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Children’s Environmental Health in Early Care and Education

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Dedication

To Esme, Imogen, and Jeff.

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Note

Chapter 2 includes a version of the first study in this dissertation which was published in the Journal of Asthma: The effect of early child care attendance on childhood asthma and wheezing: A meta-analysis. Published online April 8, 2018; doi.org /10.1080/02770903. 2018.1445268. The publishers of the Journal of Asthma allow authors to include a version of the published articles in thesis or dissertations without need for licensing agreements per their scholarly use policies.

Children's Environmental Health in Early Care and Education

Alicia T. Swartz

Abstract

Background: Research designed to understand and improve the environmental health and safety of early care and education (ECE) programs is important given the potential impact of environmental exposures on young children's health and development.

Objectives: The main aims of this dissertation are to (1) synthesize the current evidence of the association between early child care attendance and the risk of childhood asthma and wheezing, (2) assess the demographic characteristic that are associated with in the prevalence of pesticide use and IPM knowledge among different regions of California, and (3) describe the frequency of key national health and safety standards in family child care homes (FCCHs) using the Health and Safety Checklist for Early Care and Education Programs (HSC).

Methods: This dissertation consists of three independent studies: (1) a meta-analysis of 32 studies to measure the association between early care and education program attendance and childhood asthma or wheeze, (2) a cross-sectional analysis of the pest management practices and knowledge of integrated pest management (IPM) of 45 child care centers by their geographic region of California, and (3) a cross-sectional pilot study assessing national standards for health and safety using a standardized HSC in 21 FCCHs in California.

Results: The main findings from this dissertation include (1) Early child care attendance is not significantly associated with the risk of asthma or wheeze in children 6 years of age or older, (2) pest management practices in child care center facilities differs by geographic region, and (3) the HSC is a feasible tool to measure health and safety in FCCHs.

Conclusion: Although early attendance in ECE programs doesn't increase the risk of asthma or wheezing older children, young children in ECE programs continue to be exposed to pesticide application in ECE facilities and poor hygiene practices that can increase their potential exposure to infectious diseases. The findings from these three studies have important implications for parents, ECE providers, pediatric nurses and medical providers. Interventions to address the health and safety quality of ECE programs are needed to improve the overall environmental health of children in ECE settings.

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Chapter 1

Introduction

Background

The United States (U.S.) Department of Education defines out-of-home "Early Care and Education" (ECE) programs as early learning and development programs, which encompasses educational and developmental programs from birth to kindergarten entry (typically ages 0-5 years) regardless of setting or funding source (Department of Education, 2018). Child care centers and family child care homes (FCCHs) are two of the most common type of state-licensed ECE programs in the United States (Child Care Aware of America [CCAOA], 2017). The persistent increase in the maternal workforce from 47.4% in 1975 to 72.5% in 2016 has led to a shift from in-home child care to the need for child care arrangements outside of the home (Bureau of Labor Statistics, 2009; Bureau of Labor Statistics, 2017). Coinciding with the significant increase of working mothers in the U.S., the need for ECE programs has consistently increased over the last few decades to the point where the availability of child care spaces in ECE is currently less than the potential need for child care placement (CCAOA, 2017).

Recent reports state that approximately 61% of children ages 0-4 years old in the U.S. (12.5 million children) spend a portion of their day in regular ECE arrangements, and 88% of these children have working mothers. On average, children ages 0-4 years old with employed mothers spend approximately 36 hours per week in ECE programs that include organized family child care homes, child care centers, and preschools (Laughlin, 2013). As the utilization of these programs for children ages 0-4 increases (Bank, 2013), it is important to study the impact of the ECE environment on children's health and development.

Environmental Health in Early Care and Education

There are risks and benefits for children's attendance in ECE programs. One component of evaluating ECE quality is evaluating the structural or physical environment. Beyond evaluating the structural safety of the ECE facility there are also other environmental exposures associated with ECE attendance that include but are not limited to exposure to infectious disease and toxic chemicals such as pesticides. These exposures impact children differently than adults. Compared to adults, children are more vulnerable to health problems associated with environmental exposures due to their age-specific physiologic development and behaviors (Bearer, 1995; Roberts, Karr, & Health, 2012). One example of children's vulnerability to their environment is the combination of early childhood developmental behaviors (hand-to-mouth behaviors) and an underdeveloped immune system that increases their susceptibility to infectious disease. Another example is that children have a proportionately larger body surface area (ratio of the skin surface area to the persons size) compared to adults, which makes them more susceptible to absorption of chemical toxins in their environment. Moreover, their limited exposure to microorganisms can make them more likely to catch and transmit opportunistic pathogens in group care settings such as ECE facilities (Brady, 2005; Ibfelt et al., 2015; Lee, Tin, & Kelley, 2007).

Infectious disease and asthma in ECE. Researchers have consistently highlighted the increased risk of infectious diseases such as upper and lower respiratory tract infections, otitis media, and gastroenteritis among children who attend ECE programs (Alexandrino, Santos, Melo, & Bastos, 2016; Brady, 2005; de Hoog et al., 2014; Lu et al., 2004). Specifically, during the first year of life, children attending ECE programs have increased morbidity secondary to respiratory tract infections compared to children who are cared for at home (Lu et al., 2004; Nafstad, Magnus, & Jaakkola, 2000). Among children ages 2-24 months that attend child care, their respiratory infections are mainly caused by respiratory synchytial virus (RSV), adenovirus (AdV) or rhinovirus (RhV) (Fairchok, Martin, Kuypers, & Englund, 2011).

Exposures to infectious disease differ across ECE settings. Children attending child care centers have over twice the risk of infections compared to children who attend smaller family child care homes (Collet et al., 1994), as do children who attend multiple ECE arrangements (Chen, 2013; Morrissey, 2013). These findings suggest that the association between ECE exposure and the risk of infectious disease is related to the amount of exposure to other non-relative children present in the ECE setting (Ball et al., 2000; Ibfelt et al., 2015).

As the need for ECE programs increase as more mothers work outside the home, the following question is raised, "Does child care attendance increase children's exposure to respiratory viral infections which may protect against the development of later asthma in children?" One approach to answering this question would be to analyze the long-term effects of frequent bacterial and viral infections in children less than 12 months of age as a risk factor for the later development of childhood asthma (Gern, 2004; Martinez, 2009; Montgomery et al., 2013; Nafstad et al., 2000).

Given the known risk of frequent infections among children younger than 12 months of age that attend ECE programs (de Hoog et al., 2014; Lu et al., 2004), exposure to ECE settings has been commonly used as a proxy for infectious disease exposure (Ball et al., 2000; Hagerhed-Engman, Bornehag, Sundell, & Aberg, 2006; Nafstad, Brunekreef, Skrondal, & Nystad, 2005; Sun & Sundell, 2011). For example, ECE attendance prior to one year of age, which is associated with a higher occurrence of RSV and RhV infections that are also known risk factors for asthma (Alexandrino et al., 2016; Brady, 2005; de Hoog et al., 2014; Lu et al., 2004) might be independently associated with childhood asthma.

Pesticide Exposure in ECE. Pesticides are defined as any substance used as a plant regulator, defoliant, desiccant, nitrogen stabilizer, or any substance which will prevent, destroy, repel, or mitigate any pest (U.S. Environmental Protection Agency, 2018). Pesticides are ubiquitous in children's environments as they are found in food, water, homes, schools, parks, and parents' workplaces (Weiss, Amler, & Amler, 2004). Additionally, there is considerable evidence that pesticides are used in and around ECE facilities (Alkon et al., 2016; Bradman, 2010; Mir, Finkelstein, & Tulipano, 2010; Morgan et al., 2007; Starr, Graham, Stout, Andrews, & Nishioka, 2008; Tulve et al., 2006; Wilson, Chuang, & Lyu, 2001).

Bradman et al. (2010) reported that 55% of 637 participating ECE programs in California reported using pesticides. In a national study by Tulve et al. (2006), 63% of 168 participating ECEs reported using pesticides in their facility, and up to 13 different pesticide residues were detected in floor wipe samples. The most common pesticides detected were chlorpyrifos, diazinon, and *cis*- and *trans*-permethrin, with chlorpyrifos being detected in over 89% of ECE floor wipe samples (Tulve et al., 2006). Similarly, Morgan et al. (2007) reported that chlorpyrifos was detected in all of the indoor air and floor dust samples from 13 participating ECE facilities in North Carolina.

It is understood that ECE facilities located near or directly adjacent to agricultural farms have a higher potential for unintended exposures to pesticides. This is of particular interest in the state of California where there is a high need for ECE programs in counties located in agricultural regions (California Child Care Resource and Referral Network [CCCRRN], 2017). To address concerns with regard to children's exposure to agricultural pesticides in ECE settings, the California Department of Pesticide Regulation (CDPR) has issued regulation prohibiting pesticide applications within a quarter mile of licensed ECE facilities during school hours (CDPR, 2017). Additionally, the California Healthy Schools Act regulates the application of pesticides in ECE settings and requires ECE programs to report any use of pesticides within their facility (CDPR, 2007).

Despite this regulation, the pesticide application in ECE facilities located in agricultural regions has not been extensively studied. Latinx children from economically disadvantaged families are more likely to live near agricultural regions in California (Carter-Pokras, Zambrana, Poppell, Logie, & Guerrero-Preston, 2007). The differences in pesticide use among ECE facilities located in agricultural regions compared to ECE facilities in non-agricultural regions are not well understood. Further, evidence shows that children in disadvantaged and race/ethnic minority families disproportionately attend lower quality ECE programs (Dowsett, Huston, & Imes, 2008; Watamura, Phillips, Morrissey, McCartney, & Bub, 2011). This suggests that Latinx children in low-income agricultural regions of California might be at greater risk for exposure to environmental health hazards, such as the use of pesticides, in ECE facilities.

Early Care and Education Overall Quality

Research has shown that the impact of ECE attendance on children's health and development is a multidimensional phenomenon in which the environmental quality of the ECE program matters (Donoghue, 2017). For this reason, parents, ECE providers, and policy makers have focused on understanding the influence of quality in ECE on children's developmental outcomes.

According to the U.S. Department of the State, a high-quality ECE refers to programs that offer an environment that is safe, nurturing, and promotes the physical, social, emotional, and cognitive development of children (U.S. Department of the State, 2018). Quality in ECE is measured using Environmental Rating Scales (ERS). Two common examples of ERS are the Early Childhood Environment Rating Scale –Revised, Third Edition (ECERS-R) (Harms, 2014) and the Family Child Care Environment Rating Scale – Revised (FCCERS-R) (Kelton, 2013). The ECERS-R is applicable to child care centers or center-based programs and the FCCERS-R is specifically applicable to FCCHs. They are the most widely used measures of overall ECE quality. These measures were designed to assess the structural (e.g., staff/child ratios and aspects of the physical environment that can be regulated) and process (e.g., personal interactions that occur within the child's environment) aspects of overall quality in ECE programs (Harms, 2014; Kelton, 2013).

The National Institute of Child Health and Human Development Early Child Care Research Network (NICHD ECCRN) conducted the Study of Early Child Care and Youth Development (SECCYD) and used ECERS-R as a measure of quality. SECCYD is a comprehensive longitudinal study from 1991 to 2007 designed to answer questions about the relationship between ECE and children's developmental outcomes. The findings from this study have consistently provided evidence to support that the educational and developmental benefit for children attending ECE programs is contingent upon the quality of the program (NICHD ECCRN, 2002, 2003). Specifically, this research has shown that children's attendance in high-quality ECE programs is independently associated with enhanced cognitive, language, social development, school readiness (NICHD, 2002, 2003, 2004), and academic achievements in adolescents (Vandell et al., 2010).

Further research from the SECCYD cohort has shown that attendance in high-quality ECE programs provides compensatory protective effects for the social-emotional development of children from low-income families (Dearing, McCartney, & Taylor, 2009; Votruba-Drzal, Coley, & Chase-Lansdale, 2004; Watamura et al., 2011). However, children from low-income families are more likely to experience low-quality ECE programs, compared to children from economically privileged families (NICHD, 2006).

At the root, standardized health and safety practices are the foundation for the components of overall quality in ECE (Administration for Children and Families U.S. Department of Health and Human Services, 2015). Therefore, indicators of high-quality ECE programs can be measured using key national health and safety standards (American Academy of Pediatrics [AAP], 2011; Alkon et al., 2016; Donoghue, 2017) along with other quality measures of administration, curriculum, and relationships found in Environmental Rating Scales (ERS). National health and safety standards recommend that the health and safety of ECE programs be evaluated annually (AAP, 2011). In accordance with this recommendation, there are many studies evaluating the health and safety quality in child care centers (Alkon et al., 2016; Alkon, To, Wolff, Mackie, & Bernzweig, 2008; Crowley, Jeon, & Rosenthal, 2013), which is the most common type of licensed ECE program in the U.S. However, few studies have evaluated health and safety quality in FCCHs, the second most common type of licensed ECE program in the U.S.

One recent study analyzed the frequency of compliance and non-compliance with health and safety regulations among licensed 746 FCCHs in Connecticut and found that the majority of the FCCHs were in compliance with state regulations. Non-compliance was more common among FCCHs in low-income communities and was identified in regulation categories for indoor safety, emergency preparedness, documentation, and qualifications of the FCCH providers (Rosenthal, Jeon, & Crowley, 2016).

Studies have shown that compared to child care centers, FCCHs disproportionately serve children from low-income families (Dowsett et al., 2008; Fuller, Kagan, Caspary, Gauthier, 2002; NICHD, 2006). The income-based inequities highlighted by Rosenthal et al. (2016) demonstrate that children from low-income communities who are already at high risk for suboptimal health outcomes are also at higher risk for attendance in a FCCH with poor compliance with health and safety regulations.

ECE environmental quality is of concern to parents and policy makers, given the consistent findings in children's developmental research linking high-quality ECE programs to positive developmental and academic outcomes. The limited number of published studies specifically measuring key standards of health and safety in FCCHs represents a gap in our understanding of research and interventions needed to improve the overall quality in these ECE programs.

Conceptual Framework

The Hygiene Hypothesis (Strachan, 1989) and the Ecological Systems Theory (EST) (Bronfenbrenner & Morris, 2006) inform my dissertation papers. Both theories can be used to address the multidimensionality of environmental exposures that occur in ECE settings as related to the health and developmental outcomes in children. The Hygiene Hypothesis offers a physiological theory for development of atopic disorders (such as asthma) and EST offers a broader systems theory for the health and development of children. Both theories can be used to address the multidimensionality of environmental exposures that occur in ECE settings as related to the health and developmental outcomes in children.

The Hygiene Hypothesis

Strachan's Hygiene Hypothesis stipulates that increasing microbial exposure during early life leads to immune stimulation that may reduce the risk of allergy development. This hypothesis initiated the exploration of immune pathways involved in asthma pathogenesis, and has since been used to link viral infections, child care attendance, older siblings, and farming environments to the disease progression of childhood atopic asthma (Schaub, Lauener, & von Mutius, 2006). However, the validity of the Hygiene Hypothesis has not been upheld over the last 27 years. To date studies that evaluate the accuracy of the Hygiene Hypothesis offer contradicting findings. For example, a recent study found that parents who "cleaned" their child's pacifier by sucking on it to clean it during the first six months of the child's life were less likely to have asthma at 18 months of age than children whose parents did not use this cleaning technique, implicating parent-to-infant oral microbe transmission as atopy protective (Hesselmar et al., 2013). Likewise, hand washing dishes instead of using a dishwasher was also associated with a reduced risk of allergic disease development in children ages seven to eight years of age. This suggests that a less efficient dishwashing method might increase children's microbial exposure and have an allergy-preventative effect (Hesselmar, Hicke-Roberts, & Wennergren, 2015).

