. 5. Neighborhood Cluster Physical Disarray Items

Item	Response Options
1. How much of a problem is litter, broken glass or trash on the sidewalks and streets? Would you say it is a big problem, somewhat of a problem, or not a problem in your neighborhood?	3*: A big problem,* 2*: somewhat of a problem,* 1*: not a problem*
2. How much of a problem is graffiti on buildings and walls?	
3. How much of a problem are vacant or deserted houses or storefronts?	

Appendix 2. Study 1 Additional Data Outputs

Appendix 2.1. Demographic comparison of included vs. excluded samples, Study 1

A. Multinomial logistic regression results comparing included vs. excluded samples on cohort membership (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Cohort 3	*(Base outcome)*			
Cohort 6	0.33	0.09	0.38	-0.14-0.21
Cohort 9	0.22	0.09	2.33*	0.03-0.40
Cohort 12	0.35	0.09	3.65***	0.16-0.53

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B. Binomial logistic regression results comparing included vs. excluded samples on gender (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Female	*(Base outcome)*			
Male	0.04	0.07	0.54	-0.09-0.17

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C. Binomial logistic regression results comparing included vs. excluded samples on household SES (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Low SES	*(Base outcome)*			
Mid SES	0.22	0.08	2.69**	0.06-0.38
High SES	-0.02	0.08	-0.19	-0.18-0.14

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D. Binomial logistic regression results comparing included vs. excluded samples on race/ethnicity (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Latino	*(Base outcome)*			
White	0.21	0.10	2.09*	0.01-0.41
Black	0.32	0.07	4.28***	0.17-0.47

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix 2. 2. Discarded HLM Models in Testing Interaction Effects between Internal Housing Quality Problems (IHQP) and SES and Race/Ethnicity in Predicting Child Externalizing Behavior Problems (EBP)

Test of interaction effects of *IHQP x SES*	
Regression coefficients (fixed effects)	
Intercept	.128 (.080)
IHQP	.022 (.017)
Cohort	
3 (Ref.)	
6	-.180 (.052)**
9	-.256 (.056)***
12	-.253 (.057)***
Household SES	
Low (Ref.)	
Middle	-.082 (.050)
High	-.167 (.055)**
IHQP x low SES (Ref.)	
IHQP x mid SES	.043 (.026)
IHQP x hi SES	-.036 (.030)
Race/Ethnicity	
White (Ref.)	
Black	.245 (.067)***
Hispanic	-.070 (.067)
Gender	
Female (Ref.)	
Male	.131 (.040)**
NC Disarray	.057 (.022)*
Variance components (random effects)	
Residual	.326 (.011)
95% CI	*.305-.349*
Intercept	.569 (.023)
95% CI	*.525-.616*
Slope	.086 (.010)
95% CI	*.068-.108*
Covariance	.022 (.010)
95% CI	*.001-.042*
Model sumary	
Deviance statistic	12,793.99
df	12
Wald Chi-Square	127.04***
AIC	12,827.99
BIC	12,939.40

Test of interaction effects of *IHQP x race/ethnicity*	
Regression coefficients (fixed effects)	
Intercept	.152 (.080)
IHQP	.117 (.041)**
Cohort	
3 (Ref.)	
6	-.181 (.052)***
9	-.259 (.056)***
12	-.254 (.057)***
Household SES	
Low (Ref.)	
Middle	-.084 (.050)
High	-.155 (.055)**
Race/Ethnicity	
White (Ref.)	
Black	.222 (.067)**
Hispanic	-.095 (.067)
White (Ref.)	
Black	-.092 (.044)*
Hispanic	-.098 (.044)*
Gender	
Female (Ref.)	
Male	.133 (.040)**
NC Disarray	.055 (.022)*
Variance components (random effects)	
Residual	.326 (.011)
95% CI	*.305-.349*
Intercept	.568 (.023)
95% CI	*.524-.616*
Slope	.086 (.010)
95% CI	*.069-.109*
Covariance	.021 (.010)
95% CI	*.001-.041*
Model sumary	
Deviance statistic	12,795.31
df	12
Wald Chi-Square	125.63***
AIC	12,829.31
BIC	12,940.71

Note 1: Standard errors listed in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix 2. 3. Discarded HLM Models in Testing Interaction Effects between External Housing Quality Problems (EHQP) and SES in Predicting and Child Internalizing Behavior Problems (IBP)