In contrast, following the theory of the Hygiene Hypothesis, inner-city environments could be considered protective on allergy and asthma development due to the increased density in population and housing arrangement which theoretically can lead to increased microbial exposure. However, research has shown that living in an urban environment versus a rural environment does not directly influence the prevalence of childhood asthma. Instead the higher prevalence of asthma found in inner-city environments is primarily explained by associations with demographic factors such as ethnicity and household income (Keet et al., 2015).

The Hygiene Hypothesis postulates that children are exposed to millions of antigens daily that help to build the responsiveness of their immune system. This dissertation explores the application of this theory in ECE facilities, that accordingly offer an opportunity to expand exposures to microflora through interactions with other non-relative children and an environment outside of the home. Which suggests that there might be a relationship between early attendance in ECE and the development of childhood asthma.

Ecological Systems Theory

The quality of ECE is particularly important because children need a safe environment with responsive and stimulating interactions with adults to enhance their social, emotional and cognitive development (Bronfenbrenner & Morris, 1998). Bronfenbrenner (1986) refers to ECE as a support system for mothers and suggests that research is needed to better understand the impact of quality ECE attendance on the child. Ecological models demonstrate that high-quality ECE attendance, although independently linked to positive developmental outcomes, is only one component of children's lived experience and does not account for the child's experiences in the home. For example, the socioeconomic status of the family (Tang, Coley, & Votruba-Drzal, 2012) and family's cultural practices (Kim & Fram, 2009) can influence the preferences of child care setting. Additionally, some characteristics of the mother, including level of education (Bank, 2013), sensitivity (Burchinal, Vandell, & Belsky, 2014), and stress (Bigras, Lemay, & Brunson, 2012) can influence children's participation ECE programs, the type of ECE setting selected, and the potential benefits of high-quality ECE attendance. Considering that children's lived environments are variable, standardized evaluation and regulation of ECE quality offers an opportunity to improve educational equity among all children, especially those who are most vulnerable. Specifically, some studies suggest that measures of quality show stronger associations with positive outcomes for children of color (Peisner-Feinberg et al., 2001) and children from low-income families (Burger, 2010; Dearing et al., 2009; Dowsett et al., 2008).

Study Aims

The overall purpose of this dissertation was to evaluate the environmental risks or exposures that may impact health outcomes among young children who attend ECE programs. This dissertation includes three separate research studies conducted with the following three aims:

Aim 1: Provide a synthesis of the current evidence measuring the overall association between early ECE attendance and the risk of childhood asthma and childhood wheezing.

Aim 2: compare the differences demographic characteristic that are associated with in the prevalence of pesticide use and IPM knowledge among different regions of California.

Aim 3: describe the frequency of key national health and safety standards met and no met in family child care homes (FCCHs) using the Health and Safety Checklist for Early Care and Education Programs (HSC).

These studies also aimed to identify disparities and other factors that might warrant additional ECE program attention. The three studies included in this dissertation include both primary and secondary data analysis conducted by the investigator under the mentorship of the faculty members from the University of California, San Francisco's School of Nursing and Department of Pediatrics. All of these studies represent a new approach to studying the environmental health of children attending ECE programs.

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Chapter 2

The effect of early child care attendance on childhood asthma and wheezing: A meta-analysis.

ABSTRACT

Objective: Research evidence offers mixed results regarding the relationship between early child care attendance and childhood asthma and wheezing. A meta-analysis was conducted to synthesize the current research evidence of the association between early child care attendance and the risk of childhood asthma and wheezing.

Data Sources: Peer reviewed studies published from 1964–January 2017 were identified in MEDLINE, CINAL, and EMBASE using MeSH headings relevant to child care and asthma.

Study Selection: Two investigators independently reviewed the selected articles from this search. All relevant articles that met our inclusion criteria were selected for further analysis. Data were extracted from studies that had sufficient data to analyze the odds of asthma or wheezing among children who attended child care.

Results: The meta-analysis of 32 studies found that (1) early child care attendance is protective against asthma in children 3 to 5 years of age but not for children with asthma 6 years of age or older. (2) Early child care attendance increases the risk of wheezing among children 2 years of age or younger, but not the risk of wheezing for children over 2 years of age.

Conclusions: This meta-analysis shows that early child care attendance is not significantly associated with the risk of asthma or wheeze in children 6 years of age or older.

Background

Asthma is a leading respiratory disorder among children worldwide[1]. When poorly controlled, childhood asthma can have a negative impact on the quality and result in significant health care costs[1 2]. Research studies suggests that asthma may develop in response to complex interactions between genetic variants and environmental exposures[3 4], which may include early life exposure to child care outside the home.

Increased utilization of child care outside the home has coincided with greater maternal participation in the workforce in both the United States (U.S.) and abroad[5]. For example, 52% of children in the U.S. attended child care in 1993[6] and by 2011, 61% of children under the age of 5 years attended child care for an average of 36 hours per week[7]. Although child care can provide a safe, nuturing environment outside the home for children with working parents, attending child care may increase young children's incidence of upper and lower respiratory tract infections[8-11], which is a potential risk factor for the development of asthma in childhood [12 13]. In a longitudinal study of respiratory infections among children 2 to 24 months of age, attending child care was associated with an increased risk of bronchial obstruction in the first 2 years of life, but not asthma at 4 years of age[14]. However, there are consistent findings in several studies[15-18] demonstrating an increased risk of asthma among children who attend child care compared to those who did not attend child care. For instance, one case-control study found that children who attended child care within the first 4 months of life were 1.6 times more likely to develop asthma later in childhood[19], and one longitudinal study reported that children who attended child care before 6 months of age were 3.1 times more likely to have asthma at 7 years of age [17]. Alternatively, other studies suggest that child care attendance before 12 months of age is protective against asthma later in childhood [20-22].

In summary, studies of child care attendance and asthma offer conflicting results. Previous studies have not consistently offered comparitive analyses of the effect of the child's age at the time of exposure or attendance in child care on the risk of asthma or wheeze. Therefore, we conducted a meta-analysis to evaluate the strength of the relationship between the age of entry into child care and the age of diagnosis of asthma or the age of onset of wheeze in children. A more refined understanding of this relationship may be salient for both health care providers and parents, given that family decisions regarding child care arrangements not only focus on location, cost, and type of child care, but also on health concerns, including the potential risk of infectious diseases and asthma.

Methods

Study Design

We conducted a meta-analysis of studies evaluating the association between child care attendance and childhood asthma or wheeze. We describe the methodology below, using guidelines based on PRISMA, a standard reporting system for meta-analyses.[23] The literature search was conducted through the following databases: PubMed (MEDLINE), CINAL, and EMBASE using MeSH headings relevant to child care attendance and asthma; *asthma* was combined with *child care*, *child preschool*, *child day care centers*, and *schools nursery*. The search yielded original studies published in English from the inception of PubMed (1964) to January 9, 2017.

Definition of Child Care and Child Care Exposure

Given the cultural, social and political differences between countries, there are a variety of terms used to refer to child care settings internationally, including child care, day care, nursery school, preschool, and pre-kindergarten. Child care can be provided in a variety of settings, including center-based and home-based (i.e., family child care homes). These programs can be publicly-funded by local, state, or federal agencies, or they can be privately operated (either for-profit or non-profit). Additionally, there are differences in the quality of care and amount of time children spend in child care. Some programs offer part-day or full-day and part-year or full-year. The programs also differ in the number of children present in each age group. We defined "child care" as programs that offer early care and education for young children in out-of-home settings before kindergarten entry. Henceforth in this paper, these programs will be referred to as *child care*.

We also defined child care exposure as the onset of attendance in child care, measured by the age of attendance in child care. Given that children under 12 months of age who attend child care have a higher risk of respiratory infections[11 24], which may subsequently increase their risk of asthma[25 26], we used 12 months as the comparison age to determine if the risk of asthma in young children was different for children under or over 12 months of age. Therefore, child care exposure was categorized as *any* child care attendance, *early* child care attendance (entering child care before 12 months of age), and *late* child care attendance (entering child care between 1 to 5 years of age).

Definition of Outcomes

The outcomes evaluated in the study are parent report of asthma and/or wheeze (see Table 1, Table 2). Medical provider report or pulmonary function testing was not uniformly required in the studies to confirm the diagnosis. We stratified these outcomes by age. To be consistent with studies that report stronger evidence of confirmed asthma among children older than 5 years of age[27], we compared children diagnosed with asthma between the ages of 3 to 5 years to those diagnosed between the ages of 6 to 18 years. Similarly, the outcome of wheezing was categorized by diagnosis between the ages of 0 to 2 years, 3 to 5 years, and 6 to 18 years.

Study Selection

Studies were included if they met the following inclusion criteria. Studies must include a sample of children 18 years of age or younger. In addition, the articles reported the age of child care attendance, the diagnosis or identification of asthma on or after 3 years of age, and the diagnosis or identification of wheeze on or after age 1 year. All studies must provide the crude odds ratio (OR) measuring the association between child care attendance and childhood asthma or wheeze, and/or provide enough data to calculate the crude OR. Studies were excluded if they were review articles, non-English language articles, or if they did not provide enough information to calculate an OR.

Two independent reviewers conducted the study selection in three phases using the inclusion criteria. First, each full bibliographic reference identified in the database search was reviewed. After narrowing down the articles, the abstracts from these references were reviewed. Finally, the full text of the selected articles was reviewed to determine which assessed the association between child care attendance and asthma or wheeze in children. A kappa score was calculated during each step of the article selection process to determine the degree of agreement between the two reviewers. Inter-rater reliability was valid for kappa scores indicating greater than 80% agreement. Differences were resolved by informal consensus among all participating reviewers. Retrieved full text articles were cross-referenced and manually screened for any potentially missed articles. Lastly, study authors were contacted to review our list of selected articles.

Data Extraction and Analysis

The following data were extracted from the selected studies by two lead investigators: authors' names, publication year, country of study, study design, sample size, study population type, mean or age range, gender of participants, age when child care attendance was assessed, age when asthma and/or wheeze was assessed, type of risk factors or confounders adjusted for in the models, and the statistic reported on the outcome variable of interest (asthma or wheeze) including: odds ratio, adjusted odds ratio, or relative risks, and 95% confidence intervals.

Data were pooled using a meta-analysis model. Random-effects was applied to each meta-analysis model with high heterogeneity as indicated by statistical tests. Heterogeneity was measured using the I-squared statistic. The pooled results were graphed using a forest plot for each association measured between child care attendance and asthma or wheeze. Because unique samples are needed for pooled analysis, only the most recent publication was included when duplicate samples were found among our selected studies. We examined the potential for weighted influence of any given study by looking at the percentage of total weight to the final pooled results for each study. Publication bias was assessed using funnel plots [28]. All analyses were performed using Stata 13.1[29].

Of the studies that provided sufficient data, we stratified the models to compare the effects of the age of entry into child care (any child care attendance, early child care attendance, or late child care attendance). We also categorized the outcomes (either asthma or wheeze) into different diagnostic age groups (ever/any diagnosis or identification, 0 to 2 years, 3 to 5 years, and 6 to 18 years).

Results

Descriptive Results

Our search used broad MeSH headings to cast a wide net, which resulted in identifying 16,749 citations. Application of our inclusion/exclusion criteria produced 43 studies of the relationship between child care attendance and childhood asthma or wheeze. Thirty-two studies included results that met the criteria to be included in the meta-analysis (Figure 1). Of the 32 included studies, 22 studies reported the odds of asthma among children who attended child care (Table 1) and 13 studies reported the odds of wheeze among children who attended child care (Table 2). Three studies reported the odds of both outcomes. Based on the funnel plot analyses, there was no evidence of publication bias among the selected studies.

Among the pooled studies that evaluated the relationship between child care attendance and asthma (n=20), the participants (mean = 12,156 participants, range = 453-109,746) were recruited from pediatric clinical settings from 9 countries, with the majority from either the United States (n = 10) or Canada (n = 5). Two studies [30 31] could not be included in this model due to the inclusion of duplicate samples from other studies [22 32].The pooled results from these studies are summarized in Table 3. Similar to the studies that evaluated asthma, the participants (mean = 3465 participants; range 109-16,333) from the studies that evaluated the relationship between child care attendance and wheeze (n=11) were recruited from pediatric clinical settings from 11 countries. Two studies [31 33] could not be included in this model due to the inclusion of a duplicate sample from another study [22].The pooled results of this group of studies are summarized in Table 4.

Pooled results: Child Care Attendance and Asthma

The pooled analysis showed that children who attend child care at any age have increased odds of asthma between ages 0 to 18 years compared to children who did not attend child care (OR = 1.17 [95% CI, 1.01 - 1.35]; I^2 statistic = 80.4%) (Table 3). The stratified analysis based on the age of entry into child care showed that there was no association between asthma among children and adolescents (ages 0 to 18 years) who attended early child care compared to those who did not attend child care (OR = 0.94 [95% CI, 0.70 - 1.27]; I^2 statistic = 64.4%) (Table 3). In contrast, the odds of asthma among children and adolescents (ages 0 to 18 years) who attended late child care was increased, compared to children who did not attend child care (OR = 1.19 [95% CI, 1.01 - 1.41]; I^2 statistic = 32.5%) (Table 3).

We found no association between asthma at ages 3 to 5 years among children who attend child care at any age compared to children who did not attend child care (OR = 1.11 [95% CI, 0.92 - 1.35]; I^2 statistic = 0.0%) (Table 3). The stratified analysis based on the age of entry showed that children who attended early child care had a reduced odds of asthma at 3 to 5 years of age compared to children who did not attend child care (OR = 0.66 [95% CI, 0.50 - 0.87]; I^2 statistic = 0.0%) (Table 3). No association was found between children who attended late child care and their odds of asthma at ages 3 to 5 years, compared to children who did not attend child care (OR = 1.12 [95% CI, 0.90 - 1.38]; I^2 statistic = 0.0%) (Table 3).

No association was found between asthma diagnosed at 6 to 18 years of age among children who attended child care at any age compared to children who did not attend child care (OR = 1.08 [95% CI, 0.88 - 1.33]; I^2 statistic = 57.2%) (Table 3). Additionally, there was no association between asthma at 6 to 18 years of age and early child care attendance compared to no child care attendance (OR = 0.98 [95% CI, 0.66 - 1.47]; I^2 statistic = 63.4%) (Table 3) or late child care attendance compared to no child care attendance (OR = 1.47 [95% CI, 0.73 – 2.97]; I^2 statistic = 71.1%) (Table 3).

Pooled Results: Child Care Attendance and Wheeze

The pooled analysis showed that there was no association between children who attended child care at any age compared to children who did not attend child care, and the odds of wheeze between the ages of 0 to 18 years (OR = 1.07 [95% CI, 0.83 – 1.39]; I^2 statistic = 86.8%) (Table 4). These studies are highly heterogeneous. Stratification of these studies by the age of entry into child care suggests that there is no association between the odds of wheezing among children under 18 years of age who attended early child care (OR = 0.98 [95% CI, 0.55 - 1.75]; I^2 statistic = 91.5%) or late child care (OR = 0.91 [95% CI, 0.54 – 1.52]; I^2 statistic = 85.0%) when compared to those children who did not attend child care (Table 4).