Test of interaction effects of *EHQP x SES*	
Regression coefficients (fixed effects)	
Intercept	.226 (.045)***
EHQP	-.012 (.023)
Cohort	
3 (Ref.)	
6	-.144 (.050)**
9	-.064 (.054)
12	.067 (.055)
Household SES	
Low (Ref.)	
Middle	-.229 (.048)***
High	-.334 (.048)***
IHQP x low SES (Ref.)	
IHQP x mid SES	.072 (.034)*
IHQP x hi SES	.028 (.034)
Variance components (random effects)	
Residual	.428 (.015)
95% CI	*.400-.457*
Intercept	.488 (.022)
95% CI	*.447-.533*
Slope	.085 (.013)
95% CI	*.064-.114*
Covariance	.026 (.011)
95% CI	*.004-.047*
Model sumary	
Deviance statistic	13,451.15
df	8
Wald Chi-Square	78.77***
AIC	13,477.15
BIC	13,562.35

Note 1: Standard errors listed in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix 2. 4. Discarded HLM Model in Testing Interaction Effects between External Housing Quality Problems (EHQP) and SES in Predicting Child Externalizing Behavior Problems (EBP; Table 2.9)

Test of interaction effects of *EHQP x SES*	
Regression coefficients (fixed effects)	
Intercept	.151 (.081)
EHQP	-.028 (.021)
Cohort	
3 (Ref.)	
6	-.180 (.052)**
9	-.254 (.056)***
12	-.252 (.057)***
Household SES	
Low (Ref.)	
Middle	-.103 (.051)*
High	-.187 (.056)**
IHQP x low SES (Ref.)	
IHQP x mid SES	.092 (.031)**
IHQP x hi SES	.016 (.032)
Race/Ethnicity	
White (Ref.)	
Black	.243 (.068)***
Hispanic	-.083 (.068)
Gender	
Female (Ref.)	
Male	.130 (.040)**
NC Disarray	.057 (.023)*
Variance components (random effects)	
Residual	.323 (.011)
95% CI	*.302-.346*
Intercept	.574 (.023)
95% CI	*.529-.622*
Slope	.089 (.010)
95% CI	*.071-.111*
Covariance	.020 (.010)
95% CI	*.00004-.041*
Model sumary	
Deviance statistic	12,797.25
df	12
Wald Chi-Square	122.79***
AIC	12,831.25
BIC	12,942.65

Note 1: Standard errors listed in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix 3. Study 2 Additional Data Outputs

Appendix 3.1 Demographic comparison of included vs. excluded samples, Study 2

A. Multinomial logistic regression results comparing included vs. excluded samples on cohort membership (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Cohort 3	*(Base outcome)*			
Cohort 6	-0.03	-.23	-0.14	-0.49-0.43
Cohort 9	0.43	0.23	1.88	-0.02-0.88
Cohort 12	0.73	0.22	3.30**	0.30-1.16

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B. Binomial logistic regression results comparing included vs. excluded samples on gender (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Female	*(Base outcome)*			
Male	-0.02	0.16	-0.12	-0.33-0.29

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C. Binomial logistic regression results comparing included vs. excluded samples on household SES (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Low SES	*(Base outcome)*			
Mid SES	0.20	0.20	1.03	-0.18-0.58
High SES	0.10	0.19	0.50	-0.28-0.48

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D. Binomial logistic regression results comparing included vs. excluded samples on race/ethnicity (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Latino	*(Base outcome)*			
White	0.06	0.25	0.24	-0.43-0.56
Black	0.55	0.17	3.23**	0.22-0.88

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix 4. Study 3 Additional Data Outputs

Appendix 4. 1. Demographic comparison of included vs. excluded samples, Study 3

A. Multinomial logistic regression results comparing included vs. excluded samples on cohort membership (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Cohort 9	*(Base outcome)*			
Cohort 12	0.12	0.26	0.48	-0.38-0.63

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B. Binomial logistic regression results comparing included vs. excluded samples on gender (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Female	*(Base outcome)*			
Male	0.55	0.27	2.06*	0.03-1.07

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C. Binomial logistic regression results comparing included vs. excluded samples on household SES (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Low SES	*(Base outcome)*			
Mid SES	0.36	0.31	1.17	-0.24-0.96
High SES	-0.12	0.32	-0.36	-0.75-0.52

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D. Binomial logistic regression results comparing included vs. excluded samples on race/ethnicity (included subjects dummy coded as 0, excluded subjects dummy coded as 1)

	Coefficient	Standard Error	Z	95% CI
Latino	*(Base outcome)*			
White	-0.54	0.49	-1.10	-1.51-0.43
Black	0.44	0.27	1.63	-0.09-0.97

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$