The relationship between child care exposure and risk of wheeze differs by the age of wheeze diagnosis. There are increased odds of wheeze among children 2-years of age or younger who attended early child care compared to those who did not attend child care (OR = 1.80 [95% CI, 1.38 – 2.36]; I^2 statistic = 63.9%) (Table 4). In contrast, there was no association between the odds of wheeze for children 3 to 5 years of age who attended early child care compared to those who did not attend child care (OR = 0.59 [95% CI, 0.31 – 1.12]; I^2 statistic = 55.0%) (Table 4). There are decreased odds of wheeze among children ages 6 to 18 years who attended early child care compared to those who did not attend child care (OR = 0.43 [95% CI, 0.27 - 0.68]; I^2 statistic = 0.0%) (Table 4).

We were not able to conduct a stratified analysis on the effect of late child care attendance on wheeze in the different age categories. There was only one study that evaluated the effect of late child care attendance on wheeze between ages 3 to 5 years, which reported reduced odds of wheeze (OR = 0.43 [95% CI, 0.24 - 0.77]). There were no studies that evaluated the effect of late child care attendance on wheeze among children six years of age or older.

Discussion

This meta-analysis of 32 studies found an overall small increased risk of childhood asthma among children who attended child care compared to children who did not attend child care. However, we found that this outcome depends on the age of asthma diagnosis and the timing of child care exposure. When the findings are stratified by early (before 12 months) and late (after 12 months) child care attendance, our results suggest that early child care attendance has a *protective* effect against asthma in children 3 to 5 years of age; however, the effect is not sustained for children with a diagnosis of asthma after 5 years of age. Additionally, we found that that early child care attendance increases the risk of wheeze among children two years of age or younger, but not the risk of wheeze in children older than 5 years of age.

A protective effect of early child care attendance on asthma is consistent with the hygiene hypothesis[34] which suggests that the lack of exposure to infectious diseases (commonly found in child care settings) may increase the risk of allergic diseases, such as asthma[35], in childhood. However, in our analysis, we found that the protective effect of child care, if any, seems to be transient. We did not note long term protection after 5 years of age when the diagnosis of asthma is more conclusive. Specifically, no association was found between 6 to 18 years of age, which may be due to the amount of heterogeneity observed among those studies.

Wheeze is a common presentation of viral infections frequently observed in infants who attend child care[6]. Therefore, the increased risk of early/transient wheeze among children two years of age or younger who attend child care could be driven by the studies that measured wheeze at age 1 year. The increase in wheeze is likely representative of the increased risk of viral infections in this age group. These results also suggest the importance of analysis stratified by age of diagnosis. By stratifying our models, we found that if the diagnosis is at an early age (two years or younger), there is an increased risk of wheeze for children who attend child care. However, there is a protective effect of early child care against wheeze in the older age group.

The studies included in this meta-analysis vary in quality and design, include both longitudinal and cross-sectional designs, and represent heterogeneous data from several different countries around the world, spanning more than two decades. This heterogeneity might affect the internal validity of the findings. Although the use of a random-effects meta-analysis model produces a more conservative estimate of the pooled statistic of heterogeneous data, it does not fully account for the heterogeneity observed in our data[36]. Despite the differences in population demographics, location and the timing of the studies, the main source of heterogeneity is likely attributed to the variation in the amount or type of each child's exposure to child care (e.g. duration of time spent in child care per week, type of child care setting, quality of child care, or number of other children in attendance).

Additionally, variations in child care settings (e.g. centers or family child care homes) can lead to misclassification bias when comparing one type of child care arrangement to another. For example, the included studies did not differentiate between the exposure times of a child who attends a large child care center with 20 other children more than 37 hours per week from those of a child who attends a small family child care home with 2 other children 6 hours per week. The measurement of child care attendance in the reviewed studies was not specific enough to accurately group the children by exposure. As a result, it is difficult to identify a dose–response relationship beyond the effect of the age of child care attendance on asthma or wheeze. The rate of each child's exposure to child care (hours per week), and the number of other children attending child care would need to be measured to standardize comparisons across child care programs.

Other potential variables that may play a role in increasing the heterogeneity between studies include differences in sample-specific potential confounding factors in each study, such as maternal history of asthma[22], maternal smoking[37], breastfeeding status during the first year of life[38], and the number of siblings present in the home[21]. Our analysis pooled the crude odds of either asthma or wheeze among children without accounting for these potential confounding factors.

Additionally, the selected studies had the potential for selection bias regarding sociodemographic characteristics. For example, most studies had families with “high” socioeconomic status (SES), which may limit the generalizability of our findings. Since high SES families tend to send their children to high quality child care programs that are more likely to adhere to quality standards for health and safety. Therefore, the children’s to infectious diseases in high quality centers may differ from children attending lower quality child care[39,40]

The variables of interest in this study (child care attendance, asthma, and/or wheeze) were all identified by parent report, which introduces potential reporting and recall bias, especially for the age of entry into child care and age of asthma diagnosis or wheeze. However, many of the studies stated that parents were able to recall if their child attended child care before 12 months of age of age. Additionally, the parent’s report of a diagnosis of asthma among children ages 3 to 5 years of age can be problematic, as it can be difficult to confirm a diagnosis of asthma for a child under the 6 years of age[41]. To determine if there was any difference in the results between stratifying the outcome of asthma diagnosis before or after 6 years of age compared to asthma diagnosed before or after 5 years of age, we conducted a sensitivity analysis and found no difference in our results.

Most studies included in our meta-analysis were cross-sectional, limiting our ability to establish a causal relationship between early child care attendance and later diagnosis of asthma or wheeze in childhood. Of the longitudinal studies included in our model of the association between child care attendance and asthma, one found that early child care attendance was associated with a approximately 2-fold increased risk of asthma at 7 years of age[17], which is not consistent with our findings.

Our findings of the association between child care attendance and wheezing were consistent with the longitudinal studies[22 31 33 42] identified in our search. Specifically, one longitudinal study[33] found that early child care attendance increased the risk of wheezing at 1 year of age, but not at 4 or 6 years of age [22 31]. Another longitudinal study [42] found that early child care attendance was protective for wheezing at 6 years of age.

Finally, the studies included in our meta-analysis were limited to those published in English peer-reviewed journals entered into three medical journal databases (EMBASE, MEDLINE, and CINAHL) from the earliest entries in these databases (1946) to January 9, 2017. Therefore, some relevant studies may not have been included in our final analysis, which could bias our results. Although our funnel plot analysis demonstrated no potential publication bias, there is a remaining possibility of missing a study published in non-peer reviewed journals or outside of the search timeframe.

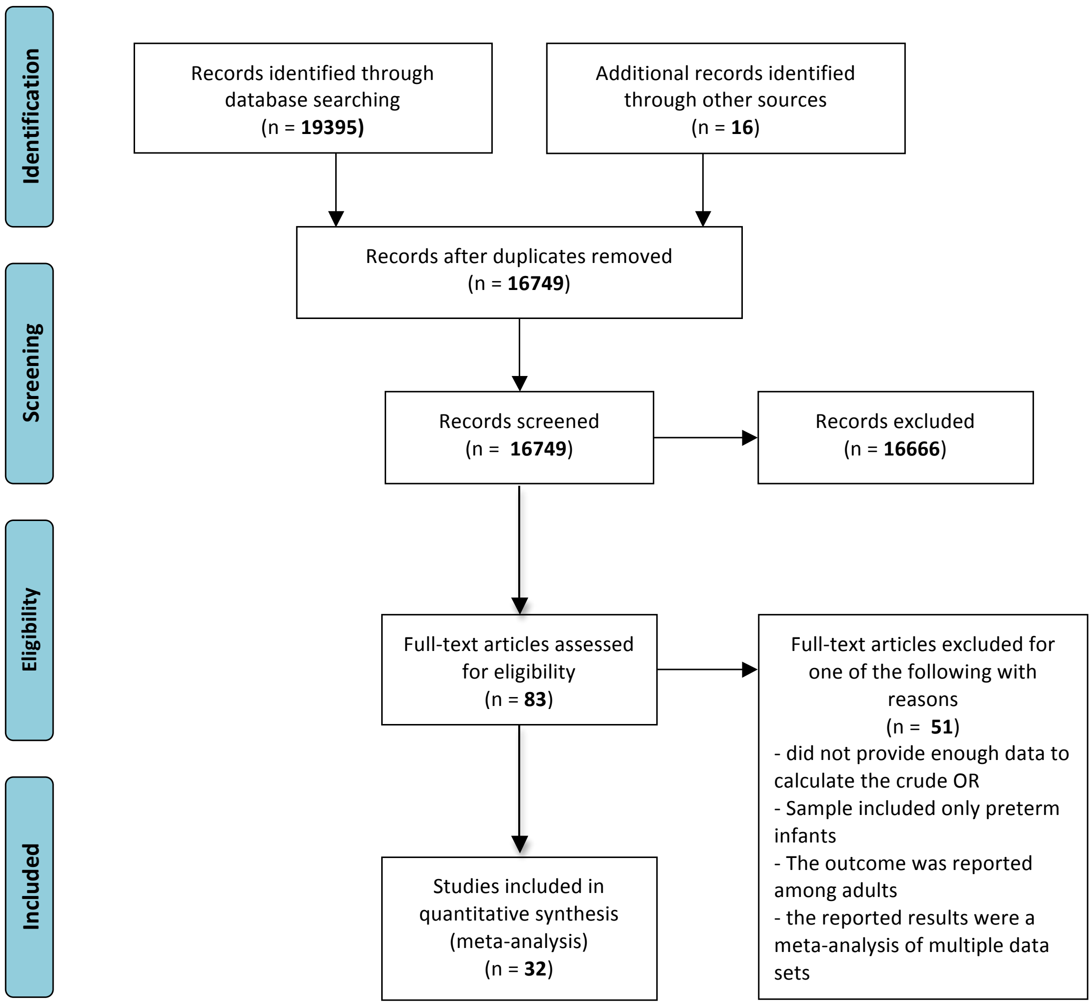
Conclusion

We found that early child care attendance increases the risk of wheeze among children 2 years of age or younger, but decreases the risks of asthma among children 3 to 5 years and wheeze among children 6 years and older. However, early child care attendance was not significantly associated with reduced risk of asthma after age 6 years. The effect of late child care attendance (after age 1 year) on asthma and wheeze remains inconclusive.

Clinically, the results of this analysis are useful for primary care providers who care for young children. The most common health concerns for parents of children less than 5 years of age include acute infections, allergies, and asthma[43]. Parents can be reassured that despite the increase in respiratory infections observed in the first year of life among children who attend early child care, child care attendance before 1 year of age is not significantly associated with asthma or wheeze later in childhood.

For clinical investigators, the variation among studies in this review highlights the need for standardized definitions of child care exposure and asthma diagnosis in children. Recommendations for future studies evaluating the potential health risks associated with child care attendance include using standardized measures of the quality of the environment, including the environmental rating rcales[44] and national health and safety performance standards[45] to provide a more in depth and comparable description of child care facilities. Additionally, standardized definitions of children's days in child care could increase the validity and reliability of the findings to determine the dose-response relationship between child care exposure and health outcomes.

Figure 1: Search Results



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

Table 1: Child Care Attendance and Asthma – Table of Studies

Author/Year	Study Design	Study Location	Sample Size	Exposure: Parent report of child care attendance age — Type of child care	Age of attendance	Outcome: Parent report of asthma diagnosis or Identification age
Ball, T. M., et al. (2000)	Cross-sectional	United States	996	Day care	<6 months 7-12 months 12 months – 3 years	Physician diagnosed asthma at age 6-13 years
Boneberger, A., et al. (2011)	Cross-sectional case-control	Chile	482	Day care	< 12 months	Physician diagnosed asthma at age 6-15 years
Celedón, J. C., et al. (2002)	Prospective cohort	United States	461	Day care	<12 months	Physician diagnosed asthma at age 4 years
Celedón, J. C., et al. (2003)	Prospective cohort	United States	453	Day care	<12 months	Physician diagnosed asthma at age 6 years
Chang, H. J., et al. (2012)	Cross-sectional	Canada	48,921	Child care	Age not specified	Asthma at age 6-14 years
Chen, Y. C., et al (2012)	Cross-sectional nested case-control	Taiwan	5804	Day care	<2 years 2-3 years > 3 years	Asthma at age 6-14 years
Cheng, G. et al. (2014)	Prospective cohort	United States	589	Day care center	<12 months	Asthma 7 years
Gurka, M. J., et al. (2009)	Prospective cohort	United States	815	Child care center	< 15 months 16-36 months	asthma by 15years
Hagerhed-Engman, L., et al. (2006)	Cross-sectional	Sweden	10,851	Daycare	< 12 months 1-2 years >2 years	Asthma diagnosed by doctor at 1-6years
Hillemeier M., et al. (2015)	Prospective cohort	United States	6900	Center based care	Age not specified	Asthma at Kindergarten age
Infante-Rivard, C., et al. (2001)	Cross-sectional case-control	Canada	914	Day care	<12 months <3-4 years	Physician diagnosed asthma at 3-4 years
Lanphear, B. P., et al. (2001)	Cross-sectional	United States	8257	Day care	>10 h/wk	Asthma <6 years
Martel, M. J., et al. (2009)	Cross-sectional case-control	Canada	109746	Day care	Birth to index date	Asthma at 10 years, or index date
Midodzi, W. K., et al. (2010)	Prospective cohort	Canada	8486	Daycare	< 2 years	Physician diagnosed asthma at age 2-5 years
Nafstad, P., et al. (1999)	Cross-sectional	Norway	3749	Day care center	<2 years 2-3 years	Asthma at age 4-5 years

				Exposure: Parent report of child care attendance age		
Author/Year	Study Design	Study Location	Sample Size	Type of child care	Age of attendance	Outcome: Parent report of asthma diagnosis or Identification age
Nafstad, P., et al. (2005)	Prospective cohort	Norway	2540	Child care	<12 months	(1) Ever diagnosed asthma by age 10 years (2) Diagnosed current asthma symptoms at age 10 years
NICHD (2010)	Prospective cohort	United States	984	Daycare	7-12 months 13-24 months	Late onset asthma at >54 months of age
Pekkanen, J., et al. (1999)	Cross-sectional	Finland	8387	Day care centre	1-3 years	(1) Ever diagnosed asthma by age 13-14 years (2) Current diagnosis asthma at age 13-14 years
Salam, M. T., et al. (2004)	Cross-sectional case-control	United States	691	Day care center	< 4 months	Parental report of physician-diagnosed asthma at age 3-5 years
Senthilselvan, A., et al. (2015)	Cross-sectional	Canada	6657	Child care	Age not specified	Asthma at <11 years of age
Sun, Y. and Sundell, J. (2011)	Cross-sectional	United States	2819	Daycare center	<12 months	Diagnosed asthma at age 1-6 years
Wickens, K., et al (1999)	Cross-sectional case-control	New Zealand	474	Day care	<12 months	Asthma at age 7-9 years

Table 2: Child Care Attendance and Wheezing – Table of Studies

Author/Year	Study Design	Study Location	Sample Size	Exposure: Parent report of child care attendance age – Type of child care	Exposure: Parent report of child care attendance age – Age of attendance	Outcome: Parent report of wheezing diagnosis or identification age
Bercedo-Sanz, A., et al. (2015)	Cross-sectional	Spain	958	Child care	< 12 months	Recurrent wheezing at 12-15 months of age
Celedon, J. C., et al. (1999)	Prospective cohort	United States	498	Day care	<12 months	Any wheeze at age 1 year 2+ episodes of wheeze at age 1 year
Celedón, J. C., et al. (2002)	Prospective cohort	United States	461	Day care	<12 months	Recurrent wheeze at age 4 years
Celedón, J. C., et al. (2003)	Prospective cohort	United States	453	Day care	<12 months	Recurrent wheeze at age 6 years
Chong Neto, H. J., et al. (2010)	Cross-sectional	Brazil	3003	Day care	<12 months	Recurrent wheeze in the first 12 months of age
Hagerhed-Engman, L., et al. (2006)	Cross-sectional	Sweden	10,851	Daycare	< 12 months 1-2 years >2 years	Wheeze (in the past 12months) at age 1-6 years
Hryhorczuk, D., et al. (2009)	Cross-sectional	Ukraine	2127	Kindergarten	< 3 years	Wheeze in past 12 months at age 6-7years
Kahwa, E. K., et al. (2012)	Cross-sectional	Jamaica	2017	Day care	Age not specified	Current wheeze (age not specified)
Morais-Almeida, M., et al. (2007)	Prospective cohort	Portugal	308	Kindergarten	< 12 months	Recurrent wheeze (>3 episodes in the last year) at age 6 years
Nicolaou, N., et al., (2008)	Prospective cohort	United Kingdom	845	Nursery School	<6 months 6-12 months >12 months	Current wheeze at age 5 years
Ozmert, E. N., et al. (2009)	Cross-sectional	Turkey	109	Day care		Ever wheeze at age 2-4 years
Rusconi, F., et al. (1999)	Cross-sectional	Italy	16,333	Day care center	<2 years	Transient wheeze at age 6-7 years Persistent wheeze at age 6-7 years Late-onset wheeze at age 6-7 years
Visser, C. A. N., et al. (2010)	Cross-sectional	Netherlands	1,115	Day care	<12 months	Wheeze ever in the first 12 months of age Recurrent wheeze in the first 12 months of age Severe wheeze in the first 12 months of age

Table 3: Summary of Pooled Results: Child Care Attendance and Asthma

Outcome: Asthma diagnosis or identification age	Exposure: Child Care Attendance* Attendance at any age	Early Attendance starting younger than 12 months of age	Late Attendance starting at 12 months of age or older
0-18 years	OR = 1.17 (1.01, 1.35) RISK	OR = 0.94 (0.70, 1.27)	OR = 1.19 (1.01, 1.41) RISK
0-2 years	*No Data*	*No Data*	*No Data*
3-5 years	OR = 1.11 (0.92, 1.35)	OR = 0.66 (0.50, 0.87) PROTECTIVE	OR = 1.12, (0.90, 1.38)
6-18 years	OR = 1.08 (0.88, 1.33)	OR = 0.98 (0.66, 1.47)	OR = 1.47 (0.73, 2.97)

When appropriate meta-analysis models were conducted using log scaled odds ratios and random effects
** Compared to no child care attendance*

Table 4: Summary of Pooled Results: Child Care Attendance and Wheezing

Outcome: Wheezing diagnosis or identification age	Exposure: Child Care Attendance* Attendance at any age	Early attendance Attendance starting younger than 12 months of age	Late Attendance starting at 12 months of age or older
0-18 years	OR = 1.07 (0.83, 1.39)	OR = 0.98 (0.55, 1.75)	OR = 0.91 (0.54, 1.52)
0-2 years	OR = 1.80 (1.38, 2.36) RISK	OR = 1.80 (1.38, 2.36) RISK	*No Data*
3-5 years	OR = 0.66 (0.49, 0.90) PROTECTIVE	OR = 0.59 (0.31, 1.12)	OR = 0.43 (0.24, 0.77) PROTECTIVE 1 study
6-18 years	OR = 0.68 (0.44, 1.05)	OR = 0.43 (0.27, 0.68) PROTECTIVE	*No Data*

When appropriate meta-analysis models were conducted using log scaled odds ratios and random effects

** Compared to no child care attendance*

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Chapter 3

Integrated Pest Management and Pesticide Practices in Child Care Centers in California

Abstract

Background: The differences in pesticide management practices and Integrated Pest Management (IPM) knowledge among ECE programs located in California agricultural regions compared to those in non-agricultural regions are not well understood.

Objective: To compare the differences demographic characteristic that are associated with in the prevalence of pesticide use and IPM knowledge among different regions of California.

Method: Cross-sectional secondary data analysis in 45 California licensed child care centers.

Results: Pest management practice and IPM knowledge data was collected from 45 child care centers in three regions of California (Central Valley, Central Coast, and the San Francisco Bay Area). The child care centers in the Central Valley had a statistically significant higher frequency of pesticide application outside the facility, IPM practices, and use of a pest management company. The child care centers in this region also had the least knowledge of IPM.

Conclusion: Further research is needed to understand barriers to IPM knowledge in the Central Valley which has a higher frequency of child care centers serving Latinx children. Interventions are needed in child care centers in this region to reduce the use of pesticides.

Background

Compared to older children and adults, young children are particularly susceptible to the effects of exposure to pesticides due to their proportionately larger body surface area, underdeveloped ability to detoxify and excrete pesticides, rapid growth, and developmental behaviors (e.g., crawling and playing on the floor) (Makri, Goveia, Balbus, & Parkin, 2004). Research suggests that there is a link between pesticide exposure and young children's neurodevelopmental outcomes, including delayed psychomotor and mental development (Eskenazi et al., 2007), and attention-deficit hyperactivity disorder (Bouchard, Bellinger, Wright, & Weisskopf, 2010). Research indicates that dietary and indirect or non-dietary ingestion, secondary to hand-to-mouth behaviors, are the main routes of pesticide exposure for young children, yielding more exposure than inhalation and dermal absorption (Morgan et al., 2007; Wilson, Chuang, & Lyu, 2001). Additionally, pesticide sprays that leave persistent residues on surfaces of rugs, furniture, and stuffed toys as well as in the air contribute to the risks associated with pesticide exposure among young children (Bearer, 1995; Tulve et al., 2006).

Many studies have reported the use of pesticides in early care and education (ECE) facilities (Alkon et al., 2016; Bradman, 2010), including the use of indoor fumigants (sprays or foggers) (Alarcon et al., 2005; Barnes, Sutherland, Brattesani, Wilhoit, & Messenger, 2012; Bradman, 2010; Tulve et al., 2006). Given that early childhood is a critical window when children may be particularly vulnerable to the neurodevelopmental effects of pesticides (Eskenazi et al., 2007; Landrigan et al., 1999; Rauh et al., 2006), it is vital to reduce or eliminate pesticide exposure in ECE facilities, where approximately 62% of children younger than 5 years of age spend time (Laughlin, 2013).

Currently, California has the largest number of ECE programs in the United States, with over 1.3 million enrollment spaces for licensed ECE programs across the state (Child Care Aware of America [CCAOA], 2017). While not mandated by the federal government, in 2000 the California legislature enacted the Healthy Schools Act (HSA) to regulate the use of pesticides in ECE and schools (California Department of Pesticide Regulation [CDPR], 2000). The HSA established requirements for pesticide use in public K-12 schools and encourages school districts to adopt Integrated Pest Management (IPM) practices. IPM is a comprehensive approach to monitoring and eliminating the presence of pests using methods that are the least toxic to humans and the environment (Barnes et al., 2012). In 2007 the HSA was expanded to support the adoption of IPM programs in licensed child care centers (CDPR, 2007) which are the largest provider of ECE in the state compared to other licensed ECE programs (CCAOA, 2017). Additionally, as of January 1, 2015 the HSA began to require that all schools and child care centers submit pesticide use reports to the CDPR for continued monitoring. The HSA requires monthly reporting of all agricultural pesticides used by farms, parks, golf courses, cemeteries, pastures, and more recently child care centers to the county agricultural commissioners, who then report the data to the CDPR (CDPR, 2018).

Following the implementation of the HSA, studies evaluating the use of IPM in California schools and child care centers reported successful adoption of IPM practices (Brajkovich, 2010; Kalmar, Ivey, Bradman, Leonard, & Alkon, 2014). However, despite these efforts to reduce pesticide use at and around schools, pesticides continue to be used in and around California public schools (Barnes et al., 2012) and licensed child care centers (Alkon et al., 2016; Bradman, 2010). In addition, the utilization of IPM practices are not uniformly implemented across California school districts. Specifically, one study reported that larger, urban schools seem to be performing better than smaller, rural schools, and suggested that the reason for this difference may be due to inadequate training or a lack of resources (Geiger, 2015).

Among the children living in urban and rural areas of California, Latinx children, who currently represent one-half of the population of children in the state (Lucile Packard Foundation for Children's Health, 2018), are disproportionately at risk for pesticide exposure. Compared to other racial/ethnic children, Latinx children are more likely to live in agricultural or urban regions that are routinely exposed to pesticides (Carter-Pokras et al., 2007). Latinx children living in agricultural regions are twice as likely as their White peers to attend schools in close proximity to locations with heavy use of pesticides (California Environmental Health Tracking Program, 2014). According to a national surveillance study that identified 406 illness cases associated with pesticide exposures in schools, 69% were from pesticides sprayed at schools and 31% were from pesticide drift from adjacent farmland (Alarcon et al., 2005). This suggests that Latinx children in agricultural areas might also be at greater risk for exposure to pesticides applied in schools and ECE settings, in addition to residential exposures from drift from farmlands (Coronado et al., 2011; Lee et al., 2011).

The differences in pesticide use and IPM practices among ECE programs located in California agricultural regions compared to those in non-agricultural regions are not well understood. Further, research studies have yet to evaluate pesticide use or IPM practices in ECE facilities attended largely by Latinx children living in California. Therefore, this study aims to address this gap by addressing the question: What are the demographic characteristics (including geographic region and children’s race/ethnicity) that predict pesticide use and IPM practices in licensed child care centers in California.

Methods

Study Design and Sample

This study was a secondary data analysis using baseline cross-sectional data collected in 2012 for a 7-month quasi-experimental, IPM intervention study in child care centers in California (Alkon et al., 2016). The parent study was conducted in a convenience sample of 49 child care centers located in five California counties (Alameda, Merced, San Francisco, San Mateo and Santa Cruz). The protocols and consent forms for this study were approved by the University of California, San Francisco (UCSF) Institutional Review Board (IRB).

The inclusion criteria for the child care intervention study were child care centers that (1) were licensed by the California Child Care State Licensing Program (California Department of Social Services, 2018), (2) had a director available to complete a pre- and post-intervention interview, (3) provided space and time for their staff to attend an IPM training workshop, (4) planned to remain in operation for the duration of the study (a minimum of 9 months). The detailed methods of the parent study are described elsewhere (Alkon et al., 2016).

For the purposes of this study the included child care centers were clustered by California region: Central Valley (Merced), Central Coast (Santa Cruz), and the San Francisco Bay Area (Alameda, San Francisco, and San Mateo). According to the county-level Pesticide Use Report ranking data (CDPR, 2017), the Central Valley has the highest agricultural pesticide use and the San Francisco Bay Area has the lowest agricultural pesticide use.

Measures

The data were obtained from the child care center directors by an in-person interview. The director interview questionnaire included questions about \age and race/ethnicity of children enrolled, children receiving government subsidies, education level and job tenure of the director, and pest management practices. For pesticide management practices within the child care center, the following five questions included in this study are: (1) Do you know what integrated pest management (IPM) is, (2) have you tried to use IPM, (3) do you work with a pest management company, (4) have pesticides been applied inside this facility, and (5) have pesticides been applied outside this facility? The questions were answered with categorical responses (yes, no, don't know, or not applicable).

Data Analysis

The study summarized demographic characteristics of the child care centers using descriptive statistics (frequency, range, mean and standard deviation). To examine differences in pesticide use in child care centers by dominant race/ethnic group of enrolled children, the centers were categorized into groups based on the majority (>50%) race/ethnic group, and three categories were created: Latinx majority, White majority, and no majority. Analysis of differences in pesticide use between the three California regions (Central Coast, Central Valley, and San Francisco Bay Area) were conducted using aggregate data of the participating centers from all three regions. Chi-square tests were performed to compare differences in pesticide management practices by California region and the Fisher's Exact Test was conducted for variables with expected values of less than five in one or more cells. All analyses were conducted using Stata 13.1 (version 13.1, StatCorp LP, 2010).

Results

Demographics

The study sample included 45 child care centers with a total of 2,326 enrolled children (Table 1). The age of the children enrolled varied by child care center and ranged from infants (children 12 months of age or younger) to school-aged children. Latinx children (35%, n =822) and White children (33%, n =773) were the largest race/ethnicity groups in the participating child care centers. The dominant race/ethnic group of enrolled children was Latinx for 44% (n = 20) of the child care centers. White was the majority for 29% (n=13) of the centers and 27% (n =12) of the centers did not have children with one majority race/ethnic group. The differences in race/ethnic majority were statistically significant among the three California regions (p=0.001). The Central Valley had a higher frequency (86%, n=6) of child care centers with Latinx majority compared to the Central Coast (53%, n=10) and the Bay Area (21%, n=4) (Table 2). The vast majority of child care centers (90%) enrolled children receiving government subsidies including the food program. Over half (52%, n= 23) of these centers had 100% of their children receive government subsidies. Child care center directors had an average of 20 years (SD = 9.75) working experience in the ECE field and 8 years (SD = 9.64) at the current center. Over three-quarters (78%, n= 35) of directors had a Bachelor's degree or higher (Table 2).

IPM Knowledge and Pesticide Management Practices

The majority of the child care center directors (73%, n=33) had no prior knowledge of IPM, however 67% (n=29) had tried some form of IPM regardless of their awareness. Less than half of the child care centers reported pesticide use either inside the facility (11%, n = 5) or outside the facility (42%, n=19). Additionally, 20% of the center directors (n=9) did not know if pesticides were applied inside, and 31% (n=14) did not know if pesticides were applied outside. Nearly half of the centers (49%, n=22) used a pest management company (Table 3). The use of a pesticide management company was significantly associated with a higher frequency of outdoor pesticide use (p = 0.018). There was no association between pesticide use either inside or outside the facility and the director's IPM knowledge.

IPM knowledge and pesticide management practices by California geographic region. All of the child care centers located in the Central Valley reported using pesticides outside their facility (100%, n=7), which was about 3-4 times the frequency of applying pesticides outside the facility in the San Francisco Bay Area (37%, n= 7) and Central Coast (26%, n= 5) (p= 0.013). None of the directors in the Central Valley had knowledge of what IPM was, compared to 37% of the directors in the Central Coast and 26% of the directors in the Bay Area. However, child care centers located in the Central Valley had a higher frequency of IPM use (43%, n=3) compared to child care centers in the Central Coast (33%, n=6) or San Francisco Bay Area (11%, n=2) (p= 0.046). Additionally, utilization of a pest management company was more frequent in the centers located in the Central Valley (86%, n=6) compared to the child care centers in the Central Coast (32%, n=6) or San Francisco Bay Area (53%, n=10) (p= 0.056) (Table 3).

IPM knowledge and pesticide management practices by enrolled children's race/ethnicity. There was a significant association between IPM knowledge among the child care center directors and the majority race/ethnicity of the enrolled children (p=0.028). Specifically, among child care centers in which Latinx children comprised the majority, 90% (n=20) of the directors had no knowledge of IPM, compared to 46% of the child care centers with a majority of White children, and 75% of the child care centers without a race/ethnic majority (p=0.028). No association was found between pest management practices and majority race/ethnicity of the children (Table 3).

IPM knowledge and pesticide management practices by director's level of education. There was no significant association between the director's level of education and IPM knowledge or pest management practices in the child care centers. However, compared to the child care center directors with a Bachelor's degree or higher, the center directors with some college or an

Associate's degree had a higher frequency of IPM knowledge (40% vs. 23%), higher frequency of IPM use (40% vs. 21%), and a higher frequency of using a pest management company (70% vs. 43%) (Table 3).

Discussion

This study found that the geographic location of the child care center was associated with the use of pesticides, IPM practices, and the use of a pesticide management company. Child care centers located in the Central Valley, where the majority of enrolled children were Latinx, used more outdoor pesticides and pesticide management companies than centers located in the Central Coast and San Francisco Bay Area regions of California. This finding suggests that Latinx children may be more exposed to pesticides, but pesticide use by child care centers was not significantly different by the race/ethnic majority group of children enrolled. Additionally, this study found no association between the child care center director's level of education and IPM knowledge or pest management practices.

These findings highlight the influence of the geographic location of the child care center as potential key driver of pest management practices among the child care centers. Child care centers located in the Central Valley had the highest frequency of outdoor pesticide use and were all located in Merced county, which has one of the highest rankings for pesticide use in California (CDPR, 2017). This suggests that child care centers in this region need interventions for increasing awareness of IPM practices and reducing pesticide use, in addition to the need for addressing pesticide applications near the facilities.

Implementation of IPM in ECE remains a component of best practices that are in agreement with national quality standards in ECE (American Academy of Pediatrics, 2011). Findings from this study and others indicate that most ECE providers are not familiar with IPM

(Bradman, 2010; Kalmar et al., 2014). Additionally, knowledge and use of IPM were different by geographic region. Even though the centers located in the San Francisco Bay Area demonstrated some knowledge of IPM, the centers in this region were significantly less likely to use IPM practices compared to the centers in Central Valley and Central Coast.

Less than half of the centers in this study reported indoor or outdoor pesticide use, which was comparatively lower than previous studies. For example, a survey of 637 California licensed child care centers found that more than half of the centers (55%) used pesticides (Bradman, 2010), and a national survey of 168 licensed child care centers in the United States reported that approximately 75% of centers applied pesticides (either indoors or outdoors) during the previous year (Viet et al., 2013).

This study has several limitations that should be considered when interpreting the results. This study involved a relatively small convenience sample of child care centers in California, as a result the ability to generalize to other licensed ECE facilities or other ECE settings is unknown. Additionally, the center directors that agreed to participate in the study may have more interest in IPM and/or pest management. Another limitation is that the director's self-report interviews were not objective and there were no direct measures to validate the director's responses. This allows for the possibility of self-report bias or social desirability bias, which the director may have over-reported or under-reported pesticide used based on what they felt was a more socially favored response. Further, previous research has found that self-report of pesticide use does not correlate with measured levels of detected pesticides in ECE facilities (Tulve et al. 2006). This suggests that questionnaire responses might not be adequate for assessing potential pesticide exposure in ECE facilities. For example, ECE facility respondents do not often know if or what pesticides have been applied (Tulve et al., 2006; Viet et al., 2013; Alkon et al., 2016).

Therefore, it is possible that the centers with "unknown" answers or missing data on pesticide use may not have used pesticides. This may have biased our results toward null findings for the frequency of pesticide use between centers.

Conclusion

This study was the first to evaluate the relationship between ECE demographic characteristics (geographic region and children's race/ethnicity) and IPM knowledge and pest management practices among child care centers located in different regions of California.

This study finding suggests that (1) children attending child care centers located in agricultural regions such as Central Valley have increased risk of pesticide exposure from a high application of agricultural pesticides and pesticides being applied in and/or around their child care facilities, and (2) there is a need to expand IPM interventions and education in child care centers, particularly, in California Central Valley, which are more likely to use pesticides. This study also shows that within our sample the children attending child care centers with a majority of Latinx children have the greatest potential exposure to pesticides as they (1) more likely to be located the Central Valley, which has the highest reported agricultural pesticide use and the highest frequency of pesticide use outside the child care facility, and (2) have child care center Directors with the least knowledge of IPM. In an effort to reduce the use of pesticides in the Central Valley child care centers, further research is needed to understand the barriers to awareness of IPM in Central Valley communities and to improve state regulation of pesticides in vulnerable communities and ECE facilities located in regions of high pesticide use.

Table 1. Children's Demographics (N = 2, 326)

	n(%)
Race/ Ethnicity *(listed in order of frequency)*	
Latino	822 (35%)
Non-Latino, White	773 (33%)
Asian American/ Pacific Islander	221 (10%)
Non-Latino, Mixed	247 (11%)
Non-Latino, African American	219 (9%)
Other	35 (2%)
Native American	9 (1%)
Age	
0-12 months (infant)	122 (5%)
13-35 months (toddler)	485 (21%)
3-5 years (preschool age)	1583 (68%)
>5 years (school age)	136 (6%)

Table 2: Child Care Center Characteristics (N = 45)

	Total	Geographic Region			
	N (%)	Central Coast n (%)	Central Valley n (%)	San Francisco Bay Area n (%)	Chi^2(df), p-value
	45 (100%)	19 (42%)	7 (16%)	19 (42%)	
Director's level of education					
Community college/ Associates degree	7 (16%)	3 (16%)	2 (29%)	2 (11%)	4.31(6), p=0.634
Some College	3 (7%)	0	1 (14%)	2 (11%)	
Bachelor's degree	31 (69%)	14 (74%)	4 (57%)	13 (68%)	
Master's degree or higher	4 (9%)	2 (11%)	0	2 (11%)	
Race/Ethnicity majority (> 50%) of the children enrolled					
Majority Latino	20 (44%)	10 (53%)	6 (86%)	4 (21%)	19.46(4), p=0.001
Majority White	13 (29%)	8 (42%)	1 (14%)	4 (21%)	
Centers without an ethnic majority	12 (27%)	1 (5%)	0	11 (58%)	
Children receiving government subsidy					
No enrolled children receive government subsidy	5 (10%)	4 (21%)	0	2 (11%)	5.61(4), p=0.230
Some enrolled children receive government subsidy	21 (43%)	6 (32%)	1 (14%)	9 (47%)	
All enrolled children receive government subsidy	23 (47%)	9 (47%)	6 (46%)	8 (42%)	

Table 3: Demographic characteristics of IPM knowledge and pest management practices

			Geographic region				Enrolled Children's Race/Ethnicity				Director's Level of Education		
		Total number of centers N (%)	Central Coast n (%)	Central Valley n (%)	San Francisco Bay Area n (%)	Chi² (df), p-value	Majority Latinx n (%)	Majority White n (%)	No Race/Ethnic Majority n (%)	Chi² (df), p-value	Some College or Associates Degree n (%)	Bachelor's Degree or Higher n (%)	Chi² (df), p-value
IPM Knowledge	Do you know what integrated pest management (IPM) is? n = 45												
	Yes	12 (27%)	7 (37%)	0 (0%)	5 (26%)	3.55(2), p=0.228	2 (10%)	7 (54%)	3 (25%)	7.77(2), p=0.028	4 (40%)	8 (23%)	1.17(1), p=0.418
	No	33 (73%)	12 (63%)	7 (100%)	14 (74%)		18 (90%)	6 (46%)	9 (75%)		6 (60%)	27 (77%)	
Pest Management Practices	Have you tried to use IPM? n = 43												
	Yes	11 (26%)	6 (33%)	3 (43%)	2 (11%)	9.03(4), p=0.046	3 (16%)	6 (46%)	2 (18%)	7.58(4), p=0.160	4 (40%)	7 (21%)	1.82(2), p=0.330
	No	29 (67%)	9 (50%)	4 (57%)	16 (89%)		13 (68%)	7 (54%)	9 (82%)		5 (50%)	24 (73%)	
	Don't Know	3 (7%)	3 (17%)	0 (0%)	0 (0%)		3 (16%)	0 (0%)	0 (0%)		1(10%)	2 (6%)	
	Do you work with a pest management company? n = 45												
	Yes	22(49%)	6 (32%)	6 (86%)	10 (53%)	7.91(4), p=0.056	8 (40%)	6 (46%)	8 (67%)	5.84(4), p=0.205	7 (70%)	15 (43%)	2.40(2), p=0.440
	No	22 (49%)	13 (68%)	1 (14%)	9 (42%)		12 (60%	7 (54%)	3 (25%)		3 (30%)	19 (54%)	
	Don't Know	1 (2%)	0 (0%)	0 (0%)	1 (5%)		0 (0%)	0 (0%)	1 (8%)		0 (0%)	1 (3%)	
	Have pesticides been applied <u>inside</u> this facility? n = 45												
	Yes	5 (11%)	3 (16%)	1 (14%)	1 (5%)	1.69(4), p=0.785	3 (15%)	1 (8%)	1 (8%)	2.27(4), p=0.771	0 (0%)	5 (14%)	1.66(2), p=0.643
	No	31(69%)	13 (68%)	5 (71%)	13 (68%)		14 (70%)	10 (77%)	7 (58%)		8 (80%)	23 (66%)	
	Don't Know	9 (20%)	3 (16%)	1 (14%)	5 (26%		3 (15%)	2 (15%)	4 (33%)		2 (20%)	7 (7%)	
	Have pesticides been applied <u>outside</u> this facility? n = 45												
	Yes	19 (42%)	5 (26%)	7 (100%)	7 (37%)	13.51(4), p=0.013	9 (45%)	4 (30%)	6 (50%)	4.70(4), p=0.353	4 (40%)	15 (43%)	0.07(2), p=1.000
	No	12 (27%)	8 (42%)	0 (0%)	4 (21%)		5 (25%)	6 (46%)	1 (8%)		3 (30%)	9 (26%)	
	Don't Know	14 (31%)	6 (32%)	0 (0%)	8 (42%)		6 (30%)	3 (23%)	5 (42%)		3 (30%)	11 (31%)	

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Chapter 4

Assessing Key National Health and Safety Standards in Family Child Care Homes

Abstract

Background: Indicators of high-quality ECE programs can be measured using key national health and safety standards found in the Health and Safety Checklist for Early Care and Education Programs (HSC). This measure of health and safety quality has not been assessed in Family Child Care Homes (FCCHs).

Objectives: The aims of this pilot study were to (1) evaluate the feasibility of assessing the quality of the health and safety environment in FCCHs using the HSC, (2) describe the frequency of the national key Health and Safety Standards met and not met in FCCHs, (3) evaluate the association of the FCCH characteristics (ECE providers level of education and geographical location) with the HSC, and (4) to evaluate the internal consistency of the HSC in FCCHs.

Methods: This study used an observational cross-sectional design in 21 California licensed FCCHs.

Results: The HSC was fully completed in 19 of the 21 FCCHs and was found to be feasible tool for measuring health and safety in FCCHs with an internal consistency within each subscale ranging from 0,04 to 0.98. The mean HSC score was 3.50 (SD = 0.24, range 1 to 4)

Conclusion: The FCCHs included in this sample demonstrated a high frequency of meeting national health and safety standards. Particularly, the subscale categories for personal relationships, supervision, interaction and activity were usually met. Handwashing and diapering practices were not usually met and this suggests that these are areas for future intervention in FCCHs.

Background

In the United States, more than half of all children younger the 5 years of age regularly spend time in one or more early care and education (ECE) arrangements (Child Care Aware of America [CCAOA], 2017; Laughlin, 2013). ECE programs include a variety of out-of-the home programs such as preschools, Head Start, child care centers and family child care homes (FCCHs). Young children's experiences across these settings can have an impact on their educational outcomes and future lives. Specifically, there is a relationship between the quality ECE environments and child development, whereas high quality ECE positively affects developmental outcomes including, cognitive, language development, and social relationships or social-emotional development in children (De Marco & Vernon-Feagans, 2013; Li, Farkas, Duncan, Burchinal, & Vandell, 2013; NICHD, 2003).

Research indicates that the quality of the program has a critical role in fostering positive impact of ECE attendance on developmental outcomes. However, the quality of ECE varies in the absence of standardized national or state regulations among the different types of ECE programs. As a result, children who attend lower-quality ECE programs are at risk for negative social emotional interactions and are less likely to be ready for school entry (Burchinal et al., 2000). On the other hand, attendance in high quality ECE programs provided in a safe and healthy environment has lasting positive developmental effects for children (Vandell et al., 2010). Specifically, the protective effect of high-quality ECE programs is particularly evident among children from low-income families (Dearing, McCartney, & Taylor, 2009). One longitudinal study of 1,364 children found that children who attended ECE between the 6 to 54 months of age had improved long-term education success through fifth grade, compared to those who did not attend an ECE program (Dearing et al., 2009). Among children living in poverty, there is a stong relationship between high-quality child care and improved developmental outcomes, while poor quality of care has been linked to worse outcomes for children (Burchinal et al., 2000). Although this relationship is present for all children the effect it is not as strong for children from middle-income families (Dearing et al., 2009).

Affordability and accessibility influence how families choose the type of care for their children. Presently, the cost of ECE remains high and has resulted in socioeconomic disparities in access to high quality ECE programs. In 2016, several U.S. states reported that the cost of center-based ECE or care in a FCCH for infants can be as high as 10.4 to 15.9 percent of a married couples' annual income, or as high as 33.0 to 50.8 percent of a single parent's income (CCAOA, 2017). In 2016, the annual cost for infant care in a FCCH was $4,792 less than the annual cost for infant care in a Child care center. Therefore, FCCHs are typically more affordable for lower income families.

With the exception of federally funded Head Start programs that have limited accessibility (Schmit et al. 2013), low-income and minority children are more likely to receive care in low-quality ECE programs (Dowsett et al., 2008; Fuller, Kagan, Loeb, & Chang, 2004; Magnuson & Waldfogel, 2005) compared to children from high socioeconomic backgrounds, who are more likely to be able to afford high quality ECE programs (CCAOA, 2017; NICHD, 2004). Data from 7,500 children in the Early Childhood Longitudinal Survey Birth Cohort was used to evaluated the quality of the ECE programs attended using Early Childhood Environmental Rating Scale (ECERS) and the Family Day Care Rating Scale (FDCRS) and found that less than one third of children from poor families attended head-start programs and that attendance in lower quality FCCHs was associated with less maternal education and minority ethnicity (African-American or Latinx) (Hillemeier et al., 2013). Additionally, the children's mothers' level of education is related to the type of ECE program they attend. According to national data, in 2011, children of mothers with a college degree utilized state-regulated ECE programs (i.e., Child care centers and FCCHs) at a higher rate than children of mothers without a high school diploma (Bank, 2013).

Licensed FCCHs are the second most common type of state regulated ECE program offered in non-relative home settings and are more frequently utilized by children from lower income families (Dowsett et al., 2008; Fuller, Kagan, Caspary, & Gauthier, 2002). However, the quality of FCCHs utilized by low-income families is comparatively lower than the quality of similar FCCHs utilized by higher income families, and also lower than the quality of child care centers serving low-income families (Fuller et al., 2004). Given the positive effect of ECE attendance in high quality programs on developmental outcomes for children living in impoverished environments (Dearing et al., 2009; Dowsett et al., 2008), it is critical to develop tools to assess the quality of ECE programs that serve these populations. Measures of quality include curriculum, environment, and health and safety. This study focuses on assessing health and safety quality in California licensed FCCHs.

Health and Safety Quality

A national survey of parents found that among the many factors that parents consider when choosing an ECE program (i.e.; cost, hours of operation, type of program, or distance from home or work), the most important are the health and safety of the ECE environment (Shlay, 2010), which are the foundational attributes of the overall quality of care that their child will receive in that setting (Administration for Children and Families, 2015). Quality care in ECE programs requires the consistent use of basic health and safety practices and has thus become an area of focus for child care administrators, providers, researchers, and policy makers.

Health and safety indicators of ECE quality have been studied and identified by national experts in child care research and published by the American Academy of Pediatrics (AAP), the American Public Health Association (APHA), and the National Resource Center (NRC) for Health and Safety in Child Care and Early Education in the National Health and Safety Performance Standards: Guidelines for Out-of-Home Child Care Programs [Caring for Our Children, Third Edition (CFOC3)] (American Academy of Pediatrics [AAP], 2011). CFOC3 provides 686 evidence-based standards of health and safety that include the following key domains: immunizations, infections control, nutrition, environment, oral health, physical activity, staff ratios and supervision, staff qualifications (training and education), policies for children with special health care needs, emergency procedures, and injury prevention (Donoghue, 2017).

Overall, young children are at risk for becoming overweight and obese (Benjamin et al., 2009). Nutrition and physical activity, identified as key health indicators for health and safety quality in ECE (American Academy of Pediatrics, 2011; Donoghue, 2017), are important for reducing health risks associated with overweight and obese weight classifications. Studies have shown that ECE providers have limited training and practices in age appropriate nutrition or physical activity for young children (Tandon, Garrison, & Christakis, 2012; Trost, Messner, Fitzgerald, & Roths, 2009). As discussed by Story, Kaphingst, & French (2006), ECE programs provide a setting for interventions designed to improve nutrition and physical activity practices.

The ECE provider's level of education and pre-service training are important components of health and safety quality in ECE (Donohue, 2017; Administration for Children and Families, 2015). Child care researchers have shown that the ECE provider's level of education is an independent predictor of children's social-emotional competence and long-term academic outcomes (Dowsett et al., 2008; Li et al., 2013). Recently, the Institute of Medicine and the

National Research Council recommended that all lead teachers in ECE programs have a minimum of a Bachelor's degree (Institute of Medicine, 2015). Higher levels of formal education and/or child development training among ECE providers, has been consistently shown to positively affect the overall quality of the ECE program in center-based child care settings (Hartman, Warash, Curtis, & Hirst, 2016; Weaver, 2002). However, there are few studies of this relationship in FCCHs; thus, it is not known if the same relationship exists in FCCHs.

Health and Safety Quality in Family Child Care Homes

Despite the well-documented protective benefits for young children attending high quality ECE programs, few studies assess the quality of FCCHs based on the health and safety of the environment. Health and safety quality are regulated differently for each state (Hashikawa et al., 2010). In addition to state regulations for FCCHs, quality can be assessed by accreditation status from the National Association for Family Child Care (NAFCC) and ratings based on the Family Child Care Environment Rating Scale–Revised (FCCERS–R) (Kelton, 2013). One limitation of the FCCERS-R is that its health and safety practices' subscales do not contain key evidence-based health and safety standards outlined in CFOC3 (AAP, 2011). This current study addresses the need for ERS to include the current CFOC3 standards for health and safety in FCCH.

Out of the 686 CFOC3 standards, the basic standards needed to meet the foundations of health and safety in ECE programs were identified by Administration of Children and Families, Child Care Bureau and part of the CCDF program that provides federal subsidies for low-income children in child care programs (Administration for Children and Families, 2015). Broader and key national health and safety standards were established in Stepping Stones, Third Edition (American Academy of Pediatrics, 2014), and were used to develop the Health and Safety

Checklist for Early Care and Education Programs (HSC) (Alkon et al., 2016). The HSC includes 72 observable and validated standards of health and safety practices in ECE programs (Alkon, To, Wolff, Mackie, & Bernzweig, 2008). The HSC provided a user-friendly instrument to assess key health and safety standards in ECE.

Despite the variability in regulation across states, the HSC has been shown to be a valid and reliable tool to assess National health and safety standards in child care centers across three states (California, Arizona, and North Carolina) (Alkon et al., 2008). Additional field-testing of the HSC in child care centers demonstrated a weak to strong internal consistency of the 14 HSC subscales (range from 0.07 to 0.82) (Alkon et al., 2016). To date the HSC has not been validated for use in FCCHs. The aims of this pilot study were to (1) evaluate the feasibility of assessing the quality of the health and safety environment in FCCHs using the HSC, (2) describe the frequency of the national key Health and Safety Standards met and not met in FCCHs, (3) evaluate the association of the FCCH characteristics (ECE providers level of education and geographical location) with the HSC, and (4) to evaluate the internal consistency of the HSC in FCCHs. The protocols and consent forms for this study were approved by the University of California, San Francisco (UCSF) Institutional Review Board (IRB).

Methods

This pilot study used an observational cross-sectional design to determine the feasibility and reliability of the HSC to assess the health and safety environment and practices in FCCHs. The FCCHs in this study were participants in a larger study that conducted an environmental health intervention in FCCHs. A full description of this project, including recruitment and sample characteristics are described elsewhere (Stephens et al., 2017).

Participants

FCCHs located in one of the three California geographical regions (San Francisco Bay Area, Central Coast and Central Valley) were enrolled in the study if the following inclusion criteria was met: (1) held a California FCCH license, (2) in operation during the study period (3) provided service to low-income, minority children ranging from infants to five years of age, and (4) FCCH has an English-speaking director. The participating FCCH directors provided consent for participation in the study.

Measures

This study used two measures for data collection, (1) Director Interview and (2) the HSC. To insure inter-rater reliability of the HSC data, the researchers conducted training among data collectors, and achieved 90% inter-rater reliability prior to data collection in FCCHs not included in this study. The researchers recorded the start and end time for completion of the HSC and scored each item on the HSC. The HSCs were completed on paper forms by the researchers and then entered into a database using the Qualtrics® platform. Data integrity was examined to assure accuracy and reliability before exporting the data for analysis.

ECE children, director, and staff demographics. FCCH demographic information including the location, children's age group, and the FCCHs director's education level was provided by the FCCH director during an initial interview with the research staff person. The research staff calculated the child-to-staff ratios based on the number of children and number of ECE staff present within each FCCH at the time of the HSC observation.

Health and safety quality measure. The HSC consisted of 112 items grouped into six subscales: Section 1: Emergencies, Medications, Equipment and Furnishings (Items 1-41), Section 2: Interaction, Physical Activity, and Nutrition (Items 42-59), Section 3: Personal

Hygiene, Food Safety/Food Handling, Environmental Health (Items 60-85), Section 4 Pools, Spas, and Hot Tubs (Items 86-88), Section 5: Infant and Toddler Personal Relationships, Diapering, Injury Prevention (Items 89-97), and Section 6: Infants Activity, Sleep, Safety, Nutrition (Items 98-112). The 112 items across these subscales were scored using a 4-point Likert type scale ranging from 1 to 4 based on the ability of the FCCH to meet the national standards for each item, with two additional options of "not applicable" or "not observed." Items were rated 1 = never (none of the components in the item are met), 2 = sometimes (≤50% of the components in the item are met), 3 = usually (51-99% of the components in the item are met), to 4 = always (every component in the item is met). For each subscale, a mean score of the subscale items was calculated. An overall HSC score was calculated by averaging the subscale scores.

Feasibility. The feasibility of the measure was determined by the time needed to complete the HSC, ease of completing the HSC on-site, and the number of missing items (not-observed, or sections that were unable to be completed).

Statistical Analysis

Each HSC items was summarized using frequencies and the subscales and total scores were summarized using means and standard deviations (SD). Differences in observed health and safety quality were analyzed by dichotomizing the HSC item score by median rated score, either above or below, and compared to FCCH characteristics (California region and director's level of education: bachelor's degree or higher or some college/ associates degree) using the Fisher's Exact test of independence. Psychometric analysis of the HSC conducted in FCCH setting were evaluated using Cronbach's alpha coefficients to measure the internal consistency of the items within each subscale. Only items with sufficient data were included in the calculation of the

Cronbach's Alpha coefficient therefore, the number of items included in each analysis differs. All analyses were completed using Stata 13.0 (version 13.1, StatCorp LP, 2010).

Results

A total of 21 FCCHs were enrolled in this study from the three geographic regions of California (San Francisco Bay Area, Central Coast, and the Central Valley). The HSC was fully completed in 19 of the 21 FCCHs; the remaining two FCCHs only completed a portion of the HSC. Across the FCCHs, the average number of children enrolled was 10.42 (n = 21, SD = 3.59, range = 5 to 18) and the average number of staff was 1.88 (n = 21, SD = 0.70, range = 1 to 3) (Table 1). All of the participating FCCH directors had more than a high school education; the majority (67%, n=14) attended "some college" or received an "Associates degree" (Table 2). Those FCCHs in the San Francisco Bay Area had directors with higher levels of education (71% had a Bachelor's degree or higher), compared to those in Central Valley (100% had attended some college or held an associated degree) or Central Coast (71% attended some college or held an associated degree) ($p<.05$).

Health and Safety Quality

Among the 21 FCCHs the mean HSC score was 3.50 (SD = 0.24). The average HSC subscales scores across the FCCHs ranges from the lowest 2.03 (n = 17, SD=1.35) (for Infants and Toddlers—Diapering) to the highest 3.97 (n = 17, SD = 0.12) (for Infants and Toddlers—Personal Relationships) and 3.90 (n=20, SD = 0.12) (for Supervision, Interaction and Activity). Additionally, the Nutrition subscale score was 3.78 (n = 19, SD = 0.21) (Table 3).

Personal Hygiene—Handwashing was the only HSC subscale with statistically significant differences across geographic region. Specifically, FCCHs located in the Central Coast were more likely to demonstrate higher scores (scores above the median) for handwashing practices compared to FCCHs located in the other two California regions ($p<.05$). Despite the statistically significant differences in the directors' education levels across counties, the directors' level of education was not associated with the average HSC subscale scores or the total HSC score in the FCCHs. The average score for each of the 112 HSC items is reported in Table 4.

Feasibility

Average time to completion of the HSC was 60.33 minutes (range from 25 to 105 minutes). During the observation the researchers were not able to observe all of the items on the HSC. The subscales with the highest frequency of missing data included Medications, Personal Hygiene—Tooth Brushing, Pools, Spas, and Hot Tubs, Infants Only—Activity, Sleep, Safety, and Infants Only—Nutrition. Among these HSC subscales there was a wide range of items that were completed (5% to 43%). Additionally, not all FCCHs have pools or children enrolled who require medications, therefore these items would have been marked "not applicable" or "not observed".

Psychometric Analysis

Among the FCCHs observed in this study Cronbach's alpha coefficients of the subscales widely ranged from weak to strong (0.04 to 0.98) (Table 3). The subscales with the weakest internal consistency included: Supervision, Interaction, and Activity (0.04), Nutrition: Eating and Drinking (0.23), and Equipment and Furnishings: Outdoors Only (0.28). Subscales that did not have enough items or variability between the items to calculate the Cronbach's alpha included Medications, Personal Hygiene—Tooth brushing, Pools, Spas, and Hot Tubs, and Infants and Toddlers— Personal Relationships.

Discussion

The FCCHs in this study demonstrated an overall high prevalence in the key national health and safety standards met on the HSC. Additionally, the application of the HSC was found to be both feasible and reliable in the FCCH setting. However, no association was found between the FCCH demographic characteristics (ECE providers level of education and geographical location) with observed health and safety HSC scores. These findings are not supported by other studies that have consistently shown the association between high quality ECE programs with the characteristic of the programs (i.e.; the ECE provider's level of education, the socioeconomic status of enrolled children, or the race/ethnicity of the children) (Hartman et al., 2016; Dowsett et al., 2008). Given the small size of the sample of FCCHs, this study is likely not powered enough to detect these associations.

A comparison of the HSC results in FCCHs in this study with another study of child care centers (Alkon et al., 2016) shows similarities between the two samples of observations. In both studies, the diapering and handwashing subscales had the lowest scores and the supervision, interaction, activity, and infant/toddler relationships subscales had the highest scores. This demonstrates similar health and safety quality between child care centers and FCCHs and demonstrates the feasibility of the HSC for the FCCH setting. In addition, it provides a description of the number and type of CFOC3 standards met and not met in FCCHs. The HSC subscale items observing toothbrushing showed higher scores in FCCHs compared to child care centers (Alkon et al., 2016).

The highest scoring subscales were Supervision, Interaction, and Activity, and Infants and Toddlers – Personal Relationships. These findings are also consistent with other previous research that demonstrates that compared to child care centers, FCCH providers typically provide care for fewer children (NICHD, 2004), which can result in closer interactions and more time spent directly with each child (Vandell, 1996).

This pilot study showed that is it feasible to complete the HSC to assess health and safety quality in FCCH settings despite the occurrence of missing data in the sample. Given the small sample of conveniently recruited FCCHs in this study, caution should be used when generalizing predictions of the performance of the HSC in other settings based on the psychometric findings. The internal consistency within each subscale was variable secondary to missing data.

Unobserved, skipped, or items deemed not applicable on the HSC were secondary to expected variation between FCCH settings or due to lack of observation time during the data collection. This study shows that the measure was used once during an approximate one-hour observation, therefore it might not be representative of all of the practices that typically occur in each setting. Given that California's licensing regulations are covered in the HSC, the missing data within these subscales is likely attributable to the items not observed during the timeframe when the data were collected or not being applicable to the individual FCCHs in the sample. For example, researchers were not always able to observe activities such as sleeping practices or mealtime practices if they were not present during those activities.

This study did not include a measure of test-retest reliability, which would help determine if the HSC is stable over time. To improve the accuracy of the data collected future studies would need to conduct repeat measures testing on different days and during different times of the day to collect more representative data. Moreover, while all items of the HSC are applicable to ECE settings, including licensed FCCHs, some items or subscales were not applicable to some FCCHs in this study (i.e.; Pools, Spas, and Hot Tub and Infants Only subscales).

Research suggests that receipt of ECE subsidies may promote positive child outcomes due to increased access to higher quality care for children from lower-income families (Krafft, Davis, & Tout, 2017). However, no association was found between the percentage of children receiving government subsidies (including the food program) and overall HSC score. This could be due to high percentage of FCCHs in our sample (90%) that enrolled children from lower-income families that were eligible to receive government subsidies.

There is evidence to suggest that children attending FCCHs are at higher risk for childhood obesity compared to those in child care centers (Benjamin et al., 2009), which make FCCHs an optimal setting for promoting and modeling healthy weight-related behaviors (nutrition and physical activity) for young children. Within our sample nutrition practices (i.e.; amount of drinking water available, use of lower fat milk for children two years of age or older, and the types of food provided) had high HSC subscale and item scores. Specifically, the FCCHs in or sample frequently met the standard for serving lower-fat milk (1% or skim milk) to children two year of age or older (Table 4, Item #54), which is inconsistent with another study that measured nutrition and physical activity policies and practices in FCCHs in Kansas and found that only 13% of their sample of FCCHs (n=297) met this standard (Trost et al., 2009). There is also some evidence that teacher-led physical activities are frequently practiced in FCCHs (Tandon et al., 2012), which is consistent with our findings. Specifically, the FCCHs within our sample met the standard for structured or adult-led physical activities and games that promote movement for children more than 50% of the time (Table 4, Item #52).

A limitation of this study is that the participating FCCHs were recruited as a convenience sample and included directors that were aware that their FCCHs health and safety policies and practices were being observed during the observation; thus, the results cannot be generalized to all licensed FCCHs.

Conclusion

This study represents the first to evaluate the health and safety practices in California licensed FCCHs based on observable key national health and safety standards operationalized in the HSC. The main findings from this study show that the HSC, previously validated in child care centers, is feasible and reliable when used in FCCHs. The FCCHs included in this sample met the majority of the national health and safety standards. Particularly, the subscale categories for personal relationships, supervision, interaction and activity were usually met. The health and safety practices least met were handwashing and diapering which suggests that these are areas for future intervention in FCCHs.

The classification of FCCH encompasses a wide variety of settings that can provide different levels of quality. Researchers and policymakers should focus on improving the quality of FCCHs to enhance early development of vulnerable children. The application of the HSC can be useful in providing descriptive comparative assessments between FCCHs in different locations, including states, and to assess health and safety standards and how they relate to the risk of illness and/ or injury among children attending of ECEs.

Table 1: Family Child Care Home Characteristics

	Total FCCH Sample (n = 21)
FCCH Characteristics	
County location	n, %
San Francisco Bay Area	7 (33%)
Central Coast	7 (33%)
Central Valley	7 (33%)
Ages of children enrolled	n, %
Infants (younger than 1 year of age)	10 (48%)
Toddlers (1-2 years of age)	14 (66%)
Preschool (3 years of age to Pre-K)	16 (76%)
School Age	11 (52%)
Enrollment	mean (standard deviation, range)
Average number of children enrolled	10.43 (SD = 3.60, range = 5 to 18)
Average number of staff	mean (standard deviation, range)
	1.88 (SD = 0.70, range = 1 to 3)

Table 2: Family Child Care Home Director Demographics

	Total FCCH Sample (n = 21)
FCCH Director Demographics	
Directors' highest level of education	*n* (%)
Some College	8 (38%)
Associates Degree	6 (30%)
Bachelors' degree	4 (19%)
Masters' degree or higher	3 (14%)
ECE Experience	Mean (standard deviation, range)
Directors' years of ECE experience	15.38 (11.01, range = 1 to 28 years)

Table 3: Health and Safety Checklist (HSC) section and subscale average scores and internal consistency.
* Items are scored using a Likert scale ranging from 1 to 4.

Sections and Subscales	#FCCH	Mean (SD)*	#Items	Cronbach's Alpha Coefficient	#Items (alpha)
Section 1 FACILITIES: Emergencies, Medications, Equipment and Furnishings (Items 1-41)					
Emergencies	21	3.45 (0.44)	10	0.46	8
Medications	9	3.85 (0.34)	3	~	~
Equipment and Furnishings: Indoors and Outdoors	20	3.49 (0.41)	22	0.86	16
Equipment and Furnishings: Outdoors Only	19	3.36 (0.45)	6	0.28	6
Section 1 Total	21	3.44 (0.30)	41	0.7	29
Section 2 SUPERVISION: Interaction, Physical Activity, and Nutrition (Items 42-59)					
Supervision, Interaction, and Activity	20	3.90 (0.12)	11	0.04	6
Nutrition: Eating and Drinking	19	3.78 (0.21)	7	0.23	4
Section 2 Total	20	3.86 (0.12)	18	0.41	10
Section 3 SANITATION: Personal Hygiene, Food Safety/Food Handling, Environmental Health (Items 60-85)					
Personal Hygiene — Handwashing	20	2.97 (0.95)	5	0.79	5
Personal Hygiene — Tooth brushing	8	3.69 (0.46)	2	~	~
Food safety, Food handling	21	3.50 (0.63)	8	0.56	5
Environmental Health	20	3.50 (0.44)	11	0.48	9
Section 3 Total	21	3.41 (0.42)	26	0.74	17
Section 4 POOLS, SPAS and HOT TUBS (Items 86-88)					
Pools, Spas, and Hot Tubs	1	2.5	3	~	~
Section 4 Total	1	2.5	3	~	~
Section 5: INFANTS and TODDLERS: Personal Relationships, Diapering, Injury Prevention (Items 89-97)					
Infants and Toddlers — Personal Relationships	17	3.97 (0.12)	2	~	~
Infants and Toddlers — Diapering	17	2.03 (1.35)	2	0.98	2
Infants and/or Toddlers — Injury Prevention	17	3.63 (0.43)	5	0.47	4
Section 5 Total	17	3.42 (0.41)	9	0.59	7
Section 6: INFANTS ONLY: Activity, Sleep, Safety, Nutrition (Items 98-112)					
Infants Only — Activity, Sleep, Safety	8	3.61 (0.60)	9	0.71	3
Infants Only — Nutrition	7	3.43 (0.55)	6	0.61	2
Section 6 Total	*8*	3.58 (0.33)	15	0.19	5
Complete Checklist (Items 1–112)					
Checklist Total	*21*	3.50 (0.24)	112		

Table 4: Health and Safety Checklist (HSC) item average scores
* Items are scored using a Likert scale ranging from 1 to 4.
** n= the number of FCCHs

Item*	n**	Mean	SD
Section 1 FACILITIES: Emergencies, Medications, Equipment and Furnishings (Items 1-41)			
Emergencies			
1. A sign-in/sign-out system tracks who (other than children) enters and exits the facility. It includes name, contact number, purpose of visit (for example, parent/guardian, vendor, guest, consultant) and time in and out. (Std. 9.2.4.7)	20	3.1	1.29
2. Phone numbers to report child abuse and neglect (Child Protective Services) are clearly posted where any adult can easily see them. (Std. 3.4.4.1)	20	2.65	1.53
3. Phone number for the Poison Center is posted where it can be seen in an emergency (for example, next to the phone). (Stds. 5.2.9.1, 5.2.9.2)	20	2.3	1.49
4. Fire extinguishers are inspected annually. Check date on fire extinguisher tag. (Std. 5.1.1.3)	21	3.28	1.31
5. Each building or structure has at least two unobstructed exits leading to an open space at the ground floor. (Std. 5.1.4.1)	18	4	0
6. A smoke detector system or alarm in working order is in each room or place where children spend time. (Std. 5.2.5.1)	21	4	0
7. Carbon monoxide detectors are outside of sleeping areas. (Std. 5.2.9.5)	18	3.83	0.71
8. First aid supplies are well-stocked in each location where children spend time. (Std. 5.6.0.1)	21	3.95	0.22
9. First aid supplies are kept in a closed container, cabinet or drawer that is labeled. They are stored out of children's reach and within easy reach of staff. (Std. 5.6.0.1)	21	3.95	0.22
10. A well-stocked first aid kit is ready for staff to take along when they leave the facility with children (for example, when going on a walk, a field trip or to another location). (Std. 5.6.0.1)	17	3.6	0.87
Medications			
11. *Medications are stored in an organized fashion and are not expired. They are stored at the proper temperature, (for example, in the refrigerator or at room temperature according to instructions) out of children's reach and separated from food. (Std. 3.6.3.2)	8	3.88	0.35
12. *Over-the-counter medications are in the original containers. They are labeled with the child's name. Clear written instructions from the child's health care provider are with the medication. (Stds. 3.6.3.1, 3.6.3.2)	6	4	0
13. *Prescription medications are in their original, child resistant container, labeled with child's name, date filled, prescribing health care provider's name, pharmacy name and phone number, dosage, instructions and warnings. (Stds. 3.6.3.1, 3.6.3.2)	6	3.83	0.41
Equipment and Furnishings — Indoors and Outdoors			
14. There is fresh air provided by windows or a ventilation system. There are no odors or fumes (for example, mold, urine, excrement, air fresheners, chemicals, pesticides.) (Stds. 5.2.1.1, 3.3.0.1, 5.2.8.1)	19	3.89	0.46
15. Windows accessible to children open less than 4 inches or have window guards so that children cannot climb out. (Std. 5.1.3.2)	14	2.07	1.27
16. There are no unvented gas or oil heaters or portable kerosene space heaters. (Std. 5.2.1.10)	19	4	0

Item*	n**	Mean	SD
17. Gas cooking appliances are not used for heating purposes. Charcoal grills are not used indoors. (Std. 5.2.1.10)	18	4	0
18. Portable electric space heaters are not used with an extension cord and are not left on when unattended. They are placed on the floor at least three feet from curtains, papers, furniture and/or any flammable object and are out of children's reach. (Std. 5.2.1.11)	7	4	0
19. All electrical outlets within children's reach are tamper resistant or have safety covers attached by a screw or other means that cannot be removed by a child. (Std. 5.2.4.2)	18	3.67	0.77
20. All cords from electrical devices or appliances are out of children's reach. (Stds. 4.5.0.9, 5.2.4.4)	19	3.58	0.84
21. There are no firearms, pellet or BB guns, darts, bows and arrows, cap pistols, stun guns, paint ball guns or objects manufactured for play as toy guns visible. (Std. 5.5.0.8)	19	4	0
22. Plastic bags, matches, candles and lighters are stored out of children's reach. (Stds. 5.5.0.7, 5.5.0.6)	19	4	0
23. There are no latex balloons (inflated, underinflated, or not inflated) or inflated objects that are treated as balloons (for example, inflated latex gloves) on site. (Stds. 6.4.1.5, 6.4.1.2)	19	4	0
24. Bathtubs, buckets, diaper pails and other open containers of water are emptied immediately after use. (Std. 6.3.5.2)	13	3.7	0.85
25. Children do not play in areas where there is a body of water unless a caregiver/teacher is within an arm's length providing "touch supervision". Bodies of water include tubs, pails, sinks, toilets, swimming pools, ponds, irrigation ditches and built-in wading pools. (Std. 2.2.0.4)	9	3.67	1
26. Hot liquids and food (more than 120°F) are kept out of children's reach. Adults do not consume hot liquids in child care areas. (Std. 4.5.0.9)	19	3.89	0.32
27. Equipment and play areas (including water play areas) do not have sharp points or corners, splinters, glass, protrusions that may catch a child's clothing (for example, nails, pipes, wood ends, long bolts), flaking paint, loose or rusty parts, small parts that may become detached or present a choking, aspiration, or ingestion hazard, strangulation hazards (for example, straps or strings), or components that can snag skin, pinch, or sheer or crush body tissues. (Stds. 5.3.1.1, 6.2.1.9, 6.3.1.1)	18	3.5	0.86
28. All openings in play or other equipment are smaller than 3.5 inches or larger than 9 inches. There are no rings on long chains. (Stds. 6.2.1.9, 5.3.1.1)	19	3.42	0.84
29. All openings in play or other equipment are smaller than 3/8 of an inch or larger than 1 inch. (Std. 6.2.1.9)	19	3.47	0.84
30. Climbing equipment is placed over and surrounded by a shock-absorbing surface. Loose fill materials (for example, sand, wood chips) are raked to maintain proper depth/distribution. Unitary shock-absorbing surfaces meet current ASTM International standards and/or CPSC Standards. http://www.astm.org/Standards/F2223.htm http://www.cpsc.gov//PageFiles/122149/325.pdf (Std. 6.2.3.1, Appendix Z)	11	1.64	1.03
31. Fall zones extend at least six feet beyond the perimeter of stationary climbing equipment. (Std. 6.2.3.1)	13	2.08	1.44

Item*	n**	Mean	SD
32. Equipment and furnishings are sturdy and in good repair. There are no tip-over or tripping hazards. (Std. 5.3.1.1)	18	3.17	1.15
33. There is no hazardous equipment (for example, broken equipment, lawn mowers, tools, tractors, trampolines) accessible to children. (Std. 5.7.0.4, 6.2.4.4)	19	3.84	0.69
34. Open sides of stairs, ramps, porches, balconies and other walking surfaces, with more than 30 inches to fall, have guardrails or protective barriers. The guardrails are at least 36 inches high. (Std. 5.1.6.6)	14	2.93	1.33
35. Children one year of age and older wear helmets when riding toys with wheels (for example, tricycles, bikes) or using any wheeled equipment (for example, rollerblades, skateboards). Helmets fit properly and meet CPSC standards. Children take off helmets after riding or using wheeled toys or equipment. (Std. 6.4.2.2)	5	1.8	0.84
Equipment and Furnishings — Outdoors Only			
36. Children play outdoors each day. Children stay inside only if weather poses a health risk (for example, wind chill factor at or below minus 15°F, heat index at or above 90°F). (Std. 3.1.3.2)	17	3.82	0.53
37. Outdoor play areas are enclosed with a fence or natural barriers that allow caregivers/teachers to see children. Openings in fences and gates are no larger than 3.5 inches. (Std. 6.1.0.8)	19	3.84	0.69
38. Enclosures outside have at least two exits, one being remote from the building. (Std. 6.1.0.8)	18	2.94	1.4
39. Each gate has a latch that cannot be opened by children. Outdoor exit gates are equipped with self-closing, positive latching closure mechanisms that cannot be opened by children. (Std. 6.1.0.8)	16	3.31	1.2
40. Shade is provided outside (for example, trees, tarps, umbrellas). Children wear hats or caps with a brim to protect their faces from the sun if they are not in a shaded area. (Std. 3.4.5.1)	18	3.17	1.5
41. Broad spectrum sun screen with SPF of 15 or higher is available for use. (Std. 3.4.5.1)	18	3	1.46
Section 2: SUPERVISION: Interaction, Physical Activity, and Nutrition (Items 42-59)			
Interaction and Physical Activity			
42. Child/Staff Ratios of children observed (Indoors) (Std. 1.1.1.2) For Family Child Care Programs, see CFOC3 (Stds. 1.1.1.1, 1.1.1.2)	14	3.71	0.825
43. Child/Staff Ratios of children observed (Outdoors) (Std. 1.1.1.2) For Family Child Care Programs, see CFOC3 (Stds. 1.1.1.1, 1.1.1.2)	3	4	0
44. Caregivers/Teachers directly supervise children by sight and hearing at all times. This includes indoors, outdoors and when children are sleeping, going to sleep or waking up. (Std. 2.2.0.1)	19	3.9	0.32
45. Caregivers/Teachers encourage positive behavior and guide children to develop self-control. Caregivers/Teachers model desired behavior. "Time out" is only used for persistent, unacceptable behavior. (Std. 2.2.0.1)	19	3.95	0.23

Item*	n**	Mean	SD
46. Caregivers/Teachers support children to learn appropriate social skills and emotional responses. There are daily routines and schedules. (Std. 2.2.0.6)	19	4	0
47. There is no physical or emotional abuse or maltreatment of a child. There is no physical punishment or threat of physical punishment of a child. (Std. 2.2.0.9)	19	4	0
48. Caregivers/Teachers do not use threats or humiliation (public or private). There is no profane or sarcastic language. There are no derogatory remarks made about a child or a child's family. (Std. 2.2.0.9)	19	3.95	0.23
49. Children are not physically restrained unless their safety or that of others is at risk. (Std. 2.2.0.10)	19	4	0
50. Physical activity/outdoor time are not taken away as punishment. (Std. 2.2.0.9)	19	4	0
51. Children engage in moderate to vigorous physical activities such as running, climbing, dancing, skipping and jumping. All children (including infants) have opportunities to develop and practice gross motor and movement skills. (Std. 3.1.3.1)	18	3.94	0.24
52. There are structured or adult-led physical activities and games that promote movement for children. (Std. 3.1.3.1)	16	3.31	0.87
Nutrition			
53. Individual children's food allergies are posted where they can be seen in the classroom and wherever food is served. (Std. 4.2.0.10)	7	2.71	1.6
54. Children two years of age and older are served skim or 1% milk. (Std. 4.9.0.3)	18	3.67	0.97
55. Drinking water is available, indoors and outdoors, throughout the day for children over six months of age. (Std. 4.2.0.6)	19	3.58	0.84
56. A variety of nourishing foods is served at meals and snacks. Nourishing foods include fruits, vegetables, whole and enriched grains, protein and dairy. (Std. 4.2.0.3)	17	3.82	0.39
57. Foods that are choking hazards are not served to children under four years of age. This includes hot dogs and other meat sticks (whole or sliced into rounds), raw carrot rounds, whole grapes, hard candy, nuts, seeds, raw peas, hard pretzels, chips, peanuts, popcorn, rice cakes, marshmallows, spoonfulls of peanut butter or chunks of meat larger than can be swallowed whole. (Std. 4.5.0.10)	18	4	0
58. Children are always seated while eating. (Std. 4.5.0.10)	19	4	0
59. Food is not used or withheld as a bribe, reward or punishment. (Std.2.2.0.9)	18	4	0
Section 3 SANITATION: Personal Hygiene, Food Safety/Food Handling, Environmental Health (Items 60-85)			
Personal Hygiene — Handwashing			
60. Situations or times that children and staff should perform hand hygiene are posted in all food preparation, hand hygiene, diapering and toileting areas. (Std.3.2.2.1)	18	2.39	1.42
61. Handwashing Procedures — *Staff (Std. 3.2.2.2)*	18	2	1.32
62. Handwashing Procedures — *Children (Std. 3.2.2.2)*	18	3	1.37

Item*	n**	Mean	SD
63. Caregivers/Teachers help children wash their hands when children can stand but cannot wash their hands by themselves. Children's hands hang freely under the running water either at a child level sink or at a sink with a safety step. (Std. 3.2.2.3)	18	3.78	0.73
64. Adults and children only use alcohol-based hand sanitizers as an alternative to handwashing with soap and water if hands are not visibly soiled. Hand sanitizers are only used for children over 24 months with adult supervision. (Stds. 3.2.2.2, 3.2.2.3)	5	3.8	0.45
Personal Hygiene — Toothbrushing			
65. When toothbrushes are present, they are not worn or frayed. Fluoride toothpaste is present. (Std. 3.1.5.1)	8	3.5	0.76
66. *Except in the case of children who are known to brush their teeth twice a day at home, caregivers/ teachers brush children's teeth or monitor tooth brushing activities at least once during the hours that the child is in child care. (Std. 3.1.5.1)	7	4	0
Food Safety/Food Handling			
67. The food preparation area of the kitchen is separate from eating, play, laundry, toilet, bathroom and diapering areas. No animals are allowed in the food preparation area. (Std. 4.8.0.1)	19	3.53	1.12
68. The food preparation area is separated from child care areas by a door, gate, counter or room divider. (Std. 4.8.0.1)	19	2.58	1.54
69. There is no home-canned food or food in cans without labels. Food from dented, rusted, bulging or leaking cans is not used. (Std. 4.9.0.3)	17	4	0
70. Meat, fish, poultry, milk and egg products are refrigerated or frozen before use. Refrigerators have a thermometer and are kept at 41°F or lower. (Std. 4.9.0.3)	16	3.63	1.02
71. Meat product labels state they are from government-inspected sources and/or dairy product labels state that they are pasteurized. (Std. 4.9.0.3)	14	3.93	0.27
72. All fruits and vegetables are washed thoroughly with water prior to use. (Std. 4.9.0.3)	5	4	0
73. Store bought fruit juice labels state the juice is pasteurized. Fruit and vegetable juices squeezed on-site are squeezed just prior to serving. (Std. 4.9.0.3)	3	4	0
74. Food surfaces (for example, dishes, utensils, dining tables, high chair trays, cutting boards) and/or objects intended for the mouth (for example, pacifiers and teething toys) are sanitized. A dishwasher is used or an EPA registered sanitizer is used according to label instructions for sanitizing. (Std. 3.3.0.1)	19	3.74	0.56
Environmental Health			
75. Kitchen equipment is clean and in working order. Food surfaces are in good repair and free of cracks and crevices. Food surfaces are made of non-porous, smooth material and are kept clean and sanitized. (Std. 4.8.0.3)	18	3.83	0.38
76. There are no cracks or holes in walls, ceilings, floors or screens. (Std. 5.2.8.1)	19	3.57	0.61
77. There is no clutter, trash, water damage or standing water. Leaking pipes and pest breeding areas are not on site. (Std. 5.2.8.1)	19	3.63	0.76
78. Objects and surfaces are kept clean of dirt, debris and sticky films. (Std. 3.3.0.1)	19	3.84	0.37

Item*	n**	Mean	SD
79. Hard, non-porous surfaces soiled with potentially infectious body fluid (for example, toilets, diaper changing tables, blood spills) are disinfected. An EPA registered disinfectant is used according to label instructions. (Std. 3.3.0.1)	12	3.25	1.22
80. There are disposable gloves available for handling blood and blood containing body fluids. (Std. 3.2.3.4)	19	3.53	1.12
81. *Infectious waste (for example soiled diapers, blood) and toxic waste (for example, used batteries, fluorescent light bulbs) are stored separately from other waste. (Stds. 5.2.7.6, 5.2.9.1)	9	3.67	1
82. Sanitizing and disinfecting are not done when children are nearby. (Std. 3.3.0.1)	11	3.45	1.21
83.*Pesticides are not applied when children are present. (Std. 5.2.8.1)	17	4	0
84. *Toxic substances are stored in the original, labeled containers. Safety Data Sheets (SDS) are on site for each toxic substance/chemical. (Std. 5.2.9.1)	5	2.8	1.64
85. *Toxic substances are inaccessible to children and in a locked room or cabinet. Bleach solutions are labeled with contents and date mixed. (Stds. 5.2.9.1, 5.2.8.1, 3.2.3.4, Appendix J)	18	3	1.33
Section 4 POOLS, SPAS and HOT TUBS (Items 86-88)			
Pools, Spas, and Hot Tubs			
86. Ratios: Ages of children observed (Pools/Spa/HotTub) (Std. 1.1.1.5)	0	~	~
87. All outdoor water hazards are enclosed with a fence at least 4-6 feet high that comes within 3½ inches from the ground. Exits and entrances around bodies of water have self-closing, positive latching gates or doors. The locking devices are a minimum of 55 inches from the ground or floor. (Stds. 6.1.0.6, 6.3.1.1)	1	4	~
88. When not in use, in-ground and above-ground swimming pools, spas, hot tubs or wading pools are covered with a safety cover. The cover meets the ASTM International standards. (Std. 6.3.1.4)	1	1	~
Section 5: INFANTS and TODDLERS: Personal Relationships, Diapering, Injury Prevention (Items 89-97)			
Infants and Toddlers — Personal Relationships			
89. Caregivers/Teachers smile, talk, touch, hold, sing and/or play with children during daily routines, such as diapering, feeding and eating. (Std. 2.1.2.1)	17	3.94	0.24
90. Caregivers/Teachers comfort children who are upset. Caregivers/Teachers are aware of and respond to children's feelings. (Std. 2.1.2.1)	17	4	0
Infants and Toddlers — Diapering			
91. Caregivers/Teachers follow diaper changing procedures (Stds. 3.2.1.4, 3.2.3.4)	9	2.33	1.41
92. Current diaper changing procedures as listed in item #91 are posted in the diaper changing area(s). (Std. 3.2.1.4)	17	1.94	1.39
Infants and/or Toddlers — Injury Prevention			

Item*	n**	Mean	SD
93. Strings, cords, ribbons, ties and straps long enough to encircle a child's neck are out of children's reach. (Std. 3.4.6.1)	17	3.82	0.73
94. The following are not within children's reach: small objects, toys, and toy parts that have a diameter less than 11⁄4 inch and a length between 1 inch and 21⁄4 inches; balls and toys with spherical, egg shaped, or elliptical parts that are smaller than 13⁄4 inches in diameter; toys with sharp points and edges; plastic bags; Styrofoam® objects; coins; rubber or latex balloons; safety pins; marbles; magnets; foam blocks, books, or objects; latex gloves; bulletin board tacks or glitter. (Std. 6.4.1.2)	17	3.53	0.72
95. Securely installed guards (for example, gates) are at the top and bottom of each open stairway where infants and toddlers are in care. (Std. 5.1.5.4)	12	2.58	1.38
96. Children over 12 months of age who can feed themselves are actively supervised by a caregiver/teacher. The caregiver/teacher is within arm's reach of the child's high chair or feeding table or is seated at the same table. (Std. 4.5.0.6)	15	4	0
97. Foods that are choking hazards are not served to toddlers. Food for toddlers is served in pieces 1⁄2 inch or smaller. (Std. 4.5.0.10)	15	3.93	0.26
Section 6: INFANTS ONLY: Activity, Sleep, Safety, Nutrition (Items 98-112)			
Infants Only — Activity, Sleep, Safety			
98. Sunscreen is not applied to infants younger than six months. Infants younger than six months are not in direct sunlight. (Std. 3.4.5.1)	2	4	0
99. Infants have supervised tummy time while awake at least once each day. (Std. 3.1.3.1)	2	4	0
100. Infants are not seated more than 15 minutes at a time except during meals. (Std. 3.1.3.1)	7	3.29	0.76
101. All infants are placed to sleep on their backs, in a crib, on a firm mattress, with a tightly fitting sheet. Only one infant is placed in each crib. (Std. 3.1.4.1)	5	4	0
102. Soft or loose bedding and other objects are kept away from sleeping infants and are not in safe sleep environments (for example, not in cribs). This includes bumpers, pillows, positioners, blankets, quilts, bibs, diapers, flat sheets, sheepskins, toys and stuffed animals. One-piece blanket sleepers may be used for warmth. (Std. 3.1.4.1)	7	3.43	1.13
103. The room temperature where infants sleep is comfortable for a lightly clothed adult. (Std. 3.1.4.1)	8	4	0
104. Infants who fall asleep any place that is not a crib are moved and placed to sleep on their backs in a crib. Examples of places where infants may not be left to sleep are car seats, high chairs, swings, infant seats, beanbag chairs and futons. (Std. 3.1.4.1)	3	4	0
105. *Cribs meet the current guidelines approved by CPSC and ASTM International standards. Crib slats are spaced no more than 2 3/8 inches apart. The crib has a firm mattress that is fitted so that no more than two fingers can fit between the mattress and the crib side in the lowest position. Cribs with drop sides are not used. Cribs are placed away from window blinds or draperies. (Std. 5.4.5.2)	7	3.57	1.13

Item*	n**	Mean	SD
106. Infants mobile enough to potentially climb out of a crib sleep on cots or mats. (Std. 5.4.5.2)	4	3.25	1.5
Infants Only — Nutrition			
107. Bottles or containers with mother's milk are labeled with the infant's full name, date and time the milk was expressed. Mother's milk is stored in the refrigerator or freezer. (Std. 4.3.1.3)	2	3	1.41
108. Bottles of formula prepared from powder or concentrate or ready-to-feed formula are labeled with the child's full name and the time and date of preparation. (Std. 4.3.1.5)	5	2	1.41
109. If caregivers/teachers warm bottles and infant foods, bottles are warmed under running warm tap water or by placing in a container of water no warmer than 120°F. Bottles and infant foods are not thawed or warmed in microwave ovens. The temperature of warmed milk does not exceed 98.6 F. (Stds. 4.3.1.3, 4.3.1.9)	6	3.5	1.22
110. Infants are not fed solid foods sooner than four months of age (preferably six months of age). Introductory foods are single ingredient. (Std. 4.3.1.11)	2	4	0
111. Infants who are learning to feed themselves are actively supervised by a caregiver/teacher. Infants are seated within arm's reach of caregiver/teacher at all times while being fed or eating. (Std. 4.5.0.6)	3	4	0
112. Foods that are choking hazards are not served to infants. Food for infants is served in pieces 1⁄4 inch or smaller. (Std. 4.5.0.10)	5	4	0

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Chapter 5

Discussion and Conclusion

Discussion

Well-documented increases in maternal employment rates over the past 40 years and the corresponding increases in non-maternal care experienced by children have led to concerns about the impact of child care on children's development. The gap in knowledge regarding (1) a consensus understanding of the risk of asthma among children who attend ECE, (2) the differences in pesticide use among child care centers located in agricultural compared to other regions of California, and (3) the feasibility of assessing national health and safety standards in FCCHs is addressed in this dissertation. The findings from the three studies in this dissertation offer new contributions to the field of ECE, nursing and pediatrics.

Parents' decisions regarding when to enroll their children in ECE program and what type of program are influenced by many factors including work arrangements, financial constraints, cultural preferences and availability of placement in ECE programs (Pungello & Kurtz-Costes, 1999; NICHD 2003). In addition, one of the main health concerns of parents is childhood asthma (Garbutt et al., 2012). The findings from the first study provide evidence for pediatric providers to reassure parents that attendance in ECE does not increase children's odds of having a diagnosis of asthma in childhood. Specifically, the findings from this study show that even though children who attend ECE before 12 months of age have a higher odds of wheezing up to 2 years of age, they have a slightly lower odds of a diagnosis of asthma between the 3 to 5 years of age. However, the effect of ECE attendance before 12 months of age was not sustained among older children. The meta-analysis of 32 studies found no association between ECE attendance before 12 months of age and asthma diagnosed after 6 years of age.

The findings of the second study highlight the environmental health disparities among children attending ECE programs in the Central Valley in California compared to other non-agricultural regions. Specifically, there is a higher prevalence of pesticide use among ECE programs in California's Central Valley compared to two other regions of California with less agricultural farmlands. Congruent with findings of pesticide use in California's Central Valley was the lack of knowledge of IPM among the ECE director in this region. It is well-established that agricultural communities are at higher risk for pesticide exposure and there is a high proportion of Latinx children in agricultural regions. The findings from this study suggest that policy and program interventions are needed to improve the dissemination IPM knowledge to improve the awareness of pesticide exposures and the need for IPM among ECE providers particularly in agricultural regions.

Recently, the California Department of Pesticide Regulation (CDPR) established a regulation to reduce pesticide application and drift by creating pesticide spray-free buffer zones around schools and ECE facilities (CDPR, 2017). However, this restriction only limits the spraying of pesticides within a quarter mile of an ECE facility during the day (Monday thru Friday, 6:00am – 6:00pm), which may not be sufficient to fully prevent the drift of pesticides to nearby ECE facilities. Further research is needed to evaluate the impact of this new regulation.

The third study demonstrates the feasibility and validity of the HSC used in FCCHs. In the U.S. FCCHs have less stringent state licensing regulation (Slining et al., 2014) compared to child care centers. However, the sample of FCCHs in this study had overall high scores on the HSC that were comparable to the application of the HSC in child care centers (Alkon et al., 2016). In both ECE settings the HSC identified that national health and safety standards (AAP, 2011) for personal hygiene practices like handwashing and diapering were not being met. This demonstrates areas for intervention and teaching among ECE providers, as these practices might possibly impact the spread of communicable infections that are already present in ECE settings.

The finds from this dissertation have particular implications for pediatric public health nurses. In particular, interventions led by nurses trained as Child Care Health Consultants (CCHCs), are highly effective at improving health and safety policy and practices in ECE programs. (Alkon et al., 2009; Crowley and Kulikowich, 2009; Johnston et al., 2017). In a recent randomized control trial of 17 child care centers across California, Connecticut, and North Carolina that were given a nutrition and physical activity intervention (NAP SACC) led by nurse CCHCs, there were increased ECE provider nutrition knowledge, improved the child care center's policies, and lowered BMIs for children in the intervention versus control groups (n=9 child care centers) (Alkon et al., 2014). Additionally, another environmental health intervention led by nurse CCHCs was also shown to be effective at improving IPM knowledge and policy in child care centers located in California (Alkon et al., 2016).

Conclusion

The findings from this dissertation have implications for pediatric health care providers, ECE providers, and local or state ECE regulation agencies, and can contribute to ongoing research nationwide aimed at improving environmental health policy in ECE. One of the main implications for future research in ECE is the importance of including standardized measures of (1) ECE quality and (2) children's ECE exposure based on the amount of time children spend in the ECE setting being studied. Without these measures it is difficult to contextualize any health-related associations with ECE attendance or make comparisons across multiple ECE sites.

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